Attachments

A. Technical Specifications
B. CoGC Supplementary Mechanical & Electrical Specification
C. CoGC Supplementary Trenchless Specification
D. Standard Drawings and Specifications
A. Technical Specifications
PART A. Technical Specifications

1. Pipework – General

All work and materials must be in accordance with the current South East Queensland Water Supply Design and Construction Code specifications and standards.

Pipework and fittings must comply with the requirements of Section 20 in CoGC Supplementary Mechanical & Electrical Specification - refer Attachment B and Council’s Accepted Civil Products and Materials list.

Above ground marker posts must be provided in accordance with CoGC standard drawing 05-02-601 at:

- Either end of HDD sections/river crossings,
- Either end of major road crossings,
- Scour valves, gas release and isolation valves (valve marker posts).

Detectable marker tape must be provided either above the embedment zone or 1000mm below the Finished Surface Level (FSL), whichever is closest to the FSL, for pipes laid in trenches.

Ductile Iron pipe and fittings must be PN16 and coated internally and externally with a fusion bonded epoxy (FBE). Must be manufactured and tested in accordance with AS/NZ2280 and be:

- PN 20 for pipe $\geq$225mm nominal diameter unless pressure requirements dictate PN 35 pipework;
- PN 35 for pipe <225mm nominal diameter or where pressure requirements so dictate.

Ductile iron fittings must be manufactured and tested in accordance with AS/NZ2280. Fittings for use underground must, as a minimum, be coated externally with a bituminous compound in accordance with AS/NZS2280.

Mild Steel pipes and fittings must be externally coated with a Medium Density Fusion Bonded Epoxy coating (Sintakote or equivalent), and internally lined with a Fusion Bonded Epoxy lining (Sintaline or equivalent) or Calcium Aluminate Cement lining (12mm thick), as nominated on the drawings.

Polyethylene pipes and fittings must be PE100 PN16 SDR 11 and/or PN20 SDR 9 (cream stripe pipe).

Stainless steel pipes and fittings must be Grade 316.

Flanges must be raised face, PN16 to AS 4087.

Buried flanged joints must be Denso wrapped.

Flange bolts and nuts must be Stainless Steel Grade 316 Class 50.

Bolt tightening torque values for flanges must be in accordance with pipe manufacturer’s recommendations.

Elastomeric gaskets (3mm thick) to be used.

Gibault Joints
Only elongated gibault joints with a fusion bonded polymeric coating must be used in the Works. They must be reviewed by the Superintendent and must be in accordance with the Supplementary Mechanical and Electrical Specification (Specifications: Part E1).

**Dismantling Joints**

Dismantling joints must be Class PN16, either thrust type or non-thrust type depending on the pipeline arrangement. They must be manufactured from ductile iron with natural rubber seals to AS1646. The ductile iron components must be epoxy painted in accordance with the Supplementary Mechanical and Electrical Specification (Specifications: Part E1).

**Butt Welded Joints**

Pipe welding must be performed in accordance with the pipe manufacturer’s recommendations and the pipe weld testing requirements below. Only trained and factory certified welders must undertake the butt welded jointing of PE pipelines. The Contractor must submit the proposed procedures to the Superintendent for approval prior to commencing work and all welding must conform with the procedure reviewed by the Superintendent. A proposed procedure must be submitted for each pipe diameter and wall thickness and must contain at least the following items:

- The welding parameters to be used;
- The welding equipment to be used;
- The name of the certified welder;
- The standard cooling time;
- A demonstration weld for each welding machine, pipe diameter, wall thickness and material type with a record of the parameter valves for each weld;
- The test results confirming the specification strength requirements;
- A test sampling plan to demonstrate ongoing quality; and
- Retention of QA records for each weld, numbered and located on a plan.

**Electrofusion Coupling Joints**

For PE pipework systems utilising electrofusion fittings such as tees, bends and flanged stubs, all pipe joints must be made using approved electrofusion fittings. In jointing a pipe with a fitting, the pipe’s square cut face must be lightly bevelled and the external joint end of the pipe thoroughly scraped and cleaned before jointing. It is recommended that the pipe and fitting be restrained during the fusion process. The manufacturer’s recommendations for fusion jointing must be followed and care taken to ensure that the fusion process is not carried out while the pipe and fitting are above the recommended ambient air temperature for effective joint fusion. The recommended cooling time must be allowed to occur before the joint restraints are removed and pipe laying continues. Each pipe joint must be checked to ensure correct assembly and records of each electrofusion joint must be kept. Electrofusion couplings cannot be used for any pipework installed underwater or buried in a marine environment. Oxidised material must be removed from the outside of the pipe before each coupling is applied to the pipe.

Pipe spigot and socket welding is not permitted.
The Contractor must submit the proposed procedures to the Superintendent for approval prior to commencing work and all welding must conform with the procedure reviewed by the Superintendent. A proposed procedure must be submitted for each pipe diameter and wall thickness and must contain at least the following items:

- The welding parameters to be used;
- The standard fusion time;
- The standard cooling time;
- The welding equipment to be used;
- The details of the control box;
- The name of the certified welder;
- A demonstration weld for each welding machine, pipe diameter and wall thickness with a record of the parameter value for each weld;
- Test results confirming the specification strength requirements;
- A test sampling plan to demonstrate ongoing quality; and
- Retention of QA records for each weld, numbered and located on a plan.

All PE pipework welding inspection must be carried out by a person who holds current welding inspection certification issued by the PE manufacturers, or an equivalent accredited group. The welding service provider must provide an inspection and test plan for the intended welding work, ten working days prior to commencement of the work. The test plan must contain the necessary elements to assure the completed welding work complies with the standards/codes. For all welded joints in PE pipework, the joints must be:

- Tested if pipe strings are part of the scope of the Works to the pressure rating of the pipeline at the pipe string assembly area
- Tested after assembly and before sinking or burying if the Works involves assembling pipe strings into completed pipelines in the field

The welding service provider must maintain accountable testing records for all weld testing and provide the records upon request, including test records on heating and compression times of all butt welds.

2. **Pipework – Valves & Actuators**

All valves must comply with Section 21 in CoGC Supplementary Mechanical & Electrical Specification - refer Attachment B and Council’s Accepted Civil Products and Materials list.

Sluice valves must be anticlockwise closing resilient seated with FBE coating and integrated bypass valve.

Gas Release Valves must be ‘SMART’ valves or equivalent.

Ball valves must be Stainless Steel Grade 316.
Valve actuators must be 240V AC single phase Rotork IQ type with Modbus interface for information and hard wired controlled, in accordance with Section 23 CoGC Supplementary Mechanical & Electrical Specification - refer Attachment B.

3. **Excavation & Backfilling**

   Trenching must comply with AS 2566.2 unless otherwise noted.

   Embedment material must comply with AS 1141 and be compacted to 70% density index.

   Unless noted otherwise on the drawings, minimum cover must be 1000mm.

   Provision must be made for de-watering where trenches are inundated with groundwater or rainwater. Where Acid Sulfate Soils (ASS) are encountered, groundwater must be treated in accordance with the guidance provided in the ASCMP.

   For concrete structures and thrust blocks, the bottom of the excavation must remain in undisturbed condition and be suitable for the concrete face. The minimum bearing pressure must be 100 kPa.

   All excavations must be made secure against movement by means of stable batters, benching, timber.

   No soil must be stockpiled within 5m of the adjacent waterway. Appropriate sedimentary controls must be sheet piling or protective shields used to prevent sediment from entering adjacent waterways.

   Topsoil and subsoil must be stockpiled separately.
B. CoGC Supplementary Mechanical & Electrical Specification
SEWERAGE NETWORK
WATER SUPPLY NETWORK

SUPPLEMENTARY MECHANICAL & ELECTRICAL SPECIFICATION

Date: September 2016 V1.02
Version History

<table>
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<th>Version</th>
<th>Change</th>
<th>Changed by</th>
<th>Reviewed by &amp; date</th>
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<tr>
<td>0.01</td>
<td>Initial Draft</td>
<td>Lewis Wells</td>
<td>Lewis Wells 26/7/2013</td>
</tr>
<tr>
<td>0.02</td>
<td>Draft for Approval</td>
<td>Lewis Wells</td>
<td>Lewis Wells 1/8/13</td>
</tr>
<tr>
<td>1.00</td>
<td>Approved</td>
<td>Lewis Wells</td>
<td>Chris Gripton 17/2/14</td>
</tr>
<tr>
<td>1.01</td>
<td>2016 Revision</td>
<td>Lewis Wells</td>
<td>Lewis Wells</td>
</tr>
<tr>
<td>1.02</td>
<td>Clause 34.3.4 &amp; 35.3 Amended, Appendix C revised</td>
<td>Lewis Wells</td>
<td>Lewis Wells 20/9/16</td>
</tr>
</tbody>
</table>

Version naming convention is V.RR where V is version and RR is release. For draft versions use V.RR=0.00, 0.01 etc. At approval use V.RR=1.00. Subsequently, for minor releases index RR by +1. For major releases index V by +1 and reset RR to 00.

Document owner: Coordinator Electrical Engineering

Approved by: Executive Coordinator Mechanical Electrical Services

Key stakeholders: Asset Solutions Project Managers, PE&T City Development, System Control, Service Sustainability

Application: All branches of GCW

Next review date: June 2017
WATER NETWORK AND SEWERAGE NETWORK
SUPPLEMENTARY MECHANICAL AND ELECTRICAL SPECIFICATION

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1 SCOPE

1.1 General

The Water Service Provider (SEQ-SP) applicable to this Supplementary Mechanical and Electrical Specification (hereafter referred to as the/this Supplementary Specification) is the “City of Gold Coast” (the Principal). Where a reference is made in any document or on any drawing to “Gold Coast Water” or GCW, it shall be taken as a reference to City of Gold Coast.

“The Principal” means the City of Gold Coast a local government within the meaning of the Local Government Act 2009;

This Supplementary Specification shall be read in conjunction with the current version of the Sewage Pumping Station Code of Australia, SEQ Water Supply and Sewerage Design & Construction Code (SEQ-SPS Code). This Supplementary Specification shall take precedence on any requirements that conflict with the code.

This Supplementary Specification covers the detailed design for the supply and/or fabrication of the components, procurement, fabrication, installation, and construction, commissioning and testing of mechanical and electrical components for sewerage network infrastructure and water network infrastructure as scoped in sub-clauses below.

The Glossary of Terms in the SEQ-SPS Code or any other relevant SEQ codes also applies to this Supplementary Specification with the exception of “Constructor” where “Contractor” and its derivatives have been used.

This Supplementary Specification applies to:

- Sewage Pumping Stations;
- Other Sewerage Network Infrastructure including Vacuum Sewage Pump Stations, network controlled valves, chemical injection stations etc.;
- Water Pumping Stations (specifically potable water);
- Other Water Supply Network Infrastructure including pressure boosting stations, reservoirs, chemical injection stations etc.;
- Recycled Water Pumping Stations (see Clause 1.2 below); and
- Other Recycled Water Supply Network Infrastructure including pressure boosting stations, reservoirs, chemical injection stations etc.

1.2 Recycled Water Pumping Stations

This Supplementary Specification shall also apply to the extent that it is relevant to recycled water pumping stations including those for Class A+, Class A, Class B, and Class C recycled water.

There is no differentiation in this Supplementary Specification between potable water pumping stations and recycled water pumping stations; they are all referenced as “water pumping stations” unless a specific requirement applies.

2 THE PRINCIPAL’s RESPONSES AND LIABILITY
2.1 Terminology

Reference in this Supplementary Specification to terms such as 'approval by PRINCIPAL’s Representative', or 'acceptance by the Principal’s Representative', or 'review by the Principal’s Representative', or 'consideration by the Principal's Representative' or 'endorsement by the Principal’s Representative' or the like in any tense of each term shall be taken by the Developer or the Developer’s Designer or the Contractor to mean 'acceptance by the Principal’s Representative' for the limitations that are detailed in Clause 2.2 of this Supplementary Specification.

The Principal requires the opportunity to review the information as the eventual owner of the asset and to consider the information in terms of the immediate, medium term and long term legacies that ownership brings.

2.2 Acceptance of Detailed Design Submittals and Project Deliverables

Acceptance by the Principal of any design report, detailed design drawing, fabrication or manufacturing drawing, any other project deliverables; proposed method of work or any information regarding materials and equipment which the Contractor proposes to supply and install, shall not relieve the Contractor of his responsibility for any errors or omissions therein, and shall not be regarded as an assumption of risks or liability by the City of Gold Coast, and the Contractor shall have no claim under the Contract or against the Principal on account of the failure or partial failure or inefficiency of any plan or method of work or material and equipment so accepted by the Principal's Representative.

Such acceptance shall be considered to mean that the Superintendent and the the Principal’s Representative have no objection to the Developer, or the Developer's Designer, or the Contractor using, upon their own full responsibility, the plan or methods of work proposed or supplying the materials and equipment proposed.

Acceptance of the Developer's, or the Developer's Designer's, or the Contractor's drawings shall not relieve the Developer, or the Developer’s Designer, or the Contractor of their full responsibility to comply with the requirements of the Contract Drawings and specifications and the requirements of the Principal whether detailed in this Supplementary Specification or elsewhere.

In accordance with AS2124, the Superintendent is not a party to the contract; he is a person named in the contract by the two parties to the contract (the Proprietor and the Contractor) and given certain functions under that contract by those two parties.

The role of the Superintendent would usually include:-

• assessment of progress claims and issue of progress certificates;
• assessment of claims for extra payment for variations to the contract;
• assessment of claims for extension of time;
• assessment of quality of materials and workmanship in accordance with the contract documents; and
• assessment of claims for extra payment (such as claims under the latent conditions provisions) under the contract.

Accordingly, though the Superintendent is usually appointed by and paid by the Proprietor (and may sometimes be the Proprietor's original design consultant), the Superintendent’s role is principally to decide major issues of potential dispute under the contract between the Proprietor and the Contractor.

3 ASSET IDENTIFICATION

The Principal has developed a standard asset and equipment numbering and naming protocol which shall be applied throughout the Project. All assets, (components and items of equipment) shall be assigned to
WATER NETWORK AND SEWERAGE NETWORK

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a hierarchy and allocated numbers and Plain English Names according to the Principal’s standards as early in the design process as is practicable to ensure that they are referenced on all design drawings including P&IDs, general arrangement and detailed drawings, schematics, cable schedules, connection diagrams, in operational software (PLC and SCADA systems), on component and items of equipment labelling and in the Operations and Maintenance Manual. The adoption of any other numbering and naming system other than the Principal’s numbering and naming system is not permitted.

The Superintendent shall provide the Developer, the Contractor and/or the Developer’s Designer a “Facility Description” and “Asset Number” for all major and relevant components (assets) that are supplied and installed. The Contractor shall label each component where appropriate, and shall record the required details for each component including attribute data.

This information shall be forwarded to the Superintendent for on-forwarding to the Principal upon the commissioning of that particular component.

The above-mentioned process shall be conducted in accordance with the latest versions of the Principal’s QEMS procedures SD-22 “Asset Hierarchies and Numbering Definition”.

It is the Developer’s/Contractor’s responsibility to ensure asset numbers have been issued for labelling and reporting processes.

Any drawings, documents and other deliverables that do not follow the Principal’s numbering and naming convention will be rejected by the Principal.

4 PROJECT INFORMATION – DRAWINGS AND OTHER SUBMITTALS

The project information detailed in Clauses 5 to 13 of this Supplementary Specification shall be supplied to the Superintendent for on-forwarding to the Principal’s Representative. The timing of information hand over is detailed below.

At the completion of the project, City of Gold Coast will become the Copyright holder for all documentation (detailed design calculations, drawings, schedules, specifications and the like), PLC code and SCADA configuration produced specifically for the project.

5 DETAILED DESIGN AND DRAWING REQUIREMENTS

5.1 Detailed Design Extent

5.1.1 Sewage Pumping Stations

The Developer, the Contractor and/or the Developer’s Designer shall prepare the detailed design as required for all of the components that are included in the scope of the work for a sewage pumping station in accordance with the SEQ-Sewage Pumping Station Code, this Supplementary Specification and good engineering practice. The components shall include but not be limited to the following:

- Pump/s;
- Pipework including any automated valves and instruments;
- Pump well and manholes/access structures;
- Fabricated metalwork;
- Peak flow storage tanks or vessels;
- Valve pit and/or flowmeter pit;
- Equipment enclosure or building;
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- Lifting equipment including fixed cranes and/or davits;
- Odour management system;
- Any other ventilation or air-conditioning systems;
- Any chemical dosing systems (for odour management);
- All switchboards/motor load centres/motor control centres and control panels, including supporting frames and all other details necessary to obtain proper performance of each switchboard/motor control centre and control panel;
- All electrical cables including conduit systems;
- All electrical mains power supply components;
- Any standby electrical power supply components;
- All other site services including potable water supply; and
- Pumping station access roadway and site improvements.

5.1.2 Water Pumping Stations
The Developer, the Contractor and/or the Developer’s Designer shall prepare the detailed design as required for components that are included in the scope of the work for a water pumping station in accordance with the Principal’s requirements, this Supplementary Specification and good engineering practice.

The components shall include but not be limited to the following:
- Pump/s;
- Pipework including any automated valves and instruments;
- Any building foundations and/or slabs;
- Valve pit and/or flowmeter pit;
- Any chemical dosing systems;
- Equipment enclosure/s or building/s;
- Lifting equipment including fixed cranes and/or davits;
- Any ventilation or air-conditioning systems;
- All switchboards/motor load centres/motor control centres and control panels, including supporting frames and all other details necessary to obtain proper performance of each switchboard/motor control centre and control panel;
- All electrical cables including conduit systems;
- All electrical mains power supply components;
- Any standby electrical power supply components required under the scope of the works;
- All other site services including potable water supply; and
- Pumping station access roadway and site improvements.

5.2 Medium and Large Pumping Station Definition
The term ‘Medium and Large Pumping Stations’ is referenced in this document. This definition applies to delineate those pumping stations which typically have a building/s providing shelter to pumping equipment, or housing electrical switchgear and control gear, or housing odour management equipment, or providing an enclosure for some other process units or facility.

In some cases ‘Small Pumping Stations’ may also have a building/s providing shelter to pumping equipment, or housing electrical switchgear and control gear, or housing odour management equipment, or providing an enclosure for some other process units or facility.

### 5.3 Pumping Capacity Back-up/Standby Requirements

The Developer and the Developer’s Designer shall refer to the SEQ Water Supply and Sewerage Design & Construction Code for the requirements for back-up/standby pump units for water pumping stations and sewage pumping stations.

For a water pumping station, typically the normal requirement is for the Developer or the Contractor to supply and install ‘n+1’ pump units where ‘n’ pump units are capable of delivering the peak design flow and the additional unit shall be equal in size/capacity to the largest pump unit in the ‘n’ set. Satisfying the fire flow requirements may increase this requirement.

For a sewage pumping station, typically the normal requirement is for the Developer or the Contractor to supply and install ‘n+1’ pump units where ‘n’ pump units are capable of delivering the design flow (C1 x ADWF where 3.5 < or = C1 < = 5.0) and the additional unit shall be equal in size/capacity to the largest pump unit in the ‘n’ set. The ‘n+1’ pump units operating together shall deliver the peak wet weather flow.

### 5.4 Site Conditions

The Developer, the Contractor and/or the Developer’s Designer shall familiarise themselves with the site conditions including all requirements for access to plant and equipment.

These requirements shall be incorporated in the detailed design.

### 5.5 Access Requirements

All equipment shall be located and installed so that it will be readily accessible for operation and maintenance with adequate clearance without obstacles and/or trip hazards which could lead to subsequent slips, trips and falls.

The clearances shall be:

- 600 mm minimum measured in plan dimensions; and
- 2200 mm minimum in walkways around the facility.

Specific access requirements are further detailed subsequently in Parts 1 and 2 of this Supplementary Specification.

The Principal reserves the right to require changes in the location of equipment to achieve this requirement.

### 5.6 Safety

The Developer, the Contractor and/or the Developer’s Designer shall comply with all federal and state legislation on safety requirements as well as the requirements of all applicable Australian Standards.

These requirements shall be incorporated in the detailed design.
The Developer, the Contractor and/or the Developer’s Designer shall provide to the Superintendent full details of safety facilities included in the design to facilitate safe operation and maintenance of the Works for consideration by the Principal’s Representative. The submission of “Safety in Design Report” shall be provided.

5.7 Asset Design Lives

It is recognised that all water and sewerage systems have component parts with differing design lives. However, all water and sewage pumping stations shall be designed to have a nominal asset life of more than 80 years without the need for rehabilitation. It is recognised that some component parts of such systems will have shorter economic lives. Minimum design lives are set out in Table 5.1.

Table 5.1 Minimum Design Lives

<table>
<thead>
<tr>
<th>Item</th>
<th>Minimum Design Life (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pumps and Motors</strong></td>
<td></td>
</tr>
<tr>
<td>Pumps Large (&gt; 300 kW)</td>
<td>60</td>
</tr>
<tr>
<td>Pumps Medium (&gt; 20 kW and &lt; 300 kW)</td>
<td>40</td>
</tr>
<tr>
<td>Pumps Small (&lt; 20 kW)</td>
<td>20</td>
</tr>
<tr>
<td>Motors Large (&gt; 300 kW)</td>
<td>60</td>
</tr>
<tr>
<td>Motors Medium (&gt; 20 kW and &lt; 300 kW)</td>
<td>40</td>
</tr>
<tr>
<td>Motors Small (&lt; 20 kW)</td>
<td>20</td>
</tr>
<tr>
<td>Protective Paint Coatings – Cast Steel and Cast Iron</td>
<td>20</td>
</tr>
<tr>
<td><strong>Pipework and Ductwork</strong></td>
<td></td>
</tr>
<tr>
<td>Steel Cement Lined (SCL)</td>
<td>80</td>
</tr>
<tr>
<td>Cast Iron Cement Lined (CICL)</td>
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<td>Ductile Iron Cement Lined (DICL)</td>
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<tr>
<td>Polyvinyl Chloride (PVC)</td>
<td>80</td>
</tr>
<tr>
<td>Polyethylene (PE)</td>
<td>80</td>
</tr>
<tr>
<td>Fusion-Bonded Medium-Density Polyethylene (FBMDPE)</td>
<td>80</td>
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<tr>
<td>Polypropylene (PP)</td>
<td>80</td>
</tr>
<tr>
<td>Acrylonitrile Butadiene Styrene (ABS)</td>
<td>80</td>
</tr>
<tr>
<td>Glass Reinforced Plastic (GRP)</td>
<td>80</td>
</tr>
<tr>
<td>Protective Paint Coatings – Steel Pipe</td>
<td>20</td>
</tr>
<tr>
<td>Item</td>
<td>Minimum Design Life (years)</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>Protective Paint Coatings – PVC and ABS Pipe</td>
<td>20</td>
</tr>
<tr>
<td><strong>Valves</strong></td>
<td></td>
</tr>
<tr>
<td>Non-return Valves =&gt; DN300 mm</td>
<td>25</td>
</tr>
<tr>
<td>Non-return Valves &lt; DN300 mm</td>
<td>20</td>
</tr>
<tr>
<td>All Other Valves (accept as noted below) =&gt; DN300 mm</td>
<td>40</td>
</tr>
<tr>
<td>All Other Valves (accept as noted below) &lt; DN300 mm</td>
<td>30</td>
</tr>
<tr>
<td>Reduced Pressure Zone Valves</td>
<td>20</td>
</tr>
<tr>
<td>Pressure Reduction Valves</td>
<td>15</td>
</tr>
<tr>
<td>Solenoid Valves</td>
<td>15</td>
</tr>
<tr>
<td><strong>Process Vessels</strong></td>
<td></td>
</tr>
<tr>
<td>Grade 316 Stainless Steel</td>
<td>50</td>
</tr>
<tr>
<td>FRP/GRP/Plastic (PE/PP)</td>
<td>25</td>
</tr>
<tr>
<td><strong>Fabricated Metalwork</strong></td>
<td></td>
</tr>
<tr>
<td>Aluminium</td>
<td>80</td>
</tr>
<tr>
<td>Grade 316 Stainless Steel</td>
<td>80</td>
</tr>
<tr>
<td>Steel (coated with maintained coatings)</td>
<td>60</td>
</tr>
<tr>
<td>Protective Hot Dip Galvanising Coatings – Steel</td>
<td>20</td>
</tr>
<tr>
<td>Protective Duplex Galvanising Coatings – Steel</td>
<td>30</td>
</tr>
<tr>
<td><strong>Other Mechanical Equipment</strong></td>
<td></td>
</tr>
<tr>
<td>Compressors</td>
<td>15</td>
</tr>
<tr>
<td>Centrifugal Fans (Grade 316 Stainless Steel Casing and Impeller)</td>
<td>30</td>
</tr>
<tr>
<td>Centrifugal Fans (GRP/FRP Casing and Impeller)</td>
<td>30</td>
</tr>
<tr>
<td>Overhead Travelling Gantry Cranes</td>
<td>30</td>
</tr>
<tr>
<td>Manual Chain Hoists and Trolleys</td>
<td>15</td>
</tr>
<tr>
<td>Electric Chain Hoists and Trolleys</td>
<td>30</td>
</tr>
<tr>
<td>Passenger and Goods Lifts</td>
<td>50</td>
</tr>
<tr>
<td>Hydraulic Drive Systems</td>
<td>30</td>
</tr>
<tr>
<td>Chemical Storages Feeders and Hoppers</td>
<td>30</td>
</tr>
</tbody>
</table>
### Item

<table>
<thead>
<tr>
<th>Item</th>
<th>Minimum Design Life (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical Dosing Pumps</td>
<td>15</td>
</tr>
</tbody>
</table>

### Electrical Equipment

- Electrical Switchgear/Switchboards: 25 years
- Electrical Cabling: 35 years
- PLCs and Electronic Devices: 15 years
- Diesel Generators (Prime and Standby Rated): 40 years
- Fire Monitoring and Reporting Systems: 20 years
- Security Systems: 15 years
- Telecommunications Equipment: 10 years
- Fixed Radio Equipment: 10 years
- Instrumentation: 10 years

### Cathodic Protection

- Ground Beds: 10 years
- Bonding Cables: 80 years
- Electrical Systems: 20 years

### Fencing and Gates

- Security/Boundary including Gates: 30 years
- Motorised Gates: 20 years

### 5.8 Design Studies

The Developer, the Contractor and/or the Developer’s Designer shall undertake the following risk assessment procedures as part of the detailed design process for medium and large pump stations:

- Hazard Identification (HAZID) Study of each pumping station and all relevant associated components;
- Construction Hazard Analysis Implication Review (CHAIR) Study of each pumping station and all relevant associated components;
- Hazard and Operability (HAZOP) Study of each pumping station and all relevant associated components;
- Confined Spaces / Hazardous Area Study of each pumping station and all relevant associated components;
- Environmental Risk Assessment; and
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- Hazardous Substances Assessments.

The Contractor shall provide to the Superintendent full details of safety facilities included in the design to facilitate safe operation and maintenance of the Works for consideration by the Principal as per Clause 5.6.

The Developer, the Developer’s Designer or a specialist engaged by either of these two parties shall physically undertake a radio signal strength study between the proposed site of each pumping station and the radio repeater site/s nominated in writing by the the Principal’s Representative and prepare a report on the test results.

The Developer or the Developer’s Designer shall submit all reports prepared as part of the detailed design to the Superintendent for on forwarding to the the Principal’s Representative.

5.9 General Design Requirements

For sewage pumping stations, the design requirements are set out in the SEQ-SPS Code. The Developer’s Designer shall comply with these requirements including those related to RPEQ certification of the detailed design details.

For water pumping stations, the design requirements are generally similar as those set out in the SEQ-SPS Code. The Developer’s Designer shall generally comply with these requirements including those related to RPEQ certification of the detailed design details.

5.10 Electrical Design Requirements

Electrical design including switchboard/motor load centres/motor control centre and control panels shall be in accordance with the requirements of this document, relevant Australian Standards and the the Principal’s Standard Drawings.

5.11 Design Certification

All design work shall be certified by fully qualified and experienced engineers. Appropriate certifying engineers shall be:

- An RPEQ registered engineer in Queensland in the relevant discipline of engineering applicable to the design provided;

- An NPER3 nationally registered engineer in the relevant discipline of engineering applicable to the design provided where an RPEQ registered engineer with the required skill is not available on the Queensland register; and

- An internationally recognised qualification for components designed and manufactured/fabricated out of Australia provided substantiation of documentation is provided and is equivalent to a NPER3 qualification.

5.12 Drawing Numbers

The Developer’s Designer in consultation with the the Principal’s Representative shall be allocated the Principal’s drawing numbers for use on his own and Contractor’s/sub-contractor’s drawings. The content and structure for drawing title blocks is set out in the the Principal’s Procedure SD-22 available through the Superintendent from the the Principal.

5.13 Drafting Requirements

Drawing drafting requirements are set out in the SEQ-SPS code reference document SEQ D&C Code “Asset Information Standard”. The Developer’s Designer shall comply with these requirements.

All drawings shall be clearly drawn to scale by competent draftsperson for the particular application of this project. Drawings of a generalised nature applicable to a number of models or equipment types will not be accepted. Failure to comply with the foregoing will be cause for rejection.
All drawings for all stages of the submittal process shall be cross referenced by means of the Principal’s drawing numbers and not by any other drawing numbers allocated by the Developer’s Designer, the Contractor or any sub-contractors.

All drawings and in particular all text shall be fully legible at A3 size.

In addition, where the total number of drawings is five or greater, a complete listing, in a MS Excel (or Word) spreadsheet format, indicating the Principal’s drawing numbers and a specific description shall be supplied.

6 PRE-FABRICATION/CONSTRUCTION DRAWINGS AND OTHER SUBMITTALS

6.1 General Requirements Mechanical – General Arrangements, Equipment and Other Components

The following requirements shall apply to all mechanical equipment, pipework, fabricated metalwork etc., to be supplied.

The Contractor shall at the earliest practical date, but not later than four weeks prior to the construction of any relevant portion of the works or commencement of manufacture of equipment or placing firm orders for any components, submit drawings (1 electronic pdf or 2 hard copies) to the Superintendent for on-forwarding to the Principal’s Representative for endorsement. Works shall not proceed on the fabrication, manufacture or supply of equipment, components or structure, until the relevant drawings have been submitted and endorsed by the Principal.

Should additional information and/or drawings or any amendments to the previously submitted drawings, be required, the Contractor/Developer shall supply the additional information and/or drawings or amended drawings to the Superintendent for on-forwarding to the Principal’s Representative within a period of two weeks of being requested to do so.

6.2 Fabrication/Manufacturing Drawings

The following drawings are the minimum requirement that shall be prepared and submitted for approval.

6.2.1 Fabricated Metalwork

The Developer, the Contractor and/or the Developer’s Designer shall provide:

- General arrangement drawings showing leading assembly dimensions and piece marks of all components; and
- Detailed fabrication drawings of all members and components; details of all joints and fixings shall be provided.

The drawings shall set out details of all surface preparation, post fabrication treatments (ie pickling and passivating) and protective coatings and such details as are required to comply with AS 4100 and AS 1554 Parts 1 and 2. All welding symbols shall be as defined in AS 1554.3.

Where the Contractor desires to make substitutions of sections or to have joints in members other than as shown on Contract Drawings, or to vary any other detail from what is shown on these drawings, the Contractor shall seek specific approval from the Superintendent.

If the Contractor wishes to vary the design in any way because of difficulty in obtaining certain sections or for any other reason, he shall obtain the written approval of the Superintendent for such alterations before ordering any of the proposed material. Any variations so made shall have at least the full strength of the
original design and shall be subject to all relevant clauses of the Project Specification, the Contract Drawings and the requirements of the Principal.

6.2.2 Fabricated/Manufactured Proprietary Equipment

The Developer, Contractor and/or the Developer’s Designer shall provide:

- General arrangement drawings of all equipment; and
- Sectional and sub-assembly drawings where necessary to fully describe the equipment and allow for future maintenance.

These drawings shall include details of all fixing and clearance dimensions including dismantling clearance dimensions, plate and rolled or extruded section thickness and dimensions, bearing types, shaft diameters, bolt sizes, welding details, lubrication details and a listing of all individual components and their material of manufacture, cross-referenced to the general arrangement drawing.

These drawings shall also include full details of proprietary components, e.g. gauges, switches, valves, gear boxes, etc. identified by their make, model, type, figure number etc., fully defining the item and its materials of construction. Specification data sheets shall be submitted for all such items.

The general arrangement drawings shall show the exact location of the equipment within the structure in both plan and elevation and full details of required plinths, fixing bolts, block outs, and connections to external process lines and services. Full details of integral piping shall be given.

Full details of surface preparation, post fabrication treatments (i.e. pickling and passivating) and protective coatings for all components shall be shown on the drawings. Where electric motors are included, full details of the outline dimensions of the motor, shaft size and projection, terminal box location and conduit connections shall be shown on the drawings, along with full details of make, mass, type, frame size, bearings, power, speed and electrical characteristics.

Fully dimensioned arrangement drawings for inspection doors etc., shall be provided.

6.2.3 Built-in Items

The general arrangement drawings shall show the exact location of all built-in components such as fixing bolts for equipment and fittings, all built-in anchorages for pipe supports, cable trays, duct work, etc., and all built-in pipework tailpipes or nozzles, electrical conduits, stop board/slide gate or penstock frames, etc., and where permitted, location and size of block outs for equipment and services.

6.3 General Requirements Electrical – Switchgear and Controlgear Assemblies

Complete drawings shall be submitted to the Superintendent for on-forwarding to the Principal’s Representative for acceptance prior to manufacture of switchgear and control gear assemblies (switchboards, motor control centres, distribution boards, control cubicles, cabinets and panels and the like).

The drawings shall detail:

- Panel layouts & dimensions;
- Construction details;
- Busbar size and capacity;
- Power and control circuit diagrams;
- Circuit breaker ratings;
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- Switch and fuse ratings;
- Circuit numbers;
- Cable routes and installation details;
- Asset component identifiers (on single line diagram/s);
- Wire numbers and contact cross-referencing; and
- Telemetry connections.

The following information shall be submitted in MS Excel table form:

- Equipment electrical ratings;
- Fault level (from Energex);
- Distribution system protective device co-ordination with sizes and settings of protective devices;
- Maximum demand details;
- Voltage drop calculations;
- Cable types, sizes and lengths;
- Earth loop calculations; and
- Asset component identifiers i.e. asset numbers.

At the time at which drawings or other submittals are submitted to the Superintendent for on-forwarding to the Principal’s Representative for review and approval, complete data including type test certificates and samples, where required, and catalogue information on all electrical equipment covered by the drawings shall also be submitted.

A complete equipment schedule shall also be provided to the Superintendent for on-forwarding to the Principal’s Representative at that time which shall list the manufacturer, trade name and model (where applicable) and any other information that may be required by the Principal in identifying the item and determining its acceptability.

7 MAJOR PROJECTS DRAWINGS AND OTHER SUBMITTALS

For designated major projects (as determined by the Principal), the following drawings shall be supplied in draft form to the Superintendent for on-forwarding to the Principal's Representative for review and approval prior to the commencement of site works:

- Process and Instrumentation Diagrams (P & IDs);
- General Arrangement Drawings;
- Pipework Drawings (in a 3-D model) for all above ground, below ground and within structures pipelines down to and including DN15;
- Mechanical (pumps and odour management, ventilation, air conditioning, lifting and other components) Equipment Drawings;
- Structural Works Drawings;
- Civil Works Drawings;
- Architectural Drawings;
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• Electrical, Control and Instrumentation Drawings:
  • Single Line Diagrams;
  • Electrical Schematic Drawings;
  • Switchboard General Arrangement Drawings;
  • Local Control Station (LCS) General Arrangement Drawings;
  • Cable Schedules;
  • Electrical Equipment Layout Drawings;
  • Embedded Conduit Arrangement Drawings;
  • Cable Block Diagrams;
  • Earthing Arrangement Diagrams;
  • Power, Lighting And Communications Plans;
  • Cable Route Drawings;
  • Instrument Loop Diagrams;
  • PLC I/O Module Connection/Wiring Diagrams;
  • Termination Diagrams; and
  • Control System Logic Diagrams;
  • Any Other Drawings requested by contract specification.

For designated major projects (as determined by the Principal), the following documents shall also be supplied to the Superintendent for on-forwarding to the Principal’s Representative in draft form for review and approval prior to the commencement of site works:

• Electrical Equipment Schedules;
• Instrument Schedules;
• Load Listing And Maximum Demand (MD) Calculations For All Main Switchboards, DC/UPS Power Supplies, And Other Emergency Power Supplies;
• Fault Calculations And Cascading/Discrimination Tables;
• I/O Allocation Tables;
• Control System Tag Databases;
• Functional Specifications;
• Inspection And Test Procedures; and
• Completed Inspection and Test Checklists.

8 "WORK AS CONSTRUCTED" INFORMATION RECORDING

A neatly red pen marked up set of work as constructed drawings, detailing interconnections and other changes shall be maintained on site during construction. Drawings shall be kept current with the work as it progresses and shall be subject to inspection at any time by the Superintendent or by the Principal’s Representative.
9 “WORK AS CONSTRUCTED” DRAWINGS AND OTHER HAND OVER DOCUMENTATION

9.1 General Requirements

“Work As Constructed” drawing requirements are set out in the SEQ-SPS Code reference documents SEQ D&C Code “Asset Information Specification”. Water pump stations shall follow the same requirements.

The Certificate of Practical Completion will not be issued until this set of “Work As-Constructed” drawings is submitted to the Superintendent for on-forwarding to the Principal's Representative and accepted by the Principal's Representative.

Two (2) paper copies of A3 sized “Work As Constructed” drawings are required. They should be issued or updated on completion of each major project milestone and updated and reissued on project completion.

For sewage pumping stations and water pump stations (excluding major projects), one (1) copy of the drawings shall be supplied full size & laminated (suitable for day to day engineering use).

For major projects only, the drawings shall be supplied in a sturdy folder (minimum 4 rings); the folder is to be fully titled and dated. The folder shall contain a drawing index.

In addition to the paper copies, one STORAGE MEDIA copy of all “Work As Constructed” drawings in native file format and pdf format is required. They should be issued on completion of each minor and major milestone and updated and reissued on project completion.

They should be fully labelled and dated, and supplied in similarly labelled cases.

9.2 SCADA and PLC Handover Documentation

9.2.1 PLC Configuration
Two STORAGE MEDIA copies of the PLC configuration code are required. They shall be issued on completion of each major milestone and shall be updated and reissued on project completion.

They shall be fully labelled and dated and supplied in identically labelled cases. The STORAGE MEDIA shall be given to the Superintendent for on-forwarding to the Principal’s Representative.

9.2.2 SCADA Configuration
Two CD or DVD or memory stick back up copies of the SCADA configuration code are required. They shall be issued on completion of each major milestone and shall be updated and reissued on project completion.

They shall be fully labelled and dated and supplied in identically labelled cases. They shall be complete with all required files and drivers to allow the reinstallation of the SCADA system on a new PC loaded only with the appropriate MS Windows operating system. The storage media shall be given to the Superintendent for on-forwarding to the Principal’s Representative.

9.2.3 Project Specific Customisation Documentation
Two copies of Project Specific Documentation shall be supplied on paper in draft form (for evaluation and approval) before the start of site works. The information shall be updated and re-issued on storage media on completion of each major milestone and shall be updated and reissued on paper (and STORAGE MEDIA) on project completion:
Project Tag List, featuring for each tag:

- Tag Number;
- Tag Description;
- PLC Address;
- Signal type (AI, AO, DI, DO);
- Signal electrical range;
- Process value range;
- Location/Plant Area;
- Signal Origin PLC;
- Termination Card Number;
- Input Number;
- Terminal Number;
- Termination Drawing Number;
- Control Loop Drawing Number;
- Other PLCs where the tag is used;
- Sequences where the tag is used;
- Graphics where the tag is used; and
- Trends where the tag is used.

PLC List, featuring for each PLC:

- PLC Number;
- Source of supply;
- Module Part List;
- Module Individual I/O list; and
- Associated Drawing Numbers.

Equipment List, featuring for each new piece of equipment:

- Equipment Number;
- Equipment Description;
- Equipment Location;
- Associated Tag Numbers;
- Associated PLC I/O Termination Details;
- Associated Drawing Numbers;
10 OPERATION AND MAINTENANCE MANUAL

10.1 Manual Format

10.1.1 General Requirements
Information shall be collated into a single unified and indexed operation and maintenance manual. The operation and maintenance manual shall be written in English and all content shall be presented in English.

Two (2) hard copies and one (1) electronic copy of the operation and maintenance manual shall be supplied covering the extent of works. The hard copy of the operation and maintenance manual shall be submitted two hole-punched and in one or more high quality slip in stiff covered arch lever folders. Where required or submitted, the draft operating and maintenance manual may be submitted for review in soft folders.

10.1.2 Electronic Copy of the Manual
The electronic copy of the manual shall be in a form (native file format) that can be edited at a later time so that the electronic manual can be kept up to date. PDF format is not acceptable because this format cannot be easily edited. All documentation must be in the formats detailed in.

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<td>Drawings</td>
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<td>Diagrams</td>
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<td>Spreadsheets</td>
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10.1.3 Subject Material
Subject material shall be specific to the particular unit described. Original material is preferred but photocopies will be accepted provided the reproduction quality, and in particular the reproduction of photographs and figures, is satisfactory.

10.1.4 Text and Drawings
Text shall be submitted on A4 sheets. Drawings shall be A3 sized and shall be folded to A4 size in such a way that their title block is visible at the bottom right hand corner when folded.

10.2 Manual Contents

10.2.1 Manual Scope
The operation and maintenance manual shall include but not be limited to providing:

- Full and detailed information regarding the design criteria and sizing of the components;
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- Standard operating procedures (SOPs);
- Description and operation of unit processes;
- Process troubleshooting;
- Regulatory requirements, including reports and records;
- Sampling and laboratory procedures;
- Plant staffing;
- Emergency operations;
- Safety and housekeeping procedures;
- Maintenance instructions;
- Assembly/dis-assembly instructions; and
- Maintenance schedules.

10.2.2 Specific Content Requirements for the Manual
Specific content requirements are as follows:

Cover and face sheets - The cover and face sheets shall include the following information, suitably arranged:

- City of Gold Coast (in full, not abbreviated);
- Name of pumping station (e.g. Pumping Station S025-A78) and the street address;
- Contract number;
- Name of equipment;
- Date of project;
- Titled “Operating and Maintenance Manual”; and
- Contractor’s name and address and contact phone number for service calls (Face sheet only, not the cover sheet).

Note: The cover sheet information is also required on the spine of the manual.

Table of contents - The table of contents shall thoroughly indicate the content and arrangement of the operation and maintenance manual.

Theory of operation - There shall be a discussion of the theory of operation and a listing of all the functions of the system, showing how the various functions are tied together to accomplish the overall function. The description shall include an overall analysis of the principles of operation of the equipment and its functions, such as control interlocks, where such principles would not be obvious to maintenance tradespersons. The descriptions shall be sufficiently detailed to provide system personnel with the understanding necessary to adequately perform the system activities and to correctly interpret the results of these activities.

Title page - For each item of equipment or for each grouping of similar equipment, the title page shall include the following information, suitably arranged:

- City of Gold Coast (in full, not abbreviated);
- Name of pumping station (e.g. Pumping Station A78) and the street address;
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- Contract number;
- Date of contract;
- Equipment name (and telephone number if applicable);
- Manufacturer’s name, telephone and facsimile numbers, email address and web site address;
- Equipment supplier’s name, address and telephone number; and
- Nameplate data - where applicable, sheets shall be included showing nameplate data as required by separate sub-clauses of the relevant specifications.

Data sheets - For each item of equipment or for each grouping of similar equipment, the data sheets shall show:

- Title (e.g. ‘Data Sheet’);
- Equipment name (and number if applicable);
- Equipment type, model number and serial number;
- Specific design characteristics;
- Performance characteristics (including any relevant curves);
- Lubrication type, specification, brand and quality;
- List of individual items of equipment which are components of, or are associated with, the equipment described in this sub-clause;
- Reference drawings list;
- All other information necessary to fully specify the item of equipment; and
- Equipment supplier’s name, address and telephone number.

Data sheets for components/items of equipment - For each item that is a component of equipment (arrangement, system or facility) included in this Supplementary Specification or incorporated into the work, the data sheets shall show:

- Title (e.g. ‘Data Sheet’);
- Equipment name (and number if applicable);
- Associated equipment;
- Equipment type, model number, serial number;
- Specific design characteristics;
- Performance characteristics (including any relevant curves);
- Lubrication type, specification, brand and quality;
- Reference drawing list;
- Bearing numbers and loads;
- All other information necessary to fully specify the component equipment;
- Component equipment supplier’s name, address, telephone & facsimile number, email and web site addresses;
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- Mean-time-between-failure (MTBF), defined as the average interval of system uptime during the defined operation, as supplied by the manufacturer;
- Mean-time-to-repair (MTTR), defined as the average system downtime, excluding logistics delays such as waiting for spare parts or maintenance personnel, as supplied by the manufacturer/Contractor;
- Special tools and test equipment list;
- Warranty data information; and
- Drawings (project specific where prepared or generic if not prepared).

**Operating instructions** – For each item of equipment, the operating instructions shall include:

- Theory of operation (in plain English);
- Function of the equipment;
- Pre-start-up checks and adjustments;
- Start-up procedures;
- Normal shut-down procedures including double isolation measures where appropriate;
- Emergency operation and shut-down procedures;
- Visual checks and observations that should be made routinely to ensure that the equipment is operating satisfactorily; and
- Diagnostic and trouble-shooting techniques, where applicable, to determine probable causes of operating difficulties or alarm situations.

**Maintenance instructions** - For each item of equipment, the maintenance instructions shall include:

- Recommended maintenance procedures to ensure that equipment and components are adequately maintained;
- Frequency with which each preventative maintenance procedure should be carried out;
- Lubrication points, recommended lubricants, and quantities;
- Details of any special tools, spare parts, lubricants or cleaning agents necessary to implement the preventative maintenance procedures; and
- Testing procedures.

**Assembly/dis-assembly instructions** - Assembly/dis-assembly instructions shall include step-by-step procedures to extract, fully dismantle, re-assemble and re-install the equipment. The instructions shall include checks, tests, tolerances on fitting and lining up components of the equipment and all procedures necessary to re-install the equipment correctly. Exploded view drawings or photographs shall supplement the instructions.

**Maintenance schedules** - Maintenance schedules showing a complete listing of all equipment supplied and installed under the Contract shall be included in the manual. The schedule shall give an easy to follow view of daily, weekly, monthly and yearly maintenance of all equipment, as well as recommended greases, lubricants and quantities.

### 10.3 Manual Submission and Acceptance

#### 10.3.1 Submission of a Draft Revision of the Manual
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The submission of a draft manual to the Superintendent for on-forwarding to the Principal’s Representative for review is required for all the Principal designated major projects. The manual shall be revised after review.

The submission of a draft manual to the Superintendent for on-forwarding to the Principal’s Representative for review is recommended for all other projects. If a draft is not submitted, the Superintendent and/or the Principal’s Representative reserve the right to review the submitted manual and request changes. The submitted manual shall be revised after review.

10.3.2 Submission of a Final Revision of the Manual
Two (2) hard (paper) copies and one (1) electronic copy of the manual will be submitted to the Superintendent for on-forwarding to the Principal’s Representative.

If the manual is not in the correct format or does not include the required information, it will be returned to the Superintendent to return to the Developer or the Contractor for rectification.

11 PLC AND HMI SPECIFIC INSTRUCTION MANUAL

11.1 General Requirements
Two (2) hard copies and two (2) electronic copies of the fully updated project PLC and HMI specific instruction manual shall be supplied on project completion.

The project PLC and HMI specific instruction manual (hard and electronic) shall include copies of all technical information on all supplied equipment.

The electronic copies shall be provided on USB’s. The USB’s shall be fully labelled, securely located and protected at the front or rear of each hard copy specific instruction manual, alternatively they could be supplied independent of the hard copy specific instruction manual but still attached together, fully labelled, securely located and protected.

The specific instruction manuals shall include:
- Full engineering and configuration instructions for the site SCADA system;
- Full engineering and configuration instructions for the site PLC system;
- Full engineering and configuration instructions for all smart instrumentation and all VFDs; and
- Full operating/maintenance instructions for all other supplied equipment.

11.2 PC/PLC Based Operating Procedures
The instruction manuals shall contain detailed step-by-step methods for all PC based operational and maintenance procedures.

The methods shall include but not be limited to:
- PC based methods;
- The installation of a backup copy of the SCADA software and associated drivers on to a PC loaded only with the appropriate “Windows based” operating system;
- The installation of a backup copy of the SCADA configuration code on to a PC loaded only with the appropriate “Windows based” operating system and the SCADA operating system;
- The making of a “back up” copy of the SCADA configuration code;
11.3 PLC and SCADA Software

Licensed copies of all programming and configuration software (complete with all license keys) shall be supplied on project completion. The USB’s shall be given to the Superintendent for on-forwarding to the project’s nominated City of Gold Coast custodian.

The USB’s shall cover all essential aspects of the project including:

- Windows Operating System;
- SCADA System Software;
- PLC Engineering/Programming Software;
- Equipment Drivers; and
- All necessary ancillary software.

In addition, all necessary PLC programming cables shall be supplied with the programming software.

12 INSPECTIONS AND TESTING

12.1 Inspection and Testing - Mechanical Work

Inspection and testing shall include, but will not necessarily be limited, to the following:

- Factory acceptance testing of pumps prior to delivery to site;
- Factory acceptance testing of flowmeters prior to delivery to site;
- Inspection of fabricated metalwork after fabrication prior to post fabrication coatings (hot dip galvanising, painting or other coatings) and prior to delivery to site;
- Factory acceptance testing of odour management or ventilation fans prior to delivery to site;
- Inspection of all completed odour management and ventilation ductwork after fabrication prior to post fabrication coatings (flow coating or other coatings) and prior to delivery to site;
Factory acceptance testing of odour management or chemical dosing vessels prior to post fabrication coatings (flow coating or other coatings) and prior to delivery to site; and

Site acceptance testing of all installed pumping and other equipment after completion of site wiring.

### 12.2 Inspection and Testing – Electrical Work

Inspection and testing shall include, but will not necessarily be limited, to the following:

- Inspection of SCAs (switchboards, motor load centres, cubicles and other items) fabricated from sheet metal when assembled prior to wiring;
- Inspection of all completed SCAs after completion of internal wiring and prior to delivery to site;
- Factory acceptance testing of all completed SCAs after completion of internal wiring and prior to delivery to site;
- Site acceptance testing of all completed SCAs after completion of site wiring;
- All statutory and specified tests on all completed wiring after completion of site installation;
- Site testing and verification as required by AS/NZS 3000, particularly Section 8;
- Site testing of the earth loop resistance of each leg of the earthing system;
- Site testing of the insulation resistance for all motors, low voltage cables and auxiliary equipment;
- Point to point testing of all completed control and instrumentation wiring after completion of site installation; and
- Site test all instruments establishing the overall accuracy of the devices from primary element to the PLC/RTU.

### 12.3 Inspection and Testing Documentation Requirements

A complete inspection and testing document shall be prepared in advance of performing any factory acceptance or site acceptance testing. This document shall cover all of the control and SCADA functionality required by the system. The object of this document will be such that when testing is complete, then the system shall have all functionality required by the design documentation.

The same test document may be used for both factory acceptance and site acceptance testing. In the case of programmable control system testing, the factory acceptance testing shall use the actual PLC/RTU hardware where possible and shall simulate all field devices. The site acceptance testing shall use the actual installed equipment and shall be the mandatory testing undertaken before commissioning commences.

The test documentation shall include all of the following details:

- Each step of the preparation, configuration and start-up of all equipment that will be used to perform the required testing shall be included as a list item;
- Each aspect of the functionality required of the equipment shall be included as a list item. These items shall be as detailed as possible to ensure that all required functionality is fully tested; and
- Checkbox columns for factory acceptance and site acceptance testing. These columns will include the initials of the tester and the date of the test.
For items such as pumps or instruments that have identical testing routines, it will be acceptable to write one general testing routine for each type of device. Each step in the routine shall still be included in the detailed test list, but this will reduce the amount of detail required in the test checklist.

Where PLC or SCADA is integrated into the project, the testing documentation shall include all configured PLC functionality and SCADA elements. All required alarm, trend display and report functionality shall be included as a list item in the testing documentation.

At the end of the testing process, all setpoints, equipment settings and software and firmware revisions shall be noted.

12.4 Factory Acceptance Testing – Mechanical Work

The equipment shall be subject to inspection by the Superintendent or his representative and the Principal’s Representative at any stage during manufacture.

Pumps and other mechanical equipment shall be witness tested at the manufacturer’s works, with copies of the test certificates provided to the Principal. Tests shall be conducted to AS 2417 Part 2 Class C.

The Developer and/or the Contractor shall, at his own expense, carry out all tests and shall provide all necessary equipment and NATA certified instruments.

Sufficient notice shall be given by the manufacturer to enable the Superintendent or his representative and the Principal’s Representative to be present at the tests.

The Superintendent may at his discretion, accept in lieu of actual tests carried out, manufacturer test certificates in respect of the mechanical properties and chemical composition of the materials used in the manufacture of the items in this Contract. This alteration shall be agreed with the Principal’s Representative.

Performance tests shall be as scheduled.

12.5 Factory Acceptance Tests – Electrical Work

Factory acceptance tests (FATs) shall be completed to the satisfaction of the Superintendent or his representative and the Principal’s Representative before the equipment is released for delivery to site.

FATs shall include:

- Complete circuit checks per cubicle (including control cubicles and load centres) of each cable, termination and circuit components against the drawings. These drawings shall be marked off accordingly and erroneous designations corrected to the satisfaction of the Superintendent and the Principal’s Representative;

- Insulation tests with 1,000 volt “Megger” on all low voltage busbars, cables and equipment. Insulation resistance of a complete circuit shall be measured from the isolator contacts. Note: Care must be exercised not to “Megger” test sensitive equipment, such as thermistors and other solid-state equipment;

- Completion of the settings sheet for all control and protection parameters. This includes soft starters and VFD parameters for correct indication and logic functionality;

- Completion of the commissioning sheet outlining the commissioning tests and procedures;

- Availability of all software;

- Testing where practical, communication links between RTU and soft starters or VFDs; and

- Testing of all PLC hardware configuration, PLC programming and SCADA configuration.
12.6 Site Acceptance Tests, Commissioning and Inspections

Site Acceptance Tests (SATs) shall be undertaken prior to commissioning. These shall include:

- Complete circuit checks for site cabling against the drawings. These drawings shall be marked off accordingly and erroneous designations corrected to the satisfaction of the Superintendent or his representative and the Principal’s Representative;
- All necessary site safety checks are performed:
  - Insulation tests;
  - Earth continuity;
  - Installations, circuits and sub mains shall be tested in accordance with AS/NZS 3000, and the Supply Authority’s Regulations;
  - Operational sequence and interlocking checks;
  - Primary or secondary current injection testing of protection circuits and operation of protective relays shall be performed;
  - Equipment rating checks and operational tests shall be performed including phase rotation; motor rotation; polarity; fuse ratings and overload and protection settings; and
  - Operation of protection equipment;
- All control modes shall be tested including all back-up control modes for sewage pumping stations;
- All control modes shall be tested for water pumping stations;
- Sealing of all cables around conduits and glands shall be confirmed;
- Locks and keys are to be checked for compliance;
- Ventilation filters shall be checked for compliance;
- Mechanical operation of doors does not foul with electrical equipment;
- Telemetry mast foundations are solid;
- All PLC hardware configuration and I/O checking is performed;
- All PLC programming and SCADA configuration is tested;
- Black start tests will be performed on each pumping station to ensure that all equipment will return to operating status following a power blackout without generating alarms or callouts to operators; and
- All settings, set points and software and firmware revisions are noted.

The Superintendent or his representative and the Principal’s Representative may also wish to confirm that the items tested and inspected comply with the requirements by further testing.

The Superintendent or his representative and the Principal’s Representative shall at their sole discretion, witness checks and tests. An electrical test sheet shall be completed and submitted to the Superintendent for on-forwarding to the Principal’s Representative as required.

A written report shall be submitted to the Superintendent for on-forwarding to the Principal’s Representative.

Other supplementary special tests including HV testing, partial discharge, loss factor, ratio tests, vibration, noise tests may be specified separately to this Supplementary Specification when required.
13 TRAINING

13.1 General

The Developer and/or his Contractor shall prepare Operational Training Modules and Maintenance Training Modules to provide formal training to the Principal’s management, operational and maintenance personnel for each facility, system, component and/or item of mechanical and electrical equipment in the Works.

13.2 Training Concept and Schedule

The Developer and/or his Contractor shall provide a proposed training concept and schedule to the Superintendent for on-forwarding to the Principal’s Representative for approval. After approval, the Developer and/or his Designer shall develop documentation for those items of equipment, systems and facilities for which the Contractor is required to provide formal training to the Principal’s management, operational and maintenance personnel.

13.3 Training Documentation

Operational Training Modules shall each be a separate document, shall each be based on systems or facilities at the pumping station and shall include, but not necessarily limited to:

- Description of Operations;
- Start-up Procedures;
- Normal Shut-down Procedures;
- Extended Shut-down Procedures (for maintenance, removal or mothballing) including double isolation provisions;
- Emergency Shut-down Procedures if applicable; and
- Adverse Event Management.

Maintenance Training Modules shall each be a separate document, shall be based on systems or facilities at the pumping station and shall include, but not necessarily be limited to:

- Description of Maintenance Shut-down Procedures including double isolation provisions;
- Routine/Preventative/Scheduled Maintenance;
- Corrective Maintenance; and
- Restart Procedures including isolation removal.

The requirements for training shall be broken down as to the number of hours of operator training and the number of hours of maintenance training for both classroom instruction and hands-on equipment instruction. If requested by the Principal during project development, video-taping of the training shall be included in the project delivery Contract.

The Operational Training Modules and Maintenance Training Modules shall be included in a Training Document. Each copy of the Training Document shall be provided in an A4 folder identified in a similar manner to the Operations and Maintenance Manual.

Two (2) hard (paper) copies and one (1) electronic copy of the Training Document will be submitted to the Superintendent for on-forwarding to the Principal’s Representative.

If the Training Document is not in the correct format or does not include the required information, it will be returned to the Superintendent to return to the Developer or the Contractor for rectification.

13.4 Training Records
14 SPECIAL TOOLS AND SUPPORT EQUIPMENT

Where equipment being supplied/installed requires special tools to dismantle/reassemble the equipment and/or support equipment such as proprietary software for maintenance and operations optimisation that may be undertaken by the Principal’s staff, such special tools and support equipment shall be provided with the equipment.

The Developer or the Contractor shall provide the special tools and support equipment required to the Superintendent for on-forwarding to the Principal’s Representative. Specialist tools shall be taken to include any non-standard spanners, pliers, pullers, guides, jigs, etc.

Where plant or instruments have hand held programming devices / software, e.g. ultrasonic instruments, valve actuator, etc., the Developer and/or the Contractor shall provide the Superintendent with any such device/software for on-forwarding to the Principal’s Representative. Where multiple instruments require the same programming device/software application, one device/software application shall be provided for each group of five instruments.

15 CONSUMABLES, INITIAL CRITICAL SPARE PARTS AND SPARE PARTS

Maintenance components shall be supplied with each item of plant, as necessary, to permit effective maintenance. This shall include calibration kits and two years consumables.

Consumables shall be defined as products which, after use, cannot be restored to a functional condition. Consumables are therefore not re-usable, and supplies of these items will need to be replaced over time.

Critical spare parts shall be supplied with each item of plant, as necessary, to permit effective maintenance.

Spare parts shall be defined as reserve, replacement and repair parts. Critical spare parts are distinct, serviceable and / or replaceable elements, parts, components, assemblies or tools which perform a critical function such that in the event of failure the associated item will fail to sustain its serviceability.

A priced list of provided longer term (5 years) spare parts, including their source of supply and availability, manufacturer’s parts numbers and detailed descriptions, shall also be provided with the equipment. Typical lead times for delivery shall also be included. This listing shall cross reference item identification to a relevant exploded/component view drawing. This schedule shall be included in the Operations and Maintenance Manual.

The critical spares, consumables and specialist tools shall include as a minimum the manufacturer’s recommendations for 2 years operation for the following equipment:

- Each pump and its motor drive;
- Each valve and its actuator;
- Each fan and its motor drive;
- Each air compressor;
- Each filter;
- Each motor control centre;
- Each emergency/standby electrical generator;
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- Control system including any PLC components;
- PLC programming tools and licensed software; and
- Building services apparatus.

Any spare parts used by the Contractor shall be replaced as a matter of urgency and may only be used with the approval of the Superintendent and the Principal’s Representative.

Spares and consumables shall be stored securely until they are handed over to the Superintendent for on-forwarding to the Principal’s Representative as part of the Handover Deliverables.
16 GENERAL MECHANICAL INSTALLATION REQUIREMENTS

This Supplementary Specification covers the general requirements for mechanical installations for sewerage network infrastructure including sewage pumping stations and water supply network infrastructure including water pumping stations.

16.1 Mechanical Standards

For sewage pumping stations and any other sewerage network infrastructure, in addition to complying with the SEQ-SPS Code and this Supplementary Specification, all mechanical plant, equipment and installation works shall be supplied and set into operation in accordance with the latest edition of the standards in Table 16.1 and any other relevant standard not mentioned herein.

For water pumping stations and any other water supply network infrastructure, in addition to complying with this Supplementary Specification, all mechanical plant, equipment and installation works shall be supplied and set into operation in accordance with the latest edition of the standards in Table 16.1 and any other relevant standard not mentioned herein.

Where more than one standard is quoted for the same item of equipment and the provisions of each standard are in conflict, the Principal’s decision upon which standard takes precedence, shall be final and binding.

All standards referred to in the body of the SEQ-SPS Code or this Supplementary Specification in Table 16.1 or elsewhere shall be complied with. The latest published version of each standard or any replacement standard for the nominated standard at the date of approval of the work to proceed by the Principal shall be the applicable version.

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### SUPPLEMENTARY MECHANICAL AND ELECTRICAL SPECIFICATION

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MECHANICAL WORK MATERIALS AND MECHANICAL EQUIPMENT

All materials used in the mechanical work shall be procured, fabricated, supplied, delivered and installed in accordance with this Supplementary Specification and the relevant Australian Standard or international standard where there is no Australian Standard. All materials used in the mechanical installation work shall be handled, transported and stored in accordance with the relevant Australian Standard or international standard where there is no Australian Standard and the manufacturers’ recommendations.
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Reference is made in Part 1 of this Supplementary Specification to the “Principal’s Accepted Mechanical Materials and Equipment Schedule”. The Developer, the Developer’s Designer and the Contractor shall refer to the documents listed in Table 17.1 for the components for various locations which are acceptable to the Principal.

Table 17.1 The Principal Accepted Mechanical Materials and Equipment Schedule

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18 PUMPING STATION AND PUMP UNITS

18.1 Pumping Station and Pump Unit General Requirements

18.1.1 Terminology

The term ‘pump unit’ shall be taken as synonymous with the term ‘pump set’. In most situations, a pump is coupled typically with an electric motor to form a pump unit or pump set. However, the motor could be diesel powered, petrol powered, pneumatically (compressed air) powered or hydraulically powered as alternatives.

Typically, two or more ‘pump units’ are combined with common suction and/or discharge pipework and associated valves and other components to form a ‘pumping station’. In this clause, the focus is on issues related to different types of pump units as well as different types of pumping applications.

18.1.2 Pump Drive Power Alternatives

Where the pump drive motor is proposed to be other than an electric motor i.e. diesel powered, petrol powered, pneumatically powered or hydraulically powered, the alternatives shall only be considered and adopted with the written approval of the Principal’s Representative during the detailed design process.

18.2 Pumping Station and Pump Unit Hydraulic/Mechanical Design Requirements

18.2.1 Fluid Specification

Fluid specifications for sewage pumps are as follows:

- Density - 998 kg/m³
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- Viscosity - 1 mm²/s
- Solids Content  Contains solids up to 90mm diameter, abrasive
- Temperature – max 40° C
- Temperature – min 6° C
- pH max - 9.0
- pH min - 6.5

18.2.2 Duty Point
The duty point of each pump shall be as stated in the Design Report, in the detailed Project Specification or on the Project Drawings. The duty point for each pump unit is derived from the duty point for its pumping station and depends on the number of pumps in service to deliver the design flow.

A Guarantee Point must be given for the purposes of performance testing to Grade 2 under AS 2417 and is subject to the tolerances stated therein. Other International Standards providing a similar or better testing standard will be acceptable subject to approval by the Superintendent and the Principal’s Representative.

Each pump’s duty may be achieved using a variable speed drive. If necessary, each pump may be operated at a frequency greater than 50 Hz to achieve the wide range of flows required subject to approval by the Superintendent and the Principal’s Representative in writing during the detailed design process.

The pumped material shall be as stated in the Design Report, in the detailed Project Specification or on the Project Drawings. The design of each pump and its suction and discharge pipework shall be based on the properties of the pumped material.

18.2.3 Pump Selection
Each pump selected shall have a stable head-flow quantity characteristic curve (i.e. negative gradient from zero flow to end-of-curve) and shall be non-overloading at every condition of discharge. Each pump shall be selected to:

- meet all of the duty points within the range of 70% to 120% of the pumps optimum flow rate (i.e. Best Efficiency Point), with the Guarantee Point as close to the optimum flow rate as possible; and
- attain a Maximum Achievable Flow, for continuous operation, not less than 20% greater than the highest flow duty point.

The diameter of the selected impeller for each pump shall not be the maximum impeller diameter for the pump model. At least one increase in impeller size shall be allowed.

18.2.4 Operating Speed
For submersible centrifugal pumps including sump pumps, the nominal pump operating speed at 50 Hz shall not be greater than 1500 r/min i.e. 2 pole motors are not acceptable.

For other centrifugal pumps, generally the nominal pump operating speed at 50 Hz shall not be greater than 1500 r/min i.e. 2 pole motors are not acceptable.

Subject to the approval of the Superintendent and the Principal’s Representative in writing, a higher pump operating speed at 50 Hz up to 3000 r/min may be acceptable. In these cases, a higher pump vibration standard (i.e. lower amplitudes and accelerations) shall be set by the Developer’s Designer. Alternatively, two ‘sewage pump stations’ may be arranged to operate in series to achieve a high head for a particular location, e.g. a sewage booster pumping station located close to a sewage pumping station, refer to Clause 18.2.7 of this Supplementary Specification, to keep the operating speed for the pump units to no greater than 1500 r/min.
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For progressive cavity (helical rotor) pumps and any other pumps, the nominal pump operating speed at 50 Hz shall not be greater than 350 r/min without the approval of the Superintendent and the Principal's Representative in writing.

**18.2.5 Efficiency and Power Consumption**

Each pump shall be selected to maximise operating efficiencies without modification, polishing or coating of the impeller.

Power consumption of each pump shall not exceed 92.5% of the motor rated power output at any point on its curve.

**18.2.6 Net Positive Suction Head**

Each pump shall have a Net Positive Suction Head required (NPSHr) at least 2 m less than the Net Positive Suction Head available or, the NPSHa shall be at least 133% greater than the NPSHr, whichever is the greater, at any point between zero flow and the maximum operating range flow attainable against the characteristic curve.

The NPSHr of each pump shall be based on actual 3% head drop method test result.

**18.2.7 Sewage Booster Pumping Stations**

A sewage booster pumping station may be required in order to achieve a relatively high duty head for the duty flow at a particular location that is beyond the head capacity of the selected pump units for a sewage pumping station operating at 1500 r/min. Depending on the pressure rating of the rising main, the sewage booster pumping station may be located:

- Either close to the sewage pumping station where its motor starters can be consolidated with the mains supply and motor starters for the sewage pumping station and commonly controlled using the RTU provided for the sewage pumping station;
- Or at some convenient point along the rising main where it would need a separate mains supply and RTU.

Each sewage booster pumping station may use:

- Submersible centrifugal pump units operating in the dry at a maximum of 1500 r/min; or
- Progressive cavity (helical rotor) pump units operating at no greater than 500 r/min.

A minimum of two pump units shall be provided for each sewage booster pumping station.

**18.3 Pump Unit Monitoring Requirements**

**18.3.1 Pressure Gauging**

Each submersible pump unit shall be provided with a tapping into the vertical riser five (5) pipe diameters above the discharge connection stand flange for each pump unit. Where the vertical riser pipe is polyethylene (PE), a Grade 316L stainless steel tapping band shall be supplied and installed with a nominal DN20 (3/4 inch BSP) threaded socket. A nominal DN20 3 piece Grade 316 stainless steel ball valve shall be provided and attached to the socket using a threaded nipple and a nominal DN20 Swagelok or similar Grade 316 stainless steel connector provided to connect the nominal 20 mm diameter PE pressure monitoring pipe. The PE pressure monitoring pipe shall lead from each tapping isolation valve over to the wall and up to the top of the pump well and shall be provided with a nominal DN20 block and bleed valve arrangement. The valve arrangement shall be mounted on a Grade 316 stainless steel support bracket so that a pressure gauge may be fitted to the vertically upward facing branch by means of a DN20 to DN12 (1/2 inch BSP) reducer. This assembly shall be located on the side of the pump unit access opening, or where shown on the Drawings clear of the space required for raising and lowering pump units. The pipework shall be fastened using Grade 316 stainless steel saddles at a maximum spacing of 500 mm.
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Small sump pumps up to 1.5 L/s capacity do not require pressure monitoring. All larger sump pumps shall be provided with pressure monitoring as for submersible pumps.

Each horizontal shaft and vertical shaft centrifugal pump shall be provided with a pressure gauge on the suction side of the pump and a pressure gauge on the discharge side of the pump. Typically the pressure gauges shall be mounted together on a common stand, located at a convenient location where the gauges can be easily read and typically located at the same vertical centreline as the discharge pipework.

Each progressive cavity (helical rotor) pump shall be provided with a pressure gauge on the suction side of the pump and a pressure gauge on the discharge side of the pump. Typically the pressure gauges shall be mounted together on a common stand and located at a convenient location where the gauges can be easily read.

Each pressure gauge shall:

- Be suitable for direct mounting;
- Have a Grade 316L stainless steel case and bezel;
- Have a nominal 100 mm diameter face;
- Be marked in ‘m’, and not in ‘kPa’ or ‘bar’ or any other units;
- Have a ½ inch BSP Grade 316L stainless steel connection unless otherwise agreed in writing by the Principal’s Representative;
- Be suitable ranged to either 150 % of the positive suction head, full vacuum for a negative suction head and 150 % of the shut-off head of the pump for the discharge pipework; and
- Be provided with a block and bleed valve arrangement either at each pressure gauge’s tapping or at the pressure gauge where it is mounted remotely from the tapping.

Refer to the Principal’s Accepted Mechanical Materials and Equipment Schedule for accepted pressure gauges, see Table 17.1.

18.3.2 Pressure Monitoring

Where required by the Principal’s Representative, a sewage pumping station with wet well mounted submersible pump units shall be provided with a pressure transmitter in the common discharge pipeline (rising main).

Each sewage or water pumping station with horizontal centrifugal pump units, vertical centrifugal pump units, progressive cavity (helical rotor) pump units, or any alternative positive displacement pump unit type and a single pump duty point capacity of less than 50 L/s shall be provided with a pressure transmitter tapping point on the suction pipeline and on the discharge pipeline.

Each sewage or water pumping station with horizontal centrifugal pump units, vertical centrifugal pump units, progressive cavity (helical rotor) pump units, or any alternative positive displacement pump unit type and a single pump duty point capacity of 50 L/s or greater shall be provided with a pressure transmitter on the suction pipework and on the discharge pipework for each pump.

Each pressure transmitter shall have a local digital read-out, mounted in an instrumentation cubicle, and shall be connected to the pumping station’s control system for logging and trending of the pressure data.

18.3.3 Vibration Monitoring

Each sewage or water pumping station with horizontal centrifugal pump units, vertical centrifugal pump units, progressive cavity (helical rotor) pump units, or any alternative positive displacement pump unit type and a drive motor size of 37 kW or greater shall be provided with vibration monitoring for each pump unit. Details for vibration monitoring are provided in Clause 44.1.3 of this Supplementary Specification.

Each vibration monitor shall be connected to the pumping station’s control system for alarming only.
18.4 Pump Unit Ancillaries Requirements

18.4.1 Flushing and Drainage Connections

18.4.1.1 General Requirements

Flushing and drainage connections are required to:

- Facilitate safer and cleaner maintenance of the pumps and pipework; and
- Physically prove in a safe manner that pumps and pipework have been depressurised after they are isolated for maintenance.

18.4.1.2 Sewage Pumping Stations - Wet Well Mounted Submersible Pump Unit Installations

The discharge pipework from each submersible pump mounted in a wet well shall be provided with a DN20 (¾ inch BSP) flushing point on the crown of the discharge pipework at the highest point between the pump and the non-return valve with a DN20 3 piece fully Grade 316 stainless steel ball valve and a DN20 Grade 316 stainless steel male Kamlok coupling.

The discharge pipework from each submersible pump mounted in a wet well shall be provided with a DN20 (¾ inch BSP) flushing point on the crown of the discharge pipework at the highest point between the non-return valve and the discharge isolation (sluice or alternate) valve with a DN20 3 piece fully integrated Grade 316 stainless steel ball valve and a DN20 Grade 316 stainless steel male Kamlok coupling. The discharge pipework from each submersible pump shall be provided with a DN40 (1½ inch BSP) drainage point on the bottom of the discharge pipework at the lowest point between the non-return valve and the discharge isolation valve with a DN40 Grade 316 stainless steel 90 degree bend, a DN40 3 piece fully integrated Grade 316 stainless steel ball valve and a DN40 Grade 316 stainless steel male Kamlok coupling.

Where the pipework diameter is greater than DN200, the sizes shall increase from DN20 to DN25 and from DN40 to DN50 respectively.

18.4.1.3 Sewage Pumping Stations – Dry Mounted Submersible and Other Centrifugal Pump Unit Installations

The suction or discharge pipework to each dry mounted submersible and other centrifugal pump shall be provided with a DN20 (¾ inch BSP) flushing point on the crown of either the suction and discharge pipework at the highest point between the suction isolation (sluice or alternate) valve and the discharge non-return valve with a DN20 3 piece fully Grade 316 stainless steel ball valve and a DN20 Grade 316 stainless steel male Kamlok coupling. The suction or discharge pipework to each dry mounted submersible and other centrifugal pump shall be provided with a DN40 (1½ inch BSP) drainage point on the bottom of either the suction or discharge pipework at the lowest point between the suction isolation valve and the discharge non-return valve with a DN40 Grade 316 stainless steel 90 degree bend, a DN40 3 piece fully Grade 316 stainless steel ball valve and a DN40 Grade 316 stainless steel male Kamlok coupling.

The discharge pipework from each submersible and other centrifugal pump shall be provided with a DN20 (¾ inch BSP) flushing point on the crown of the discharge pipework at the highest point between the non-return valve and the isolation (sluice or alternate) valve with a DN20 3 piece fully Grade 316 stainless steel ball valve and a DN20 Grade 316 stainless steel male Kamlok coupling. The discharge pipework from each submersible and other centrifugal pump shall be provided with a DN40 (1½ inch BSP) drainage point on the bottom of the discharge pipework at the lowest point between the non-return valve and the isolation valve with a DN40 Grade 316 stainless steel 90 degree bend, a DN40 3 piece fully Grade 316 stainless steel ball valve and a DN40 Grade 316 stainless steel male Kamlok coupling.

Where the discharge pipework diameter is greater than DN200, the sizes shall increase from DN20 to DN25 and from DN40 to DN50 respectively.
18.4.1.4 Pumping Stations – Other Than Submersible and Other Centrifugal Pump Unit Installations

The suction pipework to each progressive cavity (helical rotor) pump or any alternative positive displacement pump type shall be provided with a DN20 (¾ inch BSP) flushing point on the crown of the suction pipework at the highest point between the non-return valve and the suction pipework at the highest point between the isolation (sluice or alternate) valve and the pump with a DN20 3 piece fully integrated Grade 316 stainless steel ball valve and a DN20 Grade 316 stainless steel male Kamlok coupling. The suction pipework to each progressive cavity (helical rotor) pump or any alternative positive displacement pump type shall be provided with a DN40 (1½ inch BSP) drainage point on the bottom of the suction pipework at the lowest point between the isolation (sluice or alternate) valve and the pump with a DN40 Grade 316 stainless steel 90 degree bend, a DN40 3 piece fully Grade 316 stainless steel ball valve and a DN40 Grade 316 stainless steel male Kamlok coupling.

The discharge pipework from each progressive cavity (helical rotor) pump or any alternative positive displacement pump type shall be provided with a DN20 (¾ inch BSP) flushing point on the crown of the discharge pipework at the highest point between the non-return valve and the discharge isolation (sluice or alternate) valve with a DN20 3 piece fully Grade 316 stainless steel ball valve and a DN20 Grade 316 stainless steel male Kamlok coupling. The discharge pipework from each progressive cavity (helical rotor) pump or any alternative positive displacement pump type shall be provided with a DN40 (1½ inch BSP) drainage point on the bottom of the discharge pipework at the lowest point between the non-return valve and the discharge isolation valve with a DN40 Grade 316 stainless steel 90 degree bend, a DN40 3 piece fully Grade 316 stainless steel ball valve and a DN40 Grade 316 stainless steel male Kamlok coupling.

The discharge pipework from each progressive cavity (helical rotor) pump or any alternative positive displacement pump type shall be provided with a DN20 (¾ inch BSP) flushing point on the crown of the discharge pipework at the highest point between the non-return valve and the isolation (sluice or alternate) valve with a DN20 3 piece fully Grade 316 stainless steel ball valve and a DN20 Grade 316 stainless steel male Kamlok coupling. The discharge pipework from each submersible pump shall be provided with a DN40 (1½ inch BSP) drainage point on the bottom of the discharge pipework at the lowest point between the non-return valve and the isolation (sluice or alternate) valve with a DN40 Grade 316 stainless steel 90 degree bend, a DN40 3 piece fully Grade 316 stainless steel ball valve and a DN40 Grade 316 stainless steel male Kamlok coupling.

Where the discharge pipework diameter is greater than DN150, the sizes shall increase from DN20 to DN25 and from DN40 to DN50 respectively.

18.5 Pump Unit Maintenance and Repair Requirements

18.5.1 Pump Unit Removability

Every pump unit supplied and installed shall be designed to enable repair or replacement without causing an overflow to the environment, surcharge above the maximum design level or a violation of the Developer’s or the Principal’s statutory requirements (ie Development Approval conditions or discharge license). Where permitted by the Principal’s Representative in writing, double valved isolation can be reduced to single isolation with an alternate means to provide the second isolation.

Each submersible pump unit installed in a wet well/tank shall be readily removable and replaceable without dewatering the wet well/tank or disconnecting any pipework in the wet well/tank.

Each dry mounted submersible pump unit and each other type of pump unit shall be readily removable and replaceable by instigating double containment on both sides of the pump unit and disconnecting the appropriate pipework.

18.5.2 Pump Unit Access Space

Adequate access and removal space shall be provided around each pump unit to permit easy maintenance and/or removal and replacement without interfering with the operation of other equipment. Pump units located inside buildings or other structures shall be removable without affecting the structural
18.5.3 Pump Unit Handling
The Developer shall provide lifting and handling equipment pump units greater than 18 kg, refer to Clause 24 of this Supplementary Specification, to aid in the maintenance and the removal/replacement of the pump units or their components.

In addition, the detailed design shall include the supply and installation of lifting/handling devices, such as pad-eyes and hooks, to aid the handling of pump units and other components. This is particularly important for large and/or heavy pumps greater than 200 kg which require special handling and lifting equipment. Means shall be provided for removal of pump units located above and below the ground level of buildings and other structures.

18.6 Specific Pump Type Requirements

18.6.1 Submersible Pump Units – Wet Well Mounted
Submersible pump units installed/mounted in pump/wet wells shall be in accordance with the Water Services Association of Australia Pump Code WSA 101 except for the nominated additional or alternative requirements listed below. Refer to the Principal’s Accepted Mechanical Materials and Equipment Schedule for accepted pump models, see Table 17.1.

18.6.1.1 Minimum Submergence

Each pump shall be guaranteed to operate continuously at a minimum submergence level that would just cover the motor section and intermittent operation of the pump where the motor section is not submerged, without:

- Formation of vortices; or
- Over-heating of the motor.

18.6.1.2 Noise

The Sound Pressure Level (SPL) of each pump unit shall not exceed 80dB(A) measured on a one metre radius above the pump/wet well cover, measured in accordance with AS 1055.2. Unless otherwise agreed in writing by the Principal’s Representative, the Developer or the Contractor shall take measurements over a 24 hour period during which each pump unit shall be scheduled to operate so that background noise can be filtered out of the noise spectrum.

The use of and provision of sound attenuation treatments to the underside of the pumping station pump/wet well cover will be permitted to meet this requirement.

Detailed information including details covering the frequency range on the acoustic performance of each pump unit and the attenuation capacity of any sound attenuation shall be provided to the Superintendent and the Principal’s Representative for approval.

18.6.1.3 Mechanical Design Requirements

Each pump unit shall be a composite of the drive motor and the pump wetted end. The latter shall be joined to the former by means of an oil chamber housing containing the shaft sealing devices. The impeller shall be mounted on the one-piece motor shaft.

Each pump unit shall be supported on a separate discharge bend manufactured with integral mounting feet which typically provides an effective water seal against the discharge flange of the pump.

Discharge bends for submersible pumps must:
- Comply with WSA 101 standard discharge bends
18.6.1.4  Pump Solids Handling Capacity

The Minimum Sphere Passing Capability shall be 90 mm.

18.6.1.5  Impeller

Each impeller shall:

- Be accurately finished to reduce friction and leakage losses to a minimum;
- Have clearing vanes integrally cast into the backs of shrouds; and
- Be of the screw centrifugal type or other proven non-clog design.

18.6.1.6  Pump Casing

The pump casing shall comprise of a volute, a removable end-cover and a back-plate. The back-plate may be cast integral with the seal-chamber housing.

The pump casing components shall be of an approved grade of flake-graphite grey cast iron (AS 1830 Grade T250 or superior) or wear resisting high-chrome iron. Carbon steels are not acceptable.

The volute wall thickness shall be sufficient to accommodate pressures up to 1200 kPa pressure, after loss of 25% of the wall thickness due to erosion, etc..

A pump intended for dry-well service shall have the volute incorporate in-built hand-holes to enable operator access for impeller inspection (discharge ports DN250 and larger).

18.6.1.7  Alternate Wear Plates

Where wear rings are not appropriate e.g. screw centrifugal type pump, an externally adjustable liner shall be provided to enable clearances to be maintained.

18.6.1.8  Pump Shaft

The shaft shall:

- Be equipped with replaceable shaft sleeves in areas subjected to wear.

18.6.1.9  Bearings

The bearings shall:

- Be stocked in Gold Coast/Brisbane by specialist bearing suppliers;
- For ball or roller bearings, be designed for a L10 Rating Fatigue life of 100,000 hours at the maximum operating speed;
- Be lubricated by oil bath or grease lubrication.
Where oil bath lubricated bearings are used, have fill and drain plugs, a breather and a method of checking the oil level.

The bearing housing shall be:

- Totally enclosed to prevent contamination; and
- Sealed at the shaft openings by lip type seals.

18.6.1.10 Shaft Seal

Sealing of the shaft shall be:

- Achieved by tandem mechanical seal arrangement or other approved arrangement such that no external flushing and cooling of the seal arrangement is required; and
- Guaranteed for a minimum operating life of 20,000 hours under normal pumping conditions.

Seal face materials shall be either Silicon Carbide or Tungsten Carbide and individually replaceable.

Spring and other metal components shall be manufactured from Grade 316 stainless steel or better.

18.6.1.11 Motor Rating

The motor shall be maximum continuous rated and shall be rated at least 10 % in excess of the maximum power required by the driven unit under all specified operating conditions. The motor shall be capable of a minimum of 15 starts per hour when coupled to the driven unit and be able to withstand at least two consecutive starts. The torque speed curve of the motor shall match the torque speed curve of the driven unit to ensure smooth positive starting and operation in conjunction with the starter used under operating conditions, which include variations in supply voltage. The Developer or the Contractor shall state the maximum permissible number of starts per hour when started under the driven load and the maximum number of consecutive starts.

18.6.1.12 Electrical Supply Variation

The motor shall meet all the requirements of this Supplementary Specification with the supply voltage, 415V, within the tolerance limits listed below:

- Supply Voltage: +6/- 6 %
- Frequency: +/- 2 %

18.6.1.13 Motor Insulation

Each motor shall have an insulation system with a rating of not less than Class 155 to IEC 60085. Each motor shall have an assigned temperature of 130 °C where the assigned temperature is the sum of the ambient temperature (taken to be 30 °C) plus temperature rise plus hot spot allowance (taken to be 20 °C).

18.6.1.14 Electrical Interference

The motor and associated motor starter shall not cause interference of any kind (including radio frequency interference) with any existing installation nor shall the motor be affected by external electromagnetic or acoustic interference. Should any incident be reported prior to the expiration of the defects period, this shall be investigated and made good at no additional cost to the Principal.
18.6.1.15  Motor Cooling

The motor shall be designed and adequately rated to operate at full load in air with convective cooling i.e. without additional cooling effect due to immersion in the pumped fluid. The temperature of the fluid in which the pump is immersed shall be taken as being taken as being up to 30 °C. Motors using a separate cooling jacket containing oil or glycol or similar shall be provided. The coolant filled jacket shall be cooled using the pumped fluid on a backplate type intercooler or similar arrangement is acceptable.

Motors which use the pumped medium or an external water supply around an intermediate cooling jacket shall not be acceptable.

18.6.1.16  Motor Protection

For motor sizes equal to or above 5.5kW, they shall be protected from overheating by:

- PTC thermistors or thermal (microtherm) switches - a minimum of one (1) embedded in each of the three (3) stator windings. The thermistors shall be rated for the insulation class.

18.6.1.17  Pump Unit Lifting Chains

Lifting chains, shackles and eyebolts shall be Grade 316 stainless steel and shall be designed to have a minimum factor of safety of 4 with the maximum Rated Capacity to be 1000 kg. Lifting eyes shall be designed to have a minimum factor of safety of 4 with the maximum Rated Capacity to be 1000 kg.

Shackles shall be sized to suit the chain supplied and installed.

18.6.1.18  Pump Unit Motor and Control Cables

Cables shall be provided with intermediate lifting cleats/devices to facilitate their removal from the well as the pump unit is lifted.

Submersible pump cable must be a continuous length of minimum 15 m.

18.6.2  Submersible Pump Units – Dry Well/Structure Mounted

Submersible pump units installed/mounted in the ‘dry’ in wells and other structures shall be in accordance with the Water Services Association of Australia Pump Code WSA 101 and the requirements of Clause 18.6.1 of this Supplementary Specification except for the nominated additional or alternative requirements listed below.

Refer to the Principal’s Accepted Mechanical Materials and Equipment Schedule for accepted pump models, see Table 17.1.

18.6.2.1  Mechanical Design Requirements

Each pump unit shall be a composite of the drive motor and the pump wetted end. The latter shall be joined to the former by means of an oil chamber housing containing the shaft sealing devices. The impeller shall be mounted on the one-piece motor shaft. The pump flanged suction bend shall be attached to the pump volute. The flanged pump discharge shall be cast with the volute.

The pump suction bend shall be provided with a removable impeller cleaning and inspection access cover.
For pumps with suction sizes 300mm or greater, suction bends must be provided with a minimum of 150mm inspection port and cover to enable cleaning and access to the pump impeller.

All suction bends must be manufactured from grey cast iron AS1830 grade 250.

A pump support spool shall be supplied and installed with each pump unit.

The dry well mounted submersible pump units must be mounted on a hot-dip galvanised steel support stand to meet site installation requirements.

The stand design must ensure:

- The natural frequency is at least 20% above the pump maximum operating speed
- Easy access to pump suction bend connection, pump mounting bolts and suction bend inspection cover
- Prevention of areas for water accumulation
- Grey cast iron (AS 1830, grade T220) or superior material

18.6.2.2 Pump Unit Lifting Chains

Lifting chains and shackles are not required. Grade 316 stainless steel lifting eyebolts shall be provided. They shall be designed to have a minimum factor of safety of 4 with the minimum Rated Capacity to be 1000 kg.

Access and hoisting equipment to remove each pump unit as detailed in Clause 18.5 of this Supplementary Specification shall be provided.

18.6.2.3 Pump Unit Motor and Control Cables

Where nominated by the Principal’s Representative in writing, submersible pump unit motor and control cables shall be provided with intermediate lifting cleats/devices to facilitate their removal from the well as the pump unit is lifted. The cables shall be connected either by plug and socket (<55 kW) or in a termination box for larger pump motors (> or = 55 kW) above the ‘inundation’ level.

In all other cases, the plug and socket (<55 kW) or in a termination box for larger pump motors (> or = 55 kW) may be at a lower level nearer to the pump unit.

18.6.3 Sump Pumps

18.6.3.1 Pump Type

Each sump pump shall be of a non-clog type. It shall comply with the requirement for a submersible pump unit as detailed shall be in accordance with the Water Services Association of Australia Pump Code WSA 101 and the requirements of Clause 18.6.1 of this Supplementary Specification modified as detailed below. Refer to the Principal’s Accepted Mechanical Materials and Equipment Schedule for accepted pump models, see Table 17.1.

Each sump pump shall have a three phase 415V AC motor. Single phase 240 V sump pumps typically do not meet the Principal’s design life requirements and shall only be used where approved by the Principal’s Representative in writing during the detailed design process.
18.6.3.2 Pump Arrangement

Typically each sump pump shall:

- Be provided with a minimum 500 mm square by minimum 450 mm deep sump formed in the base of the structure; and
- Have a minimum flow capacity of 1.5 L/s at the operating head of the discharge pipeline (static plus friction head).

18.6.3.3 Electrical Installation Requirements

For a sump pump with a duty flow less than 3 L/s at the duty point, it may be complete with an integral motor starter and level controller or where this arrangement is not available for the selected pump, a local control panel with a main switch, DOL motor starting contactor, thermal overload, duty selector switch, a Multi-Trode MTR or similar approved control relay for automatic control and local push buttons for manual control shall be provided (all in accordance with the requirements in Part 2 of this Supplementary Specification).

18.6.3.4 Mechanical Installation Requirements

Each sump pump with a duty flow less than 3 L/s at the duty point shall:

- Be provided with a Grade 316 stainless steel lifting chain extended to a suitable lifting location and attached by a Grade 316 stainless steel shackle to a suitable Grade 316 stainless steel support with 1 m of spare lifting chain;
- Be fitted with a minimum 50 mm diameter Grade 316 stainless steel hose tail shall be screwed into the pump’s volute;
- Be provided with a minimum 50 mm diameter Grade 316 stainless steel three piece ball valve for the discharge pipeline from the sump pump
- Be provided with a minimum 50 mm diameter Grade 316 stainless steel nipple screwed into the ball valve;
- Be provided with a minimum 50 mm diameter Grade 316 stainless steel non-return valve screwed onto the nipple;
- Be provided with a minimum 50 mm diameter Grade 316 stainless steel hose tail screwed into the non return valve; and
- Be provided with a minimum 50 mm diameter flexible discharge hose attached to this hose tail and to the pump discharge hose tail with two fully Grade 316 stainless steel hose clamps each end. The discharge hose shall long enough to allow the pump to be raised to the lifting location. Where the flexible discharge hose is more than 1.5 m long, the non-return valve shall be screwed onto the pump to prevent excessive backflow into the sump.

Where the sump pump has a duty flow equal to or greater than 3 L/s at the duty point, typically serving a larger facility (ie a medium or a large pumping station), two sump pumps shall be provided configured in a lead-follow arrangement. Each pump shall be suitably sized to manage the possible drainage flow scenarios and shall be provided with motor starters in Form 3b compartments (all in accordance with the requirements in Part 2 of this Supplementary Specification).

18.6.4 Horizontal Shaft Centrifugal Pump Units

18.6.4.1 Application
WATER NETWORK AND SEWERAGE NETWORK

SUPPLEMENTARY MECHANICAL AND ELECTRICAL SPECIFICATION

The section applies to horizontal shaft centrifugal pump units including small horizontal end suction centrifugal pump units, large horizontal end suction centrifugal pump units and horizontal split casing centrifugal pump units.

Specific details are provided in Clause 18.6.5 of this Supplementary Specification for small horizontal end suction centrifugal pump units, Clause 18.6.6 for large horizontal end suction centrifugal pump units and Clause 18.6.7 for horizontal split casing centrifugal pump units.

18.6.4.2 Pump Unit Arrangement

Each pump and motor shall be mounted on a common base plate. Regardless of pump size, the pump and motor shall both be adjusted using packing screws and skims to ensure that the unit is truly aligned.

The base plate shall be fabricated from substantial steel sections and shall be hot dip galvanised after fabrication. Four (4 No) Grade 316 stainless steel eye bolts and/or black steel lugs with 25 mm diameter holes for lifting purposes shall be provided on each base plate at or near to the extremities of the unit.

18.6.4.3 Pump Speed Requirements

The rated speed of each pump unit shall not exceed 1500 r/min unless otherwise specified or where approved by the Principal’s Representative in writing during the detailed design process.

During operation, resonance of each pump unit shall not occur. To ensure this outcome, the first lateral critical speed of the rotating assembly shall be calculated for the maximum diameter impeller that can be fitted to each pump unit. This calculation shall not include any support from the casing or impeller wear rings or shaft seals. The first lateral critical speed shall greater than 125% of the maximum speed of the pump unit. Where a variable frequency inverter is proposed or required, this speed shall be calculated at 60 Hz.

18.6.4.4 Pump Unit Mechanical Requirements

The flanges for each pump shall comply with AS 4087 Class PN16 unless a higher pressure class is required.

All fasteners used to assemble each pump and its motor including body fasteners in the pump and motor shall be Grade 316 stainless steel with suitable stress ratings for each application.

The direction of rotation shall be clearly and permanently marked on each pump’s casing.

18.6.4.5 Pump Unit Performance

The pumping units shall have steadily falling head/quantity curves from no-flow to flow rates 10% in excess of the flooded head flow rates.

Each pumping unit shall operate satisfactorily between the maximum and minimum pipe network characteristics including at any “flooded minimum head” condition without:

- Resonance or significant vibration; or
- Exceeding a current in any motor cable equivalent to 95% of the motor MCR current under the specified supply conditions.

18.6.4.6 Motor Requirements
The duty rating of the motor, when determined by the method shown in AS 1359 Part 30, shall be classified as Duty S1. The output rating of the motor as defined in AS 1359 Part 30 shall be such that when cooled by air at 40 oC, it exceeds the power required by the pump pumping against minimum head and system resistance.

Where an electric motor driving a pump is powered by a variable frequency inverter, then the maximum output rating for the motor shall be increased by 10 % above the requirements for an identical pump driven by a motor without a variable frequency inverter in its motor starter.

Each motor greater than or equal to 5.5 kW shall be fitted with thermistors of the positive thermal coefficient resistor type, connected in series, one per phase, integral with the stator windings and clearly marked in the terminal box. The thermistors, their fitting in the motor, reference temperatures and testing of the motor shall be in accordance with AS 60947 Part 8. The Principal’s Representative may request that smaller motors be provided with protect where the driven pump is a critical component of a facility.

Even though the motor is not submerged, a 660 V motor cable suitable for use under water shall be supplied and connected to the motor by means of a watertight gland. The cable shall be solid where it passes through a gland and be encapsulated in an appropriate sealant.

Insulation resistance shall be guaranteed for both works test and site service conditions. Before and after the pump test at the works, the insulation resistance shall be not less than 15 megohms. The Developer or the Contractor shall guarantee the insulation resistance of the motor at the end of the Defects Rectification Period. The guarantee for insulation in service shall be the recommendation of the motor manufacturer of a value above the minimum resistance at which the motor should be repaired or replaced. A 1.6 mm thick WBW Traffolyte label shall be attached beside the local control station for the motor giving the value at which the motor should be repaired or replaced.

18.6.4.7 Pump Unit Vibration Requirements

During operation, vibration of each pump unit shall not exceed:

- A displacement of 0.05 mm peak to peak; and
- A velocity of 6 mm/s zero to peak or just peak; and
- A peak acceleration of 1.0 g.

Vibration of each pump set shall be measured in-situ during commissioning with the pump operating at or near to its duty point or at any time during the defects liability period if the pump or pipework connected to the pump is vibrating significantly and the Principal’s Representative requests that the testing be repeated. Vibration measuring and reporting shall comply with the provisions of AS 2625, Parts 1 and 4.

18.6.4.8 Noise Requirements

The Sound Pressure Level (SPL) of each pump unit shall not exceed 60 dB(A) measured on a one metre radius above the pump/wet well cover, measured in accordance with AS 1055.2. Unless otherwise agreed in writing by the Principal’s Representative, the Developer or the Contractor shall take measurements over a 24 hour period during which each pump unit shall be scheduled to operate so that background noise can be filtered out of the noise spectrum to demonstrate compliance.

The use of and provision of sound attenuation treatments to the underside of the pumping station pump/wet well cover will be permitted to meet this requirement.

Detailed information including details covering the frequency range on the acoustic performance of each pump unit and the attenuation capacity of any sound attenuation shall be provided to the Superintendent and the Principal’s Representative for approval.
18.6.5 Small Horizontal End Suction Pump Units

Small horizontal end suction centrifugal pump units shall generally be in accordance with the Water Services Association of Australia Code WSA 130 for the bare shaft pump and WSA 131 for motor pumps except for the nominated requirements listed below. These standards are limited to pump units with suction and discharge flange sizes up to DN200 and DN150 respectively. Refer to the Principal’s Accepted Mechanical Materials and Equipment Schedule for accepted pump models, see Table 17.1.

In addition to the arrangement provided in WSA 130, a motor which is flange mounted to the pump, may be acceptable subject to obtaining written acceptance from the Principal’s Representative.

18.6.6 Large Horizontal End Suction Pump Units

This section applies to pump units with suction and discharge flange sizes greater than DN200 and DN150 respectively. Refer to the Principal’s Accepted Mechanical Materials and Equipment Schedule for accepted pump models, see Table 17.1.

Each pump shall be a single stage end suction centrifugal pump, long coupled to its motor. The impeller shall be of the single entry shrouded type. The impeller shall be able to be removed from the pump without dismantling the pump casing or motor from the base plate. Alternatively a motor, flange mounted to the pump, is acceptable subject to obtaining written acceptance through the Superintendent from the Principal’s Representative. Each pump shall be manufactured to the dimensional requirements of ISO 2858 End-suction Centrifugal Pumps (Rating 16 bar) - Designation, Nominal Duty Point and Dimensions.

The casing for each pump shall be Grade T-220 cast iron to AS 1830 and shall be tested to a pressure of 1.6 MPa unless a higher design pressure is nominated by the Developer, the Contractor, the Developer’s Designer or the Principal’s Representative. The test shall be either quality assured or be witnessed by the inspection and testing organisation and the casing then stamped.

Both the body and back plate shall be fitted with renewable phosphor bronze wearing rings to AS 1565/C 90250. A leaded tin bronze casing wear ring may acceptable subject to obtaining written acceptance through the Superintendent from the Principal’s Representative.

The impeller shall be of phosphor bronze to AS 1565/C 90250 statically and dynamically balanced on the spindle; accurately machined and fitted to reduce friction and leakage losses to a minimum. Alternatively, the impeller may be of stainless steel to AS 2074/H6C.

The pump shaft shall be of stainless steel to AS 2074/H5B of ample diameter to transmit the maximum power of the motor with safe margin for torque and critical speed. The pump shaft may be duplex stainless steel to EN 10088-3 1.4462.

The pump shaft shall be fitted with mechanical shaft seal consisting of a carbon compound rotating element running against a lapped solid silicon carbide face. Spring and backing washers shall be Grade 316L stainless steel to AS 1444.

Components not specifically above listed shall comply with Table 2.2 of WSA 130. Where alternate materials are proposed, the Developer or Contractor shall advise the Superintendent who will forward the information to the Principal’s Representative of the proposed alternate materials for approval (which may be in service performance conditional).

18.6.7 Horizontal Split Casing Centrifugal Pump Units

Each pump shall be a single stage, horizontally split casing, between bearings, centrifugal pump, long coupled to its motor. Refer to the Principal’s Accepted Mechanical Materials and Equipment Schedule for accepted pump models, see Table 17.1.
The impeller shall be of the double entry shrouded type. The impeller and shaft shall be able to be removed from the pump by removing the top part of the casing and without dismantling the motor from the base plate.

The casing for each pump shall be Grade T-220 cast iron to AS 1830 and shall be tested to a pressure of 1.6 MPa unless a higher design pressure is nominated by the Developer, the Contractor, the Developer’s Designer or the Principal’s Representative. The test shall be either quality assured or be witnessed by the inspection and testing organisation and the casing then stamped.

Both the body and impeller shall be fitted with renewable phosphor bronze wearing rings to AS 1565/C90250. Leaded tin bronze casing wear rings may acceptable subject to obtaining written acceptance through the Superintendent from the Principal’s Representative.

The impeller shall be of phosphor bronze to AS 1565/C 90250 statically and dynamically balanced on the spindle; accurately machined and fitted to reduce friction and leakage losses to a minimum.

The extension shaft shall be of stainless steel to AS 2074/H5B of ample diameter to transmit the maximum power of the motor with safe margin for torque and critical speed. The shaft shall be fitted with mechanical shaft seal consisting of a carbon compound rotating element running against a lapped solid silicon carbide face. Spring and backing washers shall be Grade 316L stainless steel to AS 1444.

### 18.6.8 Vertical Shaft Centrifugal Pump Units

Typically only split casing centrifugal pump units shall be installed with their shaft in a vertical orientation. The Developer or the Developer’s Designer shall obtain the written approval from the Principal’s Representative for the use of end suction pumps in a vertical orientation.

Each vertical shaft pump and motor shall be supplied with a pump support stool to mount the pump and a motor mounting flange to mount the motor. In some instances, a vertical line shaft drive may be required so that the motor is located above possible submergence level. This is the Principal’s non-preferred arrangement and shall only be adopted with the written approval from the Principal’s Representative.

Some bearing and seal changes shall be made from the equivalent horizontal shaft pump and motor assembly. In all other respects, the pump shall comply with the requirements of Clause 18.6.4 and Clause 18.6.7 of this Supplementary Specification. Refer to the Principal’s Accepted Mechanical Materials and Equipment Schedule for accepted pump models, see Table 17.1.

### 18.6.9 Progressive cavity (Helical Rotor) Pump Units

Each pump and motor shall be mounted on a common base plate. Each pump and motor shall be adjusted using packing screws and shims to ensure that the unit is truly aligned. Refer to the Principal’s Accepted Mechanical Materials and Equipment Schedule for accepted pump models, see Table 17.1.

Each base plate shall be fabricated from substantial sections. Where black steel is used, it shall be hot dip galvanised after fabrication. Four (4 No) Grade 316 stainless steel eye bolts and/or black steel lugs with 25 mm diameter holes for lifting purposes shall be provided on each base plate at or near to the extremities of the unit.

The maximum speed of each pump unit shall be limited to 500 r/min. The actual operating speed to meet the duty point shall be as nominated by the Developer, the Developer’s Designer or the Contractor.

The preferred orientation for each pump shall be suction on the shaft sealing gland end, ie an arrangement with discharge on the shaft sealing gland end is not preferred by the Principal.

The orientation of each pump’s inlet shall normally be top facing but shall be able to be orientated in any of the three directions; left, top and right.

Each pump shall be a pedestal mounted, positive displacement progressive cavity (helical rotor) pump. The pumping element shall consist of a Grade 316 or better stainless steel rotor to AS 2837 revolving in a moulded stator. The composition of the stator shall be chosen to suit the material to be pumped and to minimise wear. The rotor shall be hard chrome plated and polished.
The stator body, inlet connection, outlet connection bearing housing and mounting feet shall be Grade T-180 cast iron to AS 1830 tested to a pressure of 1.2 MPa. The test shall be either quality assured or be witnessed by an inspection and testing organisation and the housing then stamped.

The rotor drive shaft shall be of Grade 431T stainless steel to AS 1444 designed to take the whip from the eccentric rotation of the rotor.

The hollow drive shaft shall be stainless steel. The shaft shall run in grease lubricated bearings, and shall be sealed by a mechanical seal.

Each pump unit shall be suitable to the pumping application and shall be acceptable to the Superintendent and to the Principal's Representative. Each pump shall be fitted with a dry run protection temperature probe mounted in the pump stator as approved by the Superintendent. For example, for a Mono pump unit, the device shall be a PT100 - Mono 80D2434.

Each pump shall be designed for coupling through a flexible coupling of the rubber bushed pin type to a 4 pole squirrel cage motor. Each pump shall be provided with a suitable coupling guard manufactured from the same material as the base plate and similarly finished.

If recommended by the manufacturer, anti-vibration mounts shall be supplied and fitted to each pump unit.

The duty rating of the motor, when determined by the method shown in AS 1359 Part 30, shall be classified as Duty S1. The output rating of the motor as defined in AS 1359 Part 30 shall be such that when cooled by air at 40 oC it exceeds the power required by the pump pumping against minimum head and system resistance.

Where an electric motor driving a pump is powered by a variable frequency inverter, then the maximum output rating for the motor shall be increased by 10 % above the requirements for an identical pump driven by a motor without a variable frequency inverter in its motor starter.

The motor shall be fitted with thermistors of the positive thermal co-efficient resistor type, connected in series, one per phase, integral with the stator windings and clearly marked in the terminal box. The thermistors, their fitting in the motor, reference temperatures and testing of the motor shall be in accordance with AS 60947 Part 8.

Even though the motor is not submerged, a 660 volt motor cable suitable for use under water shall be supplied and connected to the motor by means of a watertight joint. The cable shall be solid where it passes through a gland and be encapsulated in an appropriate sealant.

Insulation resistance shall be guaranteed for both works test and site service conditions. Before and after the pump test at the works, the insulation resistance shall be not less than 15 megohms. The Contractor shall guarantee the insulation resistance of the motor at the end of the Defects Rectification Period. The guarantee for insulation in service shall be the recommendation of the motor manufacturer of a value above the minimum resistance at which the motor should be repaired or replaced. A 1.6 mm thick WBW Traffolyte label shall be attached beside the plug and socket for the motor giving the value at which the motor should be repaired or replaced.

Each pump discharge shall be fitted with a pressure relief valve designed to protect the pump in the event of accidental starting against either a closed discharge valve or a flow controlling valve in the discharge pipework being closed. The pressure relief valve shall be capable of adjustment so that it will open when the gauge pressure on the discharge side of the pump is at the by-pass pressure.

For DN80 and DN100 discharge pipework, each pressure relief valve shall be a minimum 50 mm nominal diameter, flanged base, Grade 316 stainless steel Stead and Baker Rapid Fig 270 or equivalent acceptable to the Superintendent and the Principal's Representative. Where the proposed pressure relief valve has a screwed base, it shall be combined with a Grade 316 stainless steel blank flange with a tapped hole to suit the valve base diameter. The blank flange shall be attached to a tee located in an acceptable manner.

For DN150 and DN200 discharge pipework, each pressure relief valve shall be a minimum 80 mm nominal diameter, flanged base, Grade 316 stainless steel Stead and Baker Rapid Fig 270 or equivalent
acceptable to the Superintendent and the Principal's Representative. Where the proposed pressure relief valve has a screwed base, it shall be combined with a Grade 316 stainless steel blank flange with a tapped hole to suit the valve base diameter. The blank flange shall be attached to a tee located in an acceptable manner.

Provision shall be available in each pressure relief valve to connect a Grade 316L stainless steel pipe to its outlet to collect the discharge and return it to the suction pipework or to a suitable drainage location. Each pipe shall include sufficient dismantling joints to allow the pipe’s removal from the discharge of the pressure relief valve.

Where requested by the Principal’s Representative in writing, a proximity or similar switch shall supplied and installed to detect the operation of the pressure relief valve.

18.6.10 Vacuum Generators/Pumps
The vacuum generator shall be a rotary vane vacuum pump with a heater installed in the oil tank set at 80 °C. The heater is required to stop any water carry over into the oil.

The operating vacuum developed by the vacuum pump shall be determined from the reticulation design. For further guidance, the Developer, the Contractor or the Developer's Designer shall refer to the SEQ Vacuum Sewerage Code.

Factors such as noise, water quality and temperature shall also be considered by the Developer, the Contractor and the Developer’s Designer, as well as the effect of the exhaust gases on the type of odour management unit to be installed by the Developer for the facility. The Principal preferred odour control device is ODouriDder Biofilter system or similar, refer to Water Services Association of Australia, Industry Standard For Biofilters For Odour Control WSA 121 - 2004.

18.6.11 Water Submersible Pumps
Refer to the Principal’s Accepted Mechanical Materials and Equipment Schedule for accepted pump models, see Table 17.1. Selection of pump shall be the approval of the Principle prior to ordering of the pumps.

The pump material shall be stainless steel (AISI 316) including the pump casing and all components in contact with water. AISI 304 stainless steel is acceptable when an equivalent AISI 316 stainless steel cannot match the duty at a high efficiency point. The number of impellor stages shall be matched to the duty point to achieve highest efficiency rating. Two pole motors are acceptable for this application.

See clause 50.3 Water Pump Station Automatic control for SCADA interface requirements.

18.6.12 Water Package Units Using Vertical Multistage Pumps
Refer to the Principal’s Accepted Mechanical Materials and Equipment Schedule for accepted pump unit models, see Table 17.1. Selection of pump shall be the approval of the Principle prior to ordering of the pumps.

The pump material shall be stainless steel (AISI 316) including the pump casing and all components in contact with water. AISI 304 stainless steel is acceptable when an equivalent AISI 316 stainless steel cannot match the duty at a high efficiency point. The number of pumps shall be matched to the normal operation duty point to achieve minimum energy usage but provide sufficient capacity for fire flow. Different size pumps are acceptable. Integrated VSDs and fully engineered control packages are acceptable. Two pole motors are acceptable for this application.

See clause 50.3 Water Pump Station Automatic control for SCADA interface requirements.

19 PUMP WELL AND VALVE PIT OPENING COVERS AND FALL PROTECTION
19.1 Pump Well And Valve Pit Opening Covers

Pump well and valve pit and any other similar opening covers shall be installed as per the SEQ-SPS-1304 series of standard drawings.

The Contractor shall refer to Clause 25.3.5, Clause 30.4 and Clause 30 of this Supplementary Specification for the Principal’s requirements for the fabrication of each aluminium cover for each pump well and valve pit opening.

All external surfaces of aluminium covers shall be coated with an anti-slip coating system conforming to AS/NZS 4586 at a Classification of W of Table 2 and R11 of Table 5 applied to the manufacturer’s recommendations over a suitable aluminium chemical etchant and primer.

The anti-slip coating system shall be applied so that the operation/movement of the cover is not restricted

The anti-slip coating system shall be either:

- 100% solids moisture curing MDI based polyurethane prepolymer including a crumbed rubber binder such as Huntsman Daltobond CR2; or a similar approved coating; or
- A liquid applied acrylic-polyurethane composite coating including a 16/30 crumbed rubber such as Neoferma Neotop or a similar approved coating; or
- A high content =>90% by volume of solids content, epoxy flooring system suitable for marine and industrial environments such as Epirez Supatuff AS-550 or a similar approved coating; or
- A medium content =>50% & =<80% by volume of solids content, water base polyurethane flooring system suitable for marine and industrial environments such as Parbury Tex·Cote or a similar approved coating.

19.2 Pump Well and Valve Pit Opening Fall Protection

Pump well and valve pit and any other similar opening “fall protection” shall be installed as per the SEQ-SPS-1304 series of standard drawings.

For existing pumping stations without fall protection, each pump well, valve pit and any other similar opening shall be provided with a personnel safety netting system. The safety net shall be made from black polyethylene rope complying with AS 4142.3 with 10 mm diameter rope for the net mesh and 16 mm diameter rope for the border. The border rope may be white.

The safety net shall be constructed to the requirements Appendix F Industrial Safety Nets of AS/NZS 4576 with a square aperture of 100 mm and shall be fixed with 150 mm long by 12 mm diameter Grade 316 stainless steel twisted “J-hooks” or 100 mm Thread Lock Grade 316 stainless steel Carbine Hooks at 300 mm centres.

Each J-hook shall be attached to a 12 mm diameter Grade 316 stainless steel threaded eye bolt that is welded closed. Each eye bolt shall be screwed into a 12 mm diameter Grade 316 stainless steel ferrule cast into place in the wet well and/or valve chamber top slab opening at a maximum spacing of 300 mm. Each ferrule shall have a 300 mm length of R8 reinforcing steel through its cross hole.

The hooks shall be placed so that they do not interfere with pump removal.

The net shall be provided with an Asset Identifier number. A Grade 316 stainless steel label shall be attached to the net with the Asset Identifier number and the date of manufacture so that its timely replacement at the end of its safe service life of 2 years can be managed.
20.1 General

20.1.1 Scope of Application
This clause shall apply to both sewage pumping stations and water pumping stations. Generally this clause shall apply to pipework and fittings which are installed in an 'above ground' application including within an enclosed pumping station, a valve pit or a similar location, ie they are not buried below the ground surface. In some instances pipework may extend from a 'below ground' location to an 'above ground' location in which case this clause shall apply to the whole of the section of pipework.

20.1.2 Restrictions on Materials
Where pipes or fittings do not comply with AS/NZS 4020, they shall be marked continuously along their length 'not suitable for drinking water' with legible lettering of minimum 20 mm height.

A UV protection system in accordance with any requirements shown on the drawings and approved by the Superintendent shall be provided on all PVC or ABS pipework that is not buried or embedded. Normally, two coats of PVA paint with an appropriate colour (typically White for most applications except Light Blue for compressed/instrument/service/process air and Lilac for recycled/service water applications) shall be applied to the pipework after it is assembled but before it is clamped/fastened in place.

Copper pipework shall generally not be used within sewage pumping stations or within sewage treatment plants. Exception are where the pipework is:

- Not exposed to sewer or process unit gases even at low concentrations; or
- Fully enclosed within the fabric of buildings other than those containing process units.

20.1.3 Serviceability Requirements
Pipework shall be:

- Designed and installed to enable automatic flushing and drainage of pipework and all equipment where required specifically for process purposes;
- Designed and installed to enable manual flushing and drainage of pipework and all equipment under all situations to prove isolation and safe conditions for operators/maintainers;
- Designed and installed to enable cleaning of pipework and all equipment;
- Fitted with easily removable flanges or couplings and cleanouts where appropriate to allow for maintenance including rodding;
- Provided with sufficient dismantling joints to allow easy dismantling of each section of pipework and for removal and replacement of all valves, meters and injection points;
- Designed to be thrust resistant and adequately braced under all load conditions; and
- Constructed in accordance with the designers and / or manufacturer's recommendations.

20.1.4 Design Requirements
The combined stresses in the pipework system shall not exceed the allowable stresses for the pipe material.

Deflection of the pipe when filled shall not exceed the value given in the following formula:

\[ D = \frac{L}{350} \]

Where \( D \) = deflection (mm)
L = span between supports (mm).

The maximum spacing of pipe supports, unless otherwise shown on the drawings, shall not exceed 3000 mm.

The design shall provide thrust restraint for each valve in accordance with the design prepared by the Developer's Designers and as shown on the project drawings or with the Principal's Standard Drawing/s. The design shall provide thrust restraint for each section of pipework and in particular section work pipework with out of balance hydraulic loads in accordance with the design prepared by the Developer's Designers.

20.1.5 Fabrication and Installation Requirements
The Contractor shall provide/fabricate and install all pipe support systems required to fully and adequately support all pipework, valves and fittings to the manufacturer’s recommendations, the detailed design prepared by the Developer’s Designer and the requirements of this Supplementary Specification.

The spacing of pipe supports shall be as indicated on the drawings or where not indicated shall be such that the following requirements are complied with:

- Pipework shall not be fastened in direct contact with any wall, floor, ceiling, beam, column, equipment item or other surface; and
- Pipework running parallel to such surfaces shall be supported by means of bolted pipe clamps and brackets or approved pipe clips so that the minimum distance between any part of the pipe, pipe fittings, valve or inline fitting and the adjacent supporting surface shall not be less than 20 mm for pipes up to 25 mm diameter, 40 mm for pipes up to 80 mm diameter and 50 mm for pipes over 80 mm diameter.

Thrust supports and other supports for pipes, valves and fittings shall be designed to be readily de-mountable without dismantling the pipework to allow for:

- Either replacement;
- Or future modifications of the supports;
- Or re-application of corrosion protection coatings.

20.1.6 Flexible Couplings and Dismantling Joints
Flexible couplings and dismantling joints include flanged joints (where the pipework sections can be moved apart – typically PVC, PE, PP and ABS pipe systems), compression unions, gibault joints, loose flanged couplings and tied dismantling joints as appropriate to the pipe material.

‘Uni-Flange’, ‘Adaptor’ or similar types of flanges shall only be used in the work with the written approval of the Principal’s Representative.

Flexible couplings and dismantling joints shall be carefully selected for each application and shall be capable of withstanding the pressures and forces imposed on the pipework under all operation and testing. The Developer, Contractor and/or the Developer’s Designer shall submit all flexible couplings proposed to be used to the Superintendent for on-forwarding to the Principal’s Representative for review and approval.

When subjected to the manufacturer’s recommended maximum angular deflection, the assembled joints shall provide a watertight seal at all pressures up to the test pressure of the pipes with which they are to be used.

Refer to Clause 20.10 of this Supplementary Specification for further details on flexible pipework jointing components.

20.1.7 Pipework Labelling Requirements
‘Above ground’ pipework, conduits and ducts shall be provided with identification markers indicating contents and direction of flow in accordance with AS 1345. Markers shall be long life, UV resistant, self-adhesive labels and shall be subject to approval by the Superintendent. Marker tape shall also be provided for ‘below ground’ pipework and conduits.

**20.2 Ductile Iron Pipework**

**20.2.1 General**

Ductile iron (DI) pipe shall comply with AS/NZS 2280. DI pipes shall be internally lined with cement mortar as set out in Table 2.1 of AS/NZS 2280.

Where exposed in pits, structures or ‘above ground’, the pieces of pipe shall have applied to the external surfaces of each pipe including all flanges:

- Either a factory applied high build, virtually solvent free epoxy protective coating system similar to Jotacote 412 or Devtar 5A; or a coating system that complies with the Australian Paint Approval Scheme Specification No. 0213 - Coatings for Steel Used in Sewage Works.

Each pipe shall be supplied with two (2) coats of the protective coating system that has been applied over a compatible primer following abrasive blast cleaning of each pipe in accordance with AS 1627.4 at Class 2.5.

The two applied coats shall have a combined dry film thickness of 500 microns minimum with the dry coatings to be continuity tested, by wet sponge in accordance with AS 3894.2 with any holidays to be repaired in accordance with the manufacturers’ instructions:

- Or a factory applied thermal bonded polymeric (TBP) corrosion protective coating that shall comply with the requirements of AS/NZS 4158 and be applied by a fluidized bed technique.

TBP coated pipe shall not be field cut except where it is nominated as a ‘site cut’ make-up piece on the project drawings (usually jointed by a gibault joint, loose flange coupling or tied dismantling joint). The cut end shall be repaired using a coating system approved by the pipe manufacturer under the direct supervision of the pipe manufacturer’s personnel in the first instance.

The pipe colour shall match the colour of the TBP coated valves and fittings.

**20.2.2 DI Flanged Pipework**

All DI flanged pipework shall be manufactured in accordance with AS/NZS 2280 - flange class wall thickness ductile iron pipe to which has been fitted threaded boss flanges in accordance with AS 4087.

Flanges shall be raised face as detailed in Appendix C of AS 4087 and the pressure rating shall be equal to that of the fittings and shall match or exceed the design pressure rating for the pipework.

Pipes may be of flange/flange, flange/socket or flange/spigot configuration as required. All flange faces shall be machined at right angles to and concentric with the axis of the internal diameter of the pipe. For all new pipework, flanges shall be drilled in accordance with AS 4087 - Figure B.5 unless connecting on to existing pipelines where the connecting flange shall match the existing flange.

**20.2.3 DI Flanged Fittings**

Flanged DI pipe fittings shall be manufactured in accordance with AS/NZS 2280 and flanges shall be in accordance with AS 4087 - Figure B.5 unless connecting onto existing pipelines, where the connecting flanges shall match the existing flanges.

Flanges shall be raised face as detailed in Appendix C of AS 4087 and the pressure rating shall be equal to that of the fittings and shall match or exceed the design pressure rating for the pipework.
Fittings shall be coated externally as specified in Clause 20.2.1 of this Supplementary Specification herein. DI pipe fittings shall be internally lined with cement mortar as set out in Table 2.1 of AS/NZS 2280.

20.2.4 Puddle Flanges

Puddle flanges include both weep flanges for the sealing of pipe penetrations through concrete sections including walls, floor and roofs, and thrust flanges for the transfer of hydraulic loads to concrete sections including walls, floor, roofs and other structural elements.

Each puddle flange shall comply with AS/NZS 2280 - Clause 3.3 except that all nuts, bolts and washers used in the assembly of the puddle flange shall be Grade 316 stainless steel.

Puddle flanges shall be attached to flange class pipe by a machined groove complying with AS/NZS 2280. Each puddle flange shall be installed on the pipe section before it is coated as specified in Clause 20.2.1 of this Supplementary Specification.

20.2.5 Pipework Supports

Pipework supports shall comply with Clause 20.8.1 of this Supplementary Specification.

20.2.6 Pipework Jointing

Pipework jointing shall comply with Clause 20.9.40 of this Supplementary Specification.

20.3 Stainless Steel Pipework

20.3.1 Large Diameter Pipework (> & = DN50)

Stainless steel pipe shall be Schedule 10S or 40S as applicable, shall comply with ASTM A312M - 12a Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes with dimensions to ASTM A269 - 10 Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service and shall be Grade 316L. Unless otherwise stated or required for particular applications, longitudinally welded stainless steel pipe is acceptable provided that it meets the safe pressure requirement of the application.

Grade 316L stainless steel butt welded forged bends and other fittings with flanged joints between pipework sections shall be used to fabricate the pipe system. Stainless steel bends and other fittings shall be Schedule 10S or 40S as applicable, shall comply with ASTM A403M - 12 Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings and shall be Grade 316L.

The pipework sections shall be designed and fabricated to be demountable ie it will not be acceptable for the Principal’s personnel to have to cut pipework systems into pieces to dismantle the pipework for maintenance.

Cold cutting is preferred over friction cutting.

Where full, unhindered access is not available to debur, pickle and descale internal weld surfaces, complete argon gas purging shall be used during welding.

20.3.2 Small Diameter Pipework (< & = DN38)

Stainless steel tube shall comply with AS 1528 or with ASTM A554 - 11 Standard Specification for Welded Stainless Steel Mechanical Tubing with dimension to ASTM A269 and shall be Grade 316L.
Cold cutting is preferred over friction cutting.

Stainless steel fittings used for this pipework may be compression fittings to AS 1528 or DIN 2353, Swagelok or similar approved, or alternatively branches may be ‘pulled’ into the tube. Where ‘pulled’ branches are used, sufficient dismantling joints, either flanges, unions or compression fittings, shall be incorporated into the pipework system to allow the Principal's personnel to dismantle the pipework for maintenance.

All welds in the pipework shall be exclusively undertaken using the TIG welding process. Complete argon gas purging shall be used during welding.

### 20.3.3 Flanged Joints
Grade 316L stainless steel flanges shall be in accordance with AS 4087 - Figure B.5 unless connecting onto existing pipelines, where the connecting flanges shall match the existing flanges. Flanges shall be raised face as detailed in Appendix C of AS 4087 and the pressure rating shall be equal to that of the fittings and shall match or exceed the design pressure rating for the pipework.

### 20.3.4 Puddle Flanges
Puddle flanges include both weep flanges for the sealing of pipe penetrations through concrete sections including walls, floor and roofs, and thrust flanges for the transfer of hydraulic loads to concrete sections including walls, floor, roofs and other structural elements.

Each puddle flanges shall comply with AS 4087 for plate flanges and shall be Grade 316L stainless steel. Each puddle flange shall be attached to the pipe by continuous welding as designed by the Developer's Designer.

### 20.3.5 Pickling and Passivating
All welds in fabricated stainless steel pipework sections and other associated components shall be pickled and de-scaled in accordance with ASTM A380M – 13 Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems. All discoloration at welds and friction cuts shall be removed as part of the pickling process.

The whole external and internal surfaces of all fabricated stainless steel pipework sections and associated components shall be completely cleaned and passivated in accordance with ASTM A380M after fabrication. The process shall be repeated in-situ immediately before completion of the work if the surfaces have been contaminated during installation, testing or commissioning as evidenced by visible corrosion or tea staining.

### 20.3.6 Pipework Supports
Pipework supports shall comply with Clause 20.8.1 of this Supplementary Specification.

### 20.3.7 Pipework Jointing
Pipework jointing shall comply with Clause 20.9.40 of this Supplementary Specification.

### 20.4 Steel Pipework

#### 20.4.1 General
Steel pipes shall comply with AS 1579. The minimum wall thickness shall be 5 mm. The pipes shall be externally coated with a fusion bonded medium density polyethylene (FBMDPE) coating in accordance with AS 4321.
Steel flanged pipework shall be manufactured from AS 1579 pipe to which has been fitted plate flanges in accordance with AS 4087 Figure B7 as raised face flanges.

Pipes may be of flange/ flange, flange/ socket or flange/ spigot configuration as specified. All flange faces shall be machined at right angles to and concentric with the axis of the internal diameter of the pipe. For all new work flanges shall be drilled in accordance with AS 4087 Figure B7 unless connecting on to existing mains where the connecting flange shall match the existing flanges.

Prior to welding the flange to the pipe, the FBMDPE coating shall be cut back to a neat edge 50 mm clear of the weld. After the completion of welding and inspection, the pipe barrel and exposed parts of the flange shall be coated with an epoxy painted coating as specified in Clause 20.2.1 of this Supplementary Specification.

The epoxy painted coating between the original FBMDPE coatings shall be covered using a UV stabilised heat shrink sleeve.

All pipes shall be cement mortar lined.

20.4.2 Flanged Joints
Flanges shall be in accordance with AS 4087 - Figure B.5 unless connecting onto existing pipelines, where the connecting flanges shall match the existing flanges. Flanges shall be raised face as detailed in Appendix C of AS 4087 and the pressure rating shall be equal to that of the fittings and shall match or exceed the design pressure rating for the pipework.

20.4.3 Puddle Flanges
Puddle flanges include both weep flanges for the sealing of pipe penetrations through concrete sections including walls, floor and roofs, and thrust flanges for the transfer of hydraulic loads to concrete sections including walls, floor, roofs and other structural elements.

Each puddle flange shall comply with AS 4087 for plate flanges and shall be steel. Each puddle flange shall be attached to the pipe by continuous welding as designed by the Developer’s Designer.

20.4.4 Pipework Supports
Pipework supports shall comply with Clause 20.8.19 of this Supplementary Specification.

20.4.5 Pipework Jointing
Pipework jointing shall comply with Clause 20.9.4 of this Supplementary Specification.

20.5 PVC Pipework

20.5.1 General
Only PVC to AS/NZS 1477 Series 1 is approved for ‘above ground’ and ‘in building’ applications.

20.5.2 Pressure Rating
Small diameter PVC pipe (less or equal to than DN50) shall be a minimum Class 15 and shall conform to AS 1477 Series 1 Solvent Weld Joint.

Large diameter PVC pipe (greater than DN50) shall be a minimum Class 12 unless the Developer’s Designer nominates a higher pressure rating and shall conform to AS 1477 Series 1 Solvent Weld Joint.
20.5.3 PVC Fittings and Jointing
Small diameter PVC fittings shall be Class 18 and conform to AS 1477 Series 1 Solvent Weld Joint.

The pipework sections shall be designed and fabricated to be demountable ie it will not be acceptable for the Principal’s personnel to have to cut pipework systems into pieces to dismantle the pipework for maintenance. Sufficient dismantling joints, either flanges, unions or compression fittings, shall be incorporated into the pipework system.

Grade 316 stainless steel backing rings shall be used on all PVC flanges regardless of the application.

20.5.4 Pipework Supports
Pipework supports shall comply with Clause 20.8.1 of this Supplementary Specification.

20.5.5 Pipework Jointing
Pipework jointing shall comply with Clause 20.9.4 of this Supplementary Specification.

20.6 Polyethylene Pipework

20.6.1 20mm to 90mm OD Pipes and Fittings
Polyethylene (PE) pipe shall comply with the requirements of AS/NZS 4130 and shall be Series 1 SDR9 PE80B. Fittings shall be polyethylene compression fittings complying with AS/NZS 4129 and shall be compatible with the above pipe.

20.6.2 90mm and above OD Pipes and Fittings
PE pipe shall comply with the requirements of AS/NZS 4130 and shall be Series 1 SDR9 PE80B. Fittings shall be polyethylene electrofusion couplings conforming to AS/NZS 4129 and shall be compatible with the above pipe.

The PE pipework sections shall be designed and fabricated to be demountable ie it will not be acceptable for the Principal’s personnel to have to cut pipework systems into pieces to dismantle the pipework for maintenance. Sufficient dismantling joints, either flanges, unions or compression fittings, shall be incorporated into the pipework system.

Grade 316 stainless steel backing rings shall be used on all PE flanges regardless of the application.

20.6.3 Pipework Supports
Pipework supports shall comply with Clause 20.8.1 of this Supplementary Specification.

20.6.4 Pipework Jointing
Pipework jointing shall comply with Clause 20.9.4 of this Supplementary Specification.

20.7 Acrylonitrile Butadiene Styrene Pipework

Acrylonitrile Butadiene Styrene (ABS) pipe and fittings shall comply with the requirements of AS 3518 Parts 1 and 2 and shall be either Series 1 or Series 2 as well as DR 01083.

Fittings may be solvent weld jointed.

The ABS pipework sections shall be designed and fabricated to be demountable ie it will not be acceptable for the Principal’s personnel to have to cut pipework systems into pieces to dismantle the
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pipework for maintenance. Sufficient dismantling joints, either flanges or unions, shall be incorporated into the pipework system.

Grade 316 stainless steel backing rings shall be used on all ABS flanges regardless of the application.

20.7.1 Pipework Supports
Pipework supports shall comply with Clause 20.8.1 of this Supplementary Specification.

20.7.2 Pipework Jointing
Pipework jointing shall comply with Clause 20.9.4 of this Supplementary Specification.

20.8 Copper Pipework

Copper pipe shall comply with AS 1432 with the particular type used to be suitable for operating at a minimum safe working pressure of 1600 kPa.

Copper pipe and fittings shall have silver soldered joints.

The copper pipework sections shall be designed and fabricated to be demountable ie it will not be acceptable for the Principal’s personnel to have to cut pipework systems into pieces to dismantle the pipework for maintenance. Sufficient dismantling joints, either unions or compression fittings, shall be incorporated into the pipework system.

20.8.1 Pipework Supports
Pipework supports shall comply with Clause 20.8.1 of this Supplementary Specification.

20.8.2 Pipework Jointing
Additional pipework jointing materials shall comply with Clause 20.9.4 of this Supplementary Specification.

20.9 Pipework Supports

20.9.1 Sewage Pumping Stations
Pipework supports for sewage pumping stations in all locations shall be fabricated from Grade 316L stainless steel. Hot-dip galvanised black (low carbon) steel supports shall not be used.

20.9.2 Water Pumping Stations
Pipework supports for water pumping stations may be fabricated from Grade 316L stainless steel or may be fabricated from hot-dip galvanised black steel. Where hot-dip galvanised black steel supports are used, any components with damaged hot-dip galvanising shall be returned to the galvanising works for rehot-dip galvanising.

20.9.3 Fabrication Requirements
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All joints in either Grade 316L stainless steel or black steel supports shall be seal welded. Where the Superintendent and the Principal’s Representative are prepared to accept stitch welding in writing, the parts being jointed shall be gapped apart by 3 mm to avoid forming crevices.

All welds in fabricated stainless steel supports and other associated components shall be pickled and descaled in accordance with the standard used in this Supplementary Specification for pipework pickling and passivating, ASTM A380. All discoloration at welds and friction cuts shall be removed as part of the pickling process.

The whole external and internal surfaces of all fabricated stainless steel supports and associated components shall be completely cleaned and passivated in accordance with ASTM A380 after fabrication. The process shall be repeated in-situ immediately before completion of the work if the surfaces have been contaminated during installation, testing or commissioning as evidenced by visible corrosion or tea staining.

Patch painting, where accepted by the Superintendent and the Principal’s Representative for very small areas of damaged galvanising (less than 1000 square mm) per component, shall be undertaken using an aluminium filled or similar epoxy repair system. The patched areas shall only be over-coated with a cosmetic colour coating after the Superintendent and the Principal’s Representative have signed off on the repairs.

Any Unistrut or similar sections used in any pipe support shall be Grade 316L stainless steel. Hot-dip galvanised Unistrut or similar shall not be used. Pipework saddles used with Unistrut shall be fabricated from Grade 316L stainless steel.

Pipework saddles used in or at sewage pumping stations shall be fabricated from Grade 316L stainless steel. Pipework saddles used in or at water pumping stations shall be fabricated from Grade 316L stainless steel where used on stainless steel supports or may be hot dip galvanised steel where used on hot dip galvanised supports.

Pipework saddles used with PVC and PE pipework shall be fabricated from Grade 316L stainless steel or may be co-polymer (polyethylene, polypropylene or similar) with Grade 316 stainless steel plates and fasteners. Pipework saddles used with copper pipework shall be fabricated from copper or may be co-polymer with Grade 316 stainless steel plates and fasteners.

All pipework larger than DN50 shall be provided with a suitable separator (rubber, polyethylene, polypropylene or similar) between the pipe barrel and the pipework supports and saddles.

20.9.4 Support Fasteners

All fasteners used in supports and elsewhere shall comply with Clause 31 of this Supplementary Specification.

20.10 Pipework Jointing

20.10.1 Flange Gaskets

Flange gaskets shall comply with the requirements of Figure B5 and Appendix D of AS 4087.

Gaskets shall be manufactured from an elastomer complying with AS 1646 and may contain a reinforcement material. The maximum working pressure for gaskets shall be 1600 kPa at 3.0 mm thick.

20.10.2 Gibault Joints

Gibault joints shall be cast iron fittings complete with Grade 316 stainless steel bolts, nuts and washers and chloroprene rings. The rings shall be coated in accordance with Clause 6.2.1 of AS/NZS 2544 for underground use regardless of the proposed installation location. Rubber rings shall comply with AS 1646. All gibault joints and reducing gibault joints shall be of the elongated type. They shall be approved by the Superintendent and shall be on the Principal’s Accepted Mechanical Materials and Equipment Schedule, see Table 17.1.
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All fasteners, nuts, bolts and washers used in the assembly of gibault joints shall be Grade 316 stainless steel.

20.10.3 Dismantling Joints
Dismantling joints shall be Class PN16, either thrust type or non-thrust type depending on the pipeline arrangement.

For ductile iron pipework, they shall be manufactured from ductile iron generally as detailed below. For steel and stainless steel pipework, they shall be manufactured from Grade 316L stainless steel generally as detailed below.

20.10.3.1 Loose Flange Couplings
The components for each loose flange coupling shall be machined from:

- Either DI flanges for DI pipework in accordance with the manufacturer’s design before the components are coated as specified in Clause 20.2.1 of this Supplementary Specification;
- Or Grade 316L stainless steel plate flanges for steel and stainless steel pipework in accordance with the Developers Designer’s design.

The rubber ring in each loose flange coupling shall comply with AS 1646.

20.10.3.2 Tied Dismantling (or Thrust Transmitting Flexible) Joints
The fixed flange for each tied dismantling (or thrust transmitting flexible) joint shall:

- Either be a DI flange cast onto the DI flange spigot pipe in accordance with the manufacturer’s design for DI pipework;
- Or be a Grade 316L stainless steel plate flange welded onto both steel and stainless steel pipework in accordance with the Developers Designer’s design. A painted steel flange will not be accepted on the steel pipe barrel due to the high fastener washer induced torque loads on the steel coating.

The loose components for each tied dismantling joint shall be machined from:

- Either DI flanges for DI pipework in accordance with the manufacturer’s design before the components are coated as specified in Clause 20.2.1 of this Supplementary Specification;
- Or Grade 316L stainless steel plate flanges for steel and stainless steel pipework in accordance with the manufacturer’s design.

The rubber ring in each tied dismantling joint shall comply with AS 1646.

The Grade 316 stainless steel tie rods across the fixed flanges shall be machined with either square ends or hexagonal ends to allow the tie rods to be secured as the loose flange nuts are installed or removed. The number of tie rods across the fixed flanges shall be in accordance with the manufacturer’s design for the hydraulic design load.

20.10.3.3 Uni-Flanges

Flanged assembly joints (Uni-Flange and the like) shall be DI fittings manufactured in conformance with AS/NSZ 2280 and drilled to Figure B5 of AS 4087. Jointing bolts shall be in accordance with this section of the Supplementary Specification. Set screws shall be Grade 431 stainless steel and shall be heat treated following manufacture.
Proprietary couplings shall only be used where approved by the Principal's Representative in writing. Where specified that proprietary couplings are used, regardless of the manufacturer's standard coating, all ferrous components shall be repainted with an epoxy paint coating. The surface shall be abrasive blast cleaned to AS 1627.4 Class 2½ and painted with a three (3) coat system of two pack high build, solvent free cyclo-aliphatic amine cured epoxy coating to a dry film thickness of 800 microns. All preparation and application shall be strictly in accordance with the manufacturer's specification.

The proprietary couplings shall be on the Principal's Accepted Mechanical Materials and Equipment Schedule, see Table 17.1.

20.10.4 Pipework Fasteners

All fasteners used in pipework flanges and elsewhere shall comply with Clause 31 of this Supplementary Specification.

20.10.5 Thread Tape or Thread Sealing Paste

The Contractor shall use only suitable products for sealing threaded joints that do not contain lead. For stainless steel pipework, the Contractor shall only use appropriate thread tape or thread sealing paste for stainless steel pipework.

21 VALVES

21.1 General

In general, the type of elastomer and trim materials are not specified. The Developer, Contractor and/or the Developer's Designer shall select such materials as are best suited for the service conditions given. Valves shall be provided complete with all actuators, positioners, pilot valves, solenoid valves, internal piping, strainers and the like provided as a complete and operable unit requiring only to have external wiring and piping connection made.

A 50 mm square valve spindle cap shall be provided on all buried sluice valves, on all valves to be operated through floor holes and where shown. Operating keys shall be a minimum 900 mm long with a minimum 'tee arm' length to suit a maximum operating force of 130 N required to open the valve.

Operating keys shall be fabricated of 25 mm diameter steel rod, with a hollow end block designed to match the operating nut on the top of the valve. Not less than two operating keys of each size shall be provided for operation of the wrench nut operated valves.

Unless otherwise shown or specified, all ball and butterfly up to 100 mm nominal diameter shall be lever operated and each valve shall be equipped with an operating lever. All operating levers shall be fabricated from Grade 316 stainless steel and shall show the anti-clockwise closing direction on them with a notation for closed. Levers shall be provided with a 90 degree (quarter turn) multi position notch plate fabricated from Grade 316 stainless steel.

All valves shall be capable of being opened or closed by one man with a maximum required operating force of 130N. Geared actuators of an approved type shall be supplied where necessary to meet this requirement on DN450 or larger.

Connections for valves shall be flanged unless noted otherwise in this Supplementary Specification.
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The actual positioning of valves shall be selected so that:

- Manually operated valves can be operated safely with ease;
- All valves are accessible for maintenance from the ground or a platform complying with AS 1657 and can be removed from the line without obstruction from adjacent equipment, valves or pipework; and
- Each valve shall be supplied with adequate bolts, nuts, washers and gaskets for connection to adjoining pipework and equipment.

Each valve shall be labelled with a Grade 316 stainless steel label permanently engraved in 8 mm high Arial font with the Principal’s asset descriptor/code (where the valve fits the Principal’s criteria) and any tag number that is allocated by the Developer and/or Contractor and/or Developer’s Designer. For each above ground valve, the label shall be attached by a 200 mm length of 2 mm diameter Grade 316 stainless steel flexible multi-strand wire looped through a suitable location on the valve and closed with a nickel plated copper swage applied by a swaging tool with a set of full width jaws. For a valve with a handwheel, on the valve handwheel is not an acceptable location to mount the label.

Where the valve is electrically, pneumatically, hydraulically or otherwise actuated, the Grade 316 stainless steel label shall also be permanently engraved with the Plain English Name of the valve also in 8 mm high Arial font. The larger label shall be attached to the valve’s Local Control Station.

21.2 Sluice Valves

Sluice valves shall be Class PN16 unless a higher pressure rating is required.

Each sluice valve 300 mm diameter and greater shall be hard seated and shall comply with AS 2638.1. Each sluice valve smaller than 300 mm diameter can be resilient seated with double ‘O’ ring stem seals and shall comply with AS 2638.1.

Valves shall be coated externally and internally with a thermally bonded polymeric coating complying with AS 4158. Wedges shall be fully encapsulated in an approved sewage resistant synthetic rubber in accordance with AS 1646.

Spindles shall be turned out of high tensile brass or stainless steel. End configurations shall be either flanged or double socket. Sockets shall incorporate an elastomeric sealing ring manufactured to AS 1646.

Sluice valves shall be provided with gearboxes that will allow the valve to be opened and closed against an unbalanced head of 100m (1,000 kPa) by a person using a T key on the spindle cap and applying a torque no greater than 160 Nm.

Sluice valves shall be suitable for mounting in the vertical position.

Potable water and recycled water sluice valves shall have anti-clockwise spindles for closing and shall be tested to the requirements of AS 2638.2.

Sewage sluice valves shall have clockwise spindles for closing and shall be tested to the requirements of AS 2638.2.

Wherever possible, the direction shall be marked on the valve.

For PE mains, end configurations shall be double socket with a the Principal’s approved mechanical restraint system. Sockets shall incorporate an elastomeric sealing ring as specified in Clause 20.10 of this Supplementary Specification. To assist installers, the Principal’s has identified that the Hawle E2 System 2000 valve or the AVK Supa Plus Coupling Series 01/70 valve or equal is acceptable for PE pipelines.
For PVC/DI pipelines, end configurations shall be either flanged or double socket. Sockets shall incorporate an elastomeric sealing ring as specified in Clause 20.10 of this Supplementary Specification.

Valves located above ground shall be provided with hand wheels or electric actuators. Valves located below ground shall be provided with an extension spindle as detailed in Clause 21.6 of this Supplementary Specification. It shall be designed, fabricated and installed in accordance with the standard requirements shown on the Principal’s Standard Drawings.

All body fasteners used in the assembly of each sluice valve shall be Grade 316 stainless steel.

### 21.3 Butterfly Valves

The location, size and type of each butterfly valve together with its actuator (gearbox and handwheel or extended spindle) shall be as shown on the drawings.

Each butterfly valve shall:

- Be Class 16 complying with AS 4795;
- Be fully flanged unless lugged butterfly valves are accepted in writing by the Principal’s Representative;
- Be manufactured from cast or ductile iron or an approved alternative material. When components of the valve are manufactured from other than Grade 316 stainless steel then these components shall be coated in accordance with AS 4158 or another approved protective coating;
- Be of a double-flanged format incorporating integral o-rings that cover the flange faces and flanged fittings drilled in accordance with AS 4087 Figure B.5;
- Be compatible to attach a 90 degree actuator (gearbox) with either a handwheel or an extension spindle as required; and
- Have a resilient valve seat of nitrile materials conforming to the requirements of AS 1646 and be pressure rated in full vacuum to 1200 kPa and have a minimum temperature rating of minus 10°C to plus 90°C.

Each butterfly valve actuator shall:

- Be manufactured from cast or ductile iron or an approved alternative material. When components of the actuator system are manufactured from a corrosive material then these components shall be coated in accordance with AS 4158 or another approved protective coating;
- Have the actuator input shafts and extension system (spindle) made of a non-corrosive material such as Grade 316 stainless steel;
- Have a minimum of 6 turns to close/open the valve; and
- Have a 90 degree actuator (gearbox) with either a handwheel or an extension spindle as required.

All body fasteners in each butterfly valve, in its actuator and to join the two together shall be Grade 316 stainless steel.

### 21.4 Plug Valves

Plug valves shall not be used if an acceptable alternative is available. Where an alternative is not available a full bore plug valve shall be used. The Developer, the Contractor and/or the Developer’s Designer shall obtain the agreement in writing from the Principal’s Representative for the use of plug valve/s.
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Valve construction shall be of semi-steel to ASTM A126-61, Class B, or cast iron to BS 1452, Grade 14. The plug shall be of the eccentric type and neoprene or PTFE faced. Unless otherwise shown or specified, all plug valves 200mm diameter and smaller shall be provided with non-removable levers. Plug valves greater than 200mm diameter shall have geared actuators.

When components of the valve are manufactured from other than Grade 316 stainless steel then these components shall be coated in accordance with AS 4158 or another approved protective coating.

Each plug valve actuator shall:

- Be manufactured from cast or ductile iron or an approved alternative material. When components of the actuator system are manufactured from a corrosive material then these components shall be coated in accordance with AS 4158 or another approved protective coating;
- Have the actuator input shafts and extension system (spindle) made of a non-corrosive material such as Grade 316 stainless steel;
- Have a minimum of 6 turns to close/open the valve; and
- Have a 90 degree actuator (gearbox) with either a handwheel or an extension spindle as required.

All body fasteners in each plug valve, in its actuator and to join the two together shall be Grade 316 stainless steel.

21.5 Knife Gate Valves

Knife gate valves shall not be used within any pressure system and may only be used where specifically agreed by the Principal. The Developer, Contractor and/or the Developer’s Designer shall obtain the agreement in writing from the Principal’s Representative for the use of knife gate valve/s.

Knife gate valves, where shown on the drawings shall be unidirectional threaded lug or drilled flanged style rising spindle valves complying with AS 6401. Valve operational direction shall be permanently marked on the valve.

Knife gate valves shall be manufactured from Grade 316 stainless steel or equal for the body, gate and spindle and do not require a bonnet. The gate shall be polished so that surface roughness does not exceed 1.6 µm to BS EN ISO 4288 Geometric Product Specification (GPS), Surface Texture, Profile Method: Rules And Procedures For The Assessment Of Surface Texture and the gate has a bevelled edge.

The gate seal and top seal shall be a retained resilient perimeter seal manufactured from an approved synthetic rubber material.

Knife gate valves when in the closed position shall be rated for a maximum static pressure on the upstream side of the valve of 1000 kPa with 0 kPa on the downstream side of the valve. The gate, when tested as described shall not deflect more that 1/500 of the span of the gate.

Where required, extended spindles shall be supported every 1800 mm with Grade 316 stainless steel brackets with integral bearings and shall be extended through the roof/structure above to be terminated with an approved slab mounted pedestal with 6:1 gearbox, handwheel and spindle cover. The pedestal shall be fixed to the roof/structure above with 4 x M20 Grade 316 stainless steel chemset anchors set 200 mm into the roof/structure above.

The above ground pedestal and handwheel shall be enclosed in a security fence to the Principal’s standard or within an approved cabinet as shown on the drawings.

21.6 Extension Spindles
Extension spindles where required in pumping stations or in valve pits shall be fabricated from Grade 316L stainless steel. Suitable intermediate and top supports shall be provided for the extended spindle to retain each extended spindle in position particularly during its operation. Replaceable high molecular weight polyethylene (HMWPE) or similar bushes shall be provided at each support for each extended spindle.

For each underground valve, the extension spindle shall either be fabricated from Grade 316L stainless steel or be an Allmain AVK Model 04-02-01 or a similar approved extended spindle from another supplier.

21.7 Ball Valves

Ball valves shall be three piece construction with:

- Grade 316 stainless steel body, trim, body fasteners, handle and handle retaining nut;
- Seals and seats shall be PTFE; and
- Pressure rating to a minimum of 1200 kPa.

For certain restricted applications, one or two piece valve construction may be acceptable and shall be submitted to the Superintendent and to the Principal’s Representative for review. Additional means of dismantling the pipework shall be provided in these instances.

21.8 Check Valves (Non Return Valves)

Each check valve shall comply with the requirements of AS 4794 with flanges in accordance with AS 4087 Figure B.5. Each check valve shall be coated internally and externally with a factory applied thermal bonded polymeric (TBP) corrosion protective coating that shall comply with the requirements of AS/NZS 4158 and shall be applied by a fluidized bed technique.

The type and pressure rating of the check valve shall be as shown on the drawings.

Each check valve shall incorporate a counterweight and extended spindle except where the Developer’s Designer determines that they are not required or the Principal’s Representative advises that they are not appropriate for the location. In the later case, alternate means to assist in closing the check valve shall be provided by the Developer or the Contractor.

Each valve shall be suitable to operate within the pressure ranges of the system within which it is being installed. Each check valve shall be located where applicable in a horizontal orientation within a suitability sized concrete pit or other structure. Check valves proposed to be located in a vertical orientation shall be approved in writing by the Principal’s Representative.

21.9 Gas Release Valves (Sewage Pumping Stations)

Gas release valve assemblies shall be installed onto the pipeline/pipework with a suitable sized hydrant tee.

The location, size and type of each gas release valve together with an adequately sized valve chamber if required shall be as shown on the drawings.

Unless approved otherwise, each gas release valve shall:

- Be manufactured from fiberglass reinforced Nylon or an approved alternative non-corrosive material. When components of the valve are manufactured from a corrosive material then these components shall be coated in accordance with AS 4158 or other approved protective coating;
- Seal the gas bleed hole by a mechanism made of non-corrosive flexible material sealing against a non-flexible seat which seals on the same place at all times;
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- Have a maximum rated working pressure of at least 1200 kPa and be of a design which guarantees that there is an air gap between the liquid and the sealing system within the valve which prevents the liquid from coming into contact with the sealing mechanism;

- Have a flanged fitting drilled to Figure B.5 in accordance with AS 4087. All gas release valves shall be installed atop a 100 long (min) flanged hydrant riser together with a suitable isolating lugged butterfly valve to allow the removal of the gas release valve for maintenance purposes. Attached to the wafer butterfly valve shall be a 90 degree actuator (gearbox) with extension system (spindle) brought to under side of cover;

- Be installed on the major or minor high points of all rising mains and where the main is buried, incorporated within a suitably sized concrete pit with the cover marked accordingly ie AV as shown on the drawings.

21.10 Air Release Valves (Water Pumping Stations)

Air release valve assemblies shall be installed onto the pipeline/pipework with a DN80 hydrant tee.

The location, size and type of each air release valve together with an adequately sized valve chamber if required shall be as shown on the drawings.

Unless approved otherwise, each small air release valve up to and including 50 mm diameter:

- Shall have a base with a brass BSP threaded fitting where available and shall be fixed on top of a suitable size brass gate valve with a 50 mm BSP threaded stainless steel riser pipe (where required to place the valve as shown in the drawings), with the riser pipe fitted to a 50 mm BSP threaded DN80 blank flanged fitting drilled in accordance with AS 4087 Figure B5;

- Shall have sealing of the air bleed hole preferably by a float made of noncorrosive non-flexible material sealing against a rolling flexible seat. Where the float is a flexible material, the float shall be restrained from rotating ie. it seals on the same place at all times; and

- Shall, where specified on the drawings or where requested by the Principal’s Representative, be supplied with a BSP threaded similar sized 3-way tee port stainless steel ball valve to allow for air valve isolation and water sampling.

The ARI range of valves or equal is acceptable to the Principal.

Larger combination air valves of DN80 and larger shall have a flanged fitting connected to a suitable size flanged sluice valve with gear box or resilient seated butterfly valve with gear box.

A flanged hydrant riser shall be installed on the butterfly valve installation. Flanges shall be drilled in accordance with AS 4087 Figure B5.

Combination air valves of DN80 and larger:

- Shall consist of both small orifice and large orifice valves. The small orifice part of the valve shall be as specified above; and

- Shall, for the large orifice part of the valve, consist of a body casing housing a Polycarbonate float which seals against an EPDM seal that is restrained in place with a Bronze ring. The float shall remain stable under all air outflow and inflow conditions without any possibility of premature closing of the valve during air outflow.

The ARI range of D-050 valves or equal is acceptable to the Principal.

21.11 Solenoid Valves
Solenoid valves for water service shall be specially constructed with a dampening device to prevent water hammer. Valves shall be diaphragm or piston seat type. If diaphragm type is used, diaphragm shall be supported by a metal backing plate to protect the diaphragm. Valve body and trim material shall be brass or stainless steel.

Solenoid operated valves on compressed air lines shall be specially constructed for non-lubricated air service. All materials shall be selected for the particular service and the Contractor shall submit a schedule to the Superintendent prior to purchase of valves showing, as a minimum, the following:

- Valve number;
- Manufacture and model;
- Body size;
- Voltage;
- Valve seat materials;
- Valve body materials;
- Solenoid enclosure type; and
- Orifice size

All solenoid valves shall be equipped with a piped manual bypass to operate the valve in the case of power or mechanical failure. Three manual ball valves shall be provided for the arrangement. Fail safe wiring shall be the default state.

For sewage pumping stations, the valve body material shall be Grade 316 stainless steel and valves shall be provided complete with all necessary mounting brackets whether shown or not.

For water pumping stations, the valve body material shall be brass or stainless steel and valves shall be provided complete with all necessary mounting brackets whether shown or not.

The electrical requirements for each solenoid valve shall be as required in Clause 44.4 in Part 1 of this Supplementary Specification.

The screw retaining the electrical connector to the solenoid shall be replaced with Grade 316 stainless steel if manufactured of a lesser material.

### 21.12 Globe Valves - Altitude Valves, Float Valves and Rate Of Flow Control Valves

Each Altitude Valve, Float Valve or Rate Of Flow Control Valve shall be a globe valve with different control mechanisms and instruments. Each globe valve shall be in accordance with AS 1628, AS 1271, BS EN ISO 15761 or ANSI B16.43. Each globe valves shall be manufactured by Cla-Val Pty Ltd or an alternate supplier approved by the Superintendent and the Principal’s Representative.

As a general requirement each globe valve shall:

- Have a single piece body, with a bolted or screwed bonnet as required;
- Be coated in accordance with AS 4158 or another approved protective coating;
- Have Grade 316 stainless steel body fasteners; and
- Be rated to a maximum allowable pressure greater than or equal to the pressure rating determined by the Developer or the Developer’s Designer.

Each Rate of Flow Control / Altitude Inlet Control valve shall have 3 No pilot solenoid valves and a spindle height instrument fitted (as per electrical drawings).
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Each Back up Altitude / Pressure Reducing Control valve shall have 1 No pilot solenoid valve. These valves will not have a spindle height instrument installed, but shall have fully open and fully closed limit switches.

Each Rate of Flow Control / Pressure Reducing Control valve shall have 2 No pilot solenoid valves, a 3 port ball valve and a spindle height instrument fitted.

Each spindle height instrument shall be supplied with the globe valve as a completely assembled unit with the following functionality:

- Contactless spindle height measurement;
- 4-20 mA spindle height signal to be used as PRV feedback for RTU control;
- 2 off programmable relay contacts to be set up as full open and fully closed signals for RTU control (factory default); and
- Computer USB connection capability to allow instrument set up of 4-20 mA and relay contact signals. This connection shall only be used for commissioning and will not have a hard wired permanent connection installed.

21.13 Electrically Actuated Valves

Electrically actuated valves shall be supplied with actuators in accordance with Clause 23 of this Supplementary Specification. The Contractor shall provide permanent fixed stairway and walkway access complying with AS 1657 to allow access to all actuator compartments.

21.14 Protective Coatings

Pipework and valve coatings shall be as detailed elsewhere in this Supplementary Specification.

Where it is specified that fittings and other components shall be treated internally and externally with a factory applied thermal bonded polymeric corrosion protective coating, this coating shall comply with the requirements of AS 4158 and be applied by the fluidized bed technique.

21.15 Valve Maintenance and Repair Requirements

21.15.1 Valve Repair

The arrangement of adjoining pipework for and location of every valve in the work shall be designed to enable repair or replacement without causing as applicable to the pumping station either a failure to deliver potable water, or an overflow to the environment, surcharge above the design maximum level or a violation of the Developer's or the Principal's statutory requirements (ie Development Approval conditions or discharge license).

To comply with this requirement, it is permissible to use the collection system storage capacity or holding basins and to perform maintenance during the low flow periods. This requirement applies to shutoff and isolation valves. Provision shall be made in the detailed design to permit repair and replacement of these types of valves.

21.15.2 Valve Access Space

Adequate access and removal space shall be provided around all valves to permit easy maintenance and/or removal and replacement without interfering with the operation of other equipment. Valves located inside buildings or other structures shall be removable without affecting the structural integrity of the
building or creating a safety hazard. Normal disassembly of the valve assembly into valve and actuator is permissible for removal and replacement.

This criterion requires that consideration be given to the physical layout of piping systems and valves in the initial design, especially to valves located above and below the ground level of buildings and to unusually large valves. It is a the Principal’s requirement that the complete path of removal from in-plant location, through hatches, doors and passageways, be checked and defined for these valves by the Developer, Contractor or the Developer’s Designer.

### 21.15.3 Valve Handling
Large valves shall have lifting and handling equipment available to aid in the maintenance and replacement of all valves. In addition, the detailed design shall include the supply and installation of lifting/handling devices, such as pad-eyes and hooks, to aid valve handling. This is particularly important for large and/or heavy valves greater than 100 kg which require special handling and lifting equipment. Means shall be provided for removal of valves located above and below the ground level of buildings and other structures.

### 22 STOP BOARDS, SLIDE GATES AND PENSTOCKS

#### 22.1 Scope

This section of the Supplementary Specification applies to all stop boards, slide gates and penstocks provided by the Contractor, typically in medium and large sewage pumping stations.

Typically a stop board/slide gate will be supplied and installed adjacent to a penstock to provide double isolation. The stop board/slide gate may be installed on a stand off flange surrounding the penstock or on a stepped concrete surface outside of the penstock mounting surface.

#### 22.2 Design

The Contractor shall submit detailed structural calculations and shop drawings for the proposed stop boards, slide gates and penstock design for review by the Superintendent and the Principal’s Representative prior to commencement of manufacture.

#### 22.3 Stop Boards/Slide Gates

The proposed stop boards/slide gates shall comply with the requirements below and full details shall be submitted to and approved by the Superintendent and the Principal’s Representative before design proceeds.

Refer to the details below on acceptable materials for seal frames and stop boards/slide gates. Marine grade aluminium is not acceptable to the Principal for continual full or partial immersion, particularly in sewage.

#### 22.3.1 Performance

Each stop board/slide gate shall be designed to withstand the maximum on and off-seating heads determined by the Developer’s Designer or the Contractor. At the maximum design on and off-seating heads, the leakage rate shall not exceed 0.1 L/min per metre of seal.
22.3.2 Seal Frames
Each seal frame shall be designed to withstand all loads that result from the nominated maximum head acting on the gate and using Grade 316L stainless steel sections. Deflections shall not exceed 1/500 of any span nor shall maximum stresses exceed half the yield stress of the material – which ever is the worst case.

Each seal frame proposed for embedment mounting shall be of a cross section so as the block outs required in the structure are kept to a minimum to prevent interference with the concrete reinforcement steel. Each seal frame for side wall and floor mounting shall be of a minimum cross section to reduce disruption to the flow.

22.3.3 Stop Boards/Slide Gates
Each stop board/slide gate shall be manufactured from:
- Grade 316 stainless steel; where the normal function of the stop board/slide gate requires it to be fully or partially immersed; and
- Grade 316 stainless steel or marine grade aluminium; where the normal function of the stop board/slide gate requires it to be housed out of the liquid stream.

Each stop board/slide gate shall be designed (using stiffeners as required) so that the deflection due to the nominated maximum head acting on the stop board/slide gate will not exceed 1/360 of the stop board/slide gate span nor shall maximum stresses exceed half the yield stress of the material – which ever is the worst case.

Lifting handle(s) attached to the stop board/slide gate shall be provided to remove and deploy the stop board/slide gate. Where the resultant lift force exceeds 18 kg (assumed to be twice the weight of the stop board/slide gate), two handles shall be provided to accommodate a two man lift operation. Where the resultant lift force exceeds 36 kg (assumed to be twice the weight of the stop board/slide gate), reinforced lifting eyes shall be provided to allow for removal of the stop board/slide gate using temporary hoisting equipment located above the stop board/slide gate attached to permanent anchors, refer to Clause 21.15.3 of this Supplementary Specification for details. The top of the stop board/slide gate shall be reinforced to allow the use of temporary jacking or pushing devices during its installation.

22.3.4 Seals
Each seal frame shall be fitted with fixed sealing faces that completely surround the aperture. The sealing faces shall provide a maximum coefficient of friction of 0.15 with the surface of the stop board/slide gate. Under the nominated maximum head acting on the stop board/slide gate, the resultant pressure acting on the seals shall be limited to prevent long-term creep of the material.

Each stop board/slide gate shall be equipped with UHMW polyethylene side seat/seals to restrict leakage and to prevent metal to metal contact between the frame and the stop board/slide gate. Seals utilising a combination of UHMWPE seats/guides and elastomeric seals are not acceptable.

Side seats/seals shall be mechanically attached to the frame side rail members and shall be easily replaceable in-situ. Each stop board/slide gate shall be provided with a resilient elastomeric flush bottom invert seal. The seal shall be attached to the frame invert rail member and shall be easily replaceable in-situ.

22.3.5 Fabrication Requirements
Each seal frame shall be manufactured from extruded, welded or folded Grade 316L stainless steel sections.

All structural components of the gate shall be fabricated from either Grade 316L stainless steel having a minimum thickness of 5 mm or marine grade aluminium having a minimum thickness of 6 mm for
penstocks and a minimum thickness of 5 mm for slide gates/slide gates (as applicable to the service conditions above).

All metal to metal joints that are not seal welded shall be arranged with a minimum 3 mm gap to avoid crevice corrosion. All stainless steel components shall be pickled after fabrication and the whole assembly shall be passivated after fabrication as detailed in Clause 30 of this Supplementary Specification.

All fasteners shall be Grade 316 stainless steel supplied and installed as detailed in Clause 31 of this Supplementary Specification.

22.4 Manual And Electrically Actuated Penstocks

The proposed manual and electrically actuated penstocks shall comply with the requirements below and full details shall be submitted to and approved by the Superintendent and the Principal's Representative before design proceeds.

Refer to the details below on acceptable materials for seal frames and stop boards/slide gates. Marine grade aluminium is not acceptable to the Principal for continual full or partial immersion, particularly in sewage.

22.4.1 Performance

Each penstock shall be designed to withstand the maximum on and off-seating heads determined by the Developer’s Designer or the Contractor. At the maximum design on and off-seating heads, the leakage rate shall not exceed 0.1 L/min per metre of seal.

22.4.2 Seal Frames And Headstocks For Penstocks

The seal frame and headstock for each penstock shall be designed to withstand all loads that are a result from the nominated maximum head acting on the gate and those resulting from operation of the penstock. The seal frame and headstock for each penstock shall be Grade 316L stainless steel.

Deflections shall not exceed 1/500 of any span nor shall maximum stresses exceed half the 0.2% proof stress of the material. Each seal frame shall be of such length to support a minimum of two thirds of the gate height in the fully open position. Each seal frame shall be manufactured with a flat back.

Side seat/seals shall extend to accommodate and guide a minimum of two thirds the penstock gate height when in the fully opened position.

22.4.3 Penstock Gates

Penstock gates shall be fabricated from Grade 316L stainless steel in areas subject to:

- Immersion at any time in liquid; or
- High wear areas; or
- Where they are frequently operated.

Elsewhere penstock gates can be manufactured from either Grade 316L stainless steel or marine grade aluminium.

Each penstock gate shall be designed (using stiffeners as required) so that the deflection due to the nominated maximum head acting on the gate will not exceed 1/500 of the gate span nor shall maximum stresses exceed the 0.2% proof stress.

The stem connection shall be a lift nut supported in a welded nut pocket for a non-rising stem operation with clockwise closure. The coupling or nut pocket shall be capable of withstanding, without permanent deformation, at five times the rated output of the operator (manual operation rated at 160 N rim pull).
22.4.4 Stems
Stems shall be manufactured from a machineable Grade 316L stainless steel (Ugima or similar) with a minimum diameter of 28 mm. Stems shall be of ample cross section to prevent buckling and shall be capable of withstanding without exceeding half the yield strength of the stem material and without permanent deformation, twice the rated output of the actuator (manual operation rated at 200 N rim pull). In compression, the stem shall be designed for a critical buckling load caused by a 200 N effort on the handwheel with a safety factor of 2 using the Euler column buckling criterion. Stems shall be supported such that the slenderness ratio for the unsupported portion of the stem shall not exceed 200 taking into consideration the root diameter of the thread.

The threaded portion of the stem shall have machine threads of the acme or stub acme thread forms. Stems made up of more than one section shall be joined by stainless steel couplings. The coupling shall be bolted to the stems.

Penstocks having opening widths greater than twice their opening heights shall be provided with dual stem arrangements.

For rising stem applications, a transparent polycarbonate or PVC stem cover tube shall be supplied.

22.4.5 Seals
Each seal frame shall be fitted with fixed sealing faces that completely surround the aperture. The sealing faces shall provide a maximum coefficient of friction of 0.15 with the surface of the penstock gate. Under the nominated maximum head acting on the penstock gate, the resultant pressure acting on the seals shall be limited to prevent long-term creep of the material.

Each penstock gate shall be equipped with UHMW polyethylene side seat/seals to restrict leakage and to prevent metal to metal contact between the frame and the penstock gate. Seals utilising a combination of UHMWPE seats/guides and elastomeric seals are not acceptable.

Side seats/seals shall be mechanically attached to the frame side rail members and shall be easily replaceable in-situ. All upward opening penstocks shall be provided with a resilient elastomeric flush bottom invert seal. The seal shall be attached to the frame invert rail member and shall be easily replaceable in-situ.

22.4.6 Actuators
Manually actuated penstocks shall be supplied with yoke mounted actuators with handwheel, tee key or where required, a reduction gearbox.

Electrically actuated penstocks shall be supplied with actuators in accordance with Clause 23 of this Supplementary Specification. The Contractor shall provide safe fixed stairway and walkway access complying with AS 1657 to all actuator compartments.

Stem extensions with stem guides and operator mounting pedestals shall be supplied and installed as required to suit the respective access platform level. Actuators shall be positioned between 900 mm to 1200 mm above operating level. The maximum allowable rim pull required to operate the penstock shall be limited to 160 N.

Cast iron components shall be coated externally with a thermally bonded polymeric coating complying with AS 4158.

22.4.7 Fabrication Requirements
Each seal frame shall be manufactured from extruded, welded or folded Grade 316L stainless steel sections.
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All structural components of the gate shall be fabricated from either Grade 316L stainless steel having a minimum thickness of 5 mm or marine grade aluminium having a minimum thickness of 6 mm (as applicable to the service conditions above).

Contrary to any manufacturer’s standard details, all stainless steel fasteners and other stainless steel components shall be fully separated from any aluminium components.

All metal to metal joints that are not seal welded shall be arranged with a minimum 2 mm gap to avoid crevice corrosion. All stainless steel components shall be pickled after fabrication and the whole assembly shall be passivated after fabrication as detailed in Clause 30 of this Supplementary Specification.

All fasteners shall be Grade 316 stainless steel supplied and installed as detailed in Clause 31 of this Supplementary Specification.

22.5 Stop Board/Slide Gate and Penstock Anchor Bolts

The anchor bolts shall be Grade 316 stainless steel chemical anchors (similar to Hilti HVU-HAS) and shall be designed to withstand all specified load conditions including loads resulting from the operation of the penstock under the most adverse load conditions.

The size and spacing of the anchor bolts for each stop board/slide gate or stop log or penstock seal frame shall be nominated by the Developer’s Designer or the Contractor. The size and spacing of the anchor bolts for each penstock headstock shall be nominated by the Developer’s Designer or the Contractor.

22.6 Stop Board/Slide Gate and Penstock Installation

Each stop board/slide gate with a seal frame which is proposed to be embedded in the adjoining concrete structure does not require anchor fixing although anchors should be used to securely position the frame during setting it in place. Slots shall be formed in the concrete sections and each seal frame shall be subsequently grouted in place, all in accordance with the manufacturer’s requirements. For other mounting options such as a side wall or an end wall locations, Grade 316 stainless steel chemical anchors shall be used. A non-shrink grout bed or polyurethane sealant shall be used between the frame and the wall.

Penstocks with standard flat back frames do not require a wall thimble. Grade 316 stainless steel chemical anchors shall be used with a nominal 25 mm thick non-shrink grout seal established between the penstock frame and structure.

23 Valve and Penstock Actuators

The type of actuator for all valves and penstocks shall be submitted to the Superintendent and the Principal’s Representative for approval.

23.1 Manual Actuators

Each manual actuator shall include all necessary gearing, couplings, gear case, guards, spindles and handwheels. Handwheels shall be fitted to the vertical spindle by means of a square key drive and a guard shall protect the vertical spindle. The handwheel shall have an arrow and the word “open” indicating the direction of rotation. The maximum torque required at the handwheel shall not exceed 130 Nm under the worst conditions of differential head or unseating force.
23.2 Electric Actuators

Electric actuators shall conform to the general requirements of Clause 44.3 in Part 2 of this Supplementary Specification.

Actuators shall be 415 V 3 phase AC, on-off electrically controlled with permanent gear override facility, torque travel limit switches and visual position indicator. Weatherproof protection to AS 60529 Class IP68 shall be provided.

Open and closed limit switches shall be provided in the actuator and shall be connected to the PLC based or similar control system. Remote (to the actuator) opening and closing shall also be provided through the PLC based or similar control system. Where practical for sites with a PLC based or similar control system, actuators with communications capability shall be connected to the communications network.

Extension assemblies with appropriate bracing to adjacent structures shall be provided to ensure that electric actuators are raised above the level of possible water immersion.

Rotork actuators are preferred, however, other actuator brands permitted under the Principal’s Accepted Mechanical Materials and Equipment Schedule may be submitted to the Superintendent and the Principal’s Representative for approval. The Contractor shall provide safe fixed stairway and platform access complying with AS 1657 to all actuator compartments.

24 HOISTING EQUIPMENT

24.1 Provision of Hoisting Equipment

Hoisting equipment shall be provided for all medium and large pumping stations, both sewage and water, to serve all installed pump units, all valves greater than or equal to DN300 and other maintainable components.

The Principal’s Representative will advise the Developer or the Developer’s Designer in writing if a ‘Typical Configuration’ or an ‘Alternative Arrangement’ is required for each medium or large pumping stations whether it be for either sewage or water.

Where required by the Principal’s Representative, hoisting equipment shall be provided for any ‘small’ sewage and water pumping stations. Normally, this would be a ‘Typical Arrangement’.

24.2 Hoisting Equipment Configuration

24.2.1 Typical Configuration

Pumping station hoisting equipment typically consists of a monorail beam, with a trolley-mounted chain hoist, mounted over an opening in the floor that is covered with panels of removable grating. If there is a building over the pump or wet well, the monorail beam passes through a doorway and extends outside the building to allow the item being handled to be either set down and picked up by a truck-mounted crane or loaded directly onto a truck (tray level assumed 1.35 m above finished ground level). If there is not a building over the pump or wet well, then the monorail beam extends outside the footprint of the pump or wet well to allow the item being handled to be either set down and picked up by a truck-mounted crane or loaded directly onto a truck as above.
24.2.2 Alternate Configuration

Hoisting equipment may consist of an electrically actuated overhead travelling gantry crane, either with a chain hoist or a wire hoist, mounted either in a building or under a roof structure over the sewage pump or wet well. In the case of a water pumping station, hoisting equipment may consist of an electrically actuated overhead travelling gantry crane, either with a chain hoist or a wire hoist, mounted either in a building or under a roof structure over the water pump units.

Typically the electrically actuated overhead travelling gantry crane will be wholly inside the building or roofed area and will be designed to allow the item being handled to be loaded directly onto a truck (tray level assumed 1.35 m above finished floor level).

24.3 Hoisting Equipment General Requirements

24.3.1 Compliance Requirements

The design, installation, testing, certification and operation of hoisting equipment and any associated stairways and access platforms shall comply with the following legislation, specifications and standards in the following order of precedence:

- Workplace Health and Safety Regulation 2011 (Qld);
- Plant, Code of Practice 2005 (Qld); and
- This Supplementary Specification.

“Safe Working Load” or “SWL” as an abbreviation is an expression discontinued by AS 1418 and shall not be used in reference to the hoisting equipment nor shall it be marked on any part of the hoisting equipment.

Any inconsistencies between these documents shall be referred to the Principal’s Representative for direction.

24.3.2 Safety Features

In addition to the requirements of Australian Standards, each electrically operated hoist or crane shall include the following safety features:

- Auto stop at the top of its hoisting range;
- Auto stop in the event of power failure; and
- Electrical overload limit.

24.3.3 Alignment

The hoisting equipment shall be aligned directly over the lifting points of the pump units (or any other nominated piece of equipment) such that when the hook is lowered it aligns with the centre of the lifting point on each pump unit/piece of equipment within a tolerance of +/- 50 mm.

The lifting point on each pump unit/piece of equipment shall be located in line with its centre of gravity so that the pump unit/piece of equipment does not tilt or swing as it is lifted, to ensure a simple and safe method of raising and lowering the pump unit/piece of equipment.

24.3.4 Load Capacity
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The hoisting equipment shall have sufficient capacity to lift and remove each pump unit in the pumping station.

For submersible pump units in dry well sewage pumping stations, the total load shall include the length of the pump’s electrical cable and the hoist’s chain required to reach the bottom of the pumping station dry well. An allowance of an additional 200 kg shall also be made for the force required to separate the seal between the pump unit and the adjacent pipework and the weight of any material blocked within the pump.

For submersible pump units in wet well sewage pumping stations, the total load shall include the length of the pump’s electrical cable and the pump unit’s chain required to reach the bottom of the pumping station dry well. An allowance of an additional 150 kg shall also be made for the weight of any material blocked within the pump.

The hoisting equipment shall be designed for a pump or any other nominated piece of equipment sized for the 2056 Planning Scheme Demand.

24.3.5 Hoist Chain/Wire Length, Hook Details and Height

The length of the chain on each chain hoist shall be consistent with the depth of the pump/dry or the wet well and the chain bucket shall have sufficient capacity to accommodate this length without tripping the hoist. The length of the wire on each wire hoist shall be consistent with the depth of the pump/dry or the wet well.

Where used in a sewage pumping station with submersible pump units in a wet well, the throat of the hook shall be wide enough to pick up the lifting bar on each pump unit without manual intervention. Each hook shall swivel through a full 360 degrees. A safety spring shall be provided on each hook. Elsewhere, the throat of the hook shall be wide enough to suit the lifting eyes used on the installed equipment with a comfortable clearance.

For pumping stations, each hoist or crane shall be installed at a height that provides a minimum of 300 mm of clearance between any obstructions on the pump or wet well roof and the underside of the pump unit when it is hanging under the hook. Allowance shall be made for any steps or any other installation component within the pathway for the pump unit’s removal that may protrude above finished level. The height of each hoist shall be designed to cater for a pump sized for the 2056 Planning Scheme Demand.

For other facilities, each hoist or crane shall be installed at a height that provides a minimum of 300 mm of clearance between any obstructions and the underside of any item that the hoist or crane is required to remove when it is hanging under the hook. Allowance shall be made for any steps or any other installation component within the pathway for the item's removal that may protrude above finished level.

In the case where the hoist or crane is required to lift the pump unit or other item onto a truck (tray level assumed 1.35 m above finished ground level), this height shall be taken as the minimum height of obstructions to be cleared.

24.3.6 Signs

All signs necessary for complying with the requirements of AS 1418 shall be supplied and installed by the Contractor. The signs shall include:

- “Rated Capacity xxxx kg” (Spelt in full in 150 mm high Black letters on all sides of each monorail/travelling beam);
- Crane classification (where applicable);
- Direction plate under each monorail/travelling beam;
- Manufacturer;
- Type;
- Year of Manufacture;
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- Serial number;
- Hoist chain/rope type, size, grade;
- Hoist chain/rope minimum breaking load; and
- Hoist chain/rope length.

24.3.7 Noise
Each electrically operated hoist or crane shall operate at a sound pressure level not exceeding 45 dB(A) measured at the boundary to an adjacent residential property. Unless otherwise agreed in writing by the Principal’s Representative, the Developer or the Contractor shall arrange to have sound pressure measurements taken over a 24 hour period by a recognised Sound Specialist so that background noise can be filtered out of the noise spectrum to demonstrate compliance.

24.3.8 Maintenance Log Book
A maintenance log book shall be provided for each hoist and stored on site. The log book shall be stored in the Documents Cabinet within the pumping station building.

24.4 Chain Hoists and Monorail Beams

24.4.1 Chain Hoist General Requirements

24.4.1.1 Rated Capacity
Each chain hoist shall have a ‘Rated Capacity’ in accordance with the drawings and the entire unit shall be deemed to be a Group Class C1 installation to the requirements of AS 1418. Each chain hoist shall comprise a chain hoist close coupled to a chain hoist trolley typically to suit long travel along a universal column or beam section monorail.

24.4.1.2 Load Rating Standardisation
Hoists shall be supplied in the following standard sizes:
- Rated Capacity 500 kg
- Rated Capacity 1000 kg
- Rated Capacity 2000 kg
- Rated Capacity 5000 kg

the Principal's preferred equipment is nominated in the Principal's Accepted Mechanical Materials and Equipment Schedule.

24.4.1.3 Extent of Travel
The monorail beam shall extend outside the building such that the load can be placed on the ground with a minimum of 2000 mm clearance between the edge of the pump and the building. If the roof of the building overhangs the lay-down area the clearance shall extend 2000 mm beyond the roof line to allow the pump to be lifted by a crane truck.
24.4.1.4 Labelling

The monorail beam shall be clearly labelled on both sides in red writing 150 mm high with the “Rated Capacity xxxx kg” for the hoist in accordance with AS 1418. The hoist shall also be provided with a nameplate showing the “Rated Capacity xxx kg” that can be clearly read from the floor.

24.4.2 Manual Chain Hoists

Each hoist with a ‘Rated Capacity’ less than 1000 kg or greater shall be manually operated.

Each manually operated hoist shall be operated by an endless hand chain and geared chain pulley block. All chain, hooks and blocks shall generally comply with the requirements of AS 1418, AS 2321, AS 2550.1 and AS 3777 and the following requirements.

All ‘black’ or low carbon steel components in the chain hoist shall be hot-dip galvanised. All fasteners shall be Grade 316 stainless steel in accordance with Clause 31 of this Supplementary Specification.

Each hoist shall have enough chain to reach the lowest floor level below the fully raised hook position. The hoisting chain and the actuation chain shall both be load rated Grade 316 stainless steel. Galvanised, zinc plated, cadmium plated or black steel chain will not be accepted by the Principal.

24.4.3 Electric Chain Hoists

Each chain hoist with a ‘Rated Capacity’ of 1000 kg or greater shall be electrically operated. the Principal’s Representative may request that a chain hoist with a ‘Rated Capacity’ of less than 1000 kg be electrically operated.

Each electrically operated chain hoist shall be a complete installation including all supports, necessary fixings, electrical cables and their supports, all control and supply wiring, runway conductors and all necessary access platforms and ladders.

Each chain hoist shall be powered by a reversible high torque motor designed for crane service and shall incorporate an automatic electro-mechanical type disc brake designed to hold the load in any position once power to the motor is interrupted. Each hoist shall have two-speed operation. High speed operation shall be provided for lifting equipment out of the facility. Low speed operation shall also be provided to "inch" the load either up or down to enable alignment of the equipment. Each hoist shall maintain a constant hoisting speed regardless of the load being lifted.

An electronic acceleration timer shall be fitted to provide a smooth change between low and high speeds. Each chain hoist shall be fitted with top and bottom limit switches in accordance with AS 1418 Part 2. Each chain hoist shall be self sustaining under all loads.

A remote wireless hand held control unit is the Principal’s preferred means of operating each electrically operated chain hoist. The range of the remote control unit shall be sufficient to ensure its function when operated from any location in the facility. If a pendant controller is proposed, the Developer, the Developer’s Designer or the Contractor shall obtain the written approval of the Principal’s Representative through the Superintendent for this alternative.

Each electric chain hoist shall be suitable for continuous operation.

The gears on each chain hoist shall be completely enclosed in an oil bath gear case.

All ‘black’ or low carbon steel components in the chain hoist shall be hot-dip galvanised. All fasteners shall be Grade 316 stainless steel in accordance with Clause 31 of this Supplementary Specification.

All chain, hooks and blocks shall generally comply with the requirements of AS 1418, AS 2321, AS 2550.1 and AS 3777 and the following requirements. Each hoist shall have enough chain to reach the
lowest floor level below the fully raised hook position. The hoisting chain shall be load rated Grade 316 stainless steel. Galvanised, zinc plated, cadmium plated or black steel chain will not be accepted by the Principal.

Electrical wiring, refer to Clause 41 of this Supplementary Specification, shall be supported with an off-set catenary arrangement to provide clear access below the monorail beam.

24.4.4 Manual Chain Hoist Trolleys
Chain hoists with a ‘Rated Capacity’ less than 1000 kg shall have a chain hoist trolley manually chain driven to travel along the monorail beam.

Each chain hoist trolley shall consist of steel side plates with cast iron machined plain tread wheels each fitted complete with a pre-lubricated sealed ball bearing, stub axle, dust cover and circlip. The stub axle shall be of steel and secured in the side plate to prevent its rotation.

All ‘black’ or low carbon steel components in each chain hoist trolley shall be hot-dip galvanised. All fasteners shall be Grade 316 stainless steel in accordance with Clause 31 of this Supplementary Specification.

The actuation chain for the manual drive for the chain hoist shall be load rated Grade 316 stainless steel. Galvanised, zinc plated, cadmium plated or black steel chain will not be accepted by the Principal.

24.4.5 Electrically Driven Chain Hoist Trolleys
Chain hoists with a ‘Rated Capacity’ of 1000 kg or greater shall have an electrically driven trolley to travel along the monorail beam. Electrical wiring shall be supported with a catenary arrangement to provide clear access below the monorail beam. The support catenary shall comply with the requirements in Clause 24.4.1 of this Supplementary Specification.

Where the Principal’s Representative has requested that the chain hoist with a ‘Rated Capacity’ of less than 1000 kg be electrically actuated, the trolley for the chain hoist shall also be electrically actuated.

The remote wireless hand held control unit or the pendant control unit provided to control the operation of the electrically operated chain hoist shall also control the chain hoist trolley.

Each electric trolley shall be suitable for continuous operation.

24.4.6 Electrical Power and Control
The Contractor shall include all electrical power and control cabling and equipment to each electrically operated chain hoist and trolley from its connection to a local isolator and thence to its circuit breaker in the appropriate switchboard.

The support catenary arrangement for the electrical wiring for each electrically operated chain hoist and trolley shall be fabricated from Grade 316L stainless steel Unistrut or similar sections or Grade 316 stainless steel wire of ample diameter for the application supplied with roller swaged Grade 316 stainless steel terminations. ‘Bulldog’ type clamps on the wire will not be accepted by the Principal. Hot dip galvanised, zinc plated or cadmium plated components will not meet the required design life and shall not be used.

Electrical power and control cables and equipment shall be suitable for exposed outdoor service and shall conform to the requirements of Part 2 of this Supplementary Specification.

Wire conductors for each electrically operated chain hoist and trolley shall be of the enclosed copper conductor type with spring loaded collectors and shall be complete with all necessary insulation, supports and appurtenances.

24.5 Electrically Actuated Overhead Travelling Gantry Cranes
24.5.1 General Requirements

Each electrically operated overhead travelling (EOHT) crane shall have long travel and cross travel electric drives, two-speed electric hoisting and long travel, pendant and remote controls. The Developer, or the Developer’s Designer or the Contractor shall show the proposed capacity, travel and lifting ranges of each EOHT crane on preliminary project drawings and in preliminary project schedules. The preliminary project drawings and in preliminary project schedules shall be submitted to the Superintendent and the Principal’s Representative for acceptance of the proposed capacity, travel and lifting ranges of each EOHT crane which will be provided in writing.

The EOHT crane and its components shall be designed and fabricated to provide a minimum design life as required in Table 5.1.

The Developer, or the Developer’s Designer, or the Contractor shall be responsible for ensuring that each EOHT crane complies with all applicable regulations and codes.

Each EOHT crane shall comprise:

- Crane Bridge Beam with end bogies;
- Underslung Trolley;
- Hoist;
- Temporary Load Holding Device; and
- Crane Rails and End Stops.

The class of each EOHT class shall be Class C4 Hoist Class M4 to AS 1418.

The Developer, or the Developer’s Designer, or the Contractor shall be responsible for the design of the crane bridge beam system, crane rails and rail anchor bolts. The Developer, or the Developer’s Designer, or the Contractor shall submit details of the crane rails and anchor bolts to the Superintendent and the Principal’s Representative for acceptance.

Prior to the commencement of manufacture of the bridge crane and associated works, including the access platforms, ladders and crane rails, the Contractor shall submit design details of the crane and the associated works to the Superintendent and the Principal’s Representative for acceptance. The submitted design information shall include manufacturer’s drawings and the maximum vertical and horizontal design loads applied to the supporting structure under the most adverse operating conditions. The Developer, or the Developer’s Designer, or the Contractor shall confirm that the loads submitted are within the maximum load limits assumed for the design of the crane supporting structure.

Manufacture of the crane and associated works shall not commence until the Superintendent and the Principal’s Representative accepts in writing, the submitted design from Developers, or the Developer’s Designer or the Contractor. The Contractor or the Developer, or the Developer’s Designer as the responsible party shall ensure that the maximum design loads accepted by the Superintendent and the Principal’s Representative are not exceeded during design, manufacture, testing and commissioning of the bridge crane.

The EOHT crane bridge beam, hoisting unit and trolley shall be marked with the “Rated Capacity xxxx kg” on both sides of the crane bridge beam in red writing 150 mm high in accordance with AS 1418.

24.5.2 Crane Bridge Beam

Each crane bridge beam shall typically be a single girder type suitably sized for the span as shown on the project drawings and the agreed Rated Capacity.

The Principal’s preferred girder type is a universal beam section or a universal column section. The Principal typically does not accept EOHT cranes fabricated from light weight folded sections.
24.5.2.1 End Bogy – Wheel Assembly, Bearings and Gears

A bogy shall be provided at each end of the crane bridge beam.

Each end bogy shall be fitted with double flanged SGI Grade 32/7 wheels with machined treads and bearing journals. Wheel assemblies shall be designed for ease of removal. Wheels shall be fitted with sealed-for-life deep groove ball bearings and the bores of the wheels shall be accurately keyed to accept the drive motors.

24.5.2.2 Long Travel Gearmotors

Long travel drive for each EOHT crane shall be by two (2) independent totally enclosed pole changing geared brake motors (special purpose crane drives) fitted with heavy duty fail safe disc brakes. All gearing shall be totally enclosed for maintenance free service. All gears shall be hardened and ground in accordance with the most up to date engineering practices. The gearbox shaft shall be machined from heat treated alloy steel accurately ground and keyed. Speed control shall be initiated by means of double pressure buttons on the control pendant. An electronic deceleration timer shall be fitted to provide a smooth change between low and high speed.

24.5.3 Underslung Trolley

A close headroom suspension trolley shall be provided for each EOHT crane with four flanged wheels all fitted with fully sealed anti-friction bearings. The driving wheels shall incorporate integral machine cut straight spur gears. From the trolley tie bolts, a fabricated high lift frame, on which the electric hoist is foot mounted, shall be hung. A balance bucket shall be provided to counteract the tipping effect, in the unload condition, caused by the off centre positioning of the hoist.

The cross travel motion shall be provided by electric motor and gearbox built to the same standard as the crane bridge beam travel drive train.

24.5.4 Hoists

The gears in each hoist shall be completely enclosed in an oil bath gear case. A rope guide and pressure ring shall be provided to ensure the rope lays correctly, and actuates the upper and lower limit switches to prevent overwinding of the rope.

Each hoist shall be powered by a reversible high torque motor designed for crane service and shall incorporate an automatic electro-mechanical type disc brake designed to hold the load in any position once power to the motor is interrupted. Each hoist shall have two-speed operation. High speed operation shall be provided for lifting equipment out of the facility. Low speed operation shall also be provided to "inch" the load either up or down to enable alignment of the equipment. Each hoist shall maintain a constant hoisting speed regardless of the load being lifted.

For a sewage pumping station with an EOHT crane using a wire rope hoist, the wire rope and hook shall be designed for occasional immersion in sewage. The wire rope shall be load rated 7 by 19 construction Grade 316 stainless steel wire manufactured to the requirements of AS 3569 and supplied with a test certificate.

For a water pumping station with an EOHT crane using a wire hoist, the hoist rope and crane hook shall be designed for exposure to the elements where the EOHT crane is installed. The wire rope shall be steel in accordance with AS 3569, shall be galvanised and shall be supplied with a test certificate.

24.5.4.1 Chain Hoists
The Developer or the Contractor shall supply and install an electric chain hoist complying with Clause 24.4.3 of this Supplementary Specification for each EOHT crane with the ‘Rated Capacity’ specified on the project drawings. The hoist shall be capable of hoisting speeds as specified in Clause 24.5.5.

24.5.2 Wire Hoists

The Developer or the Contractor shall supply and install an electric wire rope hoist for each EOHT crane with the ‘Rated Capacity’ specified on the project drawings. The hoist shall be capable of hoisting speeds as specified in Clause 24.5.5 of this Supplementary Specification. An electronic acceleration timer shall be fitted to provide a smooth change between low and high speeds. The hoist shall have enough wire rope to reach the lowest floor level below the fully raised hook position. The hoist shall be fitted with top and bottom limit switches in accordance with AS 1418 Part 2. The hoist shall be self-sustaining under all loads.

24.5.5 Speeds

The operating speeds of the various directions of travel shall be within plus or minus 30 % of the following operating range:

- Longitudinal (or Crane Bridge Beam) travel fast: 16 m/min;
- Longitudinal (or Crane Bridge Beam) travel slow: 4 m/min;
- Traverse: 8 m/min;
- Hoist high speed: 4 m/min; and
- Hoist low speed: 0.8 m/min.

24.5.6 Temporary Load Holding Devices For Crane Hook Reattachment

A device shall be provided to temporarily hold a load when it is necessary to move the crane hook from the initial pick-up point on the pump lifting chain or rope to another point lower down to allow the load to be lifted higher than a single lift would allow, to avoid long travel clashes with structures, equipment, piping, handrails or other items. This requirement would be satisfied by provision of an auxiliary beam trolley fitted with a sling hanging to a suitable level and with the beam trolley connected to and towed by the EOHT crane cross-travel hoist assembly.

24.5.7 Crane Rails and End Stops

Crane rails, crane rail anchor bolts, runway beams and long-travel stops shall be provided. The crane rails, runway beams and long-travel stops shall be hot-dip galvanized. Welding of the crane rails onto the runway beams/support structure is not acceptable, bolting shall be provided. The crane rail anchor bolts shall be Grade 316 stainless steel with spring washers or Nyloc nuts, refer to Clause 31 of this Supplementary Specification.

24.5.8 Protective Coatings

If installed externally, all steelwork in each EOHT crane shall be duplex galvanized, refer to Clause 30.2.3 of this Supplementary Specification. If installed wholly in a building, all steelwork in each EOHT crane shall be hot-dip galvanized, refer to Clause 30.2.3.

Metalwork that is not suitable for hot dip galvanising, such as wheels shall be grit blasted clean to Class 2.5 in accordance with AS 1647 Part 4 followed by a priming coat of two pack zinc silicate followed by a top coat of two pack epoxy enamel to a DFT of not less than 400 µm.
24.5.9 Fasteners

All other fasteners in each EOHT crane shall be Grade 316 stainless steel with spring washers or Nyloc nuts, refer to Clause 31 of this Supplementary Specification. Where the required stress capacity of fasteners for logical fastener groups is beyond the capacity of the highest stress capacity and largest practical diameter of Grade 316 stainless steel, they shall be hot dip galvanised high strength steel fasteners.

24.5.10 Electrical Power and Control

The Contractor shall include all electrical power and control cabling and equipment on each EOHT crane and from its connection to a local isolator and thence to its circuit breaker in the appropriate switchboard.

The support catenary arrangement for the electrical wiring for each EOHT crane shall be fabricated from Grade 316L stainless steel Unistrut or similar sections and Grade 316 stainless steel wire of ample diameter for the application supplied with roller swaged Grade 316 stainless steel terminations. ‘Bulldog’ type clamps on the wire will not be accepted by the Principal. Hot dip galvanised, zinc plated or cadmium plated components will not meet the required design life and shall not be used.

Electrical power and control cables and equipment shall be suitable for exposed outdoor service and shall conform to the requirements of Part 2 of this Supplementary Specification.

Wire conductors shall be of the enclosed copper conductor type with spring loaded collectors and shall be complete with all necessary insulation, supports and appurtenances.

Limit switches shall be provided on the longitudinal travel and cross travel on each EOHT crane to limit the motion of the crane bridge beam bogies or the hoist trolley prior to hitting the end stops.

24.5.11 Pendant and Remote Control Units

Each EOHT crane shall be provided with a push button pendant control unit and a separate remote control unit with duplication of all controls. The pendant control unit shall hang 1.0 m above the operating platform level, operate on no more than 32 V and shall be provided with a raised emergency stop button. The pendant control unit shall have a heavy duty polycarbonate housing fitted with double pressure buttons for two speed operation. The pendant control unit shall be suspended from the crane bridge by means of a Grade 316 stainless steel cable. The pendant control unit shall be free to rove across the crane bridge beam irrespective of the hoist position.

24.5.12 Crane Maintenance Platforms

A service platform with an access stairway conforming to the access requirement of AS 1418 shall be provided for each EOHT crane for the safe servicing of all drives and hoisting units on each EOHT crane.

The service platform and stairway access shall comply with the requirement of Clause 25 of this Supplementary Specification.

24.6 Commissioning

All hoisting equipment shall be commissioned in accordance with AS 1418.

For sewage pumping stations, the full functionality of the hoisting equipment shall be tested using a spare pump unit of equivalent size and weight to that in service. The test pump unit shall be provided by the Principal.

For all other locations, the full functionality of the hoisting equipment shall be tested using a spare pump of equivalent size and weight to that in service. The test pump shall be provided by the Principal.

24.7 Testing
All hoisting equipment shall be load tested accordance with AS 1418. The load test shall include lowering the load at full speed and activating the emergency stop. The load test shall be supervised by a competent person and a load test certificate shall be provided to the Superintendent and the Principal’s Representative.

For the purpose of carrying out the load tests, the Contractor shall provide sufficient material to load the hoist or crane as required except where a pump unit is supplied by the Principal for testing purposes.

Each electrically driven hoist shall be load tested by the Contractor to the satisfaction of the Principal’s Representative.

24.7.1.1 Monorails and Chain Hoists

Each monorail and its associated chain hoist shall be load tested as specified above.

24.7.1.2 Electrically Actuated Overhead Travelling Gantry Cranes

The hoisting unit and cross-travel trolley shall be tested in accordance with AS 1418. Tests certificates shall be supplied and the Contractor shall provide all test weights and bear the cost incurred in accordance with AS 1418. The load test shall be at site after installation and connection of power. The test record shall include the test load and the maximum deflection of the crane beam.

24.8 Technical Documentation

The Contractor shall provide technical documentation for the hoisting equipment as required by Part 0 of this Supplementary Specification.

24.9 Handover Inspection

Prior to the Superintendent granting Practical Completion, hoisting equipment shall be inspected by the Superintendent and the Principal’s Representative for conformance with the requirements detailed in this Supplementary Specification.

25 EQUIPMENT ACCESS and WORKING SPACE

25.1 Access To and Working Space Around Equipment and Components

Personnel access to equipment and components of each facility and the working space around each item of equipment and each component of each facility shall typically be provided by means of access systems comprising as necessary stairways, landings, platforms, walkways and guardrailing (often termed handrailing) where required by AS 1657 and conforming to AS 1657 and the additional requirements detailed in this Clause and elsewhere in this Supplementary Specification. These requirements apply to:

- Each access system between equipment or components and their entry/egress locations across tanks, structures and other surface discontinuities i.e. these are elevated access systems; or
- Each access system between equipment or components and their entry/egress location/s which are at different levels i.e. these are also elevated access systems; or
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- Each access system between equipment or components and their entry/egress locations where the surface is concrete, asphalt or a similar surface where these are ‘at grade’ access systems where the clearance and guarding requirements shall apply.

Under no circumstance will the Principal accept the need for operators, maintainers or any other personnel to step over or duck under obstructions to access equipment for operations or maintenance purposes. The ‘no step over’ provision also precludes the use of low folded aluminium or Grade 316 stainless steel tread plate covers over services run just above grade unless the length of the cover in the walkway direction equals its width e.g. for a 750 mm wide cover, it shall be 750 mm long (in the walkway direction) and shall be 150 mm high. Preferably such services would be in a floor trench or duct with grating at walkways.

The minimum vertical clearance above stairways, landings, platforms and walkways including ‘at grade’ walkways shall be not less than 2200 mm, contrary to the requirements of AS 1657 which only requires 2000 mm.

The minimum horizontal clearance on landings, on platforms, along walkways and around equipment including ‘at grade’ walkways once all equipment, pipework, ductwork, electrical ducts, electrical local control stations, all other electrical cabinets and all services such as potable water, service water and compressed air and any other components shall be not less than 750 mm.

25.2 Limitations and Relaxations

Stairways, rather than ladders, shall be installed for access to each pump unit or any other components requiring routine inspection and maintenance (routine is defined as occurring yearly or less than yearly).

In any existing facility where a conforming stairway cannot be installed due to space restrictions, step ladders conforming to AS 1657 may be an alternative subject to prior approval by the Principal’s Representative in writing. This relaxation does not apply to new facilities. Rung ladders are not acceptable to the Principal under any circumstance.

Fixed platforms and walkways shall be provided to allow maintenance personnel to access all existing areas currently provided with access, or as directed. In particular, platforms shall be provided to allow electrical wiring to be disconnected from the top of each pump unit safely without having to climb onto the equipment.

Where fixed platforms and walkways cannot be provided and after the limitation is discussed and agreed with the Superintendent and the Principal’s Representative in writing, then a mobile platform shall be provided.

25.3 Specific Access Requirements

25.3.1 Sewage Pumping Station Access

No fixed access is required to the pump units installed in each enclosed wet well. Typically, no fixed access is required to the valves, flowmeter and other components in the adjoining or attached valve pit when enclosed by a roof.

Access to the pump units and other equipment at the bottom of each dry well shall be provided by a stairway and platform system including guardrailing (handrails and toeboards where required) and landings to ensure safe working conditions. Additional platforms with stairways and guardrailing shall be provided where access is required to elevated equipment.

25.3.2 Water Pumping Station Access

Access to the pump units, valves, flowmeters and other equipment in each pumping station shall be provided by a stairway and platform system including guardrailing (handrails and toeboards where required) and landings to ensure safe working conditions. Additional platforms with stairways and guardrailing shall be provided where access is required to elevated equipment.
25.3.3 Equipment Access

Suitable and safe means of access shall be provided as necessary, to provide convenient and safe access to all components requiring adjustments, service or maintenance. A stairway and platform access system shall be provided for access to components requiring frequent (frequent is defined as occurring yearly or less than yearly) adjustments, service or inspection.

25.3.4 Working Space Around Pump Units

Further to the clearances required by Clause 25.1 of this Supplementary Specification, the arrangement of the pump units, pipework, valves and their actuators, flowmeter/s and other instruments in each pumping station dry well and other equipment shall be such that a minimum of 1.2 m of clear working space is provided around each pump unit with all appurtenances in place. In situations where this is not the case, all reasonable measures shall be taken to improve the access by removing obsolete equipment or relocating items that can be moved.

25.3.5 Roof Openings

25.3.5.1 Sewage Pumping Stations – Submersible Pump Units in a Wet Well

Where a pumping station has submersible pump units in a wet well with a concrete roof with openings for pump unit access, each opening through the roof to access the pump units shall be covered with a close fitting aluminium tread plate cover to contain sewage gases in the wet well. The tread plate cover shall be subdivided into the same number of parts as there are pump units or twice or thrice as many parts as there are pump units.

Where the sewage pumping station has hoisting equipment, each part of the cover shall be fabricated with lifting points at each corner to allow the part of the cover to be removed using the hoisting equipment. The lifting lugs shall be recessed below the surface of the part of the cover to avoid creating trip hazards. A 4-point sling shall be provided to suit the dimensions of each part of the cover. The sling shall be stored in a clean dry cabinet within the pumping station building.

The support frame for each cover shall be fabricated with studs or a similar locating device to prevent the parts of each cover from being able to slide horizontally under any operations or maintenance scenario when an adjacent part has been removed.

Where there are multi-part covers for each pump unit and a building or a secure enclosure around the covers, the part of the cover directly over the pump unit shall be slotted, nominally 100 mm wide, along the centreline of the pump unit to allow the lifting chain for the pump unit to extend out of the pump well to an ‘above slab tie off bracket’ located 1000 mm above the finished level of the roof. This slot arrangement shall have a minimum 300 mm square widening/opening immediately above the centre of gravity of the pump unit. This square opening shall allow each pump unit to be lifted and lowered using the hoisting equipment to clear any blockages and reseat the pump unit without needing to remove each part of its cover. The nominal 100 mm wide slot leading to the square opening through the cover part shall be just wide enough to allow the lifting chain to pass through with some manual intervention. The whole of the slot and square opening, bar the part occupied by the lifting chain when it is attached to the ‘above slab tie off bracket’, shall be filled with a removable cover.

The structure of the part of the cover around the slot and square opening shall be designed to ensure that the floor design loads and deflection limits are complied with.

Where the pumping station does not have hoisting equipment, the parts of each cover shall be hinged. The size of each part shall be such that they can be opened manually by one person, the maximum lifting weight shall be 18 kg.

Each section of each opening through the roof of each sewage pumping station shall be able to be fenced on all four sides with four removable aluminium guardrailing sections. Each removable aluminium
guardrailing section shall sleeve into Grade 316 stainless steel sleeves attached to the sides of the opening below the cover supporting frame. Enough removable aluminium guardrailing sections shall be provided to allow each part of the cover to be removed and safely fenced. Each removable aluminium guardrailing section shall comply with AS 1657, each shall have a mid rail and a toe board.

25.3.5.2 Locations Other Than Sewage Pumping Stations

Where a pumping station has pump units in a dry well with a concrete roof with openings, or where a facility has equipment in an enclosed space with a concrete roof with openings, each opening through the roof to access the pump units or equipment shall be covered with panels of aluminium floor grating.

Where the pumping station or facility has hoisting equipment, each panel shall be fabricated with lifting points at each corner to allow the panel to be removed using the hoist. The lifting lugs shall be recessed below the surface of the grating to avoid a trip hazard. A 4-point sling shall be provided to suit the dimensions of the panels. The sling shall be stored in a clean dry cabinet within the pumping station building.

The support frame for each grating cover shall be fabricated with studs or a similar locating device to prevent the parts of each cover from being able to slide horizontally under any operations or maintenance scenario when an adjacent panel has been removed.

Where the pumping station or facility does not have hoisting equipment, the parts of each cover shall be hinged. The size of each part shall be such that they can be opened manually by one person, the maximum lifting weight shall be 18 kg.

Each section of each opening through the roof shall be able to be fenced on all four sides with four removable aluminium guardrailing sections. Each removable aluminium guardrailing section shall sleeve into Grade 316 stainless steel sleeves attached to the sides of the opening below the cover supporting frame. Enough removable aluminium guardrailing sections shall be provided to allow each part of the cover to be removed and safely fenced. Each removable aluminium guardrailing section shall comply with AS 1657, each shall have a mid rail and a toe board.

25.3.6 Lay-Down Area

The lay-down area outside each building shall be a level concrete pad flush with the surrounding ground level with a minimum size of 1.5 m x 1.5 m. The pad shall be designed to be trafficable and withstand the weight of the pump unit and any other large item of equipment being placed on it. The pad shall be designed to cater for a pump unit sized for the 2056 Planning Scheme Demand.

26 PERSONNEL ACCESS SYSTEMS

26.1 General Requirements

A guardrail shall be provided on both sides of each stairway except where AS 1657 permits one guardrail to be omitted. Where a stairway is provided with a wall on each side, only a top rail (handrail) as defined in AS 1657 need be provided.

Grating shall be used for all metal stairway treads, landings and platforms. Where personnel normally work below a stairway, landing or platform, either tread plate shall be used or a secondary screen also fabricated from aluminium sheeting or Grade 316 stainless steel sheeting shall be provided below each grating panel to ensure that small objects which may fall through do not fall on the personnel below.

All metal access systems including stairways, platforms and guardrailings shall be fabricated from aluminium unless noted otherwise. All components of each access system including grating, tread plates
and structural support members shall be aluminium unless noted otherwise. The Contractor shall refer to Clause 30.1 of this Supplementary Specification for general fabrication requirements and to Clause 30.4 of this Supplementary Specification for specific aluminium fabrication requirements.

All fasteners in all applications in each access system shall be Grade 316 stainless steel, refer to Clause 31 of this Supplementary Specification.

The nosing of each stair tread and the edge of each platform at each entry/egress point shall be provided with:

- An anodised aluminium edging, alloy 6063 T5 with a Yellow coloured PVC non-slip insert such as the 71 mm wide by 9 mm high front face Stair Nosing from TGSI Pty Ltd or an approved equivalent. Each aluminium edging shall be separated from dissimilar metals as detailed in Clause 30.1.5 of this Supplementary Specification or from concrete as detailed in Clause 30.4.5 of this Supplementary Specification, or
- A Yellow aluminium oxide grit coated and resin bonded, fibre reinforced plastic (FRP) strip, such as the 70 mm wide by 9 mm high front face Stair Nosing from TGSI Pty Ltd or an approved equivalent.

The nosing of each concrete step shall also be provided with either an aluminium edging with a Yellow coloured non-slip insert or a Yellow FRP strip as detailed above. The back face of the aluminium edging shall be coated with two coats of bitumen paint. Similarly, where there is a step at each entry/egress point from each concrete landing or slab shall also be provided with either an aluminium edging with a Yellow coloured non-slip insert or a Yellow FRP strip as detailed above. The back face of each section of aluminium edging shall be coated with two coats of bitumen paint.

### 26.2 Access System Components

#### 26.2.1 Stairways

Each stairway shall be located so as to provide access for servicing and maintenance in a safe manner. The minimum width of each stairway shall not be less than 750 mm measured between the inside edges of the guardrail stanchions or top rails.

As required by AS 1657, the slope of each stairway shall not exceed 45 degrees. All rises and goings in the same set of stairs (could be multiple flights with changes of direction) shall be of uniform dimensions within a tolerance of +/- 5 mm. The geometry of the rises and goings shall conform to AS 1657.

Each stairway shall be comprised of straight flights with landings or platforms.

Curved stairways are generally not accepted other than for circular tanks and silos. In these situations, the average or stairway centreline ‘going’ for each tread shall meet the requirements of AS 1657 for the selected ‘rise’. However, the minimum ‘going’ shall be no shorter than 35 mm less than the average ‘going’ eg this would makes the minimum stairway centreline radius 2090 mm for an average or stairway centreline ‘going’ of 230 mm.

#### 26.2.2 Step Ladders

The slope of each step ladder shall not exceed 65 degrees. The vertical distance between each landing shall not exceed 6.0 m. Where the vertical height of the installation exceeds 6.0 m, and the installation consists of more than one step ladder, each succeeding step ladder shall change direction or, if this is not practicable, be staggered at each landing. A handrail shall be provided on both sides of the each ladder.

All components of each inclined step ladder access system including step treads, structural support members and guardrails shall be aluminium. A fall protection system based on a permanently installed Grade 316 stainless steel wire with Grade 316 stainless steel mountings and accessories in accordance with AS/NZS 1891 shall be provided for each ladder flight. All fasteners in all applications in each inclined step ladder access system shall be Grade 316 stainless steel, refer to Clause 31 of this Supplementary Specification.
The Contractor shall refer to Clause 30.1 of this Supplementary Specification for general fabrication requirements and to Clause 30.4 of this Supplementary Specification for specific aluminium fabrication requirements.

### 26.2.3 Platforms and Walkways

#### 26.2.3.1 Fixed Installations

The minimum width of each platform and walkway shall not be less than 750 mm measured between the inside edges of the guardrail stanchions or top rails.

Each fixed platform and/or walkway shall be horizontal with guardrailing conforming to AS 1657. The floor of each platform and/or walkway shall be grating. All platform components shall be aluminium.

#### 26.2.3.2 Portable Installations

The minimum width of each portable (or mobile) platform and walkway shall not be less than 750 mm measured between the inside edges of the guardrail stanchions or top rails. A hinged and lockable gate shall be provided at the top of each portable platform and walkway.

Each mobile platform and/or walkway shall be horizontal with guardrailing and preferably have a stairway conforming to AS 1657. The floor of the platform shall be grating. All platform components, except the tyres on the wheels, shall be aluminium unless agreed otherwise in writing by the Principal’s Representative. Each mobile platform and/or walkway shall have wheels that can be locked in place.

### 26.2.4 Guardrailing

Each guardrailing system shall be a fully welded aluminium system designed, fabricated and installed in accordance with AS 1657. Rails and stanchions shall be aluminium tube and base plates, connection plates and toe-boards shall be aluminium plate. Stanchions shall be designed and attached so that the handrails are rigid. Stanchions featuring knuckle type joints may be used.

Each guardrailing system shall be a minimum of 1000 mm high complete with a kneerail. All joints shall be seal welded, riveting of joints will not be accepted. Toe-boards shall be provided on all handrails where an object can fall more than 2000 mm to the ground or floor of a structure from a platform, walkway or landing, including into water retaining structures, in accordance with AS 1657.

Aluminium extruded components including each stanchion, each top and mid rail section and kickplates shall be alloy 6063 tempered to T5 or T6. All other aluminium components shall comply with the requirements of Clause 30.4 of this Supplementary Specification.

### 26.2.5 Aluminium Grating

All grating shall comply with the requirements of Clause 30.1 of this Supplementary Specification.

All openings in the grating shall be completely banded or trimmed. All bars terminating against edge bars and other banding bars shall be welded to such edge bars and banding bars.

Grating sections which are required to be removed for routine access purposes shall be hinged with recessed hinges and shall have a lifting weight of less than 18 kg. The hinges shall not protrude above the surface of the grating. Hinges shall be fabricated from Grade 316 stainless steel.

All grating shall be clamped to the supporting metalwork with approved fixing clips using Grade 316 stainless steel fasteners. Each section of grating shall fit snugly and safely into or onto the supporting frame. All panels shall be held in place with a minimum of four (4) clips per panel with a 500 mm maximum spacing of clips. The clips used shall be Webforge "Hi-Light" Method 1 with a Grade 316 stainless steel bolt and a 5 mm thick Grade 316 stainless steel clamp plate with tapped hole, or a similar
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sliding clamp type for equivalent types of grill flooring. The use of a lower nut to secure the clips shall not be accepted.

26.2.6 Aluminium Cover Plates
Cover plates shall be fabricated from aluminium plate complying with the requirements of Clause 30.4 of this Supplementary Specification.

Each plate shall be patterned where subject to pedestrian traffic. No single piece of plate shall weigh more than 18 kg.

27 MECHANICAL VENTILATION (FOR SMALL, MEDIUM AND LARGE PUMPING STATIONS)

27.1 General Requirements

27.1.1 Non-odorous Air Spaces
Ventilation with discharge to the atmosphere and without treatment shall be provided for enclosed spaces in sewage pumping stations such as dry wells or buildings that are not directly connected to spaces containing sewage. Ventilation with discharge to the atmosphere shall be provided for enclosed spaces in water pumping stations such as pump wells or buildings.

Ventilation is provided to:

- Achieve a sufficient exchange of fresh air to maintain a suitable workplace within the enclosed space;
- Control the humidity of an enclosed space; and
- Remove heat from the operation of electric motors and other heat emitting devices so that suitable operating conditions are maintained.

The ventilation system shall create a positive pressure in the ventilated space to avoid drawing air from unintended spaces or ducts into the space.

27.1.2 Odorous Air Spaces
The wet well of each sewage pumping station shall be independently mechanically ventilated and shall be connected to an odour management system, refer to Clause 28 of this Supplementary Specification.

Where established by an Odour Impact Assessment Report, refer to Clause 2.5 of Part 1 of the SEQ-SPS Code or where required by the Principal’s Representative, the air space for each rising main discharge structure or any other odorous space shall be independently mechanically ventilated and shall also be connected to an odour management system, refer to Clause 28 of this Supplementary Specification.

The mechanical ventilation system shall create a negative pressure in the ventilated space of at least 150 Pa vacuum relative to atmospheric pressure to ensure that:

- Air is drawn into the space and not unintentionally exhausted to other areas; and
- Rogue odours do not escape from the ventilated space.

27.1.3 Ventilation Work Co-ordination
The Contractor shall coordinate the ventilation work associated with the installation of the mechanical ventilation equipment with the other civil, structural, mechanical and electrical works. The Developer’s Designer and/or the Contractor shall ensure that conflicts with the other work are avoided. The Developer’s Designer and/or the Contractor shall ensure that provision is made for:
27.2 Air Change Requirements

27.2.1 Non-odorous Air Spaces
Ventilation shall be continuous. It shall provide at least six (6) complete air changes per hour for the complete volume of the dry well and any building spaces.

27.2.2 Odorous Air Spaces
Mechanical ventilation shall be continuous. Continuous ventilation shall provide:

- At least twelve (12) complete air changes per hour for sewage pumping station wet wells and any associated adjoining structures such as the control manhole if provided; and
- At least thirty (30) complete air changes per hour for each sewage rising main discharge structure or any other odorous structure.

The inducted air shall be added to the facility at the lowest feasible level or at the furthest feasible location from the discharge or educt location to maximise the air changes throughout the facility.

27.3 Odour Collection Covers

Where odour collection covers are required for any facility, but typically open topped sewage storage structures, the design, fabrication, installation and testing of the odour collection covers shall meet the requirements set out in SS10 Section 2 Wastewater Treatment Plant design.

27.4 Ductwork and Control Devices

27.4.1 General Requirements
The Contractor shall carry out the design, fabrication supply and installation of ventilation ductwork in accordance with this Supplementary Specification, the Project Drawings, the Project Specification and AS 4254.

The standard of ductwork construction covered by this Supplementary Specification is intended to establish minimum requirements. Alternative methods of construction may be offered provided these are of equal or superior standard to those specified. Such alternatives shall be fully detailed on the drawings.

The Contractor shall provide fabrication drawings of the proposed ductwork in accordance with this Supplementary Specification prior to fabrication. An adequate number of flanged joints shall be provided to facilitate fabrication, assembly and dis-assembly for maintenance purposes.

27.4.2 Ductwork
Ductwork shall:
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- Be manufactured/fabricated from fibre reinforced plastic (FRP), glass reinforced plastic (GRP), PVC or Grade 316 stainless steel;
- Be either circular, or square, or rectangular generally as shown on the Project Drawings;
- Have a maximum velocity within the ductwork or any fans of 10.0 m/s and a velocity out of any outlet of no less than 12.0 m/s or no more than 15.0 m/s;
- Be sealed to prevent the escape of gases;
- Have stiffening to prevent flexing, drumming or sagging. Stiffeners shall be continuously attached to the ductwork on both sides of the joint;
- Be joined with flanges attached to the sections. Flanges shall be bolted at approximately 75 mm centres with 10 mm diameter Grade 316 stainless steel nuts, bolts and washers. A soft plasticised PVC gasket or acid proof non-setting compound shall be used at each flanged connection;
- Be supported at not more than 1500 mm centres on each horizontal run, and no more than 2500 mm centres on each vertical run;
- Not be supported from flanged joints;
- Have flanged joints at a maximum spacing of 12 m to allow ductwork to be removed and reassembled, and to allow removal of the fans or equipment as required;
- Have test points located near fans for measuring air flow with an anemometer. The holes shall be approximately 32 mm diameter with removable sealed cover or plug; and
- Have a pressure test point with a 10 mm diameter Grade 316 stainless steel ball valve near the discharge of each fan.

Where GRP or FRP or polyethylene ductwork is proposed:
- The section thicknesses shall be designed by the Contractor to span between support with long term deflections including creep under the most severe loading case of better than Span/250 but in no case shall be less than 5 mm thick;
- Each duct’s cross sectional area shall be no smaller than the area shown on the Drawings;
- Have fittings fabricated from the same material as the ducts; and
- All supports shall be fabricated from Grade 316 stainless steel.

Where PVC ductwork is proposed, it shall be fabricated from PVC pressure pipe and shall also meet the requirements detailed in Table 27.1.

Table 27.1 PVC Ductwork Material Requirements

<table>
<thead>
<tr>
<th>Diameter of circular ducts (mm)</th>
<th>Length of side of square ducts (mm)</th>
<th>Minimum thickness of PVC (mm)</th>
<th>Stiffening required / not required</th>
<th>Flange sizes (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 450</td>
<td>up to 450</td>
<td>4.5</td>
<td>None</td>
<td>35 wide x 4 thick</td>
</tr>
<tr>
<td>460 to 600</td>
<td>450 to 600</td>
<td>4.5</td>
<td>None</td>
<td>45 wide x 5 thick</td>
</tr>
<tr>
<td>610 to 750</td>
<td>610 to 700</td>
<td>4.5</td>
<td>None</td>
<td>50 wide x 6 thick</td>
</tr>
</tbody>
</table>
Where Grade 316 stainless steel ductwork is proposed, it shall be fabricated from Grade 316 stainless steel sheet and sections to AS 1444 as detailed in Table 27.2.

### Table 27.2 Grade 316 Stainless Steel Ductwork Material Requirements

<table>
<thead>
<tr>
<th>Diameter of circular ducts (mm)</th>
<th>Length of side of square ducts (mm)</th>
<th>Minimum thickness of stainless steel (mm)</th>
<th>Flange sizes (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>up to 500</td>
<td>up to 500</td>
<td>1.0</td>
<td>40 wide x 4 thick</td>
</tr>
<tr>
<td>500 to 800</td>
<td>500 to 800</td>
<td>1.0</td>
<td>60 wide x 5 thick</td>
</tr>
</tbody>
</table>

All Grade 316 stainless steel ductwork greater than 500 mm nominal internal diameter shall:

- Be fabricated from Grade 316 L stainless steel;
- Be no smaller than the diameters shown on the Project Drawings; and
- Have fittings fabricated from Grade 316 L stainless steel.

Square ductwork shall have full radius bends. Half radius tees shall be used.

Full radius bends shall have an internal throat radius at least equal to the width of mating duct elements. Half radius tees shall have throat radii at least equal to half the width of mating duct elements. They shall also have internal curved gusset pieces to ensure a smooth air flow into branch lines. These gusset pieces shall be curved to a radius at least equal to the throat radius and shall penetrate the fitting walls so that full welding can be caused out from outside the fitting.

Where round ductwork is used, bends shall be of “lobster-back” construction, using five elements. The throat radius shall be at least equal to the diameter of ductwork.

Transitions shall have a maximum slope of their sides of 1:7 for expansion sections and 1:4 for contraction sections.

Ductwork supports shall be fabricated from Grade 316 stainless steel with minimum section dimensions of 32 mm x 3 mm flat.

All bolts, nuts, washers and other ductwork fasteners shall be Grade 316 stainless steel, refer to Clause 31 of this Supplementary Specification.

Horizontal ductwork shall be graded to prevent accumulation of moisture at low points and in each fan. Low points of the ductwork and each fan shall drain through pipework to the process drainage system.

Ceiling, roof and wall openings shall be trimmed and made good. Roof and wall openings shall be provided with corrosion resistant metal flashing consistent with the building cladding.

### 27.4.3 Flexible Connections
Flexible connections shall:

- Be provided to seal each fan's inlet and outlet to the adjoining ductwork;
- Be fabricated from woven nylon fabric reinforced plasticised PVC sheeting of 500 to 600 gm/m² weight;
- Be fastened by means of PVC or stainless steel collars fastened to the duct spigots by stainless steel screws and bands; and
- Have a clear 50 mm gap between supporting spigots.

The Contractor shall supply and install all necessary flow measurement tappings and devices on the ductwork to measure and balance the air flows from each source.

27.4.4 Dampers

A flow control damper shall be fitted to each extraction point to allow air balancing to occur. If a 100% seal is required (as defined by safe maintenance access or other considerations), then an airtight isolation damper shall be provided in addition to the air flow control damper.

Each duty / standby induct / educt fan set shall be provided with non-return dampers (or actuated dampers) to:

- Prevent back-driving of the out of service fan; and
- To prevent exposure of workers to air flow from the duty fan while undertaking repairs or maintenance on the out of service fan.

Each actuated damper shall be provided with an access hatch downstream of the damper (with a cover formed from clear transparent material such as polycarbonate) to allow for visual inspection of damper operation. An external indication of the damper position shall be provided which can be viewed from at least 20 m away.

27.4.4.1 Flow Control Dampers

Each flow control damper shall be constructed with a Grade 316 stainless steel stem, fibreglass gate and Grade 316 stainless steel handle and locking mechanism. Each flow control damper shall be located for ease of access and operability in a location that can easily be operated from a walkway / ground level.

Where it is unavoidable, dampers may be located in an overhead duct run provided a means of operation from ground level is developed by the Contractor. The use of a chainwheel and chain to address this requirement will be acceptable provided that a fully Grade 316 stainless steel chainwheel and Grade 316 stainless steel chain are provided.

There shall be at least one flow control damper supplied on each off-take branch.

27.4.4.2 Isolation Dampers

Each isolation damper shall be 100% isolating and shall be capable of sealing against a pressure of 800 mm water gauge. Each damper shall be of the butterfly type with FRP body and blade. The blade shall be reinforced with not less than four (2 on each side of the blade) FRP ribs to increase rigidity of the blade.

The shaft for mounting of the blade shall be full width Grade 316 stainless steel fully encapsulated within the damper blade and supported on externally mounted sealed for life ball bearings. Shaft sealing shall be achieved using Teflon or similar seals where the shaft passes through the damper body. Sealing faces between blades and the damper body shall be neoprene or EPDM (or similar and reviewed by the Superintendent).
Each damper shall be equipped with flanges for attaching it to the adjoining ductwork. Each damper shall be located for ease of access and operability in a location that can easily be operated from a platform or walkway or from ground level.

Each isolation damper shall be equipped with a gearbox and operating handle with a locking facility to prevent movement during operation and accidental movement of the operating mechanism. All metal components shall be manufactured from Grade 316 stainless steel. An indicator shall be provided so that the position of the damper blade can be identified from the exterior of the damper.

27.4.3 Non-return Dampers

Each fan shall be equipped with a non-return or automatic damper to prevent reverse running of the non service fan. Each non-return or automatic damper shall achieve 98% sealing against the maximum developed pressure of the fan. Each non-return and automatic damper shall be of the butterfly type and shall be of similar construction to the requirements for each isolating damper.

Each non-return or automatic damper shall be actuated using a 3-phase 415 V electric actuator such as manufactured by Rotork (or technically equivalent and approved by the Superintendent and the Principal’s Representen). Each non-return or automatic damper shall be equipped with a manual actuator lever and release mechanism such that the electric actuator can be readily disengaged and the damper manually opened and closed in the event of the electric actuator failing.

27.4.5 Air Intake Grilles

Each air intake grill shall be manufactured from Grade 316 stainless steel mesh of 1.5 mm diameter spot welded wire with a 12 mm square aperture. The same grilles shall be fitted to the discharge duct of each ventilation systems with the exception of vertical discharge stacks where no grille is required.

27.4.6 Discharge Stacks

The air collected from the discharge of any odour management system (and combined with any ventilation system discharges) shall be exhausted through a discharge stack. Each discharge stack shall discharge vertically and shall have a height that is the greater of either 15 m above finished surface level or 3 m above the height of any objects including trees in the immediate vicinity of the discharge stack. The immediate vicinity is defined as within 50 m.

Each discharge stack shall be constructed from FRP/GRP and shall have a contracted outlet to ensure an exit velocity for treated air of 15 m/s. Each discharge stack shall be designed to cantilever off the underlying concrete slab or concrete foundation. The Contractor shall advise the Superintendent of the design loads from each stack. As a minimum, each discharge stack shall be designed to withstand a minimum wind load of 52 m/s.

Where a discharge stack adjoins a building, it may be propped off the building. Where permission in writing has been sought and obtained from the Principal’s Representative, guy wires may be used for the support of the discharge stack. In those situations, all guy wires, fittings and fasteners shall be Grade 316 stainless steel. Roller swages terminal ends shall be used. Thimbles and copper swages or ‘bulldog’ clamps or similar clamps will not be permitted.

 Provision shall be provided at the base for draining of any water within the discharge stack. The drain shall discharge back to the sewage pumping station or to the sewerage reticulation system.

The colour of each discharge stack, along with the ductwork colour, shall be typically be Light Grey and shall be submitted to the Principal’s Representative for approval.

Where any discharge stack is part of an odour management system, the Developer or the Contractor shall provide a sampling point in the discharge stack for hydrogen sulfide and odour sampling. The sample location shall be in accordance with AS 4323.1 and shall be either accessible via a stairway to an access platform or alternatively, the Developer or the Contractor shall install a 15 mm diameter Grade
316 stainless steel tube connecting the sampling point to a suitable location at ground level where a hydrogen sulfide measuring instrument can be easily accessed.

For odorous space ventilation systems where the design air flow exceeds 500 L/s or 1800 m³/h, the Developer or the Contractor shall provide a T-mass air flow measurement instrument on the discharge stack. The Contractor shall install each T-mass flow measurement instrument in a location in straight horizontal or vertical ductwork as recommended by the instrument supplier. Each T-mass instrument shall be arranged with a ‘simple to release and re-engage’ connection detail to allow for the recommended cleaning. Stairway access is not expected to be required for this instrument where installed in a discharge stack. However, unimpeded access to the instrument by scissor lift or boom lift shall be provided.

27.5 Induct and Educt Fans

27.5.1 General Requirements
The Contractor shall carry out the design, manufacture, supply and installation of mechanical ventilation induct and educt fans in accordance with this Supplementary Specification, the Project Drawings, the Project Specification and AS 1668.

For ventilation systems where the design air flow exceeds 500 L/s or 1800 m³/h, there shall be two fans supplied and installed, one for duty operation and one for standby operation. The fans shall cycle between duty and standby as selected by the PLC/RTU or the operator.

Each ventilation induct or educt fan shall be provided with a local control station fitted with an isolator and an emergency stop pushbutton.

27.5.2 Axial Flow Fans
Each axial flow fan shall:

- Be direct coupled to single speed three phase 415 V 50 Hz electric motor;
- Have a continuous duty rating at its maximum speed;
- Have a maximum speed of 1500 r/min;
- Be housed in an FRP or Grade 316 stainless steel flanged tube with a motor terminal box located on the outside of the tube; and
- Have a non-overloading motor under all operating conditions.

27.5.3 Centrifugal Fans
Each centrifugal fan shall:

- Be driven by single speed three phase 415 V 50 Hz electric motor either directly or by means of a vee belt drive;
- Have a continuous duty rating at its maximum speed;
- Have a maximum speed of 1500 r/min;
- Have an airfoil blade impellor, manufactured from FRP or Grade 316 stainless steel and statically and dynamically balanced;
- Be housed in an FRP or a Grade 316 stainless steel volute with an inspection door and a drainage connection to plant drain;
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- Have shaft seals to prevent the egress of gasses from the fan housing;
- Be resiliently mounted with vibration dampers on the support frame with the motor mounted externally to the air stream. The fan support frame shall be fabricated from Grade 316 stainless steel; and
- Have a non-overloading motor under all operating conditions.

27.5.4 Vibration Monitoring
Each ventilation induct and educt fan with a drive motor size of 11 kW or greater shall be provided with vibration monitoring. One sensor shall be provided for direct coupled units and two sensors shall be provided for vee belt driven fans, one on the motor and one on the fan. Details for vibration monitoring are provided in Clause 44.1.3 of this Supplementary Specification.

Each vibration monitor shall be connected to the pumping station’s control system for logging and trending of the vibration data.

28 ODOUR MANAGEMENT

28.1 General Requirements

The wet well of each sewage pumping station or other which is independently mechanically ventilated, refer to Clause 27.1 of this Supplementary Specification, shall be mechanically educted and connected by ductwork to an odour management system. The air space for each rising main discharge structure or any other odorous space which is independently mechanically ventilated, refer to Clause 27.1 of this Supplementary Specification, shall also be mechanically educted and connected by ductwork to an odour management system.

The design air flow for each mechanically ventilated facility shall be as defined in Clause 27.2 of this Supplementary Specification.

Where the design air flow for odour management is less than or equal to 500 L/s or 1800 m³/h package odour treatment units shall be used. Package odour treatment units shall meet the requirements of this Clause of the Supplementary Specification.

Where the design air flow for odour management is greater than 500 L/s or 1800 m³/h, an odour control facility shall be provided. The design, fabrication, installation, testing and commissioning of each odour control facility shall meet the requirements set out in the Principal’s Standard Specification SS10, Section 2 Wastewater Treatment Plant Design.

This the Principal’s definition of the change in the design air flow from providing a package odour treatment unit to providing an odour control facility is independent of the availability or performance of package odour treatment units from any manufacturer which may have a larger rated capacity or be coupled in parallel to achieve a larger rated capacity.

For existing facilities, prior to designing the odour management system, the Developer, the Developer’s Designer or the Contractor shall conduct H₂S and odour units gas sampling and testing over a period of four (4) weeks to establish the base load H₂S levels and odour units from the facility. Five samples shall be taken and analysed during the period.

As part of the project design, the preparation of the Odour Impact Assessment Report shall include odour modelling based on the treated air discharge standards from each package odour treatment unit or odour control facility.

28.2 Odour Treatment Unit / Odour Control Facility Design

The Developer, the Developer’s Designer or the Contractor shall design each package odour treatment unit or odour control facility. As part of this design, a design report shall be prepared and submitted to the
Superintendent and the Principal’s Representative that addresses the following issues in terms of meeting the treated air discharge standards adopted in the Odour Impact Assessment Report:

- Design air flow in L/s or m³/h;
- No of educt fans;
- Fan static and dynamic pressure at design air flow in Pa or mm H₂O;
- Average odour load in terms of inlet Odour Units (OU) and part per million (ppm) of H₂S, and/or ppm of VOC, and/or ppm of any other odorous compound present as applicable;
- Peak odour load in terms of inlet OU and ppm of H₂S, and/or ppm of VOC, and/or ppm of any other odorous compound present as applicable;
- Proposed treatment process/es;
- Treatment by-products and disposal methodology;
- Reactor unit/s detention/contact time/s in seconds;
- Reactor unit loading rate/s;
- Reactor unit media design life/s at average odour load. The minimum design life of the media at the design life shall be 12 months;
- Treatment performance in terms of discharge OU and ppb of H₂S, and/or ppm of VOC, and/or ppm of any other odorous compound present as applicable;
- Height of discharge stack; and
- Proposed instrumentation.

The Developer, the Developer’s Designer or the Contractor shall prepare design drawings and documentation for each package odour treatment unit or odour control facility and submit them to the Superintendent and the Principal’s Representative for approval.

28.3 Package Odour Treatment Units Procurement, Construction, Installation, Testing and Commissioning

28.3.1 Procurement

Each package odour treatment unit or odour control facility shall be procured, constructed, installed, tested and commissioned in accordance with these approved drawings and all other documents.

The Principal’s preferred package odour treatment unit is the ODOURIDDER Biofilter system or similar approved, refer to Draft WSA 121-2002 specification.

28.3.2 Control and Instrumentation

Each package odour treatment unit shall alarm to the SCADA System through an RTU for fan status and faults.

A Drager Polytron H₂S monitoring instrument shall be supplied and installed in the ductwork on both the inlet and the outlet side of the package odour control unit. Each of these instruments shall provide a 4 to 20 mA output signal to the SCADA System through the RTU.

28.3.3 Commissioning
Following commissioning of the package odour treatment unit, the Developer or the Contractor shall allow a 4 week bio-acclimatisation period before conducting the following tests over a period of at least four (4) weeks:

- For new facilities, monitor the inlet and outlet gases H₂S gas concentrations from the site instruments seven days per week to verify that the system is working as expected;
- For new facilities, sample the inlet and outlet gases to test for H₂S gas concentrations and to establish the inlet and outlet odour units five days per week over the last fortnight (ie ten samples) to verify that the system achieves the required H₂S and odour unit reductions and is capable of meeting environmental regulations;
- For existing facilities, repeat the H₂S and odour units gas sampling and testing on the inlet to the package odour treatment unit and from its outlet to verify that the system achieves the required H₂S and odour units reduction and is capable of meeting environmental regulations; and
- Measure and record, as appropriate, the noise levels adjacent to the site at regular intervals throughout the four (4) week period to verify that the installation meets noise limitations set by the environmental regulations.

28.4 Odour Control Facility Procurement, Construction, Installation, Testing and Commissioning

The fabrication/manufacture, construction, installation, testing and commissioning requirements for each odour control facility shall be undertaken as required by the Principal’s Standard Specification SS10.

29 RE-CHLORINATION FACILITIES

29.1 Design Requirements

Where required by the Principal’s Representative, a re-chlorination facility shall be provided at a potable or recycled water storage to ensure disinfection and to maintain a residual level of chlorine in all areas of the related potable or recycled water reticulation network. The chlorination medium shall be liquid sodium hypochlorite, chlorine will not be used.

The Principal’s Representative will advise of the design requirements for each re-chlorination facility to the Developer or the Developer’s Designer. The Developer or the Developer’s Designer shall submit the detailed design to the Superintendent for on-forwarding to the Principal’s Representative for approval.

29.2 Pipework

All pipework incorporated into each re-chlorination facility shall comply with Clause 20.1 of this Supplementary Specification or where no relevant details are provided in accordance with good engineering practice.

29.3 Valves

All valves incorporated into each re-chlorination facility shall comply with Clause 21.1 of this Supplementary Specification or where no relevant details are provided in accordance with good engineering practice.
29.4 Fabricated Metalwork

All fabricated metalwork incorporated into each re-chlorination facility shall comply with clause 30.1 of this Supplementary Specification.

29.5 Fasteners

All fasteners incorporated into each re-chlorination facility shall comply with Clause 31 of this Supplementary Specification.

30 FABRICATED METALWORK

30.1 General Requirements

30.1.1 Inspection and Testing Program and Reporting

The Contractor shall submit an inspection and testing program that is consistent with the project construction program for approval by the Superintendent. The Contractor shall include particulars of inspection and test stages and procedures. The Contractor shall record inspection and test results in the Inspection and Test Reports and submit the reports to the Superintendent for on-forwarding to the Principal’s Representative.

30.1.2 Material Compliance

The Contractor shall submit evidence that the materials used in the work complies with the cited material standards. Acceptable evidence includes certified mill test reports, or test certificates issued by the mill. As an alternative, the Contractor shall have the materials tested by an independent testing authority for compliance with the chemical composition and mechanical test requirements of the cited material standard.

If products must comply with product certification schemes, the Contractor shall submit evidence of compliance to the Superintendent for on-forwarding to the Principal’s Representative.

30.1.3 Fabrication

If splicing of structural members is intended but not shown on the Drawings, the Contractor shall submit proposals together with certified computations for approval by the Superintendent.

Welding procedures shall be submitted to the Superintendent for review and acceptance prior to the commencement of welding. Procedures shall consist of the Welding Procedure Specification (WPS), Procedure Qualification Record (PQR) and supporting test records.

If a member or assembly is distorted during the fabrication or during a post fabrication coating process ie hot dip galvanising, the Contractor shall submit proposals for un-distorting the member or assembly.

30.1.4 Testing (Non-destructive Weld Examination)

The Contractor shall have the non-destructive weld examination performed by a NATA registered inspection organisation in accordance with Welding Technology Institute of Australia (W.T.I.A.) welding inspection certification.

The Contractor shall employ a qualified independent welding inspector to undertake all weld testing. If more than one welder has been utilised, at least one weld as deposited by each welder shall be inspected. The Superintendent reserves the right to nominate the welds to be tested.
The Contractor shall repair faulty welds revealed by non-destructive examination and repeat the examination. Where any joint is found to be defective by non-destructive examination (NDE), the Contractor shall repair the joint using the original procedure and the examination repeated. In addition, two further welds that are representative of the welder’s work shall also be subjected to NDE. If either of these welds is found to be defective a non-conformance report shall be raised. All repair work shall be done at the Contractor’s expense.

Table 30.1 Schedule of Non-destructive Weld Examination

<table>
<thead>
<tr>
<th>Type of weld and category</th>
<th>Examination method</th>
<th>Extent (% of total length of weld type)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fillet weld GP</td>
<td>Visual examination</td>
<td>15</td>
</tr>
<tr>
<td>Fillet weld SP</td>
<td>Visual examination</td>
<td>100</td>
</tr>
<tr>
<td>Fillet weld SP</td>
<td>Liquid penetrant or magnetic particle</td>
<td>2</td>
</tr>
<tr>
<td>Butt weld SP</td>
<td>Visual examination</td>
<td>100</td>
</tr>
<tr>
<td>Butt weld SP</td>
<td>Radiographic or ultrasonic</td>
<td>20</td>
</tr>
</tbody>
</table>

30.1.5 Dissimilar Metals
The Contractor shall separate connections between dissimilar metals such as:

- stainless steel and aluminium; or
- stainless steel and hot dip galvanised steel; or
- aluminium and hot dip galvanised steel

Separation shall be provided with PVC, neoprene or high molecular weight (HMW) polyethylene insulating sheathes or spacers. Where di-electric PVC tape is adopted, two layers with a minimum total thickness of 0.35 mm shall be used. The surfaces to receive the PVC tape shall be clean and be wiped with acetone immediately prior to applying the tape.

30.1.6 Fastener/Dissimilar Metal Separation
To prevent galvanic action, nylon or polyethylene washers, truncated cones, top hat washers and spacers as appropriate shall be used to separate stainless steel fasteners from aluminium or from hot dip galvanised steel components.

Under washers and bolt heads and on bolt shanks etc.. where the fastener size is too small for the above insulation methods, that is less than three (3) millimetres diameter, a heavy application of a zinc chromate paste such as “Duralac” or similar approved to the mating surfaces shall be substituted.

Hole sizes shall be drilled only sufficiently large enough to accommodate the fastener and isolator chosen. Oversized holes will not be accepted.

Under washers and bolt heads and on bolt shanks, etc. where the fastener diameter is less than 3 mm, a heavy application of DURALAC (or equivalent) anti-corrosive jointing compound to the mating surfaces can be substituted. In this case, holes shall be a maximum of 1 mm larger than the fastener diameter.

30.2 Steel
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30.2.1 Material Requirements
Steel shall comply with the requirement of AS 4100, AS/NZS 3678 and AS/NZS 3679.
The Contractor shall provide steel members in single lengths between nominated joints or splices.
If beam members have a natural camber within the straightness tolerance, the Contractor shall fabricate
and erect them with the camber up.
Steel sections and components shall comply with the requirements of Table 30.2.

Table 30.2 Schedule of Steel Grade

<table>
<thead>
<tr>
<th>Type of steel</th>
<th>Minimum grade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal beams and columns, parallel flange channels, large angles to AS/NZS 3679.1</td>
<td>300</td>
</tr>
<tr>
<td>Flat, small angles, taper flange beams and columns to AS/NZS 3679.1</td>
<td>250</td>
</tr>
<tr>
<td>Welded sections to AS/NZS 3679.2</td>
<td>300</td>
</tr>
<tr>
<td>Hot-rolled plates, floor plates and slabs to AS/NZS 3678</td>
<td>250</td>
</tr>
<tr>
<td>Hollow sections to AS/NZS 1163:</td>
<td></td>
</tr>
<tr>
<td>Circular sections up to 165.1 mm outside diameter</td>
<td>350</td>
</tr>
<tr>
<td>Circular sections greater than 165.1 mm outside diameter</td>
<td>250</td>
</tr>
<tr>
<td>Sections other than the above</td>
<td>C450LO</td>
</tr>
<tr>
<td>Cold-formed purlins and girts to AS 1397</td>
<td>G450</td>
</tr>
<tr>
<td>Hot-rolled plate, sheet and strip to AS/NZS 1594</td>
<td>HU250</td>
</tr>
</tbody>
</table>

30.2.2 Fabrication Requirements

30.2.2.1 Material Storage
All materials stored at the fabrication plant, and all fabricated steelwork and metalwork, shall be
supported above the ground so as not to cause overstressing, properly protected from tarnishing or
corrosion, and kept free of dirt, oil, grease, and other foreign material. Materials that show signs of pitting
due to corrosion may be rejected. Before being laid out or worked on in any way, rolled materials shall be
straight, and cleaned from any corrosion and dirt. Sharp kinks or bends shall be cause for the rejection of
the material.
If straightening is necessary, it shall not be done by methods that cause fracture or other injury. The
metal shall not be heated unless acceptable to the Superintendent, but if accepted, the temperature shall
not be higher than 650ºC. After heating, the metal shall be cooled slowly.

30.2.2.2 Material Substitution and Splices
Substitutions of sections having dimensions different to those on the drawings shall be made only when acceptable to the Superintendent. Should the substitution of heavier members be allowed, at the Contractor’s request, such substitution shall be made without extra cost to the Principal.

Welding splices that develop the full strength of the material being joined may be located as acceptable to the Superintendent, but shall be kept to a minimum.

### 30.2.2.3 Material Preparation

Other than work shown on the shop drawings as site work, the Contractor shall not fabricate or weld steel on site unless otherwise permitted by the Superintendent.

Machined, cut or sheared edges shall be filed or ground and shall be smooth and free of burrs and sharp edges. Welds in carbon or low alloy shall be chipped and brushed free of slag before surface preparation for painting or galvanizing occurs.

Holes shall be accurately located and shall be drilled or laser cut. Punching of holes will not be permitted.

### 30.2.2.4 Welding

Unless shown otherwise on the drawings or determined by the Developer’s Designer, welding shall be Category SP.

Category SP welds shall comply with the requirements of AS/NZS 1554.1 and AS 4100 Table 11.5.1.

Category GP welds shall comply with AS/NZS 1554.1.

Generally all welding shall be continuous full penetration butt welds or full seal fillet welds. Where the Developer’s Designer proposes joints that are not seal welded, the Developer’s Designer shall detail the joints to prevent crevice corrosion.

Welding shall be supervised at all times by a supervisor qualified in accordance with the code requirements and acceptable to the Superintendent.

Wherever possible, the Contractor shall locate site welds in positions for down-hand welding.

### 30.2.3 Surface Protection

All carbon steel components fabricated and installed shall be hot dip galvanised after fabrication followed by quenching in water. The galvanising shall have no adverse effect on the mechanical properties or the articles so treated. Variations in dimensional properties shall be kept to a minimum.

Contrary to provisions in AS/NZS 4680 regarding defects and imperfections in the zinc coating, the zinc coating shall consist of a uniform layer of commercially pure zinc, free from abrasions, cracks, blisters, chemical spots or other imperfections, and so applied that it will adhere firmly to the surface of the steel so as not to be removable by any reasonable process of handling and erection. Globules or heavy deposits of zinc which interfere with the intended use of the material will not be permitted.

Prior to galvanising, the surfaces shall be cleaned of all dirt, weld splatter, grease, slag, oil, paint or other deleterious materials. The steel surfaces shall be chemically descaled in accordance with AS 1627, Part 5 or abrasive blast cleaned in accordance with AS 1627 Part 4 to a Class 3 finish.

Where specified to have a ‘duplex’ system of galvanising, all carbon steel components fabricated and installed under the Contract shall be hot dip galvanised after fabrication as described above followed by the application of a paint system.

Prior to the application of the paint coating, the steelwork shall:

- Have all sharp edges or encrustations of zinc carefully brought to profile by filing or sanding; and
• Be prepared by a light ‘whip’ or ‘brush’ blasting to Class 1 in accordance with AS 1627 Part 4 to provide a profile height of between 20 and 30 microns.

Desirably within 6 hours and definitely within 24 hours of galvanising, the Contractor shall apply the appropriate paint system as approved by the Superintendent and the Principal’s Representative.

For non-immersed surfaces open to the atmosphere, the paint system shall be a three coat high build epoxy coating with a total minimum dry film thickness of 350 µm.

30.2.4 Assembly
Erection of steelwork items and components shall be carried out in accordance with AS 4100 and the Contractor’s Quality System as modified by the following requirements of the Principal.

Field erection procedures shall be such as to avoid distortion or damage of steelwork and any protective coatings. Steelwork items which are inaccurate, bent, broken or otherwise damaged shall be replaced or repaired to the satisfaction of the Superintendent.

Cutting, drilling and welding of galvanized items on site will not be permitted under any circumstance unless the component is again hot dip galvanised.

30.2.5 Fasteners
All fasteners used in steel metalwork assembly shall comply with Clause 31 of this Supplementary Specification.

30.3 Stainless Steel

30.3.1 ASSDA Accreditation
For fabrication involving the use of stainless steel products of any grade, organisations which are Australian Stainless Steel Development Association (ASSDA) accredited or equivalent shall be used.

Evidence supporting knowledge and competence must be supplied where it is proposed to utilise a non-ASSDA accredited fabricator.

30.3.2 Material Requirements

30.3.2.1 Material Standards
Materials shall comply with the following International Standards:

- ASTM A276 for flat bars;
- ASTM A312 for round tubes;
- ASTM A554 for square tubes;
- ASTM A240/480 for plate; and
- ISO 3506 for nut and bolt identification.

30.3.2.2 Material Grade
All stainless steel shall be Grade 316 (UNS S31600), or Grade 316L (UNS S31603) for section thickness of 6 mm or greater. All material shall conform to the appropriate ASTM standard.
30.3.3 Storage and processing
Stainless steel material shall not be stored with carbon steel materials.

Tools used to fabricate or assemble carbon steel shall not be used to fabricate or assemble stainless steel components. Dedicated tools for stainless steel work are preferred, but tools previously used to fabricate or assemble carbon steel may be used after being immersed in a proprietary phosphoric acid based rust convertor for an appropriate time, as specified by the manufacturer.

Work areas for stainless steel shall be isolated from those where carbon steel is processed to avoid contamination by dust and debris.

30.3.4 Welding
Welding shall be in accordance with AS/NZS 1554.6.

The fabricator shall limit the input of heat into each weld. The weld shall not be preheated, post-heated or stress relieved.

Grade 316L electrodes shall be used for Grade 316L stainless steel and AS/AWS2209 electrodes for duplex stainless steel.

Welds shall be Category 2B in accordance with AS/NZS 1554.6.

30.3.5 Pickling and Passivation
After shop fabrication, all components shall be pickled and passivated in accordance with ASTM A380.

The fabricated parts shall be immersed in a solution of 20% to 40% nitric acid plus 2 to 6% hydrated sodium dichromate (NaCr2O7·2H2O) for at least 30 minutes at 20°C to 40°C. Alternatively, 50°C to 60°C for 10-30 minutes may be used. The sodium chromate can be omitted for components with dull or non-reflective surfaces.

30.3.6 Handling
The stainless steel shall be wrapped or otherwise protected during transport to avoid contamination. If an adhesive plastic film is used, all traces of adhesive shall be removed from the steel with a suitable solvent on removal of the plastic.

When using equipment which may damage the stainless steel surface if it slips, appropriately designed masks shall be used to protect the vulnerable areas.

30.3.7 Assembly
If there is any contamination by salt water or spray before assembly, the mating surfaces shall be washed thoroughly with fresh water and wiped dry or dried with a dry heat source prior to assembly.

The Contractor or fabricator/erector shall not attach cleats except as shown on the fabrication drawings. The Contractor or fabricator/erector shall not flame cut bolt holes by hand. The Contractor or fabricator/erector shall not flame cut or flame bend anchor bolts.

30.3.8 Fasteners
30.4 Aluminium

30.4.1 Material Requirements

30.4.1.1 Material Standards

Materials shall comply with the alloys and tempers in Table 30.3.

Table 30.3 Aluminium Alloy and Temper Schedule

<table>
<thead>
<tr>
<th>Product</th>
<th>Alloy – Temper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roofing sheet and associated flashings</td>
<td>5251-H34</td>
</tr>
<tr>
<td>Purlins and girts</td>
<td>6061-T6</td>
</tr>
<tr>
<td>Extrusions</td>
<td>6061-T6, 6082-T5/T6 or 6351-T5/T6</td>
</tr>
<tr>
<td>Plate &lt;3 mm thick</td>
<td>5251-H34</td>
</tr>
<tr>
<td>Plate ≥3 mm thick</td>
<td>5083-H116/321</td>
</tr>
<tr>
<td>Round Rod</td>
<td>6063-T5</td>
</tr>
<tr>
<td>Tread Plate</td>
<td>5251-0</td>
</tr>
</tbody>
</table>

30.4.2 Aluminium Grating

All grating shall be Webforge Hi-Light or similar fabricated from marine grade aluminium. All openings in the grating shall be completely banded or trimmed. All bars terminating against edge bars and other banding bars shall be welded to such edge bars and banding bars.

30.4.3 Aluminium Tread Plate

Aluminium tread plate shall comply with AS 1734. The plate shall be patterned where subject to pedestrian traffic.

30.4.4 Welding

Welding shall be in accordance with AS/NZS 1665.

Unless shown otherwise on the Drawings, welding shall be category B.

Welding wire and electrodes shall be compatible with the parent metal and shall be classified and identified in accordance with the provisions of AS 2717.2.

30.4.5 Contact Coating

All aluminium surfaces placed in contact with concrete, wood, fibreboard or other porous material that absorbs water shall be painted with two heavy coats of alkali-resistant bituminous paint, or other coating providing equivalent protection, before installation.
30.4.6 Fasteners
All fasteners used in aluminium metalwork assembly shall comply with Clause 31 of this Supplementary Specification.

31 FASTENERS

31.1 Stainless Steel

Typically, all fasteners shall be Grade 316 stainless steel. Only in certain high strength applications, will alternate hot dip galvanised steel fasteners be accepted. This will require the written acceptance of the Principal's Representative.

31.1.1 Manufacturing Requirements
All Grade 316 stainless steel nuts and bolts shall generally comply with the metric standards AS/NZS 1111 and AS/NZS 1112.

All bolts shall be stainless steel ISO 3506-1 Grade A4-70 hexagonal head bolts, manufactured in accordance with DIN 931 unless noted otherwise.

Nuts used with stainless steel bolts shall be stainless steel ISO 3506-1 Grade A4-70 and shall be hexagonal, manufactured in accordance with DIN 934.

Washers used with stainless steel bolts and nuts shall be Grade 316 stainless steel, manufactured in accordance with DIN 125A.

Grade 316 stainless steel bolts and nuts shall have an ISO coarse pitch metric rolled thread.

Nuts and bolts shall comply with ISO 3506 identifications or, if not so marked, shall be provided with mill or NATA certified test results confirming grade and strength.

All other fasteners including metal thread and all other screws shall also be manufactured from Grade 316 stainless steel.

Bolts shall exhibit a clean cut thread with no burrs or torn peaks on the thread. Nuts must turn freely on the threads without binding.

All nuts, bolts and washers shall be either electro polished or passivated in accordance with ASTM A380.

31.1.2 Chemical Masonry Anchors
Chemical masonry anchors shall be Grade 316 stainless steel HVA adhesive anchors with HASR rods, as manufactured by Hilti (Aust) Pty Ltd or acceptable equal. Each anchor shall be supplied with a Grade 316 stainless steel nut and washer.

Insert type chemical anchors (a bolt or machine screw into a female socket set in place in adhesive in the concrete structure) shall be used where the use of stud anchors would preclude the disassembly of an installed component.

31.1.3 Mechanical Masonry Anchors
Mechanical masonry anchors shall be Grade 316 stainless steel stud anchors as manufactured by Hilti (Aust) Pty Ltd or acceptable equal. Each anchor shall be supplied with a Grade 316 stainless steel nut and washer.

Mechanical masonry anchors shall not be used except where approved by the Superintendent. These anchors typically compromise the integrity of the cover to the reinforcing steel.
31.1.4 Assembly
Flange bolt length shall be equal to the sum of the thickness of the flanges, gaskets, nut and washers and rounded up to the nearest standard size. A washer shall be placed under the bolt head and under the nut. The length of other fasteners shall be such that a minimum of 3 threads and a maximum of 6 threads shall protrude from the fastened item.

All Grade 316 stainless steel bolts, nuts and threaded items shall be lubricated with a nickel-based, anti-seize lubricant subject to the approval of the Superintendent before assembly. The anti-seize compound shall be serviceable up to 80°C and shall be UV stable. Anti-seize compounds containing graphite or other elemental carbon shall not be used. (Note: Some anti-seize compounds sold as marine grade contain graphite and are not suitable for use with stainless steel.)

The Contractor shall provide lock nuts for fasteners in moving parts or parts subject to vibration and for vertical bolts in tension.

Nuts and bolts shall be tightened to the manufacturer’s recommended torque using a torque wrench. Air or electric driven tools shall not be used to ‘run up’ nuts or insert bolts.

31.2 Steel
The use of hot dip galvanised steel fasteners will require the written acceptance of the Principal’s Representative.

31.2.1 Manufacturing Requirements
All hot dip galvanised steel nuts and bolts shall generally comply with the metric standards AS/NZS 1111 and AS/NZS 1112.

31.2.2 Installation Requirements
Each bolt and nut set shall be supplied with at least one washer. Where the head can rotate and damage a paint coating or hot dip galvanised coating, a washer shall be provided under the head of the bolt.

The length of each bolt shall be equal to the sum of the thickness of the fastened materials, the nut and the washer/s and shall be rounded up to the nearest standard size.

Bolts shall exhibit a clean cut thread with no burrs or torn peaks on the thread. Nuts must turn freely on the threads without binding.

Anti-galling compound shall be supplied in sufficient quantity to allow liberal application of the compound to the mating surface.
32 GENERAL ELECTRICAL INSTALLATION REQUIREMENTS

This Supplementary Specification covers the general requirements for electrical installations for sewerage network infrastructure including sewage pumping stations, sewage pumping booster stations and vacuum sewage pumping stations and for water supply network infrastructure including water pumping stations.

**NOTE:** SEE CLAUSES 6 TO 12 FOR DRAWING, OPERATING AND MAINTENANCE MANUAL REQUIREMENTS AND SUBMISSION DETAILS.

### 32.1 Electrical Supply

The electrical supply to each switchgear and controlgear assembly (SCA) commonly known as a switchboard or motor control centre (MCC) and the remainder of the electrical installation shall be a 415 V, 3 phases, 50 Hz AC MEN system.

### 32.2 New Connection and Tariff

The tariff shall be confirmed by the Developer, the Contractor and/or the Developer’s Designer with the Principal’s Representative prior to installation. Preference is for T22 for general supply. The Developer, the Contractor and/or the Developer's Designer shall forward a copy of the EWR (Form 2) through the Superintendent to the Principal's Representative to arrange an account when required.

### 32.3 Electrical Standards

All plant, equipment and installation works shall be supplied and set into operation in accordance with the latest edition of the standards in Table 32.1.

In addition to complying with the SEQ WS&S D&C – Sewage Pump Station Code (SEQ-SPS) for sewage pumping stations and this Supplementary Specification for both sewage and water pumping stations, work shall comply with the Queensland Electrical Safety Act, the associated Queensland Electrical Safety Regulation, the current revision of AS/NZS 3000 and any other relevant standard not mentioned herein.

Where more than one standard is quoted for the same item of equipment and the provisions of each standard are in conflict, the decision of the Principal’s Representative in writing upon which standard takes precedence, shall be final and binding.

All standards referred to in the body of the SEQ-SPS Code for sewage pumping stations or in this Supplementary Specification in Table 32.1 or elsewhere for both sewage and water pumping stations shall be complied with.

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WATER NETWORK AND SEWERAGE NETWORK
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33 ELECTRICAL WORK MATERIALS AND ELECTRICAL EQUIPMENT

All materials used in the electrical work shall be procured, fabricated, supplied, delivered and installed in accordance with this Supplementary Specification and the relevant Australian Standard or international standard where there is no Australian Standard. All materials used in the electrical installation work shall be handled, transported and stored in accordance with the relevant Australian Standard or international standard where there is no Australian Standard and the manufacturers’ recommendations.

Reference is made in Part 2 of this Supplementary Specification to the “The Principal’s Accepted Electrical Materials and Equipment Schedule”. The Developer, the Developer’s Designer and the Contractor shall refer to the documents listed in Table 33.1 for the components for various locations which are acceptable to the Principal.

Table 33.1 The Principal Accepted Electrical Materials and Equipment Schedule

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34 SWITCHBOARD/MOTOR CONTROL CENTRE REQUIREMENTS

34.1 Fault Level Capacity and Separation

34.1.1 Sewage Pumping Stations
Each switchboard or motor control centre shall comply with the requirements of AS/NZS 3000 with particular attention to Clause 2.5 (2007 Edition) – Protection Against Overcurrent.

For fault levels up to and including 6kA and for DOL motor starting (load not exceeding 2 x 5.5 kW drives), a SCA (switchboard or MCC) with Form 1 Separation to AS/NZS 3439 shall be used and for fault levels greater than 6 kA a SCA with Form 3b Separation to AS/NZS 3439 shall be used.

Separation (or segregation) shall be provided in accordance with the requirements shown on the Principal's Standard Drawings, refer to Appendix C.

34.1.2 Water Pumping Stations
Each switchboard or MCC shall be fabricated to provide the same fault level capacity and Form Separation as the switchboards or MCCs for sewage pumping stations.

The general arrangement of each switchboard or MCC shall match, as much as is practical, the general arrangement as shown on the Principal's Standard Drawings for sewage pumping stations (refer to Appendix C).

34.2 Switchboard and MCC Arrangement/Fabrication (where an outdoor location is proposed/specifed)

34.2.1 SCA Design Requirements
Each outdoor switchboard or MCC shall contain a Main Switch, all isolators (circuit breakers or combined fuse switches), contactors, starters, indicating lights, meters, push buttons, selector switches, relays, PLC–RTUs, pump controllers, surge protection and other equipment required, or as specified, or as shown on the Principal’s Standard Drawings specifically for a sewage pumping station, for the complete operation of the pumping units and other equipment.

Refer also to Clause 35 of this Supplementary Specification for general design requirements.

For each sewage pumping station, the equipment in its switchboard or MCC shall be grouped and arranged generally in accordance with the details shown on the relevant the Principal’s Standard Drawings, refer to Appendix C. For each water pumping station, the equipment in its switchboard or MCC shall be grouped and arranged generally, as much as is practicable, in accordance with the details shown on the relevant the Principal’s Standard Drawings in Appendix C.

All electrical equipment in each switchboard compartment shall be mounted either on the removable equipment mounting trays or on the compartment door or escutcheon. Equipment shall not be mounted on each compartment’s floor, ceiling or sidewalls. Equipment shall not be located in any cable ways or ducts. Exceptions to these requirements will be made for equipment such as door switches, internal light fittings and fans where the function of the equipment requires it to be mounted elsewhere. Exceptions will not be made because of insufficient space on any removable equipment mounting tray or poor layout of the equipment on the mounting tray.

Each switchboard and MCC shall be arranged so that all live parts of equipment immediately accessible when the switchboard or MCC doors are opened by authorised electrical personnel defeating compartment door locks are insulated to provide Enclosure Class IP2X to AS 60529. All connections to busbars or equipment shall either be provided with a purpose made shield supplied by the components’ manufacturer, be sheathed with PVC to the approval of the Superintendent and the Principal’s Representative or shall be installed behind a removable cover plate.
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All equipment shall be mounted at a minimum height of 300 mm above the floor level.

All equipment mounted on the removable equipment mounting trays shall be capable of being removed whilst standing in front of the respective mounting tray without having to disassemble or remove items not forming an integral part of that individual piece of equipment.

Each outdoor switchboard or MCC shall be a totally enclosed self-supporting metal structure providing busways, cableways, power control compartment, metering compartment, motor starter compartment/s, power distribution compartment, telemetry compartment and cable connection compartment/s.

Each outdoor switchboard or MCC shall be fabricated from 3 mm thick aluminium sheet, alloy 5083 H311 or alloy 5251 H34 and other sections for adequate structural support (aluminium extrusions shall be alloy 6061 tempered to T6) to withstand the mechanical stresses which may occur during operation, fault conditions, transport and erection.

Where permitted by the Principal’s Representative in writing, the switchboard or MCC may be fabricated from Grade 316 stainless steel, minimum 2 mm thick sheet together with other sections as detailed later for adequate structural support.

Each switchboard or MCC shall be fitted with sufficient vents and vent fans to meet the cooling requirements of equipment selected. Each switchboard or MCC shall be vermin and dust-proof with degree of protection IP56 to AS 60529 with the exception of the ventilation openings. The cubicle vents shall be IP 54 to AS 60529 and shall be suitable for outdoor use with termimesh stainless steel 316 screens. For sewage pumping stations, the cubicle vents shall be as shown on the Principal’s Standard Drawings, refer to Appendix C. For water pumping stations, the cubicle vents shall generally be as shown on the Principal’s Standard Drawings for sewage pumping stations.

Where accepted by the Principal’s Representative in writing, internal cable cover panels and general access panels may be of a lesser thickness than the details shown on the Principal’s Standard Drawings depending on size and supports required. A minimum of 1.6 mm thickness shall be used for stainless steel construction and 2 mm minimum thickness shall be used for aluminium construction. Removable equipment mounting trays shall be constructed from minimum 3.0 mm aluminium sheet or minimum 2.0 mm Grade 316 stainless steel sheet.

For a sewage pumping station, each outdoor switchboard or MCC shall be effectively sealed to prevent the ingress of gases from the wet well. This shall be achieved by:

- Each switchboard or MCC incorporating a “breezeway” in the lower 360 mm high section of the SCA. The breezeway sections shall be on the sides of each switchboard or MCC that have no vents to reduce the likelihood of sewer gas being drawn directly into the switchboard or MCC. The front section shall have a hinged lockable front access door. The breezeway shall be provided with 10 mm diameter holes drilled on a 20 mm square grid in the hinged lockable front access door and in the back face of the compartment. The breezeway shall have mesh over the back section and the hinged lockable front access door secured internally;

- The base of the cable way located in part above the breezeway compartment being provided with a gland plate fully sealed by an approved gasket and multiple fasteners onto the base of the cableway. Each cable shall enter the switchboard or MCC from the lowest compartment through the gland plate via an approved sealed gland. The base plate shall be sealed except for the motor and control cable gland holes. All unused holes shall be sealed mechanically with plugs using gaskets; and

- The base plate of the compartment located in part above balance of the lowest compartment being sealed by fully welded compartment joints.

For water pumping stations, the “breezeway” perforations are not required in the lowest compartment.

Aluminium hinged door and bolted panel stiffeners and mullions shall have a minimum thickness of 3 mm.

Stainless steel hinged door and bolted panel stiffeners and mullions shall have a minimum thickness of 1.6 mm.

Each outdoor switchboard or MCC shall be provided with a sun shade fitted over the switchboard’s roof as shown on the Principal’s Standard Drawings for both sewage and water pump stations. The sun
shade shall be sloped so that water falls away from where operators or maintainers stand and shall be arranged to direct rain water away from vents or cable entries.

Each switchboard or MCC shall be fitted with a minimum of two 6 mm minimum thick, 75 mm wide aluminium plate lifting lugs, alloy 5083 welded to the top of the cubicle. For Grade 316 stainless steel SCAs, 5 mm minimum thick, 50 mm wide Grade 316 stainless steel plates shall be used. The hole in the lifting plates shall be 22 mm diameter. The Contractor shall establish the number of lifting plates for the weight of the completed SCA. Eyebolts are not acceptable.

34.2.2 SCA Fabrication Requirements

All edges and corners shall be accurately and neatly folded. All metalwork shall be welded at joints. All external joints shall be stiffened and fully (continuous) welded where necessary to form a ridged weatherproof plinth mounted enclosure to Class IP56 in accordance with AS 60529 with the exception of the switchboard vents, which shall be Class IP54. The welding shall undertaken using the TIG process. All external welds shall be ground smooth.

Refer also to Clause 35 of this Supplementary Specification for general fabrication requirements.

The bottom of the drawing holder shall have two 20 x 20 mm cut-outs to allow foreign objects to fall through.

The switchboard vent cowls shall be fully welded to the walls of the switchboard and the bottom edge of each cowl shall cover the bottom of the vent cut-out by a minimum of 30 mm. Each vent shall be fitted with a removable stainless steel gauze frame. A second frame is to clamp a filter mat over the gauze frame and shall be secured with wing nuts or other approved means for easy removal.

Each removable equipment mounting tray shall be retained by a minimum of six fasteners. Welded aluminium studs, double nuts and washers (in lieu of Grade 316 stainless steel fasteners) may be used in an aluminium switchboard to support each removable equipment chassis.

Access shall be provided to Energex metering compartments by the provision of a dual locking system i.e. a pad lockable swing handle lock with a bar fitted with an Energex pad lock at one end and a Principal’s padlock at the other end. An alternative is for the Contractor to provide a separate metering cubicle fitted with its own door with an Energex lock.

Door switch mounting brackets shall be welded to body of each switchboard or MCC so that a limit switch may be operated by each door’s operation.

Door seals shall be black neoprene.

Areas designated as “Spare space” shall be fitted with DIN rail. The DIN rail shall be aluminium.

All unused holes shall be sealed with removable gas tight blanking plugs featuring resilient gaskets.

One cable only per each cable gland shall be fitted and shall be sized to suit the cable so that a cable gland rating of Class IP67 to AS 60529 is maintained.

Each switchboard or MCC shall be bolted onto a low carbon steel plinth. The switchboard plinth shall be fabricated from 75 x 40 x 6 mm steel channel with its “toes” out. The plinth shall be approximately the full size of the switchboard base, with fully welded corners and channel or similar cross members where required. Each steel plinth shall be hot dipped galvanised after fabrication. The switchboard or MCC shall be bolted to the plinth with a minimum of six M10 Grade 316 stainless steel fasteners.

Where requested by the Principal’s Representative in writing, either a stainless steel or aluminium plinth shall be provided. The switchboard plinth shall be fabricated from either 80 x 40 x 5 mm Grade 316 stainless steel channel or 76 x 38 x 6.2 mm aluminium channel, alloy 6061 T6 “toes” out to match the material of the switchboard or MCC enclosure. Each plinth shall be approximately the full size of the switchboard base, with fully welded corners and channel or similar cross members where required.

Each Grade 316 stainless steel plinth shall be pickled and passivated after fabrication, refer to Clause 30.3.5 of this Supplementary Specification. Each aluminium plinth shall be pickled after welding and
shall be painted as per the switchboard’s painting specifications, refer to Clause 35.1 of this Supplementary Specification. The switchboard or MCC shall be bolted to the plinth with a minimum of six M10 Grade 316 stainless steel fasteners.

For sewage pump stations, the remaining fabrication/construction details of each outdoor switchboard or MCC shall be as shown on the relevant Principal’s Standard Drawings, refer to Appendix C. For water pump stations, the remaining fabrication/construction details of each outdoor switchboard or MCC shall generally, as much as is practicable, be as shown on the relevant Principal Standard Drawings for sewage pumping stations.

34.2.3 Telemetry Cabinet Requirements
Where the Principal's Representative requests or accepts in writing that a separate telemetry cabinet shall be provided, each cabinet shall be constructed of either 3 mm thick marine grade aluminium or 2 mm thick Grade 316 stainless steel with a sun hood and a hinged lockable door. Where welding is incorporated in the manufacturing process for a cabinet, the welds shall be performed using the TIG process. All external welds shall be ground smooth.

Refer also to Clause 35 of this Supplementary Specification for general requirements.

The door hardware (hinges and locks) for each instrumentation cabinet shall be Grade 316 stainless steel. A Grade 316 stainless steel latching stay shall be provided for each telemetry cabinet to hold the door open at 110°. All fasteners used inside and outside of each telemetry cabinet shall be Grade 316 stainless steel, refer to Clause 31 of this Supplementary Specification. All stainless steel fasteners and components shall be separated from aluminium, refer to Clause 30.1.5 of this Supplementary Specification. Powder coated is not accepted by the Principal as provided adequate separation.

Each cabinet shall be supported on a robust and stiff Grade 316 stainless steel support such that the cabinet is mounted between 1.1 m and 1.7 m height above the finished level of the access location.

Each telemetry cabinet shall not be used for the looping or marshalling of cables other than cables for the telemetry installation.

Where not secured within a security fenced compound, all cables into and out of a telemetry cabinet shall be installed in rigid metal conduit fabricated from Grade 316 stainless steel tube, bends and other fittings. Each Grade 316 stainless steel conduit shall TIG welded and fully purged internally with argon gas to avoid “blow through” or “burn through” which create sharps within the conduit.

34.2.4 Installation Requirements
Each switchboard or MCC shall be secured to the concrete slab/floor with at least six approved masonry fasteners of not less than 12 mm diameter. Chemset fasteners are suitable for this application. Clamp plates onto the bottom flange of the plinth fabricated from the same material as the plinth and coated/treated the same as the plinth are preferred to enable the masonry anchor holes to be drilled vertically during installation rather than inclined that precludes later dismantling.

Aluminium plinths shall be separated from concrete by 3 mm thick high molecular weight polyethylene (HMWPE) separators.

34.3 Switchboard/MCC Arrangement/Fabrication (where an indoor location is proposed/specified)

34.3.1 SCA Design Requirements
Each indoor switchboard or MCC shall be a totally enclosed self-supporting metal structure providing busways, cableways, power control compartment, metering compartment, motor starter compartment/s, power distribution compartment, telemetry compartment and cable connection compartments.

Each switchboard or MCC shall be designed to the same requirements as the outdoor switchboards, refer to Clause 34.2.1 of this Supplementary Specification, with the exception of the following:
Each switchboard or MCC shall be single sided and shall be sized to fit into the proposed building or alternatively the building shall be sized to house all of the proposed SCAs and any future SCAs;

Switchboards shall be segregated from pressure piping where a joint gasket or pipe leak could reasonably be expected to cause water ingress into the switchboard. Separate switch rooms are preferred but alternatives can be discussed with the Principal.

The meter compartment for this switchboard or MCC arrangement will not be included in the SCA, it shall be a separate cabinet and shall be flush mounted outside the building to the Supply Authority’s requirements. However, the Main Switch shall be mounted in the switchboard or MCC;

Sun shades shall not be provided for indoor switchboards or MCCs; and

The telemetry compartment shall be located at one end of the switchboard or MCC mounted in a separate section of the switchboard or MCC. Space shall be allowed as required for flow and pressure transmitter equipment. A separate standalone telemetry cabinet, refer to Clause 34.2.3 of this Supplementary Specification, may be provided within the switchboard building.

Outer doors are not required, stainless steel quarter turn locks to be used on hinged escutcheon panels. Slotted 8mm square type or 2mm slotted recessed type preferred.

### 34.3.2 SCA Fabrication Requirements

Each indoor switchboard, MCC or cabinet shall be fabricated to the same requirements as each outdoor switchboard, MCC or cabinet, refer to Clause 34.3.2 of this Supplementary Specification, with the exception of the following:

- The switchboard shall be fabricated from aluminium alloy 5083 or 5251 and shall be powder coated, refer to Clause 35.1 of this Supplementary Specification;
- Where permitted by the Principal’s Representative in writing, the switchboard or MCC may be assembled from 2 mm thick zinc coated steel modular switchboard system which has been powder coated as detailed in Clause 35.1 of this Supplementary Specification. This permission may be extended in those situations where the switchboard building is air-conditioned or the humidity is low.

### 34.3.3 Supply Authority Metering Cabinet Requirements

Each Supply Authority metering cabinet shall be fabricated to the same requirements as each telemetry cabinet, refer to Clause 34.2.3 of this Supplementary Specification, with the exception of the following:

- Each metering cabinet shall be secured with a standard Supply Authority padlock; and
- The isolation requirements for the Supply Authority’s metering shall be met.

### 34.3.4 Generator Connection Cabinet or External Box Requirements

Where a generator connection cabinet is required, refer to Clause 35.13 of this Supplementary Specification, it shall be fabricated to the same requirements as each telemetry cabinet, refer to Clause 34.2.3 of this Supplementary Specification, with the exception of the following:

- A hinged door shall be provided in the bottom of the cabinet which shall provide access for the cable/s from the standby generator. The hinged door shall be key locked; and
- The installation access door shall be lockable and closable with the generator leads connected.
- Where connection lugs or tabs are required for the size of the standby generator, a removable IP2X shield shall be provided between the open cabinet door and the lugs or tabs.
34.3.5 Installation Requirements

The switchboard or MCC shall be secured to the floor with a minimum four approved masonry fasteners of not less than 12 mm diameter. Chemset fasteners are suitable for this application. Clamp plates onto the bottom flange of the plinth fabricated from the same material as the plinth and coated/treated the same as the plinth are preferred to enable the masonry anchor holes to be drilled vertically during installation rather than inclined that precludes later dismantling.

Where appropriate, each switchboard or MCC may be tied back to the switchboard building wall at the rear of the SCA rather than clamping the plinth to the floor.

35 COMMON (OUTDOOR AND INDOOR SCA) SWITCHBOARD, MCC OR CABINET REQUIREMENTS

35.1 SCA: Painting, Other Coatings or Surface Treatments

35.1.1 Outdoor Installations

35.1.1.1 Aluminium Switchboards, MCCs and Cabinets

All powder coating including pre-treatment shall be performed in accordance with AS 3715. The atmospheric environment classification is severe (coastal marine) in accordance with the requirements of AS 3715. All external welds and welds on exterior faces of internal components shall be ground smooth to achieve a high quality exterior presentation.

Aluminium SCAs for outdoor installation shall be powder coated externally in Colour G54 (Mist Green) to AS 2700. Solar resistant and anti-graffiti formulations shall be used or a clear outer anti-graffiti coating shall be applied over the powder coating to the whole exterior. The inside of external doors for aluminium SCAs for outdoor installation shall be powder coated internally in Colour G54 (Mist Green) to AS 2700.

The remaining internal surfaces of aluminium SCAs for outdoor installation including hinged doors and bolted panels shall be powder coated in Colour N14 (White) to AS 2700. Removable equipment mounting trays shall be powder coated to Colour N14 (White) to AS 2700.

Where requested by the Principal’s Representative, each aluminium plinth shall be powder coated to Colour G54 (Mist Green) to AS 2700.

35.1.1.2 Grade 316 Stainless Steel Switchboards, MCCs and Cabinets

For Grade 316 stainless steel switchboards, MCCs and cabinets, all external welds shall be ground smooth. All sheet metalwork shall be pickled and passivated externally and internally if contrary to the manufacturer’s normal practice and regardless of the final finish, refer to Clause 30.3.5 of this Supplementary Specification for the Principal’s pickling and passivating requirements.

The pickled and passivated SCA may either be:

- Polished; or
- Grit blasted with clean grit and not with any grit contaminated with ferrous metals, ensuring that grit blasting does not deform panels.

35.1.1.3 Indoor Installations
35.1.1.4 Aluminium Switchboards, MCCs and Cabinets

All powder coating including pre-treatment shall be performed in accordance with AS 3715. Even though installed internally, the atmospheric environment classification shall be taken to be severe (coastal marine) in accordance with the requirements of AS 3715. All external welds and welds on exterior faces of internal components shall be ground smooth to achieve a high quality exterior presentation.

Aluminium SCAs for indoor installation shall be powder coated externally in Colour X15 (Electrical Orange) to AS 2700.

The inside of external doors for aluminium SCAs for indoor installation shall be powder coated internally in Colour X15 (Electrical Orange) to AS 2700.

The remaining internal surfaces of aluminium SCAs for indoor installation including hinged doors and bolted panels shall be powder coated in Colour N14 (White) to AS 2700.

Removable equipment mounting trays shall be powder coated to Colour N14 (White) to AS 2700.

35.1.1.5 Zinc Plated Steel Switchboards, MCCs and Cabinets

All powder coating including pretreatment shall be performed in accordance with AS 3715. Even though installed internally, the atmospheric environment classification shall be taken to be severe (coastal marine) in accordance with the requirements of AS 3715. All external welds and welds on exterior faces of internal components shall be ground smooth to achieve a high quality exterior presentation.

Zinc plated sheet steel SCAs for indoor installation shall be powder coated externally. The colour shall be X15 (Electrical Orange to AS 2700). The inside of external doors for Zinc plated sheet steel SCAs for indoor installation shall be powder coated internally in Colour X15 (Electrical Orange) to AS 2700.

The remaining internal surfaces of Zinc plated sheet steel SCAs for indoor installation including internal hinged doors and bolted panels shall be powder coated in Colour N14 (White) to AS 2700. Removable equipment mounting trays shall be powder coated to Colour N14 (White) to AS 2700.

35.1.2 Hot Dip Galvanised Steel Plinths

All external welds in each bolted on steel plinth shall be continuous fillet welds or full penetration butt welds and shall be ground smooth on external corners. Each plinth shall be de-scaled and hot dip galvanised in accordance with AS/NZS 4680.

35.2 Gland Plates

Each SCA shall include full width removable gland plates for each tier or module, (several removable sections may be used), mounted on the base of the SCA. For aluminium SCAs, gland plates shall be 5 mm thick aluminium plate. For Grade 316 stainless steel SCAs, gland plates shall be 1.6 mm thick Grade 316 stainless steel sheet. For zinc plated steel SCAs, (where their indoor use is permitted by the Principal’s Representative), gland plates shall be 5 mm thick aluminium plate. Brass gland plates shall not be used.

Each gland plate shall be fixed with minimum M6 hexagon setscrews and a preformed gasket to maintain the IP rating of the SCA. Each gland plate is required to have access available to both sides of the cable gland to provide a means to facilitate pulling cables into the SCA.
For earth continuity, a 6 mm\(^2\) earth wire shall be connected from a 6 mm diameter stud on the gland plate to the earth busbar or local earth bar/link in the SCA.

## 35.3 Door Hardware

### 35.3.1 Door Hinges

All door hinges shall be fully Grade 316 stainless steel. Two hinges shall be provided for each door up to 800 mm high. Three hinges shall be provided for each door 800 mm high up to 1200 mm high. Four hinges shall be provided for each door greater than 1200 mm high.

### 35.3.2 Outdoor Switchboard Door Locks

Each exterior door for each outdoor switchboard or MCC shall have a 316 grade stainless steel three-point locking system. The locking bars shall be fitted with polyethylene or polypropylene rollers. The handle in each exterior door shall be a quarter turn 316 grade stainless steel swing handle with pad-lockable hasp. The low profile locking swing handles shall be capable of exerting sufficient pressure to ensure proper contact of the sealing gasket all around the door. The handle shall be flush mounted on the door.

Doors providing access to the lower outdoor switchboard compartment shall be provided with three 316 grade stainless steel 8 mm square drive slotted quarter turn locks.

All internal electrical equipment compartment doors shall be provided with three 316 grade stainless steel 8 mm square drive slotted quarter turn locks, and shall be capable of exerting sufficient pressure to ensure proper contact of the sealing gasket all around the door.

Smaller tiered internal electrical equipment compartment doors shall be sufficiently secured with 316 grade stainless steel 8 mm square drive slotted quarter turn locks.

Each Energex metering cabinet shall have locks according to their requirements. Padlocks shall be supplied by the Contractor.

### 35.3.3 Indoor SCA Door Locks

Each exterior door for each indoor switchboard or MCC shall be provided with three 316 grade stainless steel 8 mm square drive slotted quarter turn locks.

Smaller tiered external doors with less than three locks shall be capable of exerting sufficient pressure to ensure proper contact of the sealing gasket all around the door.

Internal electrical equipment compartment doors shall be provided with three 316 grade stainless steel 8 mm square drive slotted quarter turn locks.

Smaller tiered internal electrical equipment compartment doors shall be sufficiently secured with 316 grade stainless steel 8 mm square drive slotted quarter turn locks.

### 35.3.4 Door Stays
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Grade 316 stainless steel catch stays shall be fitted to all doors to hold the doors open at a minimum 110 degrees (external doors) and 100 degrees (internal doors).

35.3.1.5 Door switches

Each external MCC, Switchboard, Generator Supply Box or cabinet cubicle containing electrical equipment, or access to electrical equipment shall contain a SCADA connected intruder door switch. The door switch shall be suitably IP rated, of sturdy construction, internally mounted, adjustable and consisting of 316 S/S movable actuating parts. The door switch shall be actuated by lever or plunger action. The door switch shall consist of both NO and NC switching capabilities. Light switches shall be on a Clipsal 2025XA mounting or accepted equivalent for all lighting:-

- LED external spotlights
- Internal LED cabinet strip lights

35.4 Fasteners

Unless shown otherwise, all fasteners used in the construction of each switchboard, MCC or cabinet and the mounting support of equipment shall be Grade 316 stainless steel.

All bolts, metal threads and screws shall have hexagon-machined nuts and flat washers or be screwed into tapped holes. Each tapped hole shall have a minimum thickness equal to or greater than three times the thread pitch of the selected fastener. Self-drilling or self-tapping screws and the like shall not be used under any circumstances.

35.5 Power Distribution

35.5.1 Busbar Installations

For each SCA that includes busbars for power distribution, the busbars shall be phase colour coded at regular intervals. Busbars shall be completely insulated (except at joints) where not installed in a dedicated busway.

The main busbars and connection busbars shall be of high conductivity hard-drawn copper sized to carry the installation’s ultimate load without exceeding 40 °C temperature rise. All busbar connections shall be securely bolted.

Busbars not installed in a specific bus area shall be completely shrouded, refer to Clause 35.14 of this Supplementary Specification.

35.5.2 Non-busbar Installations

For each SCA that does not include busbars for power distribution, cables shall be supplied and installed in accordance with Clause 40 of this Supplementary Specification for power distribution between the electrical components in various SCA compartments.

35.6 Main Earth Bar

The main earth bar shall be supplied and installed within the switchboard or MCC. Each main earth bar shall:

- Be a copper bar with a cross section of not less than 50 mm by 6 mm;
- Be securely mounted such that there is a minimum clearance of 30 mm behind the earth bar for access to connection fastener nuts;
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SUPPLEMENTARY MECHANICAL AND ELECTRICAL SPECIFICATION

- Have bolted connections; and
- Have minimum 25 per cent spare (unused) connections.

All earth cable cores shall be fully labelled at each termination, refer to Clause 43 of this Supplementary Specification.

35.7 Main Neutral Bar

The main neutral bar shall be provided within the switchboard or MCC, with minimum 25 per cent spare (unused) connections. All neutral cable cores shall be fully labelled at each termination.

35.8 Earth and Neutral Busbars

Each earth busbar shall:
- Extend the full length of each switchboard or MCC;
- Have two separate connections, one at each end so that disconnection of one does not affect the earthing provided by the busbar; and
- Have bands of green or green/yellow insulation at regular intervals not exceeding 300 mm centres to identify it as the earth.

Each neutral busbar shall:
- Extend the full length of each switchboard or MCC;
- Have two separate connections, one at each end so that disconnection of one does not affect the neutral provided by the busbar; and
- Have bands of black insulation at regular intervals not exceeding 300 mm centres to identify it as the neutral.

35.9 SCA Control Voltage

The Contractor shall provide 24 V DC control circuits for each new SCA (switchboard or MCC).

When a Contractor is required to add or replace a motor starter within an existing SCA (switchboard or MCC) that has 240 V AC control circuits, then all of the motor starters in the SCA shall be changed to 24 V DC control.

Each SCA (switchboard or MCC) shall only contain one voltage for control circuits and not a mixture of two.

35.10 Power Factor Correction

All switchboards and MCC’s shall incorporate power factor correction equipment in the design. Power factor correction equipment shall be designed to achieve a target power factor of 0.95 lagging.

Power factor correction requirements currently specified and as amended by any Supply Authority or Legislation throughout the Contract period and any extensions to the Contract period are to be adhered to. Constant load switchboards do not require adjustable PF controllers but can simple bulk correction.
35.11 Switchgear and Controlgear Arrangement

For a sewage pumping station switchboard or MCC, the switchgear and controlgear shall be neatly arranged generally as shown on the Principal’s Standard Drawings. For water pumping station switchboard or MCC, the layout shall mimic the layout of the typical switchboard or MCC for sewage pumping stations.

There shall be a minimum of 5 mm clearance between isolators, circuit breakers, relays, contactors and timers and a minimum of 25 mm clearance between variable speed drives and soft starters and other electrical equipment.

Equipment shall be arranged such that the removal of access panels and the opening of compartment doors do not affect the operation of other equipment.

35.12 Switchgear and Controlgear Maintainability

The arrangement of each switchboard, MCC or cabinet and the switchgear and controlgear shall be designed to permit inspection and maintenance of individual items without causing an overflow, surcharge, bypass or violation of statutory requirements for sewage pumping stations or loss of water supply for water pumping stations. Provision shall be included in the design of equipment requiring periodic testing, to enable the tests to be accomplished while maintaining electric power to all vital components. This requires being able to conduct tests and calibration.

35.13 Emergency Generator Connection

35.13.1 Sewage Pumping Stations

For each outdoor switchboard or MCC, a 5-pole weatherproof IP66 socket or connection sockets as detailed below shall be provided in the “breezeway” lower compartment on a 1m flexible lead.

For each indoor switchboard or MCC, a 5-pole weatherproof IP66 socket or connection studs, lugs or sockets as detailed below shall be provided in a generator connection panel mounted on the outside of the switchboard building adjacent to the Supply Authority metering cabinet.

35.13.2 Water Pumping Stations

For each outdoor switchboard or MCC, a 5-pole weatherproof IP66 socket or connection sockets as detailed below shall be provided in the cable zone or, where required by the Principal’s Representative, in a generator connection panel attached to the side of the switchboard or MCC.

For each indoor switchboard or MCC, a 5-pole weatherproof IP66 socket or connection studs or lugs as detailed below shall be provided in a generator connection panel mounted on the outside of the switchboard building adjacent to the Supply Authority metering cabinet.

35.13.3 Generator Connections

The generator connections shall be as follows:

- For pump motor sizes up to 15 kW, a 90 A unswitched socket is required so 1 pump can be started/run;
- For pump motor sizes up to 30 kW, a 250 A unswitched socket is required so 1 pump can be started/run; and
- Where SPS generator connection points for pump motor sizes above 30 kW are being installed, the connection point type must comprise of five single phase unswitched sockets (panel drain type) rated at a maximum of 400A each.
- Where the maximum demand is greater than 400A, multiple sets of five single phase unswitched sockets shall be connected in parallel to provide sufficiently rated current capacity for the installation.
Existing GCW SPS installations utilising these standardised generator connection points comprise of 400A ITT Veam Powerlocks. All 400A connection points supplied must be directly compatible to the 400A ITT Veam Powerlocks to allow the Principals emergency standby generator to be connected.

Cables from the generator connection socket/s shall be connected to the switchboard or MCC power distribution cable power distribution loom or busbars via a manual transfer switch refer to Clause 37.1.1 of this Supplementary Specification. The manual switch is to prevent both closing but allow both open.

A risk analysis by the Principal will determine if 1 or both pumps will be required to run under emergency generator supply. If so, this will change the connection requirements and the Principal's Representative will advise the Developer or the Developer's Designer of this changed requirement in writing.

35.14 SCA Wiring

The Contractor shall refer to Clause 41 of this Supplementary Specification for the requirements for wiring of each SCA, be it a switchboard, MCC or cabinet.

35.15 SCA Protective Earthing

35.15.1 General Requirements

The protective earthing detailed in this clause is part of the earthing system for the whole installation; refer to Clause 38 of this Supplementary Specification.

All metal cases of instruments, selector switches and other equipment either mounted on hinged doors or front covers of any SCA (switchboard, MCC or cabinet), shall be connected by an electrically continuous PVC covered flexible earth wire or flat braided wire.

A local earth bar/link shall be provided in each SCA cableway or standalone cabinet to provide marshalling of all earth continuity that terminates in the SCA cableway or standalone cabinet. Each earth bar/link may utilise either bolted or screwed connections or a combination of both. If screwed connections are used, the earth bar/link and the connections shall comply with AS/NZS 3000.

At termination points, all earth cores shall be identified as detailed in Clause 43 of this Supplementary Specification.

The earth bar/link in each SCA cableway or standalone cabinet shall be sized for all known earth continuity conductors plus and additional 25 % spare capacity for unknown future connections. Each earth continuity conductor shall be terminated at an individual termination point such that disconnection of any one earth continuity conductor does not remove the continuity or any other earth continuity conductor.

35.15.2 Door Earthing

Each door for each SCA (switchboard, MCC or cabinet) shall be effectively earthed to the SCA frame by means of a flexible earth cable of not less than 6 mm².

35.16 SCA IP2X Internal ‘Door Open’ Protection

All electrical equipment positioned on each door or removable panel shall be protected on the rear face by insulated panels/shrouds to prevent any accidental contact with live electrical equipment when maintenance and servicing takes place to Enclosure Class IP2X to AS 60529. Each insulated panel shall be easily removable for servicing and shall be transparent for easy viewing.
The line side of the Main Switch supply zone shall be fully protected so that no exposed surface is at a higher potential than 50 V AC with the door open.

All electrical equipment provided shall possess the maximum possible built-in safety features. Where circuitry requirements dictate that some unavoidable hazard to personnel may remain, caution or danger notices or warning lights shall be provided to the satisfaction of the Superintendent and the Principal’s Representative. This shall not replace shrouding to Enclosure Class IP2X.

All exposed live terminals shall be shrouded. This also applies when the switches are by-passed during fault finding.

Hinged panels shall have one shroud to cover all exposed live terminals. This shroud shall be clear PVC or similar to allow inspection of the connections without the need to remove the cover. Shrouds shall be easily removed to facilitate repairs.

The method of shrouding shall be shown on the detailed SCA fabrication drawing when they are submitted for approved prior to fabrication.

The requirement for IP 2X protection also applies to generator connection cabinets, local control stations, cable transition cabinets or enclosures, field marshalling cabinets and the like.

35.17 Naming

For SCAs specified to comply with AS/NZS 3439.1, the Contractor shall provide and install on the SCA one or more nameplates with essential markings as required by Clause 5.1 of AS/NZS 3439.1. In addition, the Contractor shall provide a Plain English Name and Asset Identifier in accordance with the Principal’s Procedure SD22 for each SCA.

36 MOTOR CONTROL

36.1 General Requirements

Each motor shall be controlled and protected by equipment providing:

- 3-phase thermal overload;
- PTC thermistor or thermal (microtherm) switch protection (> 5.5 kW); and
- Loss of phase, phase reversal and undervoltage protection.

Each motor starter shall be provided with the following controls/indicators on the front door of its compartment (unless stated otherwise):

- Three phase motor circuit breaker as the motor starter on-load isolator (mounted on equipment tray inside motor starter compartment but padlockable on the compartment door);
- Selector switch – “Manual (or Run)/Off/Auto” (with the “Auto” position to right);
- “Stop” and “Start” pushbuttons i.e. for when the “Manual” selector switch position used (this is not the usual requirement for pumps but may be requested for other equipment);
- Electromagnetic thermal overload remote reset facility if a discrete component is used ie a separate relay is not inbuilt in motor protection unit, soft starter or variable frequency drive;
- Control circuit breaker (mounted on equipment tray inside motor starter compartment); and
- Ammeter or red adjustable indicator to show full load motor current.

Every motor shall be provided with an isolating switch complying with AS/NZS 3000 and Clause 37.1 of this Supplementary Specification.
An isolator switch shall be installed between the VFD and motor connections. Where the VFD is installed within the SCA, the isolator is to be installed as close as possible to the drive and the screened cable to terminate on the isolator (this is to minimise RF interference from any unscreened wiring and motor earth connected to earth on VFD). Where the VSD is installed externally from the SCA, the isolator is to be installed adjacent to the motor in a suitable enclosure. Isolation switches are required to enable the pump motor insulation resistance to be tested without the need to disconnect the motor from the VSD. The standard drawings SEQ-SPS-905-3 and 4 show the options.

The Contractor shall not mount any motor starter isolating switch behind a compartment door without a door mounted operator.

Each motor starter isolating switch shall be provided with one set [normally open (NO) & normally closed (NC)] early break, late make auxiliary contacts. One contact shall be incorporated into the motor’s control circuit to trip the drive before the isolator is opened.

Where a circuit breaker is rated to provide motor and cable overload and short circuit protection but not provide “on-load” drive isolation, a separate motor starter isolating switch shall be provided.

### 36.2 Water Pumping Stations

In addition to these general requirements, fault indication shall be provided on each motor starter compartment door to indicate:

- Low flow;
- High pressure; and
- Low pressure.

### 36.3 Sewage Pumping Stations

In addition to these general requirements, the following additional indicators shall be provided on each motor starter compartment door to indicate:

- “Seal Fail” indication light.

### 37 SCA MOUNTED ELECTRICAL EQUIPMENT

#### 37.1 Switches and Isolators

##### 37.1.1 Main Switches

Depending on load, each Main Switch shall be a three pole air or a non-automatic circuit breaker. An air circuit breaker shall be installed in a switchboard or MCC as the Main Switch where the connected load exceeds 500 kVA. Where the connected load is less than 500 kVA, a non-automatic circuit breaker shall be provided.

The current rating of any Main Switch shall equal the rated secondary current of the transformer supplying it, but shall never be less than the diversified maximum demand of the switchboard or MCC.

The required fault interrupting capacity of all circuit breakers must be established by the Developer, the Developer’s Designer or the Contractor from data obtained from the Supply Authority for the electrical supply. Fault level calculations shall be submitted to the Superintendent and to the Principal’s representative for review and approval.

The Mains Power Main Switch shall form one side of a “Manual Transfer Switch” arrangement, the Generator Main Switch shall form the other side. The two main switches shall be mechanically interlocked so that only one can be closed at any one time.

Each circuit breaker shall be interlocked to prevent the switchboard/MCC compartment door being opened with either main switch closed, or either main switch being closed with the door open. However,
provision shall be made for authorised electrical personnel to defeat the interlock for test purposes. Provision shall also be made for padlocking each main switch in the “OFF” position.

If an underground power supply from an underground supply is provided, a label shall be fixed adjacent to the Mains Power Main Switch identifying the electrical pillar box to which the pumping station is connected.

### 37.1.2 Motor Starter Isolating Switches

Every motor starter shall be provided with either an “on-load” rated moulded case circuit breaker complying with Clause 37.2 of this Supplementary Specification or with an “on-load” rated switch-disconnector complying with Clause 37.4 of this Supplementary Specification as the motor starter isolating switch.

Each motor starter isolating switch in each switchboard or MCC shall be provided with a door mounted operator. Motor starter isolating switches mounted behind equipment panels without door mounted operators will not be accepted even where the downstream circuit breaker is provided with a door mounted operator.

Each motor starter isolating switch shall be installed complete with terminal shrouds or clear polycarbonate sheeting with appropriate warning labels on the line and load sides to achieve Enclosure Class IP2X to AS60529 with any external or internal door open.

### 37.1.3 Isolators - Door Mounted Operators

Where a motor starter isolating switch is installed behind a door or escutcheon within a switchboard or MCC compartment, it shall be provided with a door extension shaft and door mounted operator on the door of the compartment configured to prevent the door or escutcheon being opened with the switch closed, or the switch being closed with the door open. However, provision shall be made for authorised electrical personnel to defeat the interlock for test purposes.

The isolator shall have a facility for padlocking the switch in the open position. This facility must be an integral part of the switch or the operating handle.

### 37.2 Air Circuit Breakers

Each air circuit breaker shall:

- Be withdrawable;
- Be fitted with safety shutters. A means shall be provided for padlocking the shutters and circuit breaker in the “Isolated” or “0” position;
- Include “Service”, “Test” and “Isolated” positions, with provision for padlocking the circuit breaker in the “Isolated” position;
- Be closed by a motorised or manually charged, stored energy spring closing mechanism with mechanical release;
- Be opened by an under voltage release or shunt trip coil. A minimum of one under voltage release or shunt coil shall be provided per circuit breaker. A mechanical trip facility shall also be provided. The voltage of the coil shall be as approved by the Principal’s Representative;
- Have four normally open and four normally closed auxiliary contacts;
- Have interlocks to prevent the following:
  - racking in with the spring mechanism charged;
door opening with the circuit breaker closed; and
operation of the circuit breaker with the door open except in the test position.

- Have controls and indications mounted on the front panel of the circuit breaker consisting of:
  - Manual "Close" push button;
  - Manual "Trip" push button;
  - Closed – trip indication;
  - Spring charged – discharged indicator; and
  - Service, test, isolated position indication.

- Have protection relays and associated current transformers providing the following protection:
  - Inverse definite minimum time overcurrent and earth fault protection with "Very Inverse" characteristics;
  - High set instantaneous protection for both overcurrent and earth fault with the following settings:
    - 10 % to 70 % for earth fault;
    - 400 % to 1600 % for overcurrent; and
    - full adjustment over the protection curve characteristics.

### 37.3 Moulded Case Circuit Breakers

The Contractor shall ensure that all circuit breakers are correctly sized to protect the downstream equipment against overload and fault conditions.

Each circuit breaker shall be capable of horizontal or vertical mounting and interchangeable 3 single poles for 1 triple pole. Each multi-pole circuit breaker shall interrupt all phases via a common tripping mechanism for a single-phase fault. Each circuit breaker shall comply with AS 60947.2 or AS 3111 where the rated capacity is less than 125A.

In the case of sub-circuit circuit breakers, the main circuit breaker may be used as a current limiting device. The cascaded circuit breakers shall fulfil the following conditions:

- The peak value of current interrupted by the back-up circuit breaker shall not be more than the level which the circuit breaker on the load side can withstand mechanically;
- The $I^2t$ during the short circuit current interruption shall not be more than that which the circuit breaker on the load side can withstand thermally, and
- The rated breaking current of the circuit breaker on the load side shall be higher than the current value at the crossing of its break-time characteristic with the opening time characteristics of the back-up circuit breaker.

Each circuit breaker shall be selected in accordance with the manufacturers recommended cascade co-ordination chart, Type II only (AS60947.4.1).

Each circuit breaker’s trip ratings shall be labelled or inscribed on the circuit breaker body in an approved way. This inscription shall be clearly visible with covers in place.

Each horizontally mounted circuit breaker shall have been fully tested as being capable of successfully operating under full load and short circuit conditions in the horizontal position.

Each circuit breaker shall incorporate the following features:
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- Arc interrupting device;
- Toggle action quick break;
- Inverse time limit characteristics;
- Trip-free handle;
- Contacts shall be non-welding;
- All metal parts shall be treated to ensure corrosion resistance throughout the life of the circuit breaker;
- Mechanism to be tamper proof;
- Common tripping device for multiphase units;
- Uniformity of style and construction;
- Padlockable in the "off" position;
- Handles shall have an intermediate trip position; and
- Double pole circuit breakers shall be used on 24 V DC circuits.

Each circuit breaker shall be complete with terminal shrouds or clear polycarbonate sheeting with appropriate warning labels to achieve Enclosure Class IP2X to AS60529 with any external or internal door open.

37.4 Miniature Circuit Breakers

Each miniature circuit breaker shall:

- Comply with AS 3111;
- Be DIN T rail mounted;
- Have a fault breaking capacity of 6 kA;
- Have a fault current limiting device installed where required to limit the fault level; and
- Have the facility to be padlocked in the ‘open’ position.

37.5 Switch-disconnectors

Each switch-disconnector shall be a suitably rated fault make rated, non-auto switch complying with AS/NZS 3947.3. These switches shall only be used for isolation purposes and consequently there is no requirement for remote automatic operation although a door mounted operator shall be provided. Open and closed position indication status is not required in the control system or as an input into the remote telemetry unit.

Each switch-disconnector shall be rated to accommodate and break the full-load current of the downstream load ie it shall be an “on-load” isolator.

Each switch-disconnector shall be complete with terminal shrouds or clear polycarbonate sheeting with appropriate warning labels to achieve Enclosure Class IP2X to AS60529 with any external or internal door open.
37.6 Disconnectors

Each disconnector shall be a suitably rated non-auto switch complying with AS/NZS 3947.3. These switches shall only be used for field isolation purposes and consequently there is no requirement for remote automatic operation although a door mounted operator shall be provided. Each disconnector shall be provided with one set (NO & NC) of early break, late make auxiliary contacts. One contact shall be incorporated into the motor control circuit to trip the drive before the isolator is opened.

Each disconnector shall be rated to accommodate the full-load current of the downstream load i.e. it shall be an “off-load” isolator.

Each disconnector shall be complete with terminal shrouds or clear polycarbonate sheeting with appropriate warning labels to achieve Enclosure Class IP2X to AS60529 with any external or internal door open.

37.7 Current Transformers

Each current transformer shall be of the resin encapsulated window type and shall comply with AS 1675. Unless otherwise indicated, the following requirements shall apply:

- Rated primary current shall have a current rating equal to the maximum current rating of the frame size of the controlling device;
- Secondary windings of measurement current transformers shall be rated at 5A. The burden shall be 0.4 ohms (10 VA) minimum and the accuracy shall be Class 2 minimum; and
- Secondary windings of protection current transformers shall be rated at 5 A and shall be suitable for the burden.

37.8 Motor Starters

37.8.1 General Requirements

Every motor supplied from a switchboard or MCC shall be provided with an automatic motor starter.

For each sewage pumping station up to 5.5 kW motor size, the required type of starter is direct on line (DOL) subject to the Supply Authority’s starting current limitations and shall be of the type and model as shown on the Principal’s Standard Drawings, refer to Appendix C.

For each sewage pumping station, motor sizes equal to or greater than 5.5 kW or where there are starting limitations or variable speed requirements, shall be provided with electronic starters or variable frequency drives as shown on the Principal’s Standard Drawings, refer to Appendix C.

For each water pumping station up to 5.5 kW motor size, the required type of starter is normally direct on line (DOL), refer to Clause 37.8.2 of this Supplementary Specification, subject to the Supply Authority’s starting current limitations. Where there is a Principal’s requirement to provide variable speed control for each drive, the Principal’s Representative will provide written advice of the requirement.

For a water pumping station, motor sizes equal to or greater than 5.5 kW shall be provided with electronic starters or variable frequency drives as required by the Principal. The Principal’s Representative will provide written advice of any special requirements on a case by case basis.

Electronic starters include soft starters and variable frequency drives. Each electronic starter shall be mounted in accordance with manufacturer’s instructions. The recommended free space shall be provided around each starter for cooling purposes. If necessary, additional cooling shall be provided by a quiet running fan mounted to force air over the unit’s heat sinks. Each fan ventilated enclosure shall operate under positive pressure with air inlet at the bottom and air discharge at the top of each compartment. High quality replaceable filters shall be provided to dust proof the air intakes.
The starter shall be mounted within the relevant switchboard or MCC compartment. Care shall be taken to segregate power, control and motor cables. Motor cables from each variable frequency drive shall be of the screened type, designed for use with variable speed drives.

The disturbance to the electricity supply system due to harmonics generated by the starter shall not exceed the limits specified in AS/NZS 61000.3.6. Radio interference external to the starter shall not exceed the limits of AS/NZS CISPR 11.

Starters shall be designed for utilisation category AC3 and an intermittent duty of up to 12 starts per hour.

### 37.8.2 DOL Starters

Each DOL starter shall have moulded block type construction incorporating double break contacts with arcing enclosures. Its coil shall be continuously rated. Each DOL starter shall have a minimum of two spare auxiliary contacts (1 x N/O, 1 x N/C) over and above what is required for the control circuits. It shall be possible to install additional auxiliary contacts to any DOL starter.

Each DOL starter shall comply with AS 60947.4.1 and the following requirements:

- No of poles – 3;
- Kind of current – AC;
- Interrupting medium – air;
- Method of operation – electromagnetic;
- Method of control – automatic, sequence control;
- Rated operational voltage – 415 V;
- Rated frequency – 50 Hz;
- Rated duty – uninterrupted and intermittent, Class 12;
- Utilisation category – AC 3;
- Control circuit – 240 V AC;
- Auxiliary circuits – 3 minimum;
- Type of release – thermal overload and undervoltage;
- Temperature range – 10 °C to +50 °C ambient;
- Co-ordination with protective device – Type 2; and
- Mechanical durability – minimum no load operating cycles 3.0 million.

### 37.8.3 Soft Starters

Each fixed speed motor 5.5 kW and above in size shall be controlled by a reduced voltage “soft starter”. Each soft starter shall:

- Have a microprocessor based IGCT control circuit for the control of induction motors operating on a 3 phase 415 V 50 Hz supply; and
- Have a continuous rating of not less than maximum input rating of the pump or driven device after allowing for motor efficiency.
Each soft starter shall comply with the following requirements:

- Adjustable acceleration ramp with adjustable start volts, current or torque for periods of up to 60 s;
- Adjustable deceleration ramp with adjustable volts, current or torque for periods of up to 60 s. Control settings for deceleration shall be independent to those for acceleration;
- Transient protection;
- Starter over-temperature protection;
- Display indication on starter of each of these faults;
- Operating voltage 415 V ± 20 % 50 Hz;
- Phase failure, phase reversal, under-voltage protection;
- Three (3) wire operation for start and stop control;
- Temperature range -10 °C to + 50 °C - ambient when used in conjunction with a bypass contactor;

Each starter and its starting duty shall comply with AS 60947.4.2. The motor duty is rated as S4 “Intermittent periodic duty with starting” as per AS 60034.1. The Utilisation Category of the solid-state starter shall be AC 53b with an $F=50\%$ and an $S=10$ operating cycles per hour. Each solid state starter shall have a minimum capacity of 300 % FLC for 23 seconds or 400 % FLC for 13 seconds at 50 % duty cycle for 10 starts per hour corresponding to an overload trip class 10;

- Each starter shall have output contacts to control the line and bypass contactors. Relays are to be rated at no less than 240 V AC at 1.8 A The drive shall also incorporate load terminals for the bypass contactor;
- Easy maintenance through component interchangeability and access to all control cards; and
- The starter shall have an inbuilt communications port for control and monitoring purposes of all drive parameters. The type of communication port will depend upon the requirements of the project. An external input signal from a contact must be capable of disabling all communication port controls allowing external control signals to control starter ie “force to local control mode”.

Each solid-state starter shall comply with the Australian C-tick EMC requirements as defined in the following standards AS IEC 61000.6.3 and AS IEC 61000.6.4. The manufacturer shall provide full instructions on correct installation of filters. Where filters are not required initially, adequate space shall be provided to retrofit filters on both input and output.

Each solid state starter shall include the following motor protection as an integral part of the starter:

- I²t electronic motor protection with thermal modelling;
- Under current trip (fully adjustable);
- Phase imbalance;
- Phase reversal;
- Thermistor or thermal switch protection;
- Starter thermal protection;
- Excessive acceleration time;
- Current overload; and
- Adjustable time between restarts.
Each soft starter shall include an LCD display / keyboard assembly designed to:

- Provide real time information regarding line current and voltage;
- Set or examine operating parameters;
- Provide status information; and
- To be remotely mounted where necessary.

One copy of the PC software in USB memory stick or DVD/CD disk to interface with the controlling PLC or RTU shall be provided per site.

### 37.8.4 Variable Frequency Drives

Each variable frequency drive (VFD) shall operate on the vector control principal. Each VFD shall be sized for a constant torque load that is greater than the full load current of the driven motor. Each VFD shall provide motor protection as detailed in Clause 37.8.4.6 of this Supplementary Specification.

Each drive shall be capable of operating continuously at nominated full load rating with expected variations of +/- 10% in the supply voltage and +/- 2% in the supply frequency.

Each drive shall be suitable for continuous operation at full load in ambient temperature of 50 °C. Care shall be taken during installation to ensure that the drive is protected from direct sunlight and weather.

A motor fed from a VFD shall have a shielded and appropriately earthed cable suitable for VFD operation. The length of the cable run shall be checked for reflected wave voltage amplitudes and approved motor terminators shall be used where cable length is greater than recommended maximum lengths.

### 37.8.4.1 VFD Enclosures

When a VFD is installed inside a switchboard or MCC, typically within a Form 3b motor starter compartment, an Enclosure Class of IP20 to AS 60529 is adequate. This is to ensure adequate air ventilation is provided to the VFD inside the compartment.

Generally each VFD shall be installed within a Form 3b motor starter compartment in the switchboard or MCC. However, in some situations particularly during retro-fit work, the Developer, the Developer’s Designer or the Contractor may be proposed to install a VFD outside of a switchboard or MCC but still within a switchboard room or building. In these situations, the written advice from the Principal’s Representative accepting that a VFD may be located outside of the switchboard or MCC that contains the remaining switchgear and control gear for the drive but within the same switchboard room or building is required. In these situations, either each VFD shall be supplied in an IP54 enclosure to AS 60529 or in a standalone Form 3b SCA containing the VFD. Where there is more than one VFD to be housed, the VFDs shall be installed in separate compartments within a Form 3b SCA.

The metal enclosure shall be earthed with a low impedance connection to the main earthing system.

Each VFD shall include a door-mounted interface for status indication and programming. It shall be possible to control the VFD from this local interface and from remote inputs.

### 37.8.4.2 Performance

The output waveform design shall ensure maximum total efficiency is obtained from each drive and motor at all speeds and loads.

Each VFD shall automatically correct the output voltage during mains supply variations of +/- 10% to prevent loss of torque and speed variations occurring during motor operation.
Each VFD shall be able to catch a rotating motor under any operating condition without tripping, whether through large supply interruptions or by the action of switching on and off the motor isolating switch when the motor is running at any speed. The function shall also ensure that a motor already pre-rotating, even in the reverse direction, can be switched into, braked to zero speed, and then accelerated to the preset speed in the correct direction.

### 37.8.4.3 Electromagnetic Compatibility

Each VFD shall comply with the Australian C-tick (or RCM) EMC requirements defined by the Australian Communications and Media Authority. The manufacturer shall provide full instructions on correct installation of filters. Where filters are not supplied initially, adequate space shall be provided to enable the retrofitting of filters to both input and output.

### 37.8.4.4 Harmonics

Each VFD shall comply with AS/NZS 61000.3 for harmonic distortion levels when installed on site.

Prior to installation approval, the Developer, the Developer’s Designer or the Contractor shall provide a harmonic spectrum of the anticipated harmonic currents and voltages based on the following system data at the 415 V AC busbars:

- The system data at the point of common coupling, obtained from the Supply Authority by the Developer, the Developer’s Designer or the Contractor; and
- The existing background levels shall be obtained by the Developer, the Developer’s Designer or the Contractor in order to determine compliance with AS/NZS 61000.3.

If the harmonic voltages exceed the limits specified in AS/NZS 61000.3, alternative formats of each VFD can be offered as an option to reduce harmonics to acceptable levels. The use of DC line reactors or AC series reactors within each VFD should be considered in this event. For larger units where compliance with AS/NZS 61000.3 is not possible with a 6 pulse unit, 12 or 18 pulse units shall be offered. All 12 or 18 pulse units shall include phase shifting transformers.

Upon completion of commissioning the Contractor, the Developer’s Designer or the Developer shall provide a written independent test report of the actual harmonics generated when each VFD is operating at maximum output.

In order to eliminate any system resonance occurring within the motor’s operating frequency range, each VFD shall be provided with a minimum of 2 by-pass frequency adjustments (dead band).

### 37.8.4.5 Control and Monitoring

All analogue and digital control inputs and outputs shall be galvanically or opto isolated from the mains supply. For safety reasons, only VFDs that have galvanic or opto isolation as an integral part of the VFD will be accepted.

Each VFD shall:

- Display locally the actual process variable (preferably with engineering units) and be able to re-transmit this variable to other equipment (4-20mA) for monitoring purposes;
- Respond to speed commands from: 0 – 10 V DC and or 0/4 – 20 mA control signals, and be capable of manual speed adjustment locally from the VFD;
Have the capability of communicating all monitoring and control data with the respective controller. These controllers will be either PLC, or RTUs. In each case the communication and control shall be via the applicable communication bus network. i.e. Modbus, Profibus, DeviceNet; and

Have an alphanumeric display and shall provide comprehensive information on the drive and the motor’s condition. The following are considered as minimum requirements:

- Output Frequency Hz (motor speed);
- Current A; and
- Output voltage V.

Preference shall be given to VFDs offering the additional information following:

- Reference % of control signal;
- Motor thermal reserve %;
- Inverter thermal reserve %;
- DC voltage V;
- Power kW;
- Energy kWh; and
- Hours run.

The display for each VFD shall be mounted on the front panel of the switchboard or MCC. The remote mounting of the display shall be utilised so dedicated instruments are not required i.e. ammeters and hours run meters. The drive shall display all faults in clear English text.

A minimum of two output contacts shall be provided for remote indication of the drive.

Preferably one output contact shall be reserved for an “alarm signal”. The other output contact shall be programmable, where one of the selections shall be a “no flow alarm”. The function shall be designed to only operate when the motor runs at its no-load current. The contacts shall have a minimum rating of 250 V AC, 2 A.

Preference shall be given to VFDs which incorporate an auto-manual change over function on the keypad so that change-over from automatic control to manual operation can be carried out simply from the keypad. The control of the speed shall be easily carried out from the keypad in manual operation.

The keypad shall be capable of being password protected to prevent unauthorised personnel having access to the control and protection parameters yet still allowing manual operation.

One copy of the PC software in USB memory stick or STORAGE MEDIA format shall be provided per site to set up drives.

### 37.8.4.6 Protection and Monitoring

Each VFD shall shut down safely under the following conditions, and operate the alarm relay. The drive display shall indicate the nature of the fault in clear English text.

The following is the minimum requirement:
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- Over-voltage;
- Under-voltage;
- Phase loss;
- Over-current;
- Under-current;
- Earth fault;
- Over temperature;
- I²t thermal; and
- External fault signal.

Each VFD shall:

- Include electronic motor thermal overload protection where the trip time is based on the motor’s running frequency, actual motor current, operating time and the motors rated current. The electronic overload shall automatically modify the trip time to take into account the operation at low speed;
- Provide for both automatic and manual reset operation. The restart time after a trip in automatic mode shall be adjustable; and
- Be equipped with a data log menu that will allow storage of type of faults that have occurred. Last fault memory shall be required in the event of power failures.

37.8.5 Contactors

Each contactor shall have moulded block type construction incorporating double break contacts with arcing enclosures. Coils shall be continuously rated. Each contactor shall have a minimum of two spare auxiliary contacts (1 x N/O, 1 x N/C) over and above what is required for the control circuits. It shall be possible to install additional auxiliary contacts to any contactor.

Each contactor shall comply with AS 60947.4.1 and the following requirements:

- No of poles – 3;
- Kind of current – AC;
- Interrupting medium – air;
- Method of operation – electromagnetic;
- Method of control – automatic, sequence control;
- Rated operational voltage – 415 V;
- Rated frequency – 50 Hz;
- Rated duty – uninterrupted and intermittent, Class 12;
- Utilisation category – AC 3;
- Control circuit – 250 V AC;
- Auxiliary circuits – 3 minimum;
- Temperature range – 10 °C to + 50 °C ambient;
37.9 Motor Overload and Thermistor/Thermal Switch Protection

Motor overload and thermistor/thermal (microtherm) switch protection will be incorporated in the motor drive or starter for each motor size greater than 5.5 kW, as detailed in this Supplementary Specification.

37.9.1 Motor Overload Protection – DOL Starters

Where a DOL starter is provided, its thermal overload relay shall be of the ambient compensated, three-element bi-metal adjustable type, with phase loss protection.

Each thermal overload relay shall be capable of withstanding the let through fault of the upstream circuit protection.

Each thermal overload relay shall be selectable for manual or automatic reset. Each thermal overload relay shall be selected to manual reset with a reset button on the front door of the starter compartment. The Contractor shall configure thermal overload relay to suit the Type 2 co-ordination settings of the circuit.

Thermal overload relays shall provide protection against single phasing.

37.9.2 Motor Overload Protection – Electronic Starters

Where a soft starter is provided, thermal overload protection shall be provided, refer to Clause 37.8.3 of this Supplementary Specification. Where a VFD is provided, thermal overload protection shall be provided, refer to Clause 37.8.4.6 of this Supplementary Specification.

37.9.3 Thermistor/Thermal (Microtherm) Switch Protection

Thermistor protection will comprise PTC thermistor sensors embedded in the motor stator winding (one per phase per winding). These sensors (i.e. a total of at least three per relay) shall provide an alarm by operating thermistor protection and thereby simultaneously disconnecting supply to the motor, at a tripping temperature as recommended by the motor manufacturer for the class of insulation used. PTC thermistor sensors shall be supplied and installed by the motor manufacturer.

Thermal (microtherm) switch protection in each phase is an alternative method of thermal overload protection. Appropriate resistors may be used if wired into thermistor connection points on the drive units to simulate over temperature conditions.

Thermistor or thermal switch relays (DOL only) shall be of the manual reset type and shall comply with AS 1023 and shall be supplied and installed in the switchboard or MCC.

The whole temperature protection system shall not latch-out in case of power failure, i.e. it shall not prevent the starter from restarting the motor when the power is restored from failure.

37.10 Motor Protection Units

Where required by the Principal’s Representative, a motor protection unit shall be provided. These devices may be required for DOL starter circuits where a criticality risk analysis determines a higher level of protection is required.

Each intelligent motor protection (MPU) relay shall be:

- Flush door mounted on the motor starter door; and
• Capable of being reset remotely from a programmable controller or through its communications link to the PLC/RTU.

During normal operation, each MPU shall indicate the motor load as a percentage of the full motor rated load.

Under fault conditions, the following indication shall be provided on each MPU:

• Motor overload;
• Phase loss;
• Locked rotor; and
• Motor earth leakage.

### 37.11 Motor Starter Selector Switches

Each electrical drive shall have a selector switch that will control the mode of operation of the drive, e.g. “Run-Off-Auto”. The “Run” position shall start the drive motor on selection, the “Off” position shall stop the drive and the “Auto” position will allow the electrical drive to be controlled automatically by the control system. Each selector switch shall be mounted with the “Auto” position to the right. The switch positions shall be arranged with a 60° displacement.

Each selector switch shall be non-illuminated and shall be of the flush mounting, rotary action type. Each selector switch shall include a minimum 60 mm square reverse engraved escutcheon plate designating both the switch function and its respective positions.

Each selector switch shall be rated at not less than 6A.

### 37.12 Other Selector Switches

Any other selector switch supplied and installed in a switchboard, MCC or cabinet shall be non-illuminated and shall be of the flush mounting, rotary action type. The switch positions shall be arranged with a 60° displacement.

Each selector switch shall include a minimum 60 mm square reverse engraved escutcheon plate designating both the switch function and its respective positions.

Each selector switch shall be rated at not less than 6A.

### 37.13 Pushbuttons

Each pushbutton shall:

• Comply with AS 609457.5.1;
• Have a robust, dust proof, weatherproof, hose-proof and oil tight design;
• Be provided with silver contacts rated at not less than 10 A at 250 V;
• Be 23 mm diameter; and
• Have interchangeable operators.

Each emergency stop pushbutton shall be of the mushroom head, mechanical latching type. Each pushbutton shall incorporate a latching facility such that the pushbutton latches out when the pushbutton is depressed and cannot be reset until the locking ring is released.

Each emergency stop pushbutton shall be pad-lockable in the “Actuated” position i.e safe position.
In accordance with the Standard, resetting the “Emergency Stop” shall not restart the device being controlled.

The colour of each pushbutton shall comply with Table 37.2.

Table 37.1 Pushbutton Colour and Function Indication

<table>
<thead>
<tr>
<th>Pushbutton Colour</th>
<th>Function Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Stop; Emergency Stop; Close Valve/Penstock</td>
</tr>
<tr>
<td>Green</td>
<td>Start, Open Valve/Penstock</td>
</tr>
<tr>
<td>Blue</td>
<td>Fault Reset; Trip Reset</td>
</tr>
</tbody>
</table>

37.14 Indicating Lights

Each indicating light shall:

- Comply with AS 609457.5.1;
- Be of the high intensity light emitting diode (LED) type;
- Be adequately ventilated;
- Be attached to the compartment door or escutcheon by a means other than the lamp bezel;
- Be 23 mm diameter;
- Have a lamp that is easily removable and replaceable from the front of the compartment door or escutcheon by a manual means i.e. it shall not require the use of a lamp extracting tool; and
- Have a lens that is evenly coloured throughout and is not surface coated.

The colour of each indicating light shall comply with Table 37.2.

Table 37.2 Lamp Colour and Function Indication

<table>
<thead>
<tr>
<th>Lamp Colour</th>
<th>Function Indication</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>Valve/Penstock Closed</td>
</tr>
<tr>
<td>Amber</td>
<td>Fault; Under-voltage Trip; Overload</td>
</tr>
<tr>
<td>Green</td>
<td>Mains Supply On, Drive Running, Valve/Penstock Open</td>
</tr>
<tr>
<td>Blue</td>
<td>Drive Available; Ready to Start</td>
</tr>
<tr>
<td>White</td>
<td>Mains Supply Healthy</td>
</tr>
</tbody>
</table>

37.15 Fuse Fittings and Cartridges
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Fuses shall be HRC type and shall be suitable for the fault level of the installation. All fuse cartridges (excluding those mounted in fuse combination units and fault current limiters) shall be held in a fully enclosed moulded fuse holder with shrouded contacts and provide safety to the operator while withdrawing the carrier.

Fault current limiter cartridges shall be held in approved holders and shall be readily accessible.

Fuse cartridges or fuse base/carriers shall clearly state the name of the Australian manufacture or purchasing agent.

Where fuse extraction handles are required, they shall be clipped inside the cubicle adjacent to the fuses. Where the fuses are located behind more than one cover, one handle shall be provided behind each cover.

At least one 3 phase set of fuses for every size included in the switchboard shall be mounted in fuse clips with individual fuse size labels in a spare fuse rack on the inside of one of the doors or inside a dedicated cabinet for spare fuses.

Breaker settings or fuse ratings shall be coordinated to effect sequential tripping such that the breaker or fuse nearest the fault will clear the fault prior to activation of other breakers or fuses to the degree practicable.

37.16 Relays

Each relay shall:

- Be fully enclosed;
- Be of the plug-in type;
- Have a clear plastic dustproof cover that encloses the whole relay;
- Have a plug in base that is suitable for DIN rail mounting;
- Be rated for continuous operation;
- Have contacts rated at 10 A at 250 V;
- Incorporate a test push button and inbuilt LED to indicate when the relay is energized and
- Have two (2) spare contacts, one N/O and one N/C or two C/O.

Where a relay is used to switch currents less than 1 A (light duty switching), a twin contact spring set relay shall be provided.

A relay shall not be used for switching currents in excess of 6 A, a contactor shall be used.

Relays of different coil voltages shall have different pin configurations to prevent incorrect installation onto relay bases.

Where a relay is being used to switch different voltages, a plastic separator shall be provided between each set of terminals at each voltage to avoid accidental short circuiting.

37.17 Timers

Each timer shall:

- Be of the electronic type;
37.18 Meters

37.18.1 General
Each meter shall comply with IEC 60051.1 and IEC 60051.2.

Unless otherwise indicated, each meter shall:

- Be flush mounting in the door of the appropriate compartment or in a hinged escutcheon;
- Have a 96 mm square bezel with a 90 degrees quadrant scale;
- Be of the same style and size in the one switchboard or MCC;
- Have a minimum accuracy Class of 1.5;
- Have a meter movement suitable for a high degree of vibration. The movement shall be jewel and pivot or taut band with oil damping;
- Have an adjustable zero setting; and
- Have impact resistant anti-glare glass.

37.18.2 Ammeters
The scale on each ammeter shall be suitable for the motor's full load current with five times over-scale and shall be marked in red at the motor’s nameplate current.

37.18.3 Voltmeters
The scale on each voltmeter shall be ranged from 0 to 500 V.

Each voltmeter shall be provided with a six position rotary selector switch to measure the 3 interphase and 3 phase to neutral voltages.

37.19 Hours Run Meters
For each pump contactor, an hours run meter shall be provided and shall be panel mounted with capacity to record to 9999.9 hours.

The hours run meter’s digits shall not be red on black. Each hour run meter where possible shall be mounted in its motor starter compartment door at eye level (about 1.6 m above floor level).

38 EARTHING SYSTEM
The Contractor shall supply and install all parts of the earthing system for each electrical installation in accordance with the requirements of AS/NZS 3000 and of the Supply Authority including the following components:

- Earth electrode/s, refer to Clause 38.1 of this Supplementary Specification;
- Main earthing conductor;
- Main earth bar, refer to Clause 35.6 of this Supplementary Specification;
- MEN link, refer to Clause 38.2 of this Supplementary Specification;
- Protective earthing conductors, refer to Clause 38.3 of this Supplementary Specification; and
- Equipotential bonding, refer to Clause 38.4 of this Supplementary Specification.

The Contractor shall submit details showing the proposed earthing system to the Superintendent and the Principal's Representative for review and comment.

The earth loop impedance for each earthing system shall comply with AS/NZS 3000 at the worst point. The earthing system earth loop resistance test shall be carried out at the point in the system specified by the Developer's Designer. If no test point is specified, then the Contractor shall submit a suggested test point to the Superintendent and the Principal's Representative for review and comment. The Contractor shall not carry out the test until comments on the submission is received. If the earth loop resistance exceeds this value, then the Contractor shall implement additional measures to achieve the required outcome.

### 38.1 Earth Electrodes

Each earth electrode shall be copper clad steel or where acid sulphate soils are present shall be Grade 316 stainless steel. For mains supply up to 100 A rating, each earth electrode shall be 12 mm diameter driven to a minimum depth of 1200 mm and for mains supply above 100 A rating, each earth electrode shall be 19 mm diameter driven to a minimum depth of 1800 mm.

Each copper clad steel earth electrode shall be a proprietary product. Each Grade 316 stainless steel earth electrode shall either be a proprietary product or be fabricated from 19 mm diameter solid bar.

The connection at the top of each earth electrode shall be installed in a polypropylene or polycrrete earthing box. The minimum opening size for each earth box shall be 150 mm x 250 mm.

The connection between each earth electrode and the main earthing conductor shall be an accessible removable type connection or link to enable resistance tests to be carried out.

Each earth electrode shall achieve a 1.0 ohm resistance value or less.

### 38.2 MEN Link

A MEN link sized to AS/NZS 3000 shall be provided and labelled as such. Neutral and earth bars and busbars shall be completely isolated from each other, except for the MEN link.

A plastic (Traffolyte WBW colours or equivalent) label shall be provided on the exterior of the switchboard or MCC to advise the location of the MEN link.

### 38.3 Protective Earthing

The Contractor shall refer to Clause 35.15 for protective earthing requirements within SCAs.
The Contractor shall supply and install earthing for all low voltage electrical field equipment and exposed metal on which electrical field equipment is mounted. The Contractor shall connect all metallic supports that have electrical field equipment mounted on them to the main earth bar using an earth continuity conductor.

38.4 Equipotential Bonding

A continuous equipotential earthing and bonding system shall be provided throughout the whole of each installation to achieve the following objectives:

- The same earth potential value to the PLC/RTU regardless of location within the installation;
- The same earth reference point for the PLC/RTU and instrumentation installation; and
- Step and touch electrical potentials are limited to permissible levels.

The Contractor shall supply and install all necessary equipotential bonding. This shall include as a minimum connections to the following:

- All items of equipment;
- Metallic pipework;
- Structural metalwork;
- Reinforcing steel in reinforced concrete water retaining structures;
- Reinforcing steel in concrete footings and slabs for buildings;
- Cable support systems (metallic conduits, cable tray and cable ladder);
- Cabinets and supports;
- Any lightning protection systems; and
- Any extraneous conductive components.

Transient earth clamps shall be provided between each installation’s protective earthing system communications and control system earthing systems to achieve equal potential during surge conditions.

All expansion joints in cable tray runs and cable ladder runs shall be bonded to ensure continuity. The minimum size bonding and earthing conductors for cable trays and cable ladders shall be 35 mm² or as per AS/NZS 3000 for the largest active conductor.

If the use of pipework or equipment with specialised non-conductive surface preparations cannot guarantee earth continuity, typically across flange joints, then earth bonding conductors shall be installed to ensure continuity.

Earthing points shall be provided in all electrical cabinets. The Contractor shall ensure that all cabinets and items of mechanical equipment are effectively earthed.

Each Grade 316 stainless steel gland fitted to a plastic or non-conductive component shall be earthed using a proprietary gland earthing lug.

Each radial connection to the main earth bar and the equipotential bonding system shall be PVC yellow/green insulated, crimped with an approved “C” connector to the bonding conductor and shall be lug bolted to equipment. Where conductors are looped between bonded components, they shall be secured into a common lug to ensure the continuity of the whole system should an individual component be disconnected.

Multiple earth connections within equipment shall terminate at earth bars/links, with one conductor per screw, stud or tunnel type terminal. Tunnel type terminals shall have two screws.
The equipotential earthing and bonding system shall achieve a 0.1 ohm resistance value or less from the equipment to the earth electrode connection point.

39 LIGHTNING AND SURGE PROTECTION AND INTRINSIC SAFETY

All equipment shall be protected from lightning and power surges. The protection system shall consist of surge protection devices and earthing systems. The protection system shall not affect the operation of equipment under normal operating conditions.

All surge protection systems shall be installed in accordance with the manufacturer’s recommendations.

39.1 Switchboard and MCC Protection

Earthing conductors shall be a minimum size of 6 mm$^2$ and the maximum resistance between protected components and the earthing mat or electrode shall be 0.1 ohms. The Contractor shall install the required earthing electrodes and conductors. Surge protection devices installed remotely from a switchboard or MCC shall be connected to a local earth electrode.

Shunt surge diverters shall be supplied and installed on the main three-phase bus of the switchboard or MCC before the Main Switch or immediately after the supply changeover switches if fitted. They shall be connected between each phase and the neutral bar by the shortest most direct route using straight copper bar or cables with a minimum cross sectional area of 35 mm$^2$. Suitable fuses, in accordance with the manufacturers recommendations shall be installed between the consumer’s mains and the surge diverters where the consumer’s mains are protected by fuses rated at more than 100 A. The diverters shall be rated at a minimum of 275 V RMS. The devices shall be encapsulated in shock absorbent material and have 250 V AC isolated alarm contacts. Peak let through voltage as defined in AS 1768 Cat C 20 kA pulse conditions shall not exceed 900 V. The devices shall have a design capability of withstanding and diverting at least 1000 V for a 20-kA Cat C pulse.

Where a site consists of a main switchboard and a number of sub-switchboards or MCCs, which are located separately in other buildings or via sub-main cables in excess of 20 m length, surge diverters as detailed above shall be installed in each switchboard or MCC.

A surge reduction filter rated at 10 A shall be provided in each switchboard or MCC. The unit shall incorporate filters on the active and neutral lines. This device shall supply power to all control, instrumentation and telemetry equipment within the switchboard, MCC or the same building only.

Remote equipment in a separate building, switchboard or MCC shall be supplied from the unfiltered mains and shall have a surge suppression device at its remote termination. These remote devices shall have an 800 V let through voltage.

39.2 Instrumentation Signal Protection

Surge protection devices shall be provided at both ends of the 4-20 mA signal cables and digital data lines that clamp the voltage to no more than 45 V. Each device shall be securely bonded to the earthing system. The case of each transmitter and each receiver shall be connected to the earthing system.

Remote transmitters shall use a local earth system. Surge protection devices are not required if the signal loop:

- Does not extend outside of the switchboard; or
- Does not extend outside the confines of a building.

Surge protection devices shall be of the series connected type, comprising three stages of protection, fail-safe operation (fail to short circuit), common and differential mode protection.
39.3 Antenna Protection

Coaxial antenna cables shall be protected by coaxial surge protectors suitable for the frequency of operation of the antenna system. The surge protector shall be securely bonded to ground via an earth cable to the main earth bar. The surge protector shall be securely bonded to ground via an earth cable to the main earth bar or quality tested local earth electrode.

39.4 Digital Data Lines

Both ends of digital data lines shall be provided with surge protection devices with a clamp voltage of no more than 45 V.

39.5 Instrumentation Power

39.5.1 Supply Cables

The supply cable for each 240 V AC powered instrument located external to buildings shall be surge protected.

The surge suppression units shall be located both in the field adjacent to the instrument/device and in the switchboard or MCC instrumentation distribution board. This requirement may be waived only if the distribution board is directly protected with bi-directional surge equipment rated to a minimum of 50 kA (8/20 microseconds). The use of dual surge units shall be avoided unless extreme space restrictions exist and the written approval of the Principal’s Representative is obtained.

The surge suppression units shall be series type filter devices. They shall be multi-stage devices with a primary protection rating of 10 kA (8/20 micro seconds). Unless special requirements exist, the units shall be designed for a working voltage of 240 V and current of 3 A.

39.5.2 Instrument Power Supplies

Surge reduction filters shall be provided as necessary to protect all instrument power supplies against input over-voltage and mains borne sags, surges and impulses originating from lightning, switching operations or other causes. Common and normal mode noise rejection and isolation characteristics of the supplies shall be adequate to allow for reliable operation. Voltage and frequency regulation shall be provided as necessary.

The surge reduction filter shall be rated at 250 V RMS, 40 kA on a single shot 8/20 microsecond impulse with energy absorption in excess of 3500 Joules and shall be capable of continuous supply of 10 A. The maximum let-through voltage of the device shall be 500 V. A surge diversion failure indicator shall be provided which shall be clearly visible on the switchboard or MCC front panel without the need to open any switchboard or MCC doors.

A non-sacrificial “L” section filter shall be incorporated in the surge reduction filter and shall consist of a series inductor and shunt capacitor arranged such that the capacitor is connected on the load side of the inductor. The inductor shall be a non-saturable air-cored type and the capacitor shall be a metallised polypropylene film type.

39.5.3 UPS Protection
The supply cable to each UPS shall be provided with surge protection. The UPS surge protection device will be rated at 50 kA (8/20 micro seconds). Unless agreed otherwise by the Principal’s Representative, it shall be positioned local to the UPS.

39.6 Explosive Equipment Areas

Intrinsic safety barriers shall be used on all instrumentation located in explosive areas to ensure compliance with safety standards relevant to the classification zone of the explosive area i.e. refer the Standards IEC 60079-17, AS/NZS 60079.10 “Ex” schemes.

40 FIELD MOUNTED ELECTRICAL EQUIPMENT

40.1 Local Control Stations

For all drives, except for submersible pumps installed in a wet well, a local control station shall be provided adjacent to the drive.

An “off-load” isolating switch complying with Clause 37.6 of this Supplementary Specification shall be supplied and installed in the local control station. Each “off-load” isolating switch shall have a device for padlocking the switch in the open position. This device must be an integral part of the operating handle.

Each “off-load” isolating switch shall be provided with one set (NO & NC) of early break, late make auxiliary contacts. One contact shall be incorporated into the drive’s control circuit to trip the drive before the isolator is opened.

40.2 Stop and Start Pushbutton Stations

For all drives, except for submersible pumps installed in a wet well, “Stop” and “Start” pushbuttons shall be provided in the local control station. Each pushbutton shall comply with Clause 37.13 of this Supplementary Specification.

The “Stop” and “Start” pushbuttons shall be wired into the control circuit of each drive. The “Stop” button shall immediately stop or where necessary due to load, decelerate the motor safely and isolate the motor when it is activated.

40.3 Emergency Stop Pushbutton Stations

Where required for each device where there is a risk of harm to or entrapment of the operator, the maintainer or other personnel, a red mushroom-head type “Emergency stop” pushbutton shall be provided at the device mounted in its local control station provided adjacent to the drive. Each pushbutton shall comply with Clause 37.13 of this Supplementary Specification.

Each “Emergency stop” pushbutton shall be wired into the control circuit of its motor drive and shall immediately stop or where necessary due to load, decelerate the motor safely and isolate the motor when it is activated.

The drive shall not restart automatically when the locking ring is released. The automatic or manual control circuit shall be reset at the switchboard or MCC by turning the selector switch on the motor starter compartment door to the “Off” position before returning it to the “Automatic” or “Run” position.
40.4 Local Control Station Cabinets

Each local control cabinet shall:

- Be fabricated from 2 mm thick Grade 316 stainless steel sheet, refer to Clause 34.2.2 for fabrication requirements;
- Have a sun hood and a hinged front door;
- Have an Enclosure Class of IP65 to AS 60529;
- Be sufficiently deep so that at least two contact blocks can be used on any pushbuttons;
- Include DIN rail terminal strip for the mounting of cable terminals for all cables other than for the motor circuit cables which shall either pass through a local isolator if provided or be connected directly to the motor’s terminals;
- Include an earth connection of minimum size 6 mm$^2$ between the cabinet, the cabinet door and the gland plate;
- Be provided with a removable gland plate manufactured from 1.6 mm thick Grade 316 stainless steel sheet; and
- Be supported on a robust support stand.

Each local control station cabinet shall not be used for the looping or marshalling of cables other than for its drive.

Each support stand shall:

- Be fabricated from Grade 316 stainless steel sections, refer to Clause 30.3 of this Supplementary Specification for fabrication requirements including pickling and passivation;
- Be designed to limit to horizontal deflection of the top of the attached local control station to $L/250$ in the direction of the applied load when a lateral load of 50 kg is applied at the top of the attached local control station in either direction (90° apart);
- Comprise a minimum of two vertical columns typically with welded in cross bracing to minimise torsional deflection. Each column shall be welded to a common base plate. The columns shall be of sufficient size to control the deflection as cantilevers off the common base plate. Alternatively gussets may be provided between the columns and the base plate to achieve the deflection limit;
- Have a base plate of adequate thickness but no thinner than 10 mm. Each base plate shall have a minimum of 4 No well spaced holes to suit M10 chemical masonry anchors; and
- Have drainage holes in the base of each column if SHS or RHS sections are used.

Each support stand shall be installed:

- Using a minimum of 4 No M10 chemical masonry anchors;
- Square/parallel to adjoining components; and
- With its base plate set a minimum of 20 mm clear above the adjoining concrete surface on double nutted masonry anchors. The space below the base plate shall be grouted with low shrinkage cementitious grout, neatly tool finished at a 1:1 slope all around from the bottom edge of the base plate.

Where Unistrut or similar sections are used for the support stand columns, they shall be provided with:

- Push in plastic cover plates held in place with a minimum of 2 No Grade 316 stainless steel cable ties; and
Push in plastic end cover plates for each exposed end.

### 40.5 Junction Boxes

A junction box shall be used for the marshalling and looping of all field cabling that is not marshalled in its own local control station. Each junction box shall be constructed of 2 mm thick Grade 316 stainless steel sheet, refer to Clause 34.2.2 for fabrication requirements.

A separate junction box shall be provided for each different drive or equipment system and for sections of different systems which are not isolatable at one location.

Each junction box shall:
- Have a bolted on front cover where it is no larger than 250 mm square;
- Include DIN rail terminal strip for the mounting of cable terminals;
- Have provision for 25% spare cabling in addition to that provided for initial requirements.

### 41 ELECTRICAL POWER, CONTROL AND INSTRUMENTATION CABLING

#### 41.1 Cable Requirements

##### 41.1.1 Consumer's Mains, Sub-Mains and Power Supply Circuits

The Contractor shall supply, install and terminate all motor 415 V and 240 V power supply cabling for consumer’s mains, sub-mains and power supply circuits to all drives and other components. All cabling shall be circular PVC/PVC or XLPE multi-core copper, unless other types are approved by the Superintendent and accepted in writing by the Principal's Representative.

Voltage drop calculations for consumer’s mains, sub-mains and all power circuits to drives shall be provided to the Superintendent and the Principal's Representative for review and comment.

Exposed cables shall be installed in cable support systems in locations that do not create trip or bump hazards. The Contractor shall take installation aesthetics into consideration. The Principal may reject any installation that is considered to detract from the overall appearance of the installation.

All consumer's mains and sub-mains shall have a minimum size of 16mm².

All power cabling for motors other than those with variable speed drives (VFDs) shall be PVC/PVC, 0.6/1 kV multi-stranded copper multi-core, V-75 thermal rating sized in accordance with AS 3008.1.1 for the voltage drop or the full load motor current plus 20 %, whichever is the more severe duty.

Power cabling for each motor with a VFD shall also comply with the requirements detailed in Clause 37.8.4 of this Supplementary Specification and shall be sized for the voltage drop or the full load motor current plus 20 %, whichever is the more severe duty.

Final sub-circuits to motors shall be sized for the full load motor current plus 20 %.

Areas classified as hazardous areas shall comply with AS/NZS 3000 Section 7.7, Hazardous Areas (Explosive Gas or Combustible Dusts), plus other relevant Australian Standards.

It shall be the Developer’s, the Developer’s Designer or the Contractor’s responsibility to ascertain the routes to be taken by all cables and where possible, common routes shall be used. Where a common route is used for, four (4) or more cables, a cable tray or cable ladder shall be provided.

Where cables are exposed to direct or reflected ultra-violet radiation, the cable shall be fully protected on all sides by covers or ducting.
41.1.2 Submersible Pump Unit Cables
The cable/s for each submersible pump unit shall be manufactured to the requirements of AS/NZS 5000 and meet the test criteria as described in AS/NZS 1660. Each cable shall be suitable for use in sewage applications. A certificate of compliance shall be submitted to the Superintendent prior to installation.

The Contractor shall supply a Grade 316 stainless steel stocking to support each submersible pump unit’s power cable and each submersible pump unit’s control cable if separate. Where a submersible pump unit has more than one power cable, then a Grade 316 stainless steel stocking shall be provided for each power cable. The Contractor shall supply a Grade 316 stainless steel D shackle of adequate size and a short single Grade 316 stainless steel wire sling. All stockings for each submersible pump unit shall be connected together using the Grade 316 stainless steel D shackle onto the short single wire sling. The wire sling shall be supported off a single Grade 316 stainless steel cable hook suitably positioned.

41.1.3 SCA Cabling
All cabling shall be carried out in multi-strand and 0.6/1 kV grade V75 PVC insulated cable cores to AS/NZS 5000. Single strand (solid) cable cores shall not be used.

Power circuits shall be wired in phase coloured cable cores to AS/NZS 5000, minimum size 2.5 mm². The actual size shall be determined by the size of the connected drive.

Control circuits shall be wired in minimum size 1.0 mm² stranded (32/0.20) cable cores within the switchboard or MCC.

Instrumentation wiring and cables to carry analogue signals to the RTU, PLC or process instrumentation shall be PVC covered, aluminium screened twisted cable cores of minimum size 0.5 mm² (7/0.30).

41.1.4 Field Control Cabling
All control cabling shall be supplied, installed and terminated as part of the field equipment installation.

Field control cable shall be PVC/PVC 0.6/1 kV grade, multi-stranded copper multi-core, V-75 thermal rating of minimum size 1.5mm². Single strand (solid) cable cores shall not be used.

In all cases where multi-core control cables are used, at least two (2) spare cores shall included (e.g. if 3 cores of a control cable are required a 5 core cable shall be installed).

41.1.5 Field Instrumentation Cabling
RTU or PLC control wiring may be PVC 0.6/1 kV grade, multi-stranded copper multi-core cables, V-75 thermal rating of minimum size 0.5 mm² (16/0.20).

Instrumentation wiring and cables to carry analogue signals to the RTU, PLC or process instrumentation shall be PVC covered, aluminium screened twisted cable cores of minimum size 0.5 mm² (7/0.30). Each screen of all instrumentation cables shall be earthed at only one point.

41.1.6 Separate Telemetry Cabinet Cabling
Where the Principal’s Representative requests or accepts in writing that a separate telemetry cubicle shall be provided, all cables to the telemetry cabinet shall be multi-core or coaxial and shall be separately glanded into the bottom of the telemetry cabinet. Analogue signals shall be cabled with screened twisted pair cable.

Each cable to the telemetry cabinet shall be circular.

41.1.7 Cable Core Colours
Cable core colours shall be in accordance with the following:
Phase wiring: Red, white & blue

240 V AC control: Orange

240 V AC neutral: Black

240 V AC active: Grey

24 V AC active: Grey

24 V AC neutral: Black/white trace

Telemetry (from signal source to AI or DI): Purple/violet

Telemetry (Terminal strip to RTU analogue Instrument cable (numbered black and white pairs) I/O connections):

24 V DC control +ve: Pink

24 V DC control –ve: Brown

Thermistor circuit: White (twisted pair)

12 V DC + (pos): Red

12 V DC – (neg): Red with black stripe

Under no circumstances shall cable cores with the colour Green or Green-Yellow be used for other than earth connections.

41.2 SCA Wiring Requirements

Cables and cable cores shall be neatly run within each SCA in insulated PVC or similar ducts with clip-on covers within the assembly. Each duct shall have perforated sides for cable or cable core access to individual terminals.

Each duct shall be sized so that there is at least 25% spare space after all cables and cable cores are installed.

Cables shall be firmly anchored to prevent movement.

All cables entering and exiting each SCA shall be labelled at the gland plate as detailed in Clause 43 of this Supplementary Specification. All cable cores within each SCA including earth and neutral cores shall be labelled as each termination as detailed in Clause 43 of this Supplementary Specification.

41.3 Wiring Terminations

41.3.1 SCA Incoming and Outgoing Wiring

Incoming and outgoing power, control and instrumentation wiring for each SCA shall be terminated at low level or other approved locations in approved numbered terminal strips with insulated pin type connector lugs. Terminal strips shall not be mounted lower than 100 mm above the base of the SCA cableway.
The terminal strips shall be mounted in such a manner as to provide easy access to the terminal screws and wires.

Motor terminals inside each SCA shall have a minimum size of 4 mm².

Oversize terminal spacers shall be installed between different voltages and phases.

**41.3.2 Common Requirements – SCA and Field Mounted Cabinet Wiring**

“Clip-on” rail terminals (clamp type) shall be supplied and installed. An allowance of 10% spare capacity shall be made on the rails.

“Double deck” style terminals shall not be used.

Not more than two wires shall be terminated at each side of a through terminal. Where terminal strips are used, motor cabling or incoming mains warning labels shall be placed over the terminal strip. Wires stacked on top of each other in a terminal are not acceptable. Two-wire bootlace ferrules shall be used in this situation.

Terminations shall be made with approved insulated compression lugs suitable for use with the size of conductor being used and the type of terminal strip employed.

Where stud type terminals are used, crimp-on compression type lugs shall be used. For tunnel type terminals, crimp-on compression stalk lugs shall be used.

**41.4 Field Cabling Installation**

**41.4.1 General Requirements**

The Developer, the Developer’s Designer or the Contractor shall prepare voltage drop and maximum demand calculations for submission to the Superintendent and the Principal’s Representative for review and acceptance prior to installation.

Cable installation methods shall comply with the Supply Authority’s regulations, AS/NZS 3000 and the following:

- Cables shall leave their respective motor starters via terminals located within the switchboard or MCC;
- Cables for instrumentation terminated at the PLC I/O terminal strips or transmitter or the like shall leave the switchboard or MCC;
- Cables for lighting and power circuits terminated at circuit breakers shall leave the switchboard or MCC;
- Each cable shall exit via the bottom of the cubicle and shall run via cable ladder, cable tray and or conduit to its respective equipment;
- All cables shall be installed to minimise the effects of electro-magnetic interference and harmonic interference; and
- Power and instrumentation cables shall be separated by a minimum of 300 mm.

The Contractor shall supply and install final sub-circuit cables to the respective equipment.

Outgoing cables shall be glanded through gland plates provided in the base or lower sections of the switchboard or MCC. All cables entering or leaving each switchboard or MCC shall be firmly anchored to prevent cable movement. The provision of cable gland plates is a requirement for each switchboard, MCC or cabinet, however, in some situations the Principal’s Representative may accept in writing the deletion of gland plates. In those situations where cable gland plates are not provided, cables shall be
glanded through the external skin of the switchboard, MCC or cabinet and fixed to the switchboard, MCC or cabinet as required.

Motor power cables to each field mounted cabinet, local control station or to each motor terminal box shall be terminated via Grade 316 stainless steel cable glands.

Each control and instrumentation cable gland shall be Grade 316 stainless steel except in those locations where the Principal’s Representative may accept in writing the substitution of polyamide cable glands.

Cables shall be carefully installed to avoid damage to the sheathing and to any structure or support system. All ducts and conduits shall be clear before any cables are pulled through. Cable guides shall be used to prevent damage to cables being pulled. When pulling cables grease will not be permitted. Products designed specifically for pulling cables shall be used.

Cabling external to the switchboard or MCC shall be run in conduit or on cable trays or cable ladder to the requirements of the Clauses 41.5 and 41.8 of this Supplementary Specification. Exposed cables will not be accepted.

Splices in cables will not be permitted.

Cabling installed on cable tray or cable ladder shall comply with AS/NZS 3000. Cables shall be securely tied to the cable tray or cable ladder with UV protected cable ties at maximum 600 mm centres. No cable crossovers, excepting where cables enter or leave the cable tray or cable ladder, will be permitted.

Cables not installed on cable trays shall be laid in continuous conduit runs unless prior approval is given in writing from the Superintendent and the Principal’s Representative to do otherwise.

All cables entering and exiting each field mounted isolator, local control station, field termination cabinet or field marshalling cabinet shall be labelled at the gland plate as detailed in Clause 43 of this Supplementary Specification. All cable cores within each field mounted isolator, local control station, field termination cabinet or field marshalling cabinet including earth and neutral cores shall be labelled as each termination as detailed in Clause 43 of this Supplementary Specification.

41.4.2 Underground Cabling

Cables laid under roadways shall be laid in approved ducts. They shall be category “A” PVC underground conduit, typically heavy duty Orange PVC electrical conduits to AS/NZS 2053, refer to Clause 41.7.1 of this Supplementary Specification.

The conduits shall be supplied and installed by the Contractor unless otherwise stated.

41.5 Cable Trunking

Where cable trunking is adopted (includes an enclosure such as box culverts, a trunk or trough), cables shall be installed in the cable trunking neatly and systematically to provide for free circulation of air and dissipation of heat. The maximum number of cables that may be enclosed in one cable trunking shall be such as will permit installation of the cables without damage. Cable trunking shall be sized to allow for the installation and termination of all internal and external wiring.

A minimum of 10 % spare usable capacity shall be included in the sizing of the cable trunking after all internal and external wiring has been installed.

41.6 Cable Breakout Boxes

Typically the transition of cables:

1. From an above ground cable support and into a below ground cable duct in a concrete slab or floor; or
2. Through the wall of a switchboard building or switchboard room and onto an above ground cable support; or

3. Through the wall of a switchboard building or switchboard room and into a below ground cable duct on the outside of the switchboard building or switchboard room, shall be through a breakout box to exclude vermin. Each cable shall be separately glanded through the appropriate face of the breakout box.

In those situations where 1. above applies, the Contractor shall supply and install a five sided (top, two sides, back and a front) breakout box tightly on the concrete slab or floor over the conduits to exclude vermin.

In those situations where 2. applies, the Contractor shall supply and install a five sided (top, two sides, bottom and a front) breakout box tightly on the wall over the opening with a polyurethane sealant in the interface to exclude vermin and prevent water entry.

In those situations where 3. applies, the Contractor shall supply and install a four sided (top, two sides, bottom and a front) breakout box tightly on the concrete slab or floor over the conduits and tightly against the wall over the opening with a polyurethane sealant in the interface to exclude vermin and prevent water entry.

Each standard breakout box shall:

- Be 700 mm long by 400 mm wide by 350 mm high;
- Be fabricated from minimum 1.6 mm thick Grade 316 stainless steel sheet and 50 by 50 by 3 mm Grade 316 stainless steel angle, refer to Clause 35.1.1.2 of this Supplementary Specification for fabrication requirements;
- Have a near full size bolted on front panel on the 700 mm long side to allow access into the breakout box. The M5 bolt spacing shall be no greater than 150 mm around the perimeter of the front panel. The bolts shall fasten into M5 nut inserts in the breakout box;
- Have a 50 by 50 by 3 mm Grade 316 stainless steel angle rectangular frame which fits inside the breakout box, refer to Clause 30.3 of this Supplementary Specification for fabrication requirements. It shall be bolted down to the slab with M10 Grade 316 stainless steel chemical anchors spaced equally around the frame at 250 mm maximum centres;
- Be fastened to M5 tapped holes in the 50 by 50 by 3 mm Grade 316 stainless steel rectangular angle frame with M5 bolts at 200 mm centres maximum; and
- Be assembled using Grade 316 stainless steel bolts, washers and nut inserts.

Where the standard dimensioned breakout box is too large for a particular application, the Contractor shall configure and fabricate a smaller version with the same features suited to the application.

### 41.7 Cable Conduit Runs

#### 41.7.1 Terminology

The terminology adopted in this Supplementary Specification is “conduit/s” in a “conduit run/s” for both above ground and below ground conduit systems. Below ground “conduit run/s” are constructed between “electrical conduit drawing pits” which makes an “underground conduit system”.

#### 41.7.2 Material Requirements

All conduit used throughout the electrical installation shall comply with AS/NZS 2053 whether it is rigid PVC, flexible PVC, or Grade 316 stainless steel conduit.

Conduit shall be not less than 20 mm in diameter.
Profile wall, smooth bore rigid PVC conduit shall not be used.

PVC flexible conduit shall be liquid tight, polyamide (Nylon or similar) helically wound with a black PVC cover. All fittings shall either be heavy duty black polyamide or Grade 316 stainless steel specifically to suit the proposed conduit. Chrome plated brass fittings will not be accepted.

Each conduit bend for rigid conduit runs shall be a large sweep bend. For PVC conduits, all bends and fittings shall be of the same material as the conduit.

For Grade 316 stainless steel conduits, the conduit shall be either tube or pipe, refer to Clause 30.3.2.1 of this Supplementary Specification. For Grade 316 stainless steel conduits, screwed Grade 316 stainless steel fittings shall be used.

Pull boxes shall be supplied with neoprene gaskets and Grade 316 stainless steel screws.

Conduits where surface run shall be fixed by means of Grade 316 stainless steel double-sided saddles at spacings not exceeding 600 mm.

Each conduit saddle shall be fixed with Grade 316 stainless steel screws (2 screws per saddle). Explosive or hammer-in type fasteners will not be accepted for fixing.

Support brackets, where necessary, shall be fabricated from Grade 316 stainless steel, refer to Clause 30.3 of this Supplementary Specification for material supply and fabrication requirements.

### 41.7.3 Conduit Run Design

The Developer, the Developer's Designer or the Contractor shall:

- Design each conduit run to avoid all pipework, ductwork systems and other services;
- Not design conduit runs to be length ways under roadways or access ways except the location is agreed in writing by the Superintendent and the Principal's Representative. Where a conduit run crosses a roadway or access way, it shall be designed at 90° to the roadway or access way;
- Separate power and instrument conduits by a minimum of 300 mm;
- Segregate cables throughout the site into conduits in conduit runs allocated to the following groups:
  - Power and 240 V control cables; and
  - Instrumentation cables, 24 V DC control cables, thermistor cables, data cables and the like;
- Generally grade conduits in the vertical plane to match the slope of the ground surface unless this does not suit conduit system;
- Design each conduit run as far as possible in straight lines parallel and square to other elements of the work with easy sets or bends; and
- Include in the design for the removal/release of ground water from the conduit run/s at the lowest point. If needed, a three phase sump pump shall be provided in an electrical conduit drawing pit to remove the water.

Cables and/or conduits shall be grouped as far as possible and all supports, clips, saddles and brackets spaced to prevent appreciable sag.

### 41.7.4 Conduit Installation – General Requirements

The Contractor shall:
Conceal each conduit unless otherwise agreed to by the Superintendent and the Principal’s Representative in writing. Where it is necessary to install exposed conduit/s:

- Provide a neat installation;
- Install expansion joints in all above ground PVC conduit runs, at intervals not exceeding the manufacturer’s recommendations.
- Paint conduit/s exposed on painted structures to the same colour as the structures unless otherwise agreed to by the Superintendent and the Principal’s Representative in writing.

Install a draw rope shall be installed in each conduit including conduits containing cables. The draw rope shall be 6 mm diameter braided orange polyethylene, or a prior approved equivalent. Each end of each draw rope shall be attached to/tied to purpose installed cable conduit saddles where no other permanent structure is available to attach/tie off each draw rope.

Where a PVC conduit run needs to be bent in its length, preferably large sweep bends shall be used. Where this does not suit, each PVC conduit shall be bent to the required angular deflection without altering its cross section or burning the exterior of the conduit.

The Contractor shall only use PVC conduits in areas that are not normally exposed to sunlight or other sources of ultra-violet radiation. Painting of PVC conduits to achieve UV protection will not be accepted.

Jointing of PVC conduit and fittings shall generally be carried out strictly in accordance with manufacturer’s recommended jointing method using the blue glue option rather than the gap filling cement option. Unglued joints will not be accepted.

No part of any installed conduit shall be under mechanical stress.

Outlet boxes for fittings shall be used as draw boxes. Other draw boxes shall be reduced to a minimum. The maximum runs of conduit without a draw-box shall not exceed 12 m.

Conduits shall not touch any other pipes and shall in all cases, be at least 450 mm from heating or gas pipes.

During building operations and/or installation of electrical work, the open end of all conduits shall be tightly plugged to prevent the ingress of moisture and foreign matter. The open ends of conduits shall be interpreted as meaning not only the open ends of conduit runs during process of installation, but shall also include the open ends of conduits where such conduit terminates in boxes and the like.

41.7.5 Underground Conduit Installation Requirements

In addition to the requirements in Clause 41.4.1 of this Supplementary Specification, the following requirements apply for underground conduit runs.

Before proceeding with excavation work, the details of all existing underground services and those to be installed in the area shall be ascertained by the Developer, the Developer’s Designer or the Contractor.

The conduits in each conduit run shall:

- Be laid at a minimum depth in accordance with AS/NZS 3000 on a clean bed of sand with a minimum sand surround 100 mm thick;
- Be spaced horizontally and vertically in compliance with the requirements of AS/NZS 3008.1.1 before backfilling the trench;
- Be water tight to exclude ground water. In addition to the manufacturer’s recommendations for jointing PVC conduit (in order to achieve a water tight condition), all joints in PVC conduit shall be primed with a PVC primer and glued using medium gap filling blue PVC jointing cement;
Each include a bellmouth at each entry and exit point from each electrical conduit drawing pit or any other underground structure or cable trunking; and

Be provided with a warning tape over the entire length at a depth of 300 mm. Care shall be taken when laying the tape around curves and bends.

The trench for each conduit run shall be backfilled and consolidated to finished ground level.

Reinstatement of turf shall be necessary when trenching is completed in “sensitive areas” e.g. outside domestic or commercial property or through parkland. The Principal’s Representative will provide written advice of the specific requirements.

In accordance with Clause 3.11.4.6 AS3000, marking and recording of underground cable location to minimize damage to wiring systems installed underground during manual or mechanical excavation works, the location of underground wiring shall be marked or recorded as follows:

- Permanent cable marker signs shall be provided to indicate the point where a cable enters or leaves a structure; or
- Exception: Cable entry signs need not be provided where the position of underground cable entry into the ground is obvious.
- The route of any underground cable shall be recorded on a plan to enable the location of the cable to be determined in the future. This plan shall be located at the switchboard from which the circuit originates. The plan locating the consumers mains shall be kept at the main switchboard of the installation to which it is connected.

41.7.6 Conduits at Sewage Pumping Stations

Conduits shall be provided between the switchboard or MCC and the wet well generally as shown on the Principal’s Standard Drawings in Appendix C. For larger pumping stations the conduit requirement shall be as follows:

- One conduit for each pump cable being a minimum of 100mm diameter or three times the outside diameter of the installed cable, whichever the greater; and
- One conduit for instrumentation cables being a minimum of 80 mm diameter.

41.7.7 Sealing

Where the Principal’s Representative does not require the use of breakout boxes to transition into underground duct or above ground cable supports, the Contractor shall:

- Effectively seal all openings made for entry of electrical conduits or ducts and the like into buildings, trenches and cableways, with a waterproof concrete grout, or other approved means;
- Effectively seal all cable duct openings above ground level and all cable entries into trenches, for example in switchboard rooms and cable pits, with a re-enterable sealant or by other means approved by the Principal’s Representative in writing; and
- Ensure all spare conduits and ducts are effectively capped.

For each switchboard or MCC with a “breezeway” lower compartment, each conduit shall be sealed with a conduit cap and a compression type cable gland. For every other switchboard or MCC, each conduit shall be sealed at the switchboard or MCC end with an approved waterproof re-enterable sealant.

Expanding foam shall not be used for the sealing of penetrations.
41.7.8 Electrical Conduit Drawing Pits

The Contractor shall supply and install electrical conduit drawing pits for under ground conduit runs:

- At changes of horizontal direction;
- At low points;
- Immediately prior to cables entering or exiting buildings unless the building have a sub-floor with a rigid grid access floor; and
- At an intermediate spacing of not greater than 50 m.

Each electrical conduit drawing pit shall be reinforced concrete having a floor, four walls and a roof arranged to prevent the ingress of water. The conduits shall enter each pit through the side walls square to the walls, not oblique. Where pits are provided for conduit runs for high voltage cables, the cables shall enter and exit each pit on the diagonal to allow use of the maximum space within the pit.

Electrical conduit drawing pits shall be internally sized to allow for twice the bending radius of the largest cable to be installed in the pit plus 50%. The minimum inside dimensions of an electrical conduit drawing pit shall be 650 mm long by 350 mm wide by 900 mm deep.

Conduits which enter or exit electrical conduit drawing pits shall be fitted with bellmouths which are formed into the walls of the pit to finish flush with the inside face. Where the Superintendent permits the installation of bellmouths in cored holes, each cored hole shall be a minimum of 25 mm larger than the outside diameter of the bell and the full each cored hole shall be made good with Megapoxy or a similar approved concrete repair material.

Each electrical conduit drawing pit greater than 400 mm wide shall be constructed with a cast iron cover and frame. Where appropriate, a cover may be concrete infilled. Each cover shall maintain a stabilising fit with its frame by a taper contact on the sides. All vertical meeting surfaces shall be fitted to a maximum clearance of 0.25 mm.

Each covers and its frame shall be suitable for the particular loading conditions as detailed in Table 41.1.

<table>
<thead>
<tr>
<th>Cover Class</th>
<th>Typical Usage</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>Areas where there is no access by vehicles e.g. grassed areas, gardens etc.</td>
</tr>
<tr>
<td>C</td>
<td>Areas where there is access to slow moving light commercial vehicles only</td>
</tr>
<tr>
<td>D</td>
<td>Areas where all vehicles can access</td>
</tr>
</tbody>
</table>

The Contractor shall refer to AS 3996 for details of the load classifications such as wheel loadings only, Table 41.1 shall be used for the specific application. The maximum weight of any individual section of any cover shall not exceed 50 kg.

Each electrical conduit drawing pit 400 mm wide and less shall be fitted with proprietary concrete covers. A proprietary lifting handle for all cable pit coverplates shall be supplied and mounted on a suitable bracket in the switchboard building or switchboard room or in the switchboard or MCC where there is no building.

The Contractor shall install proprietary electrical conduit drawing pits in accordance with the manufacturer's instructions on a minimum 100 mm thick bed of 19 mm coarse aggregate.
41.8 Cable Trays

Cable trays and brackets shall be fabricated from Grade 316 stainless steel and shall be adequately supported and fixed in position. Cable tray or supports fabricated from aluminium sheet, hot galvanised steel sheet or zinc plated steel sheet will not be accepted by the Principal in any location.

Depending on the size of cable to be installed on the cable tray, it shall either have a 50 mm high side or a 75 mm high side. Cable tray with a 50 mm high side shall support a load of at least 30 kg/m with a simply supported span of 3 m. Cable tray with a 75 mm high side shall support a load of at least 75 kg/m with a simply supported span of 3 m.

The maximum span shall be 3 m unless otherwise requested by the Developer’s Designer or the Contractor from the Superintendent and the Principal’s Representative and approved in writing.

Cable trays shall be of the expanded metal type of 2 mm thickness with edges trimmed in a continuous metal envelope. Standard tees, crosses, risers and bends shall be used with the cable tray. Where necessary for separation of different types of cables, full depth barriers fabricated from Grade 316 stainless steel sheet shall be supplied and securely installed.

Edges and openings in cable tray runs shall be protected to prevent cable sheath damage. The method of protection shall be subject to the Superintendent’s approval.

Cable tray fasteners shall not be explosive driven types.

Each cable tray support shall be installed with a minimum of two M10 fasteners.

Cable tray covers shall be installed where UV exposure to the cables is possible. Each cable tray cover shall be of the same proprietary manufacture as the cable tray. Where the cable tray is less than 300 mm wide, then the cover may be flat. Where the cable tray is 300 mm or more wider, then the cover shall be peaked in the middle.

Each cable tray cover shall be secured to the cable tray by Grade 316 stainless steel self-tapping metal threads at a maximum spacing of 600 mm on each side of the cover.

41.9 Cable Ladders

Cable ladders and brackets shall be fabricated from Grade 316 stainless steel and shall be adequately supported and fixed in position. Cable ladder or supports fabricated from aluminium sheet, hot galvanised steel sheet or zinc plated steel sheet will not be accepted by the Principal in any location.

Depending on the size of cable to be installed on the cable ladder, it shall either have a 65 mm high side (NEMA 12A) or a 93 mm high side (NEMA 16A). Cable ladder with a 65 mm high side shall support a load of at least 125 kg/m with a simply supported span of 3 m. Cable ladder with a 93 mm high side shall support a load of at least 470 kg/m with a simply supported span of 3 m.

The maximum span shall be 6 m unless otherwise requested by the Developer’s Designer or the Contractor from the Superintendent and the Principal’s Representative and approved in writing.

Standard tees, crosses, risers and bends shall be used with the cable ladder. Where necessary for separation of different types of cables, full depth barriers fabricated from Grade 316 stainless steel sheet shall be supplied and securely installed.

Edges and openings in cable ladder runs shall be protected to prevent cable sheath damage. The method of protection shall be subject to the Superintendent’s approval.
Cable ladder fasteners shall not be explosive driven types.

Each cable adder support shall be installed with a minimum of two M10 fasteners.

Cable ladder covers shall be installed, potentially on both sides where UV exposure to the cables is possible. Each cable ladder cover shall be of the same proprietary manufacture as the cable ladder. Where the cable ladder is less than 300 mm wide, then the cover may be flat. Where the cable ladder is 300 mm or more wider, then the cover shall be peaked in the middle.

Each cable ladder cover shall be secured to the cable ladder by Grade 316 stainless steel self tapping metal threads at a maximum spacing of 600 mm on each side of the cover.

**41.10 Equipment Mechanical Protection**

The Contractor shall supply and install approved mechanical protection on all electrical equipment under the following conditions:

- When mounted within 1.5 metres above a floor, slab, landing or access platform; or
- Where potentially subject to damage during normal plant operation and maintenance; or
- Areas on which scaffolding and / or planks may be placed, or which may be used as means of access for abnormal plant maintenance; and

Conduits and / or cables (other than single core cables) requiring mechanical protection shall be installed in Grade 316 stainless steel conduit or shall be provided with a Grade 316 stainless steel shroud/cover.

Each sheet metal shroud/cover installed to provide mechanical protection of electrical equipment shall be designed to withstand the shock loading likely to occur in the installation area. Each shroud/cover shall be fabricated from a minimum 2 mm thick Grade 316 stainless steel sheet.

Each sheet metal shroud/cover installed to provide mechanical protection of electrical equipment shall be constructed so as to totally enclose such electrical equipment and associated conduits and/or cables.

Each sheet metal shroud/cover installed for the mechanical protection of conduits and/or cables shall be free of burrs and sharp edges. Additional bushing, sleeving or other prior approved means shall be provided as required to ensure adequate bending radius and to prevent conduit and/or cable damage.

Each sheet metal shroud/cover shall be easily removed to facilitate maintenance and repair. Explosive or hammer-in type fasteners will not be accepted as fixing for any shroud/cover.

**42 FIELD EQUIPMENT POSITIONING AND MOUNTING**

Where necessary, mounting supports, brackets and plates for the mounting and positioning of electrical equipment such as switches, junction boxes, marshalling cabinets, local control stations, isolating switches, instrumentation cabinets, switched plug-socket power outlets, light fittings, conduits, cables and the like shall be supplied and installed by the Contractor.

Typically, mounting supports, brackets and plates for the electrical equipment shall be installed clear of the adjoining surface using double nutting on the fixing fasteners. Packers, shims and grouting to ensure correct levelling and alignment of the mounting supports, brackets and plates for the equipment shall be supplied and installed. The mounting supports, brackets and plates shall be neatly grouted after installation with low shrink cementitious grout.

Electrical equipment shall be mounted and positioned such that it is readily accessible for operation, inspection, replacement, modification and maintenance.
Mounting supports, brackets and plates shall be free from burrs and sharp edges; they shall have all holes drilled or machined. Cutting of holes by burning methods will not be acceptable.

Electrical equipment shall be mounted on fixed structures. Where no fixed structure is available, the Contractor shall supply and install a support bracket for the mounting for each item of equipment.

Mounting supports, brackets, plates and the like shall have space allowance, where required, for the equipment identification Plain English Name and asset identifier.

Mounting supports, brackets, plates and the like used for the mounting of electrical equipment shall be so constructed to prevent vibration due to wind, operation and adjacent equipment or other dynamic forces.

Screws and bolts used for the mounting and fixing of electrical equipment shall be an adequate size and length.

Electrical equipment such as isolating switches, control stations, light switches, power outlets and the like shall be positioned and mounted 1.5 m above operating floor and platform, unless otherwise detailed.

Electrical equipment shall be positioned and mounted to allow bottom entry of conduits and/or cables, unless otherwise detailed in this Supplementary Specification.

Electrical equipment mounted along or in access ways, shall be positioned such that they do not present a hazard to vehicular traffic or personnel using the access way.

Sufficient length of waterproof flexible conduit and/or cable shall be positioned and mounted where applicable, to permit the following:

- Positional adjustment of electrical equipment without electrical disconnection of it, for example adjustable flood lights, no-flow limit switches and the like;
- Removal and/or positional adjustment on driven equipment without electrical disconnection of the motor; and
- Full motor travel adjustment must be achievable without straining of chafing conduits and/or cables or electrical disconnection of the motor.

### 43 IDENTIFICATION AND LABELLING ELECTRICAL COMPONENTS

#### 43.1 Electrical Component Labelling

The Contractor shall supply and install:

- A label including the Plain English Name and asset descriptor to identify each switchboard, MCC and cabinet;
- A label including the Plain English Name and asset descriptor to identify each motor starter compartment in each switchboard or MCC;
- A label to identify electrical components mounted on or within each switchboard, MCC or cabinet, in accordance with the equipment identification detailed on the drawings.

In the operator accessible sections of each switchboard, MCC or cabinet, for each asset as defined in the Principal’s Procedure SD22, the label shall include the Plain English Name and asset descriptor. In all other instances, the equipment designator used on the electrical drawings shall be used. Where no such identification is given the Contractor shall seek the Superintendent’s direction as to the identification to be used.

Each switch and other electrical equipment mounted on the operator accessible sections of each switchboard, MCC or cabinet shall each be identified with a label defining its function.
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Each motor, each other item of electrical equipment and each instrument shall be identified with a label including the Plain English Name and asset descriptor.

All labels and nameplates for indoor use shall be manufactured from Traffolyte material, with black lettering on white background, unless specifically stated otherwise.

Where an item of equipment is removable or has a removable part, such as doors, covers, plug-in-relays and the like, then the removable part shall be similarly identified.

Labels shall be glued and fixed with at least two Grade 316 stainless steel metal thread screws per 120 mm label length. Self-adhesive labels will not be accepted. The mounting holes in each label shall be slightly enlarged to prevent buckling of the label.

In each switchboard or MCC, each label shall be fixed as close as possible to the identified item, yet not on the cable duct cover. i.e. on the equipment mounting tray behind and above item of equipment to be identified.

For outside use, labels shall be engraved high quality stainless steel utilizing permanent deep surface marking, black in colour. Fixing shall be with Grade 316 stainless steel metal thread screws or Grade 316 stainless steel cable ties.

Labels shall be fixed adjacent to (preferably above, but not directly on) the particular item of equipment they identify, with the wording horizontal.

Wording on labels shall be in capital block letters 10 mm high in Arial font.

43.2 Cable and Cable Core Labelling

Each cable shall be identified at each termination by means of approved tags or strips numbered in accordance with the wiring diagram cable identifier which shall typically be based on the component’s asset descriptor. Each cable shall be identified adjacent to the cable gland. Cable labels shall be arranged to read from left to right and from bottom to top.

The following methods of cable identification shall be used:

- Indoor Cables  Full length Nylon/plastic sleeve with machine printed Black letters 4 mm high in Arial font on a yellow background held on with plastic cable ties.
- Outdoor Cables Engraved Black letters 5 mm high on a Grade 316 stainless steel tag held on with stainless steel cable ties. Each tie shall be installed with the appropriate tool.

Where a cable is junctioned at a junction box or cabinet, it shall be deemed to be a separate cable either side of the junction box or cabinet and hence will have a separate cable number either side.

Each cable core including neutral and earth cores shall be labelled at each termination. The label shall be prefixed with a label based on the applicable cable identifier which is in turn based on the asset descriptor. Such identification shall be undertaken at the time of making off.

Each label shall be installed in a full length nylon/plastic sleeve with machine printed black letters 2 mm high on White card. Each sleeve shall be selected to neatly fit the insulation of each core. Core labels shall be arranged to read from left to right and from bottom to top.

44 ELECTRO-MECHANICAL EQUIPMENT

44.1 Motors

44.1.1 Motor Requirements
Each motor shall meet the following requirements:

- 415 V 3 Phase, 50Hz with squirrel cage rotor;
- Speed shall not exceed 1500 r/min, refer to the exceptions detailed below;
- Rating shall be continuous;
- Bearings shall be roller and/or ball;
- Protection shall be IP56 to AS 60529;
- Thermistors or thermal (microtherms) switches shall be embedded during manufacture;
- Insulation shall be Class 155 to AS 2768;
- Minimum of 12 starts per hour for a motor rated at less than 100 kW, 8 starts per hour for a motor rated at 100 kW and greater but less than 200 kW and 5 starts per hour for a motor rated at 200 kW and greater; and
- Non-submersible motors shall be TEFC (Totally Enclosed Fan Cooled).
- Bearings of pump motors that are specified for VSD operations must be protected from the VSD induced shaft current.

Two pole motors (3000 r/min) are not acceptable for sewage pumps but may be acceptable in some circumstances for other motor driven centrifugal pumps, refer to Clause 18.2.4 of this Supplementary Specification. Generally two pole motors are also not acceptable for other motor driven devices, however, subject to the approval of the Superintendent and the Principal’s Representative in writing, higher motor operating speeds at 50 Hz up to 3000 r/min may be acceptable.

### 44.1.2 Technical Details

Each motor rated 30 kW and above shall have the following data supplied in a dedicated booklet format (2 copies shall be provided to the Superintendent for on forwarding to the Principal’s Representative):

- kVA and kW rating;
- Number of phases;
- Voltage rating - nominal or allowable drop;
- Synchronous speed;
- Type - synchronous or squirrel cage induction;
- Frequency;
- Full load speed;
- Full load torque;
- Locked rotor torque;
- Breakdown torque;
- Service factor;
- NEMA / CEMA design;
- Insulation class;
- Symmetrical locked rotor current at rated voltage;
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- Type of enclosure;
- Maximum temperature rise at specified load;
- Rated ambient temperature;
- Current at 100 %, 75 %, 50 % and no-load;
- Power factor at 100 %, 75 %, 50 %, no-load and locked rotor;
- Nominal efficiency at 100 %, 75 % and 50 % load;
- Cold safe stall time at rated voltage;
- Hot safe stall time at rated voltage;
- Maximum power factor correction_____kVAR to ____power factor;
- Load inertia;
- Rotor inertia;
- Load torque at rated or synchronous speed; and
- Time - current and thermal limit curves i.e. acceleration time versus current, running overload and acceleration versus time.

44.1.3 Vibration Monitoring

Each motor that has a rated output in excess of 37 kW regardless of the driven device shall be fitted with continuous vibration monitoring. Each fan and its associated motor in excess of 11 kW for mechanical ventilation or odour extraction shall be fitted with continuous vibration monitoring.

The continuous vibration monitoring system shall collect all the input channels simultaneously and process the data immediately. A vibration alarm digital signal and a 4 to 20 mA analogue output signal of average vibration velocity from the continuous vibration monitoring system shall be input to the PLC/RTU.

Vibration monitoring shall comprise one or two IFM Efector Octavis VNB001 vibration diagnostic units or similar vibration diagnostic units approved by the Principal’s Representative. The vibration diagnostic units shall be attached to the monitored device/s. Where the monitored device comprises a motor direct coupled to a driven device, only one vibration diagnostic unit shall be installed on the motor where and as recommended by the manufacturer. Where the monitored devices comprises a motor and a device driven by vee belts, two vibration diagnostic units shall be installed, one on the motor and one on the driven device where and as recommended by the manufacturer.

The operating speed is needed to define speed related damage frequencies. Therefore the vibration diagnostic unit shall be capable of being used with fixed or variable speeds motors and driven devices. Where requested by the Principal’s Representative, the actual speed shall be provided by a 4 to 20 mA current loop or via a data link to ensure the correct diagnosis of variable speed applications.

The data from the PLC/RTU will be used by the Principal to establish if:

- The condition of bearings in a motor are deteriorating;
- The condition of the bearings in a fan or a driven device are deteriorating; and
- Where there is a fan, if any fan motor is exciting resonance frequencies in the fan shaft, thus causing higher vibration loads at the fan bearings.
44.2 Pneumatic Actuators

Typically pneumatic actuators for valves or penstocks will not be accepted by the Principal.

44.3 Electric Actuators

Each electric actuator for a valve or a penstock shall be Rotork IQ or approved equivalent and shall be suitable for use on a nominal 415 V 3 phase 50 Hz power supply and shall incorporate motor, integral reversing starter, local control facilities and terminals for remote control and indication connections. It shall be possible to carry out the setting of the torque and turns and configuration of the indication contacts without removing any electrical compartment covers.

Setting of the torque or turns by using the local controls is not acceptable. Infrared setting is preferred.

44.3.1 Diagnostics and Testing

Each actuator shall incorporate a data logger to capture and store operational events including local and remote control signals, number of operations and operation and torque profiles.

Diagnostic icons shall display on the actuator screen to give indication of valve, control and actuator alarms.

Help screens shall be provided on the actuator display to give real time viewing of control signal, valve and actuator status and viewing of valve torque against actuator position.

44.3.2 Actuator Sizing

Each actuator shall be sized to guarantee valve or penstock closure at the specified differential water (sewage) pressure.

The safety margin of motor power available for seating and unseating the valve or penstock shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10 % below nominal.

44.3.3 Ambient Temperature

The actuator shall be capable of functioning in an ambient temperature ranging from -30 °C to +70 °C.

44.3.4 Actuator Motor

Each electric motor for isolating (on/off) and modulating valve actuators shall be Class 155 insulated to AS 2768 and shall be suitable for 60 starts per hour, rated for a minimum S2 (15 min).

Protection shall be provided for the motor as follows:

- The motor shall be de-energised in the event of a stall when attempting to unseat a jammed valve;
- A thermostat to protect against overheating shall sense motor temperature.
- Single phasing protection; and
- Gearing.

44.3.5 Gearboxes
The gearing for each actuator shall be totally enclosed in an oil-filled gearbox suitable for operation at any angle.

The actuator gearing shall be totally enclosed in an oil-filled gearbox suitable for operation at any angle.

**44.3.6 Hand Operation**

A handwheel shall be provided for emergency operation, engaged when the motor is de-clutched by a lever or similar means, the drive being restored to power automatically by starting the motor. The hand/auto selection lever shall be pad-lockable in both hand and auto positions. It shall be possible to select hand operation while the actuator is running or start the actuator motor while the hand/auto selection lever is locked in hand without damage to the drive train.

The handwheel drive shall be mechanically independent of the motor drive and any gearing should be such as to permit emergency manual operation in a reasonable time. Clockwise operation of the handwheel shall give closing movement of the valve.

**44.3.7 Actuator Electrical Cabling Connections**

Cadmium plated or zinc plated glands shall be replaced with Grade 316 stainless steel, PVC or polyamide (Nylon) glands.

**44.3.8 Remote Valve Position/Actuator Status Indication**

Four sets of relay contacts rated at 5 A, 240 V AC, 30 V DC shall be provided to indicate valve position or valve status. Each contact shall be configurable as a normally open or normally closed contact to indicate any one of the following:

- Valve open;
- Valve closed;
- Intermediate position;
- Valve moving (continuous or pulsing); and
- Motor tripped on torque in mid travel.

The status contacts should changeover and give correct remote indication or interlock even with all power supplies isolated and the actuator moved by hand.

A monitor (availability) relay, with a changeover contact to indicate the availability of the actuator shall be provided, The relay being normally energised and will de-energise as a result of any of the following:

- “Local/Off/Remote” switch selected to “Local” or “Off”;
- Thermostat trip;
- Control voltage failure; or
- Loss of one or more of the supply phases.

The actuator shall include a contactless transmitter to give a 4-20 mA analogue output or fieldbus (protocols include Profibus/Modbus/Hart) signal corresponding to valve position.

**44.3.9 Actuator Local Position Indication**
The actuator shall include a digital position indicator with a display from fully open to fully closed in 1% increments. Red, green and yellow lights corresponding to “Open”, “Closed” and “Intermediate” positions shall be included on the actuator. The digital display shall be maintained without any external supply being connected.

44.3.10 Integral Pushbuttons and Selector

Integral to the actuator shall be local controls for “Open”, “Close” and “Stop” and a Local/Remote selector switch pad lockable in any one of the following three positions: local control only, off (no electrical operation), remote control plus local stop only. It shall be possible to select maintained or non-maintained local control.

The local controls shall be arranged so that the direction of valve travel can be reversed without the necessity of stopping the actuator.

44.3.11 Actuator Remote Operation

The necessary wiring and terminals shall be provided in the actuator for the connection of external remote controls to control the actuator using either the internal 24V DC supply or an external supply. (20 V to 240 V AC or DC) The internal circuits associated with the remote control are to be opto-isolated and are to be designed to withstand simulated lighting impulses of up to 1.1 kV.

Remote control shall be site configurable as either:

- “Open” and “Close” (push to run control);
- “Open” and “Close” (maintained control);
- “Open”, “Stop” and “Close” (maintained control);
- Two-wire control, energise to close (open) and de-energise to open (close); and
- Actuators requiring analogue 4-20 mA control shall include a Folomatic Position Controller Unit or equivalent. Adjustments shall be available for zero, span, deadband and motion inhibit timer. Infrared adjustments are preferred.

44.3.12 Enclosure

Actuators shall be “O” ring sealed, watertight to Enclosure Class IP68 to AS 60529 and shall have an inner watertight and dustproof “O” ring seal to fully protect the internal electrical compartments from the ingress of moisture or dust when the terminal cover is removed on site for cabling. A minimum of 3 threaded cable entries shall be provided.

All external fasteners shall be Grade 316 stainless steel.

44.3.13 Modulating Actuators

Modulating actuators shall incorporate an integral solid-state reversing starter and the power supply for each actuator shall be protected by suitably rated fast acting fuses installed in the power distribution panel.

Motors for modulating duty actuators shall be capable of 1200 starts per hour rated for an S4 (50%) duty.

Secondary worm type gearboxes shall be oil filed and have a worm wheel manufactured from Aluminium Bronze in accordance with AS 1565 driven by a ground steel worm.

Modulating actuators shall be controlled from an analogue 4-20 mA or fieldbus signal and adjustments shall be provided for zero, span, deadband and motion inhibit timer. Infrared adjustments are preferred.

An internally powered 4-20 mA contactless transmitter or fieldbus interface shall be provided for remote indication of valve position.
44.3.14 Secondary Gearboxes
The supplier of the secondary gearbox shall be same as that of the actuator.

44.4 Solenoid Valves
Solenoid valves shall be rated at 24 V DC as specified or shown. All coils shall be continuously rated with protection rating IP65 to AS 60529. The electrical connection shall be for 20 mm (minimum) conduit.

Coils shall have Class H insulation and shall be continuously rated. Fail safe wiring to be the default state.

Coil replacement shall be possible without shutting off water etc., supply to the valve.

The screw retaining the electrical connector to the solenoid shall be replaced with Grade 316 stainless steel if manufactured of a lesser material.

45 LIGHTING INSTALLATION

45.1 Design

45.1.1 Lighting Level Requirements
The design shall include a sufficient number of luminaries and in an arrangement in accordance with the requirements of the relevant Australian Standards.

Interior lighting levels in each building shall generally comply with AS 1680. The lighting level shall be a minimum of 240 Lux at floor level over the whole of the floor with an emergency light in every second fitting. The emergency lighting shall achieve a minimum of 20 Lux at floor level over the whole of the floor.

Emergency exit lights are required above each exit point from each building. A HID light is required externally above each access door operated by a sunset switch.

Consideration shall be given to the positioning of the emergency lights for maintenance purposes. Confirmation of lighting positions shall be obtained from the Superintendent and the Principal’s Representative prior to installation.

Exterior lighting levels shall generally comply with AS 1158 or AS 1680 as applicable. The lighting level shall be a minimum of 160 Lux at ground level in the vicinity of equipment that may need overnight maintenance such as pump units.

45.1.2 Lamp Requirements
Unless otherwise agreed by the Superintendent and the Principal’s Representative:

- Fluorescent tubes shall only be used for indoor locations below a height of 3 m; and
- All other lamps shall be LED type.

45.2 Luminaires

45.2.1 General Requirements
All luminaires shall be high energy efficiency types and include a mechanical protection over the lamp.
Each luminaire shall have power factor correction to not less than 0.85 lagging. Luminaires with fluorescent and discharge type lamps shall be fitted with ballasts for 240 V AC supply. Ballasts shall comply with AS/NZS 60921 and AS/NZS 61347.2.8.

A lamp shall be supplied for each luminaire and shall be of the size specified for the luminaire.

Each luminaire shall be installed using a minimum of two Grade 316 stainless steel fasteners. Nail in type fixings will not be accepted by the Principal.

Each luminaire shall be carefully and neatly installed complete with all necessary connectors; adjustable mountings brackets and trim, as required for ceiling conditions. All labels and marks shall be removed from the exposed parts of each luminaire. Each luminaire shall be cleaned when the job is complete.

Each luminaire shall be readily accessible and not mounted above equipment or features (e.g. drops over tanks, voids etc.) that impedes access or presents a high safety risk. Each luminaire shall be at a height accessible from 2.4 m step ladder or lower. If this is not possible, the Contractor shall provide an alternative means of access that is either fixed in place or stored on site.

### 45.2.2 External Lights

#### 45.2.2.1 Wall Mounted Luminaires

Unless otherwise indicated, each post-top luminaire shall be mounted on a tapered column with a hinge point to allow maintenance of light fitting.

#### 45.2.2.2 Post Top Luminaires

Unless otherwise indicated, each post-top luminaire shall be mounted on a tapered column with a hinge point to allow maintenance of light fitting.

Each pole shall:

- Consist of proprietary brand marine grade aluminium pole, suitable for base plate mounting on Grade 316 stainless steel rag bolt assembly set in a concrete footing;
- With its accessories, be powder coated;
- Be adequately drained and shall be fitted with an approved weatherproof lockable enclosure to house the control gear and fuse, in the lower section of the pole, within 1000 mm of ground level.

For Sewage Pump stations, where area lighting is required by the Principal, the light is to be installed on the telemetry mast / pole 40cm below the antenna and adjusted to provide light over the pump station well and valve pit locations. Lighting cables are to be enclosed within the antenna mast / pole for protection.

### 45.2.3 Internal Lights

Light switches shall be mounted in a heavy-duty housing and shall be positioned adjacent to the closing stile of doors. Confirmation shall be obtained as to the hand of doors before installing any switch wiring.

#### 45.2.3.1 Internal Surface Mounted Luminaires

Each luminaire shall:
• Have 2 x 36 Watt fluorescent lamps or equivalent LED lamp;
• Be fitted with an impact resistant polycarbonate diffuser; and
• Be constructed of reinforced polycarbonate, with an IP65 rating to AS 60529 and Grade 316 stainless steel clips.

45.2.3.2 Recessed Luminaires

Each recessed luminaire shall;

• Have 2 x 36 Watt fluorescent lamps or LED equivalent;
• Be fitted with an impact resistant polycarbonate diffuser; and
• Be fitted with flexible cords with minimum 0.75 mm² conductors and 3 pin plugs. A plug socket shall be located within 500 mm from the edge of the access aperture to allow the luminaire to be plugged-in prior to fixing.

45.2.4 Emergency Lighting

Emergency lighting shall be installed as per the requirements of AS/NZS 2293. The Contractor shall provide the means for testing of emergency lights as required by AS/NZS 2293.

46 SWITCHBOARD BUILDING/SWITCHBOARD ROOM REQUIREMENTS

46.1 Switchboard Room Construction

When the switchboard room is part of a larger building, is attached to a building, within 3 m of another building or in area which susceptible to bushfire, then the walls, ceiling, floor and doors shall be designed and constructed to a fire-resistance level of 120/120/120.

Walls shall be masonry or concrete, and ceilings shall be of non-combustible materials.

46.2 Switchboard Room Access Doors

If a switchboard is over 3 m in length, then two switchboard room access doors are required, one at each end of the switchboard room as required by AS/NZS 3000.

Each door shall open outwards. Each door shall be fitted with emergency exit push bars that operate independently of the lock on the outside and have a 2 hour fire rating. The minimum size of doors shall be 0.75 m wide by 1.98 m high. One of these doors shall be sized to allow for the largest individual switchboard to be installed or removed easily.

46.3 Switchboard Room Rigid Grid Access Flooring

Where bottom entry SCAs are proposed, switchboard room floors shall be a modular extra heavy duty rigid grid system with removable panels for access to cabling under the floor with a minimum sub floor depth of 600 mm. The Developer or the Developer’s Designer shall not propose top entry SCAs to avoid the need for a sub floor space for cable entry.
The under structure shall consist of pedestals and stringers. The pedestal bases shall be hot dip galvanised to provide additional surface protection. The remainder of the pedestals can be supplied with the standard manufacturer’s finish. Deletions of the additional requirement to hot dip galvanized each pedestal base and accept a lesser corrosion protection treatment will not be accepted by the Principal.

Each pedestal base shall be bolted down with 2 No Grade 316 stainless steel masonry anchors. The use of adhesive to fasten pedestal bases will not be accepted by the Principal.

Each stringer shall be attached to the pedestal head at each end with Grade 316 stainless steel fasteners.

The access floor shall have a high pressure melamine laminate panel surface finish. The access floor will be rigid, free from vibration and rocking panels and within a ±1.5 mm level over the entire space. Panels will be accurately cut to fit around all permanent features including SCAs. Support stringers shall be provided along all panel edges including cut edges.

All panels shall provide zero fire hazard indices under AS 1530 for ignitability, spread of flame, heat evolved, and smoke developed. All whole panels will be interchangeable allowing for any all whole panels will be interchangeable allowing for any future changes. The access floor will maintain these original conditions when runs of panels have been removed for normal under floor access.

The Contractor shall fabricate and install separate structural supports for SCAs. The Contractor shall not support the weight of any SCA on the rigid grid access floor system.

The Contractor shall supply one set of lifting handles suitable to lift the floor plates in each switchboard room.

46.4 Switchboard Building Light and Power

The Developer, the Developer’s Designer or the Contractor shall design the light and power requirements for each building. The Contractor shall supply and install all light and power components for each building.

These components shall include a 48 pole (minimum) light and power distribution board in each switchboard room in each building. The location of the light and power distribution board shall be as agreed with the Superintendent and the Principal’s Representative.

46.5 Switchboard Building/Switchboard Room Air Conditioning

The Contractor shall provide an air conditioning system for each switchboard room. Each switchboard room air conditioning system shall consist of two separate independent air conditioning units. The air conditioning units shall be sized to maintain an internal room temperature of at least:

- 20 °C when both air conditioning units are operating; and
- 25 °C when only a single air conditioning unit is running due to failure of one unit.

Each switchboard room air conditioning system shall be rated to achieve the above performance levels with an outside ambient temperature of 50 °C and with all electrical equipment inside the switchboard room operating at full load.

For switchboard rooms with a number of large variable frequency drives (total installed “duty capacity” over 300 kW), consideration shall be given to separately cooling the hot air exhaust externally to limit the loading on the switchboard room air conditioning system.

The Contractor shall submit calculations of required cooling system capacities and proposed details of any separate VFD cooling systems to the Superintendent and the Principal’s Representative for approval prior to procurement.
Where corrosive (e.g., salty air) or toxic gases are present outside the switchboard room, the Contractor shall provide suitable measures to prevent introduction of these gases into the switchboard room. Each switchboard room shall have a positive pressure of 25 Pa inside to prevent the entry of gases and contaminants.

The electrical supply for each air conditioning system shall be sourced from the light and power distribution board for the building.

The Contractor shall provide a switchboard room RTD connected to the PLC/RTU system to monitor the switchboard room temperature and have a warning set to 30 °C.

Each air conditioning system shall retain its temperature settings and automatically resume operation after any power supply interruption. Each air conditioner shall be configured to shut down during cold weather and not switch to the heating cycle.

47 SINGLE PHASE AND THREE PHASE SWITCHED PLUG-SOCKET POWER OUTLETS

For any sewage pumping station, the Contractor shall provide single-phase switched plug-socket outlets and three-phase switched plug-socket outlets as shown on the Principal’s Standard Drawings, refer to Appendix C. The requirements for each sewage booster pumping station and vacuum pumping station shall be the same as for a sewage pumping station.

For each water pumping station, the Contractor shall provide a minimum of 2 × 10 A single-phase switched plug-socket outlets and 1 × 15 A single-phase switched plug-socket outlet.

All three-phase switched plug-socket outlets shall have the same phase rotation, which the Superintendent may witness check at his discretion.

All single and three-phase switched plug-socket outlets shall be protected by RCDs. A 30mA device shall be used to protect each circuit for single-phase switched plug-socket outlets.

Each single-phase switched plug-socket outlet and each three phase switched plug-socket outlet shall be marked with the originating circuit breaker.

All switched plug-socket power outlets shall comply with AS 3123 and AS 3133 as applicable.

Switched plug-socket power outlets for outdoors or process/hosedown areas shall have an IP56 enclosure rating in accordance with AS 60529 and shall have Grade 316 stainless steel mounting screws and fittings and oil resistant rubber gaskets.

Each general purpose switched plug-socket power outlet shall be of the standard three flat pin type.

A special purpose switched plug-socket power outlet shall be used for the supply for each instrument and any other sensitive essential electronic equipment and shall be of the two flat pin and one round earth pin arrangement.

Each single phase IP56, standard 3 flat pin, switched plug socket power outlet shall have a 10 A rating unless specified otherwise and shall be of polycarbonate construction with a plain flap. Each plug shall be IP56 rated with a screwed ring, cord seal and clamp. Each single phase IP56, standard 3 flat pin, switched plug-socket outlet shall be a Clipsal 56C310 unit or approved equivalent.

Each single phase IP56, 2 flat pin, 1 round earth pin, switched plug-socket power outlet shall have a 10 A rating unless specified otherwise and shall be of polycarbonate construction with a plain flap. Each plug shall be IP56 rated with a screwed ring, cord seal and clamp. Each single phase IP56, 2 flat pin, 1 round earth pin, switched plug-socket outlet shall be a Clipsal 56C310L unit or approved equivalent.
INSTRUMENTATION INSTALLATION REQUIREMENTS

48.1 General Requirements

48.1.1 Instrumentation Redundancy
For any sewage pumping station, instrumentation whose failure could result in an overflow, surcharge, bypass or a violation of statutory requirements shall be provided with an installed back-up sensor and readout. The requirements for back-up level monitoring are shown on the Principal’s Standard Drawings, refer to Appendix C.

The other back-up instrumentation may be of a different type and located at a different point, provided that the same function is performed. No single failure within the installation shall result in disabling both sets of parallel instrumentation.

For any water pumping station, instrumentation whose failure could result in a loss of water supply or a violation of statutory requirements shall be provided with an installed back-up sensor and readout. The requirements will be advised in writing by the Principal’s Representative.

48.1.2 Accuracy
The accuracy of each instrument shall be within $\pm 1\%$ of span unless otherwise specified.

All instruments shall be suitable for continuous unattended operation and shall maintain their rated accuracy with a minimum of maintenance or need for calibration and adjustment.

48.1.3 Transmitters
Where possible “Smart” transmitters shall be offered as an option in addition to the standard models. Communications shall utilise either the “HART” protocol with transmission via high frequency signal superimposed on top of the 4-20 mA output signal.

“Smart” communications to the transmitter shall allow remote interrogation, diagnostics and reconfiguration without interruption of the transmitters signal to the control system.

48.1.4 Circuits and Components
Circuits and components shall be standardised for all similar applications to facilitate design, construction, testing, operation and maintenance. They shall be readily available within Australia and be arranged and designed to form a simple, safe and reliable system allowing rapid removal and renewal of components as required.

All electronic components shall be high-grade solid-state devices having been substantially underrated for the duty required. All components shall be assembled on high quality fire resistant epoxy fiberglass laminate or similar non-hygrosopic plug-in printed circuit boards preferably with gold plated plug and plug-top contacts. Each printed circuit board shall be clearly identified, and shall be varnished or similarly protected.

Circuit board components shall be liberally spaced whilst light emitting diodes (LED’s), test points and links shall be provided to assist in on-board fault detection. Test facilities, pre-setting adjustments and LED indicators shall be arranged on each printed circuit board so they are accessible and visible when the board is in its normal position.

Integrated circuit devices shall be used wherever possible to reduce the component count and the number of circuit boards and consequently increase reliability.

Electromagnetic interference and high frequency distortion of the terminal voltage generated by the operation of equipment shall not exceed the limits defined in AS 1044. The generation of harmonics of the mains frequency shall not exceed the limits defined in AS/NZS 61000.3.6.
48.1.5 Signals
The analogue output of all electronic signal converters, transmitters and controllers shall be a 0/4 to 20 mA DC signal. Each output shall be capable of operating into a load in excess of 600 ohms.

Where possible, all discrete outputs (on/off) of all electromechanical equipment such as flow switches, pressure switches, level switches, valve position switches, relay circuits and of all electronic switching devices such as electronic level and limit switches shall be voltage-free contacts rated for at least 1 A at 110 V AC. Where speed or reliability (number of operations) concerns have been demonstrated, devices using transistor-switched outputs may be used.

48.1.6 Power Supply Units
Analogue instruments shall where possible be of the “two wire” type deriving electrical power from the loop 24 V DC supply. The AC mains supply is expected to meet the following requirements:

- 415 V AC +/-5 % 50 Hz - 1 Hz
- 240 V AC +/-6 % 50 Hz - 1 Hz

Surge reduction filters shall be provided as specified in Clause 38 of this Supplementary Specification.

48.1.7 Environmental Considerations
All instrumentation and control equipment supplied shall be suitable for continuous operation in the environment nominated as follows:

- Temperature range -20°C to 60°C; and
- Relative humidity range 10 % to 90 % (Non-condensing).

48.1.8 Original Equipment Manufacturer’s Enclosures
All field instrument transmitters shall be contained in hose-proof dustproof original equipment manufacturers (OEM) enclosures to Enclosure Class IP65 in accordance with AS 60529 unless otherwise specified. Tapped cable entries shall be provided to accept cable glands.

Each enclosure shall preferably be manufactured from non-corroding materials such as marine grade aluminium, Grade 316 stainless steel, GRP or FRP. Metallic enclosures; cast steel and aluminium, (but not Grade 316 stainless steel) shall be treated with an epoxy paint or similar durable corrosion resistant finish unless materials of construction afford this protection inherently. All external fasteners shall be Grade 316 stainless steel or shall be replaced with Grade 316 stainless steel fasteners.

48.1.9 Instrumentation Cabinets
Where the transmitter is not included in the switchboard or MCC, the single-phase special purpose switched-socket power outlet, surge diverters, local display and/or the transmitter for each instrument shall be installed in a separate instrumentation cabinet.

Each cabinet shall be constructed of either 3 mm thick marine grade aluminium or 2 mm thick Grade 316 stainless steel with a sun hood and a hinged lockable door. Where welding is incorporated in the manufacturing process for a cabinet, the welds shall be performed using the TIG process. All external welds shall be ground smooth. Regardless of the manufacturer’s normal presentation, all Grade 316 stainless steel cabinets shall be pickled and passivated inside and outside after fabrication, not just the outside, refer to Clause 30.3.5 of this Supplementary Specification.
Each aluminium cabinet shall be powder coated after fabrication as detailed in Clause 35.1 of this Supplementary Specification.

The door hardware (hinges and locks) for each instrumentation cabinet shall be Grade 316 stainless steel. A Grade 316 stainless steel latching stay shall be provided for each instrumentation cabinet to hold the door open at 110°. All fasteners used inside and outside of each instrumentation cabinet shall be Grade 316 stainless steel, refer to Clause 31 of this Supplementary Specification. All stainless steel fasteners and components shall be separated from aluminium, refer to Clause 30.1.5 of this Supplementary Specification. Powder coated is not accepted by the Principal as provided adequate separation.

Each cabinet shall be supported on a robust and stiff Grade 316 stainless steel support such that the cabinet is mounted between 1.1 m and 1.7 m height above the finished level of the access location.

Each instrumentation cabinet shall not be used for the looping or marshalling of cables other than cables for the particular instrument.

Where not secured within a security fenced compound, all conduiting into and out of each instrumentation cabinet shall be installed in rigid metal conduit fabricated from Grade 316 stainless steel tube.

49 INSTRUMENTATION REQUIREMENTS

49.1 Level Measurement Devices

49.1.1 Hydrostatic Pressure Transducers

Each hydrostatic pressure transducer shall be a loop powered 4-20 mA continuous level device utilising a pressure cell to measure the hydrostatic pressure of the liquid being measured.

Each unit shall:

- Operate on a 24 V DC supply;
- Have an accuracy 0.20 % of range;
- Have a linearity of 0.15 % of range at 25°C;
- Have an operating temperature range of -20°C to 60°C;
- Have an adjustable range with a turn down ratio of 5:1 typical; and
- Be surge protected.

Each transducer shall:

- Have a Grade 316 stainless steel body;
- Have a ceramic diaphragm with gold plating or equivalent;
- Be overpressure protected to 200 % of its intended application;
- Be rated for 1 bar (103.4 kPa) or 2 bar (206.8 kPa) ranges for most applications or as specified for special applications; and
- Have a standard cable length of 15 m.
WATER NETWORK AND SEWERAGE NETWORK
SUPPLEMENTARY MECHANICAL AND ELECTRICAL SPECIFICATION

Each transmitter shall:
- Be sealed to Enclosure Class IP68 in accordance with AS 60529;
- Have a digital display;
- Have remote adjustable of ranging;
- Be pre-calibrated;
- Be easy to set up; and
- Display units in both m and % of set range.

49.1.2 Ultrasonic Level Transducers
Each ultrasonic level transducer shall be a loop powered 4-20mA continuous level device utilising an ultrasonic echo technique to measure the level of the liquid being measured.

Each unit shall:
- Operate on a 24 V DC supply;
- Have an accuracy of 0.25 % of range; and
- Be temperature compensated.

Each transducer shall:
- Have an operating temperature range of -20°C to 80°C;
- Have an adjustable span range with a wind down ratio of 38:1 typical;
- Have a resolution of 1 mm;
- Have a blanking distance of 3 % of range;
- Be sealed to Enclosure Class IP68 in accordance with AS 60529;
- Have cable glands to Enclosure Class IP68 in accordance with AS 60529;
- Have a false echo mapping function to eliminate false echoes from fixtures; and
- Have automatic gain adjustment.

Each transmitter shall:
- Have a digital display;
- Have remote adjustment of ranging;
- Be pre-calibrated;
- Be easy to set up;
- Display units in m or % of set range; and
- Have an ultrasonic frequency suitable for the application.
49.1.3 Multi-Sensor Probes

Each probe shall be constructed from PVC tubing with moulded sensor units at regular intervals along the probe. Probes shall be designed and manufactured to:

- Prevent the ingress of moisture;
- Promote self cleaning; and
- Operate continuously in a waste water environment.

A minimum of ten (10) sensors will be spaced along the length of the probe assembly, and each will be individually connected to a correspondingly numbered PVC/PVC 0.75 mm² flexible cable. The cable will be numbered (number and text) along the entirety of the cable and at intervals not greater than 200 mm for identification.

The flexible cable shall be capable of supporting the weight of the probe and cable, without the need for additional support.

The length of each probe shall be a minimum of 1.0 m.

The length of the probe cable shall be sufficient to allow vertical adjustment within the full depth of the wet well. Spare cable shall be coiled and cable tied at the mounting point.

Each probe shall be mounted in a turbulent area of the wet well, suspended on its own cable and connected to a minimum 6 mm diameter Grade 316 stainless steel hook which shall be hooked to a 30 mm stainless steel angle attaching a polyurethane squeegee pad positioned in the opening into the wet well, so that the probe can be removed without entering the wet well. The squeegee will have a 30 mm hole and slot, enabling the probe to be pulled through and cleaned.

Each probe shall be installed in accordance with the manufacturer’s installation instructions.

49.1.4 Capacitance Level Measurement

Each capacitance level measurement system shall consist of an electrode (or probe), an electronic unit in the head of the probe and a signal converter unit. An earthing reference shall also be supplied if necessary.

The electronic unit shall operate at a frequency suitable for the application, shall be mounted in the head of the probe and shall be encapsulated in an inherently non-corrosive, durable material to at least electrical enclosure class IP65 to AS 60529.

Each electronic signal converter unit shall generate an isolated 4-20 mA DC current analogue output corresponding to the level and shall incorporate provision for continuous adjustment for both measurement span and zero. The signal converter shall incorporate an analogue or LED indicator with an accuracy of better than ± 2 % of full scale. The power, frequency and pulse rate shall be suitable for this application.

49.2 Pressure Devices

49.2.1 Differential Pressure Transmitters

Each electronic differential pressure transmitter shall be of the capacitance or strain gauge types and shall transmit a current signal proportional to differential pressure.

“High” and “low” process pressures shall be applied to sensing diaphragm(s) in the measuring section. These pressures shall be transmitted to a measuring element connected to an electronic transmitter. Adjustable internal damping shall be provided. Positive over-range protection shall be provided. Zero and span shall be independently adjustable. The transmitter shall include an integral output indicator accurate to ± 2 % and scaled from 0 to 100 %.
The transmitter shall be supplied with a three way manifold to provide for isolation and pressure equalising. The instrument shall be provided with 2 No Grade 316 stainless steel “block and bleed” ball valves.

All wetted materials of the differential pressure transmitter, and three way manifold shall be Grade 316 stainless steel.

Unless advised otherwise in writing by the Principal’s Representative, a local display of the differential pressure shall be provided in kPa or other similar units.

When part of a flow measurement system, the range, and maximum working pressure of the differential pressure transmitter shall suit the associated flow element.

49.2.2 Pressure Transmitters for Pressure and Level Measurement
Each electronic pressure transmitter shall be of the capacitance, strain gauge or similar manufacture and shall transmit a current signal proportional to pressure.

The pressure shall be applied to a sensing diaphragm in the measuring section and transmitted to a measuring element connected to an electronic transmitter. Remote sensing diaphragms shall be provided where specified or where appropriate for the application.

Adjustable internal damping shall be provided along with adjustable elevation and suppression where appropriate. Positive over-range protection shall be provided. Zero and span shall be independently adjustable. Each transmitter shall include an integral indicator accurate to ± 2 % and scaled from 0 to 100 %.

All wetted materials shall be shall be Grade 316 stainless steel. The range and maximum working pressure shall be as specified or as otherwise suitable for the application.

Unless advised otherwise in writing by the Principal’s Representative, a local display of the pressure shall be provided in m, kPa or other similar units.

In the event that a differential pressure transmitter is utilised, the low pressure vent to atmosphere shall be via protective piping arranged to prevent the ingress of dust moisture and insects.

49.2.3 Pressure Switches
The wetted materials in each pressure switch shall be suitable for each application, typically shall be Grade 316 stainless steel. Each pressure switch shall satisfy Enclosure Class IP65 or better of As 60529. Each pressure switch shall be provided with a voltage free, changeover contact output. A calibrated adjustment for the setpoint shall be provided. Each pressure switch shall be suitable for the application.

Process connections shall be as specified including the provision of remote sensing diaphragms.

The adjustable set point range shall be such that the noted setpoint falls between 30 % and 70 % of the adjustable range. The switch shall be of the automatic reset type with an adjustable switching differential.

49.3 Temperature Devices

49.3.1 Temperature Transmitters (Resistance Type)
Unless otherwise agreed by the Principal’s Representative in writing, resistance thermometers shall be utilised for temperature measurement.

Each resistance thermometer shall include a three wire platinum resistance temperature detector complying with BS1904 (Ro=100 ohms). The sensing element shall be sealed in a ceramic former and enclosed in a Grade 316 stainless steel sheath. Sensing currents of up to 10 mA shall not have a significant effect on accuracy.
Each thermometer shall include a suitable connector head, with Enclosure Class IP65 to AS 60529 allowing cable entry via a compression type cable gland.

Pockets (thermowells) shall be provided for installation of the resistance thermometers. The pocket material shall be Grade 316 stainless steel. The inside diameter of thermowells shall be sized to match thermometer so as to permit easy removal whilst providing close contact for maximum heat transfer and fast accurate temperature measurement.

Installation of the resistance thermometers, including wiring to the associated resistance to current converter, shall comply with BS1041 Part 3. A “three wire” circuit shall be used between each thermometer and the associated converter. The converter shall be located in thermometer connector head.

Resistance to current converters shall be of the “two wire” type deriving electrical power from the loop 24 V DC supply. Converters shall include continuously variable span and zero. The output shall be a 4-20 mA DC signal linear with respect to temperature.

Accuracy shall be ± 0.5 % of span or better.

Unless advised otherwise in writing by the Principal’s Representative, a local display of the temperature shall be provided in °C.

49.3.2 Temperature Transmitters (Thermocouple Type)

Where specified or as otherwise required for the temperature range, thermocouple type sensors shall be utilised for temperature measurement.

Each thermocouple shall include a type J, single element, ungrounded temperature detector. The sensing element shall be sealed in a ceramic former and enclosed in a Grade 316 stainless steel sheath.

Each thermometer shall include a suitable connector head, with Enclosure Class IP65 to AS 60529 allowing cable entry via a compression type cable gland.

Pockets (thermowells) shall be provided for installation of thermocouples. The pocket material shall be Grade 316 stainless steel. The inside diameter of thermowells shall be sized to match thermocouple so as to permit ready removal whilst providing close contact for maximum heat transfer and fast accurate temperature measurement.

Each thermocouple and its signal converter shall be interconnected with wire that shall maintain the specified accuracy of the temperature measurement. The converter shall be located in thermocouple connector head.

Each signal converter shall be of the “two wire” type deriving electrical power from the loop 24 V DC power supply. The output shall be a 4-20 mA DC signal linear with respect to temperature.

Each converter shall include continuously variable span and zero.

The converter shall include automation reference junction compensation and thermocouple burnout protection.

Accuracy shall be ± 0.5 % of span or better.

Unless advised otherwise in writing by the Principal’s Representative, a local display of the temperature shall be provided in °C.

49.3.3 Temperature Switches (Thermostats)

Temperature switches (thermostats) shall be of the capillary tube type.

Where specified or as otherwise required, a copper tube protected capillary shall be provided for connecting the switch mechanism to the remote bulb installation.
A calibrated adjustment for the setpoint shall be provided. The adjustable set point range shall be such that the noted setpoint falls between 30 and 70 % of the adjustable range. The switch shall be of the automatic reset type with an adjustable switching differential (except where noted).

Wetted materials shall be suitable for the application, typically Grade 316 stainless steel. Each temperature switch shall satisfy Enclosure Class IP65 to AS 60529 or better and shall be provided with a voltage free, changeover contact.

49.4 Level Switch Devices

49.4.1 Level Switches (Float Type I)
Each level switch shall be of the encapsulated immersible mercury switch type. Each level switch shall be supplied complete with a sufficient length of heavy-duty flexible cable to provide a generous allowance for adjustment of the operating level.

All wetted materials shall be inherently non-corrosive material and shall be entirely suitable for the application.

49.4.2 Level Switches (Float Type II)
Each level switch shall be of the float-activated bulkhead mounting type. Float, stem and other wetted materials shall be constructed from inherently non-corrosive material and shall be entirely suitable for the application.

Each level switch shall be provided with a voltage free, changeover contact.

49.4.3 Level Switches (Paddle Type)
Each level switch for sensing level of non-liquid bulk materials shall be of the motor driven rotating paddle type. A rotating paddle achieves the detection of material when the control signal changes when material impedes rotation of the paddle. The shaft and paddle shall be constructed from materials that are corrosion resistant to the material being sensed.

The number and size of paddle vanes shall be selected as appropriate for the density of materials sensed.

The paddle switch sensing unit shall include controls to ensure that when material impedes the rotation of the paddle that all moving parts are stationary and no wear takes place. Each paddle switch shall satisfy Enclosure Class IP65 to AS 60529 or better and shall be provided with a voltage free, changeover contact output.

49.4.4 Capacitive Level Switches
Each capacitive level switch shall consist of an electrode (or probe), and an electronic signal converter unit. An earthing electrode (or probe) shall be provided as necessary for correct operation.

The electronic signal converter shall have a sensitivity rating suitable for the application.

Each electrode (or probe) and all other wetted materials shall be suitable for the application.

Where the electronic signal converter is mounted in the head of the probe it shall be encapsulated in an inherently non-corrosive, durable material to at least Enclosure Class IP65 to AS 60529.

Each electronic signal converter shall satisfy Enclosure Class IP65 to AS 60529 or better and shall be provided with a voltage free, changeover contact output.
49.5 Current to Pressure (I/P) Transducers

Current to pressure transducers shall be of the closed loop pressure feedback control type.

Each transducer shall be of the “two wire” type deriving electrical power from the loop 24VDC supply and shall accept an isolated 4-20 mA DC input current signal with a maximum input resistive load of 250 ohms.

A continuous adjustment for both measurement span and zero shall be provided. Accuracy shall be better than ± 0.1 % of full scale.

Integral damping adjustment to prevent overshoot and “hunting” shall be provided. Each transducer enclosure shall satisfy Enclosure Class IP65 to AS 60529. The maximum air consumption for each transducer shall be less than 0.04 L/s. Output pressure shall be in the range of 20 to 100 kPa.

49.6 Magnetic Flow Meters

The flow meter shall comprise an electro-magnetic detector, power supply and converter providing an overall system accuracy of ± 0.5 %.

The detector shall have a Grade 316 stainless steel metering tube suitably lined to resist wear and corrosion. The whole of the detector unit shall be suitable for continuous submerged operation.

The converter shall incorporate all range settings, zero settings and necessary controls and shall produce a linear 4-20 mA analogue signal. The converter shall be capable of accurately rejecting quadrative signal components and line voltage variations of 6 % to -10 %.

Signal cables between the detector head and the converter shall be screened to suppress interference and the entry at the detector head shall maintain waterproof protection of the coil enclosure. Electricity supply shall be derived from a single pole circuit breaker within the switchboard and the Contractor shall provide transformers or power supplies required for operation of equipment at voltages other than 240 V AC.

The Contractor shall use a calibrated flow simulator to test the converter and meter. The Contractor’s proposed testing procedure shall be fully detailed.

49.7 Indicator/Display Units

Indicators shall be of the digital display type of flush mounting pattern utilising a LCD or LED display.

Indication shall be sufficient to allow for accurate reading at a distance of 3 m from the unit. Indicators shall be scaled from 0 to 100 % or as otherwise specified. Indicators shall include continuously variable span and zero adjustments. Adjustment shall be provided via inconspicuous front panel controls.

Each indicator shall accept a 4-20 mA DC signal input with a maximum input resistive load of 100 ohms.

The housing for each indicator must be rated to at least IP65. If this is not possible, then each indicator shall be mounted in a clear enclosure to at least Enclosure Class IP65 to AS 60529.

50 NETWORK CONTROL AND OPERATIONAL DATA REQUIREMENTS

50.1 Sewerage Network – Sewage Pumping Stations

50.1.1 General Requirements
Sewage pumping stations and supplementary network valve and chemical injection systems shall have radio telemetry based monitoring and control.

The network utilises UHF and microwave radio networks with three repeater sites and two base server sites. The system utilises multiple master stations or radio repeaters with the Principal’s main monitoring site located at Pimpama.

All new telemetry equipment supplied for sewerage network sites shall be capable of seamlessly integrating in the existing network without redesign of the network communications system, operator interface or control philosophies. No degradation of the communications systems performance will be acceptable. The Principal uses peer-to-peer communications. New equipment installed under this Supplementary Specification shall allow peer-to-peer communication with existing and supplied equipment.

All telemetry sites shall be capable of initiating reports to the system masters or servers on change of state of digital inputs, significant change of analogue inputs and alarm conditions. The master stations or servers will periodically poll all telemetry sites to determine the current state of their inputs and outputs.

All sites must be capable of being reprogrammed remotely via the radio network.

Telemetry sites must be capable of providing local control functions with ladder logic, the preferred programming style. Control capability shall include simple on/off control as well as PID control functionality.

Telemetry sites must be capable of communicating with the following equipment via an RS232C link:

- Solid state soft starters;
- OMRON C Series PLC’s;
- Equipment utilising the Modbus protocol (including PLCs and Operator Interface Panels);
- VFDs or VSDs; and
- MPUs (motor protection units).

Telemetry sites shall be programmed to transmit the status of all hard wired and derived I/O, as specified, to the master stations or servers.

The telemetry unit shall have sufficient I/O capacity to undertake the monitoring and operating tasks outlined in this Supplementary Specification.

The back-up control and communication battery supply must meet the requirements of the SEQ WS &S Design and Construction Code - “The backup capacity shall be sufficient to sustain at least four hours of full load operation” unless specified differently in contract specification.

50.1.2 Sewage Network Control

50.1.2.1 Sewage Pumping Stations – Automatic Control

Pump drives shall utilise RS232/RS485 or industrial Ethernet digital communication links between drive and the controlling RTU.

The MODBUS or ethernet serial link from the drive shall enable the RTU to:

- Stop and start the pump;
- Receive alarms;
- Receive all operational data; and
- Enable fault interrogation and recall fault history.
Each pump shall have a local override of the RTU control via a “Run-Off-Auto” selector switch on the front door of each motor starter compartment which when selected to each position as follows carries out the actions indicated:

- **“Auto”** RTU controls the drives;
- **“Off”** Drive is isolated from all control signals & alarm is sent to the SMART Control Centre indicating non-auto control; and
- **“Run”** Drive runs under local control & alarm is sent to the SMART Control Centre indicating non-auto control.

For pumping stations that do not match the Principal’s Standard Drawings in the SEQ WS&S D&C Code and indexed in Appendix C, the software coding for the pumping station shall be provided by the Contractor as specified in the Project Specification and meet any operational requirements specified.

The Principal will provide the RTU software for pump station built to SEQ Code standard drawings.

If the chosen “soft starter” or “VSD” software is not compatible with the supplied RTU program, then the Contractor shall contact the Principal’s Representative for resolution of this compatibility problem. The resolution process will involve discussions with the drive manufacturer, the Contractor and the Principal’s Representative. The Contractor shall be responsible for the integration of the soft starter with the RTU program and its performance.

### 50.1.2.2 Sewage Pumping Stations – Backup Level Control

The Contractor shall provide a back-up level control system. The system shall be independent of the main control system using the RTU. A Multitrode MTRA relay/probe or an approved equivalent shall be used. This control mode shall be enabled by the occurrence of a wet well high level alarm. After extended power failure, the back-up system shall not start both pumps together but ensure a time delay between starts. Both pumps must not stop together to avoid deceleration current spikes.

### 50.1.2.3 Odour Management System Control

A “Run”-“Off”-“Auto” selector switch shall control each odour management system as follows:

- **“Auto”** RTU controls odour management system;
- **“Off”** Odour management system isolated from all control signals; and
- **“Run”** Odour management system run on selection.

### 50.1.2.4 Sewage Booster Pumping Station Control

All the general requirements for a sewage pumping station shall apply to a sewage booster pumping station except as varied as follows or specified in the Project Specification.

The control system shall limit upstream or downstream pressure to a set value within a specified bandwidth by controlling the pumps using the installed variable frequency drives.

Inlet and outlet pressures, flows and motor speeds and currents shall be monitored as analogue values.

Remote control shall be provided by the SCADA system where specified.

Additional requirements shall include:

- Inlet Pressure monitoring; and
Pump Speed monitoring.

50.1.2.5 Vacuum Receiving Pumping Station Control

All requirements for a gravity system shall apply.
Additional requirements shall include:
- Monitoring of all vacuum pots – valves, pressure, temperature, Hi alarms
- Monitoring of remote vacuum pressure mains
- Control of main line isolation valves
- Vacuum pump motor control
- Any other parameter as identified through detail design process or specified in contract documentation.

The following table provides a general list of IO (RTU input and output signals) that correspond to a typical pump station. A “Functional Specification for Vacuum Pump Station - Common Base Type” is available on request for a vacuum sewage pump station to assist in detail design of a vacuum pump station.

<table>
<thead>
<tr>
<th>Signal</th>
<th>Device type Inputs /Outputs</th>
<th>STATUS or DISPLAY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply Monitoring Healthy</td>
<td>DI OR COMMS (DERIVED)</td>
<td>OK</td>
</tr>
<tr>
<td>Sewage pump 1 Auto selected</td>
<td>DI</td>
<td>AUTO</td>
</tr>
<tr>
<td>Sewage pump 1 motor fault</td>
<td>DI OR COMMS</td>
<td>FAULT</td>
</tr>
<tr>
<td>Sewage pump 1 drive fault</td>
<td>DI OR COMMS</td>
<td>FAULT</td>
</tr>
<tr>
<td>Sewage pump 1 seal failure</td>
<td>DI OR COMMS</td>
<td>FAULT</td>
</tr>
<tr>
<td>Sewage pump 1 speed (VSD ONLY)</td>
<td>COMMS</td>
<td>RPM OR %</td>
</tr>
<tr>
<td>Sewage pump 1 run/stop</td>
<td>DO OR COMMS</td>
<td>RUNNING(green)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>STOPPED ( red)</td>
</tr>
<tr>
<td>Sewage pump 1 Current</td>
<td>COMMS</td>
<td>Amps</td>
</tr>
<tr>
<td>Sewage pump 2 Auto selected</td>
<td>DI</td>
<td>AUTO</td>
</tr>
<tr>
<td>Sewage pump 2 motor fault</td>
<td>DI OR COMMS</td>
<td>FAULT</td>
</tr>
<tr>
<td>Sewage pump 2 drive fault</td>
<td>DI OR COMMS</td>
<td>FAULT</td>
</tr>
<tr>
<td>Description</td>
<td>Output Type</td>
<td>Value</td>
</tr>
<tr>
<td>-----------------------------------------------------------------</td>
<td>-------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Sewage pump 2 seal failure</td>
<td>DI OR COMMS</td>
<td>FAULT</td>
</tr>
<tr>
<td>Sewage pump 2 speed (VSD ONLY)</td>
<td>COMMS</td>
<td>RPM</td>
</tr>
<tr>
<td>Sewage pump 2 run/stop</td>
<td>DO OR COMMS</td>
<td>RUNNING(green)</td>
</tr>
<tr>
<td>Sewage pump 1 Current</td>
<td>COMMS</td>
<td>Amps</td>
</tr>
<tr>
<td>Vacuum pump 1 DUTY SELECTED</td>
<td>DI</td>
<td>DUTY</td>
</tr>
<tr>
<td>Vacuum pump 2 DUTY SELECTED</td>
<td>DI</td>
<td>DUTY</td>
</tr>
<tr>
<td>Vacuum pump 3 DUTY SELECTED</td>
<td>DI</td>
<td>DUTY</td>
</tr>
<tr>
<td>Sewage Duty Selection Pump 1 or Storage mode inhibit</td>
<td>DO</td>
<td>ON –duty selected, flashing inhibited i.e Storage mode</td>
</tr>
<tr>
<td>Sewage Duty Selection Pump 2 or Storage mode inhibit</td>
<td>DO</td>
<td>ON –duty selected, flashing inhibited i.e Storage mode</td>
</tr>
<tr>
<td>Vacuum pump 1 auto selected</td>
<td>DI</td>
<td>AUTO</td>
</tr>
<tr>
<td>Vacuum pump 1 motor fault</td>
<td>DI OR COMMS</td>
<td>FAULT</td>
</tr>
<tr>
<td>Vacuum pump 1 Current</td>
<td>COMMS</td>
<td>Amps</td>
</tr>
<tr>
<td>Vacuum pump 1 Run/stop</td>
<td>DO OR COMMS</td>
<td>RUNNING(green)</td>
</tr>
<tr>
<td>Vacuum pump 2 auto selected</td>
<td>DI</td>
<td>AUTO</td>
</tr>
<tr>
<td>Vacuum pump 2 motor fault</td>
<td>DI OR COMMS</td>
<td>FAULT</td>
</tr>
<tr>
<td>Vacuum pump 2 Current</td>
<td>COMMS</td>
<td>Amps</td>
</tr>
<tr>
<td>Vacuum pump 2 Run/stop</td>
<td>DO OR COMMS</td>
<td>RUNNING(green)</td>
</tr>
<tr>
<td>Vacuum pump 3 auto selected</td>
<td>DI</td>
<td>AUTO</td>
</tr>
<tr>
<td>Vacuum pump 3 motor fault</td>
<td>DI OR COMMS</td>
<td>FAULT</td>
</tr>
<tr>
<td>Vacuum pump 3 Current</td>
<td>COMMS</td>
<td>Amps</td>
</tr>
<tr>
<td>Parameter</td>
<td>Status</td>
<td>Description</td>
</tr>
<tr>
<td>---------------------------------------------------------------</td>
<td>----------</td>
<td>-----------------------------------</td>
</tr>
<tr>
<td>Vacuum pump 3 Run/stop</td>
<td>DO OR COMMS</td>
<td>RUNNING(green) STOPPED ( red)</td>
</tr>
<tr>
<td>Vacuum pump water solenoid valve fault</td>
<td>DI</td>
<td>FAULT</td>
</tr>
<tr>
<td>Vacuum pump 1 water solenoid open</td>
<td>DO</td>
<td>ON</td>
</tr>
<tr>
<td>Vacuum pump 2 water solenoid open</td>
<td>DO</td>
<td>ON</td>
</tr>
<tr>
<td>Vacuum pump 3 water solenoid open</td>
<td>DO</td>
<td>ON</td>
</tr>
<tr>
<td>Vac pump 1 flow switch (Liquid ring pumps)</td>
<td>DI</td>
<td>ON</td>
</tr>
<tr>
<td>Vac pump 2 flow switch (Liquid ring pumps)</td>
<td>DI</td>
<td>ON</td>
</tr>
<tr>
<td>Vac pump 3 flow switch (Liquid ring pumps)</td>
<td>DI</td>
<td>ON</td>
</tr>
<tr>
<td>Vacuum Pump Discharge air Temperature</td>
<td>Analog</td>
<td>DEG C</td>
</tr>
<tr>
<td>Vessel level High High Alarm</td>
<td>DI</td>
<td>ALARM ON</td>
</tr>
<tr>
<td>Vessel high pressure switch alarm time delayed</td>
<td>DI</td>
<td>ALARM ON</td>
</tr>
<tr>
<td>Vessel pressure transmitter</td>
<td>Al</td>
<td>- Kpa</td>
</tr>
<tr>
<td>Sewage Discharge flow meter 1 flow</td>
<td>Al</td>
<td>l/s</td>
</tr>
<tr>
<td>Sewage Discharge flow meter 2 flow</td>
<td>Al</td>
<td>l/s</td>
</tr>
<tr>
<td>Vacuum main 1 Isolating Valve Actuator Fault</td>
<td>DI OR COMMS</td>
<td>FAULT</td>
</tr>
<tr>
<td>Vacuum main 2 Isolating Valve Actuator Fault</td>
<td>DI OR COMMS</td>
<td>FAULT</td>
</tr>
<tr>
<td>Vacuum main 3 Isolating Valve Actuator Fault</td>
<td>DI OR COMMS</td>
<td>FAULT</td>
</tr>
<tr>
<td>Vacuum main 4 Isolating Valve Actuator Fault</td>
<td>DI OR COMMS</td>
<td>FAULT</td>
</tr>
<tr>
<td>Vacuum main &quot;private estates” Valve Actuator Fault</td>
<td>DI OR COMMS</td>
<td>FAULT</td>
</tr>
<tr>
<td>Description</td>
<td>DI OR COMMS</td>
<td>Status</td>
</tr>
<tr>
<td>--------------------------------------------------</td>
<td>-------------</td>
<td>---------</td>
</tr>
<tr>
<td>Sewage Discharge flow meter 1 fault</td>
<td>DI OR COMMS</td>
<td>FAULT</td>
</tr>
<tr>
<td>Sewage Discharge flow meter 2 fault</td>
<td>DI OR COMMS</td>
<td>FAULT</td>
</tr>
<tr>
<td>Sewage Discharge Main Pressure transmitter</td>
<td>AI</td>
<td>kPa</td>
</tr>
<tr>
<td>Vacuum sewage main 1 Vessel isolating Valve Open</td>
<td>DI OR COMMS</td>
<td>OPEN</td>
</tr>
<tr>
<td>Vacuum sewage main 2 Vessel isolating Valve Open</td>
<td>DI OR COMMS</td>
<td>OPEN</td>
</tr>
<tr>
<td>Vacuum sewage main 3 Vessel isolating Valve Open</td>
<td>DI OR COMMS</td>
<td>OPEN</td>
</tr>
<tr>
<td>Vacuum sewage main 4 Vessel isolating Valve Open</td>
<td>DI OR COMMS</td>
<td>OPEN</td>
</tr>
<tr>
<td>Vacuum sewage main 1 Vessel isolating Valve Closed</td>
<td>DI OR COMMS</td>
<td>CLOSED</td>
</tr>
<tr>
<td>Vacuum sewage main 2 Vessel isolating Valve Closed</td>
<td>DI OR COMMS</td>
<td>CLOSED</td>
</tr>
<tr>
<td>Vacuum sewage main 3 Vessel isolating Valve Closed</td>
<td>DI OR COMMS</td>
<td>CLOSED</td>
</tr>
<tr>
<td>Vacuum sewage main 4 Vessel isolating Valve Closed</td>
<td>DI OR COMMS</td>
<td>CLOSED</td>
</tr>
<tr>
<td>Vac main private estates Auto isolation Valve Closed</td>
<td>DI OR COMMS</td>
<td>CLOSED</td>
</tr>
<tr>
<td>Vac main private estates Auto isolation Valve Open</td>
<td>DI OR COMMS</td>
<td>OPEN</td>
</tr>
<tr>
<td>Monitor system external Global Pit Fault Alarm</td>
<td>DI OR COMMS</td>
<td>FAULT</td>
</tr>
<tr>
<td>External Pit Alarms</td>
<td>COMMS</td>
<td>Pit No, High Alarm, Valve alarm, Temperature</td>
</tr>
<tr>
<td>Sump float switch alarm</td>
<td>DI</td>
<td>FAULT</td>
</tr>
</tbody>
</table>
### Water Network and Sewerage Network

#### Supplementary Mechanical and Electrical Specification

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vacuum Mains 1 Pressure</td>
<td>AI</td>
<td>1-kPa</td>
</tr>
<tr>
<td>Vacuum Mains 2 Pressure</td>
<td>AI</td>
<td>1-kPa</td>
</tr>
<tr>
<td>Vacuum Mains 3 Pressure</td>
<td>AI</td>
<td>1-kPa</td>
</tr>
<tr>
<td>Security Alarm</td>
<td>DI</td>
<td>ALARM ON</td>
</tr>
<tr>
<td>Pump Station Flooded Float Switch Alarm</td>
<td>DI</td>
<td>STATION FLOODED</td>
</tr>
<tr>
<td>RTU Control Request Relay</td>
<td>DO</td>
<td>ON</td>
</tr>
<tr>
<td>Remote Fault Reset Relay</td>
<td>DO</td>
<td>ON</td>
</tr>
<tr>
<td>RTU Control Request</td>
<td>DI</td>
<td>ON</td>
</tr>
</tbody>
</table>

**50.1.3 Sewerage Network RTU Equipment**

The RTU equipment shall consist of SCADAPACK 334E RTU.

All additional equipment supplied shall be compatible with this RTU eg. IO expansion modules.

**50.1.4 Sewerage Network Input and Output Requirements**

Telemetry installations at sewage pumping stations shall provide for the control and data signals (I/O) as shown on the Principal’s Standard Drawings, refer to SEQ Code and indexed in Appendix C.

Where the switchboard or MCC is not a standard design, the Principal’s Representative will provide a list of required I/O usually through a contract specification.

The I/O shall be hard wired from switchboard relays / selector switched or where the switchboard contains the following equipment shall be obtained via RS232C/RS485 or ethernet (comms) link:

- Solid State Starter;
- Omron C Series PLC;
- Equipment with Modbus or Profibus Interface; and
- VFDs or VSD’s.
- Chemical injection controllers
- Genset control systems
All hardware, cabling and programming software required to implement the communication links shall be supplied (2 sets minimum).

The wet well status alarm shall be independent of level control system i.e. it shall be operated by a separate float switch located in the station wet well (floats must activate within 50 mm of contact). This input shall be hardwired to the telemetry unit. Monitoring of this input via a comms link will not be acceptable.

The security alarm shall be via reed switches installed on all external doors, if inside a building only required on building doors (the switches to be normally closed when the doors are locked).

50.1.5 Sewerage Network - Radio Communications

The Developer, Developer's Designer or the Contractor shall undertake a radio communications survey for each site where telemetry equipment is to be installed and provide a written report detailing the survey results.

Prior to undertaking the survey, the location of the existing Principal sewerage network radio repeaters shall be confirmed with the Principal's Representative in writing.

The radio communications survey shall determine the best antenna height and location for the site with the object of attaining a minimum fade margin of 20 dB with a 9 dB six-element yagi antenna.

Where this fade margin is not attainable with a 9 dB yagi the fade margin shall be measured for the most practical antenna type, height and location.

Radio survey results to each repeater for both the analogue and digital networks for each site are to be utilised during the design and provided to the Principal.

The radio communications survey report for each site shall include but not be limited to:

- The survey shall include results of testing commencing at 4m AGL and at 1m intervals until 1m beyond the height at which the minimum fade margin can be achieved.
- Personnel performing the testing;
- Equipment used - including serial numbers;
- Atmospheric conditions;
- Results of all measurements;
- Recommended antenna configuration including type height and bearing; and
- Radio equipment.

50.1.5.2 Radio Equipment

The radio shall meet the following requirements:

Radio

- Frequency range 370-520 MHz;
- Channel selection Fully programmable;
- Frequency splits Tx/Rx frequency splits available including simplex;
WATER NETWORK AND SEWERAGE NETWORK

SUPPLEMENTARY MECHANICAL AND ELECTRICAL SPECIFICATION

- Frequency stability ±1.5 kHz (-10 °C to 60 °C ambient, opt. -30 °C to 70 °C) digital temperature compensation;
- Aging <= 1 ppm/annum;
- RF channel Audio / 2400 bps / 4800 bps; and
- Configuration All configuration via Windows OS’s.

Transmitter
- Tx power 0.1 to 5 Watts (programmable);
- Modulation Direct FM DC to 25 kHz;
- Occupied bandwidth In accordance with international regulatory guidelines for point-to-point and point-to-multipoint;
- Tx/Rx turnaround time < 30 ms;
- Timeout timer Disabled or programmable 1 to 60 s; and
- Tx spurious <= -65 dBc.

Receiver
- Sensitivity -118 dBm for 12 dB SINAB;
- Blocking > 75 db (EIA);
- Intermodulation <= 70 dB (EIA);
- Spurious response <= 70 dB (EIA);
- Select and desense Better than 70 dB (EIA);
- AFC tracking ±3 kHz tracking @ -90 dBm/attack time <10 ms; and
- Mute Fully open to -60 dBm programmable.

Radio Controls and Telemetry
- Serial communication interface
- Direct processor communications to reconfigure / request diagnostic information
- Tx enable TTL active low (0.1 mA);
- RSSI output 20 dB/V (ref. 2 v @ -90 dBm);
- Rx AFC error voltage 2.5 kHz/V ref. 2 V DC via 1k;
- Rx CD (RSSI) output TTL active low (programmable 120 to -70 dBm)
- Tx power sense out Analogue dc square law output Po(watt)-0.02 x (7 x (Vsens+0.15))²; and
- Temperature sense output Analogue dc voltage proportional to absolute temperature T (Kelvin) = Vsens x 100

Connections
WATER NETWORK AND SEWERAGE NETWORK
SUPPLEMENTARY MECHANICAL AND ELECTRICAL SPECIFICATION

- User data and power: DB15 female port
- Antenna: BNC female bulkhead

Radio power supply
- Power supply: 24 V dc nominal (6-30 V DC)

50.1.5.3 Radio Antennas

50.1.5.3.1 Antenna Installation
Where the telemetry unit is mounted inside a secure building, the antenna may be mounted on the building structure. Mounting the antenna on the building structure will only be acceptable provided the antenna is a minimum of 4 m above ground level (or as determined by the radio survey, whichever the greater) and cannot be easily accessed by the public. Additionally, the antenna shall not be greater than 1.5 m above the bracket attachment point. If this type of installation is not possible, then the antenna shall be mounted on a galvanised and powder coated tapered steel pole or stainless steel pipe.

The antenna must not be installed upside down; care must be taken to ensure that the water drains are on the bottom.

50.1.5.3.2 Antenna Pole Installation
For new installations and where the telemetry unit is mounted in an external switchboard, MCC or cabinet, the radio antenna shall be mounted on a stainless steel pole attached to the switchboard, MCC or cabinet in accordance with the Principal’s Standard Drawings, refer to Appendix C.

Where an antenna mast height of greater than 6m is required, a mid-hinged or cantilever type pole shall be installed for suitable locations and upon approval by the Superintendent. Alternative materials may be considered by the Superintendent where Stainless Steel is unavailable.

“Direct bury in ground” poles shall not be used.

The pole shall be powder coated, refer to Clause 35.1 of this Supplementary Specification for details. The colour shall be Colour G54 (Mist Green) to AS 2700 and the style of the pole shall be in harmony with other lighting poles in the area.

Pole height shall be a minimum of 6 m or as determined by the radio survey, whichever the greater.

50.1.5.3.3 Antenna Cable Installation
Antenna cabling shall be run inside the pole and underground to the switchboard. The conduit run between pole and switchboard, MCC or cabinet shall be rigid conduit of a minimum size 50 mm. Large radius bends shall be utilised. Inspection and standard elbows are not acceptable.

Antenna cables shall be joined with an approved weatherproof connector and shall be protected with a generous application of self-fusing splicing tape.

50.1.6 Sewerage Network - GSM Communications
Where GSM is required for a sewerage network site, the antenna shall be mounted on the top of the switchboard, MCC or cabinet. The antenna shall be protected by a section of PVC conduit the same
height as the antenna. A PVC flange will be used to attach the conduit to the switchboard, MCC or cabinet. Two large drain holes will be drilled in the conduit to prevent water accumulating in the conduit.

50.1.7 Sewerage Network – RTU Wiring
The installed cable between the terminal strip and the RTU shall be instrument cable as specified below. In addition the screen shall be correctly earthed.

50.1.7.1 Single Pair Instrument Cables
Instrument signal cables shall be twisted individually PVC coated, overall screened and overall PVC sheathed, i.e. PVC/Screen/PVC type cable with multi-strand copper conductors. The minimum size of the conductors shall be 0.5 mm² (7/0.30) with black and white cores.

50.1.7.2 Multi-pair Instrument Cables
Instrument signal cables shall be twisted individually PVC coated, overall screened and overall PVC sheathed, i.e. PVC/Screen/PVC type cable with multi-strand tinned copper conductors. The minimum size of the conductors shall be 7/0.30 with black and white cores. Cores shall be individually numbered (number and text) along the entirety of the cable.

50.1.7.3 Telemetry Terminals
Approved knife switch terminal strips shall be installed and, located within the allocated section of the switchboard in which the telemetry equipment will be installed. Telemetry terminals shall be a minimum size 2.5 mm².
50.2 Water Supply Network

50.2.1 General Requirements

The control requirements for the various components of the recycled water network are largely the same as for the same component in the potable water network. This section of the document will refer to water network components. Any difference between the requirements potable water and recycled water will be specifically highlighted.

Water pumping stations and any supplementary network valve control or chlorination injection systems shall have radio telemetry based monitoring and control.

The Principal currently has a large telemetry network monitoring the water network. The network utilises UHF radio networks with three repeater sites relaying signals to base stations at various locations.

All new telemetry equipment supplied for water network sites shall be capable of seamlessly integrating in the existing network without redesign of the network communications system, operator interface or control philosophies. No degradation of the communications systems performance will be acceptable.

All telemetry sites shall be capable of initiating reports to the system masters on change of state of digital inputs, significant change of analogue inputs and alarm conditions. The master station will periodically poll all telemetry sites to determine the current state of their inputs and outputs.

All sites must be capable of being reprogrammed remotely via the radio network.

Telemetry sites must be capable of providing local control functions with ladder logic, the preferred programming style. Control capability shall include simple on/off control as well as PID control functionality.

Telemetry sites must be capable of communicating with the following equipment via an RS232 or 485 Communications link:

- Solid state soft starters;
- OMRON C Series PLC’s;
- Equipment utilising the Modbus protocol (including PLCs and Operator Interface Panels);
- VFDs or VSDs; and
- MPUs (motor protection units)
- Chemical injection controllers
- Genset controllers

Telemetry sites shall be programmed to transmit the status of all hard wired and derived I/O, as specified, to the master stations.

The Contractor shall supply and install a remote telemetry unit, radio, and antenna with associated equipment to monitor the infrastructure at the proposed telemetry site. The remote telemetry unit shall be a SCADAPACK 334E system.

The telemetry unit shall have sufficient I/O capacity and spares to undertake the monitoring and operating tasks outlined in this Supplementary Specification.

Where switched plug-socket power outlets are required behind cabinet doors, the outlet must be mounted on the escutcheon of the SCA and not on the DIN rail or equipment mounting tray.

Where the RTU is proposed to be solar powered, the Contractor shall supply and install sufficient solar panels and battery backup to operate the system for 48 h with no sun. Solar panels shall be located where shadows are minimised.
The back-up control and communication battery supply must meet the requirements of the SEQ WS &S Design and Construction Code - “A stand-by power supply, rated at a minimum of an 8 hour power supply failure shall be provided” unless specified differently in contract specification. For pump stations with back-up gensets, 4 hour battery back-up is acceptable.

50.3 Water Pumping Station Control

50.3.1 Automatic Control
Water pumping stations shall have supervisory control via the SCADA System with control signals relayed to and from RTUs.

Water pumping station control mode will be specified at design stage either by the Developer, the Developer’s Designer or the Superintendent, or an accompanying technical specification covering:

- The role of the pumping station in supplying demand within the water network;
- The method of operation shall be fully described in the technical specification and implemented by the programming of the telemetry or RTU/PLC;
- Configuration – usually one duty and one standby pump unit or, alternatively a triplex station where would be two duty pump units and one standby pump unit which would be rotated in duty. (A two duty/one standby pump unit arrangement can achieve energy savings where the range of flow duties is broad from minimum demand to maximum demand plus fire flows);
- A multi-pump booster system employing both fixed speed and variable speed drives;
- Efficiency requirements for normal daily loads; and
- Standby power requirements.

A set of “typical” standard drawings are listed in Appendix C showing the circuitry and construction of a water pump station switchboard or MCC. The Contractor shall provide a fully tested and operational design including programming of RTU. For security, reliability and consistency, all HMI remote interface programming must be done by Council.

Proprietary packaged unit systems from manufacturers are acceptable with the requirements for 4 pole motors (1500 r/min) not applicable and integrated VFD-pump units would be considered for use by the Principal’s Representative. Proposed packaged units shall be subject to approval by the Principal’s Representative at design submission stage. A “communications” interface to the package pump station controller may be acceptable provided the same data as per clause 50.3.8 is transferred back to the SCADA System master controller. A local display control panel is required at the water pumping station.

Integrated VFD-pump units shall be Grade 316 stainless steel or better.

50.3.2 Water Pumping Station Operation Based On Reservoir Level
This control method would be applied where a water pumping station pumps to a service reservoir and pump operation is controlled by a level transducer in the reservoir. The level signal is forwarded via telemetry from the reservoir to the master controller. When the “Start” level is reached, the master controller will send a control command to the water pumping station RTU to start the duty pump unit. When the “Stop” point is reached, the master controller will send a control command to the water pumping station RTU to stop the pump. A high level float switch at top water level (TWL) in the reservoir will send an alarm that the pump has failed to stop. A low level float switch shall notify that the filling sequence has not started and be a priority 1 alarm.

In general terms, pumping to a reservoir will require fixed speed pumping. However, a case could be made for variable speed or a two duty pump arrangement in order to reduce energy usage due to friction losses, particularly where there is a long pipeline and a significant variation in demand, meaning that the reservoir filling rate can be decreased.
The reservoir control system will have different levels which bring in the first and second pump units or could vary the speed of the operating pump via its VFD if installed.

50.3.3 Water Pumping Station Operation Based On Low Suction Pressure
This control method would include a pressure switch or transmitter connected to a tapping point on the suction side of the pump units which monitors the reticulation system pressure. For example, where a general reduction in the suction pressure occurs and a pre-set low pressure at the pump units' suction is reached, a “Start” signal is sent to the duty pump in order to provide a set delivery system pressure boost. Only after the inlet conditions to the station returns to a pre-set level will the pumps be requested to “Stop”.

50.3.4 Water Pumping Station Operation Based On Low Delivery Pressure
This control method would be similar to the above except that downstream delivery pressure would be monitored and when it dropped to a pre-set level (e.g. due to low upstream pressure) the duty pump unit would operate. This would then boost the pressure. When the upstream pressure reaches a preset high value, indicating that normal system pressure had been restored, the duty pump unit would stop. An online balance tank/s of ample capacity shall be used to minimise the number of pump starts per hour on a package unit type pumping stations to 12 times per hour multiplied by the number of pumps being rotated through the duty pump unit role.

50.3.5 Water Pumping Station Operation to Maintain A Pre-set Delivery Pressure
This control method would provide variable speed pumps to control pressure. A pressure transmitter would be connected to the delivery pipework and monitor the delivery system pressure and supply a signal to the variable speed controller. This allows the controller to regulate the pump motor speed to maintain the set point delivery pressure. Should the pressure fall (indicating an increase in demand) then the motor speed of the pump unit would be increased to maintain the pressure set-point and supply a greater flow rate. Conversely, should the delivery pressure rise, generally indicating a reduction in demand, the motor speed of the duty pump would be progressively reduced.

For a variable speed drive operation with more than one pump unit, it is important that the second pump unit is called to operate only when the Duty 1 pump is operating near or at 100% (maximum) speed and the pressure is dropping. A pressure drop generally indicates that the duty pump is unable to satisfy demand.

50.3.6 Fire Flows
A dedicated pump unit may be provided to satisfy the fire flow demand rather than achieving the fire flow capacity using the normal duty pump unit/s. Low pressure would generally be used as the trigger for the “fire” pump unit’s operation.

50.3.7 Water Network RTU Equipment
The RTU equipment shall consist of the following requirements or an approved equivalent:

- Model: SACDAPAK 334E
- Cabinet: 500 x 500 x 250 mm (Stainless Steel/Marine Grade Aluminium for outdoor installations –usually for reservoirs only).
- Power Supply: 240 V AC/24V DC with DC UPS backup.
- I/O Module Type: 16 DI, 10DO, 8AI.
- Battery Backup: 2 x 7 AH (12 V).

50.3.8 Water Network Input and Output Requirements
The I/O shall be hard wired from switchboard relays / selector switched or where the switchboard contains the following equipment shall be obtained via RS232 or RS485 C link:
WATER NETWORK AND SEWERAGE NETWORK
SUPPLEMENTARY MECHANICAL AND ELECTRICAL SPECIFICATION

- Solid State Starter;
- Omron C Series PLC;
- Equipment with Modbus or Profibus Interface; and
- VFDs or VSDs.

All hardware, cabling and PLC programming software required to implement the RS232/485 link shall be supplied (2 sets minimum).

The security alarm shall be via reed switches installed on all external doors, if inside a building only required on building doors (the switches to be normally closed when the doors are locked).

The following lists are typical only and will vary depending on the detailed design of the pumping system and system operating requirements. The I/O requirements should be specified in the contract specification, if not then this list of I/O will be used to check the I/O list on the draft electrical drawings submitted for review by the Principal.

All digital inputs shall be provided via voltage free contacts.

50.3.8.1 Water Pumping Stations

The typical digital input signals, analogue input signals, digital output signals and communications link signals to the RTU for a water pumping station are shown in Table 50.1, Table 50.2, Table 50.3 and Table 50.4 respectively.

Table 50.1 Water Pumping Station Digital Input Signals

<table>
<thead>
<tr>
<th>Digital Input Status</th>
<th>Description</th>
<th>Input ON</th>
<th>Input OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>For each pump unit</td>
<td>Pump unit status</td>
<td>Running</td>
<td>Stopped</td>
</tr>
<tr>
<td></td>
<td>Pump unit fault</td>
<td>OK</td>
<td>Fault</td>
</tr>
<tr>
<td></td>
<td>Pump unit control</td>
<td>Auto</td>
<td>Not auto</td>
</tr>
<tr>
<td>General inputs</td>
<td>Duty Selected</td>
<td>Pump 1 and Pump 2</td>
<td>Auto</td>
</tr>
<tr>
<td></td>
<td>Generator</td>
<td>Running</td>
<td>Off</td>
</tr>
<tr>
<td></td>
<td>Suction Pressure</td>
<td>Low</td>
<td>OK</td>
</tr>
<tr>
<td></td>
<td>Discharge Pressure</td>
<td>High</td>
<td>OK</td>
</tr>
<tr>
<td></td>
<td>Valve Status Open</td>
<td>Open</td>
<td>Closed or transit</td>
</tr>
<tr>
<td></td>
<td>Valve Status Closed</td>
<td>Closed</td>
<td>Open or transit</td>
</tr>
<tr>
<td>Alarms</td>
<td>Intruder alarm</td>
<td>OK</td>
<td>Alarm</td>
</tr>
<tr>
<td></td>
<td>Valve fault</td>
<td>Fault</td>
<td>OK</td>
</tr>
<tr>
<td></td>
<td>Telemetry</td>
<td>OK</td>
<td>Alarm</td>
</tr>
<tr>
<td></td>
<td>Mains Supply</td>
<td>OK</td>
<td>Alarm</td>
</tr>
</tbody>
</table>
WATER NETWORK AND SEWERAGE NETWORK
SUPPLEMENTARY MECHANICAL AND ELECTRICAL SPECIFICATION

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Signal</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow (In or Out)</td>
<td>4-20mA</td>
<td>L/s</td>
</tr>
<tr>
<td>Level</td>
<td>4-20mA</td>
<td>% (TWL=100%) BWL=0%</td>
</tr>
<tr>
<td>Pressure</td>
<td>4-20mA</td>
<td>kPa</td>
</tr>
<tr>
<td>Valve Position</td>
<td>4-20mA</td>
<td>%</td>
</tr>
<tr>
<td>Speed</td>
<td>Digital signal or 4-20mA</td>
<td>%</td>
</tr>
</tbody>
</table>

NOTE: Additional pump units shall be monitored similarly

Table 50.2 Water Pumping Station Analogue Input Signals

Table 50.3 Water Pumping Station Digital Output Signals

Note: Digital Outputs can be used as “continuous” run contacts ie control a run relay or be used as “pulse” contacts so requiring separate signal for “start” and “stop” commands. Designers must refer to type of digital output provided by chosen RTU or PLC and design accordingly.

<table>
<thead>
<tr>
<th>Description</th>
<th>Output ON</th>
<th>Output OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duty Pump Unit Start or run</td>
<td>Start</td>
<td>Pulse -no function</td>
</tr>
<tr>
<td>Duty Pump Unit Stop</td>
<td>Stop</td>
<td>Continuous-run off</td>
</tr>
<tr>
<td>Standby Pump Unit Start or run</td>
<td>Start</td>
<td>Pulse -no function</td>
</tr>
<tr>
<td>Standby Pump Unit Stop</td>
<td>Stop</td>
<td>Continuous-run off</td>
</tr>
<tr>
<td>Valve Control</td>
<td>Open</td>
<td></td>
</tr>
<tr>
<td>Valve Control</td>
<td>Close</td>
<td></td>
</tr>
</tbody>
</table>

Table 50.4 Water Pumping Station Communications Link Derived Signals

<table>
<thead>
<tr>
<th>Description</th>
<th>UNITS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>System Stats</td>
<td>Various</td>
<td>Hours run, faults</td>
</tr>
<tr>
<td>Energy Consumption</td>
<td>kWh</td>
<td></td>
</tr>
</tbody>
</table>
## 50.3.8.2 Water Reservoir

The typical digital input signals for a water reservoir are shown in Table 50.5. Where the reservoir has a flowmeter and a level transmitter installed, the Reservoir Inflow and Outflow and Reservoir Level shall be output to the SCADA System as analogue input signals to the RTU.

### Table 50.5 Water Reservoir Digital Input Signals

<table>
<thead>
<tr>
<th>Digital Input Status</th>
<th>Description</th>
<th>Input ON</th>
<th>Input OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>For each valve</td>
<td>Valve Opened</td>
<td>Opened</td>
<td>Not opened</td>
</tr>
<tr>
<td></td>
<td>Valve Closed</td>
<td>Closed</td>
<td>Not closed</td>
</tr>
<tr>
<td></td>
<td>Valve Control</td>
<td>Auto</td>
<td>Not auto</td>
</tr>
<tr>
<td>For each reservoir</td>
<td>High Level</td>
<td>OK</td>
<td>Alarm</td>
</tr>
<tr>
<td></td>
<td>Low Level</td>
<td>OK</td>
<td>Alarm</td>
</tr>
<tr>
<td>General inputs</td>
<td>Intruder / Security</td>
<td>OK</td>
<td>Alarm</td>
</tr>
<tr>
<td></td>
<td>Telemetry</td>
<td>OK</td>
<td>Alarm</td>
</tr>
<tr>
<td></td>
<td>Power Supply</td>
<td>OK</td>
<td>Alarm</td>
</tr>
</tbody>
</table>

## 50.3.8.3 Re-chlorination Facilities

All re-chlorination facilities shall have an RTU installed as per this Supplementary Specification. The telemetry requirements shall be as per clause 50.3.7.

### 50.3.8.3.1 Re-Chlorination Facility Control

Each re-chlorination facility shall have supervisory control via the SCADA System with control signals relayed to the RTU with a minimum of 2 h of battery backup.

Actuated valves and flowmeters shall be controlled and totalised to enable daily flows to be set.

Variable dosing shall be provided and set by the control system and only enabled when a set minimum flow rate is achieved.
A chlorine residual analyser shall transmit the residual concentration to the RTU for monitoring by the control room and for data recording. Alarm levels shall be capable of being set remotely.

All equipment shall have a manual override capability from the SCADA System.

Each plant control mode and transducers will be specified at design stage.

50.3.8.3.2 Re-Chlorination Facility Monitoring

The typical digital input signals and digital output signals for a re-chlorination facility are shown in Table 50.6 and Table 50.7 respectively. Where the re-chlorination facility has a flowmeter installed, the dosing flow shall be output to the SCADA System as an analogue input signal to the RTU. The chlorine valve position and chlorine residual concentration shall be output to the SCADA System as an analogue input signals to the RTU. Where the re-chlorination facility has the facility for remote setting of the chlorine dosing rate, it shall be output from the SCADA System as an analogue output signal from the RTU.

**Table 50.6 Re-chlorination Facility Digital Input Signals**

<table>
<thead>
<tr>
<th>Digital Input Status</th>
<th>Description</th>
<th>Input ON</th>
<th>Input OFF</th>
</tr>
</thead>
<tbody>
<tr>
<td>For each pump unit</td>
<td>Pump Unit Status</td>
<td>Running</td>
<td>Stopped</td>
</tr>
<tr>
<td></td>
<td>Pump Unit Fault</td>
<td>OK</td>
<td>Alarm</td>
</tr>
<tr>
<td></td>
<td>Pump Unit Control</td>
<td>Auto</td>
<td>Not auto</td>
</tr>
<tr>
<td>General Inputs</td>
<td>Pump Unit Selected</td>
<td>Pump1</td>
<td>Pump2</td>
</tr>
<tr>
<td></td>
<td>Valve Open</td>
<td>Open</td>
<td>In transit</td>
</tr>
<tr>
<td></td>
<td>Valve Closed</td>
<td>Closed</td>
<td>In transit</td>
</tr>
<tr>
<td>Chlorine Residual</td>
<td>High</td>
<td>OK</td>
<td>Alarm</td>
</tr>
<tr>
<td></td>
<td>Low</td>
<td>OK</td>
<td>Alarm</td>
</tr>
<tr>
<td></td>
<td>Leak</td>
<td>OK</td>
<td>Alarm</td>
</tr>
<tr>
<td>Alarms</td>
<td>General Station</td>
<td>OK</td>
<td>Alarm</td>
</tr>
<tr>
<td></td>
<td>Intruder Alarm</td>
<td>OK</td>
<td>Alarm</td>
</tr>
<tr>
<td></td>
<td>Power Failure</td>
<td>OK</td>
<td>Alarm</td>
</tr>
</tbody>
</table>

**Table 50.7 Re-chlorination Facility Digital Output Signals**

Note: Digital Outputs can be used as “continuous” run contacts ie control a run relay or be used as “pulse” contacts so requiring separate signal for “start” and “stop” commands. Designers must refer to type of digital output provided by chosen RTU or PLC and design accordingly.

<table>
<thead>
<tr>
<th>Description</th>
<th>Output ON</th>
<th>Output OFF</th>
</tr>
</thead>
</table>

GCCC SUPPLEMENTARY MECHANICAL AND ELECTRICAL SPECIFICATION SEQ2
50.3.9 Water Network - Radio Communications

50.3.9.1 Radio Communications Survey

The Developer, Developer's Designer or the Contractor shall undertake a radio communications survey for each site where telemetry equipment is to be installed and provide a written report detailing the survey results.

Prior to undertaking the survey, the location of the existing Principal's water network radio repeaters shall be confirmed with the Principal's Representative in writing.

The radio communications survey shall determine the best antenna height and location for the site with the object of attaining a minimum fade margin of 20 dB with a 9 dB six-element yagi antenna.

Where this fade margin is not attainable with a 9 dB yagi the fade margin shall be measured for the most practical antenna type, height and location.

Radio survey results to each repeater for both the analogue and digital networks for each site are to be utilised during the design and provided to the Principal.

The radio communications survey report for each site shall include but not be limited to:

- The survey shall include results of testing commencing at 4m AGL and at 1m intervals until 1m beyond the height at which the minimum fade margin can be achieved.
- Personnel performing the testing;
- Equipment used - including serial numbers;
- Atmospheric conditions;
- Results of all measurements;
- Recommended antenna configuration including type height and bearing; and
- Radio equipment.

50.3.9.2 Radio Equipment

The Contractor shall supply all additional equipment as per the following specification or as advised in writing by the Principal's Representative:

- Radio survey. Trio QR450 series Radio or an Icom IC-F-6023 – as per radio
50.3.9.3 Radio Antennas

50.3.9.3.1 Antenna Installation

Where the telemetry unit is mounted inside a secure building, the antenna may be mounted on the building structure. Mounting the antenna on the building structure will only be acceptable provided the antenna is a minimum of 4 m above ground level (or as determined by the radio survey, whichever the greater) and cannot be easily accessed by the public. Additionally the antenna shall not be greater than 1.5 m above the bracket attachment point. If this type of installation is not possible, then the antenna shall be mounted on a painted stainless steel pole.

The antenna must not be installed upside down; care must be taken to ensure that the water drains are on the bottom.

50.3.9.3.2 Antenna Pole Installation

For new installations and where the telemetry unit is mounted in an external switchboard, MCC or cabinet, the radio antenna shall be mounted on a stainless steel pole or attached to the switchboard, MCC or cabinet generally in accordance with the Principal’s Standard Drawings for sewage pumping stations, refer to Appendix C. Where pole mounted, the pole shall be fitted with a ladder support for poles up to 8 m high and shall be assembled and installed as per the manufacturers recommendations.

“Direct bury in ground” poles shall not be used except where no other alternative is available.

The pole shall be powder coated, refer to Clause 35.1 of this Supplementary Specification for details. The colour shall be Colour G54 (Mist Green) to AS 2700 and the style of the pole shall be in harmony with other lighting poles in the area.

Pole height shall be a minimum of 6 m or as determined by the radio survey, whichever the greater.

50.3.9.3.3 Antenna Cable Installation

Antenna cabling shall be run inside the pole and underground to the switchboard. The conduit run between pole and switchboard, MCC or cabinet shall be rigid conduit of a minimum size 50 mm. Large radius bends shall be utilised. Inspection and standard elbows are not acceptable.

Antenna cables shall be joined with an approved weatherproof connector and shall be protected with a generous application of self-fusing splicing tape.

50.3.10 Water Network - GSM Communications

Where GSM is required for a water network site, the antenna shall be mounted on the top of the switchboard, MCC or cabinet. The antenna shall be protected by a section of PVC conduit the same
height as the antenna. A PVC flange will be used to attach the conduit to the switchboard, MCC or cabinet. Two large drain holes will be drilled in the conduit to prevent water accumulating in the conduit.

50.3.11 Water Network – RTU Wiring
The installed cable between the terminal strip and the RTU shall be instrument cable as specified below. In addition the screen shall be correctly earthed.

50.3.11.1 Single Pair Instrument Cables
Instrument signal cables shall be twisted individually PVC coated, overall screened and overall PVC sheathed, i.e. PVC/Screen/PVC type cable with multi-strand copper conductors. The minimum size of the conductors shall be 0.5 mm² (7/0.30) with black and white cores.

50.3.11.2 Multi-pair Instrument Cables
Instrument signal cables shall be twisted individually PVC coated, overall screened and overall PVC sheathed, i.e. PVC/Screen/PVC type cable with multi-strand tinned copper conductors. The minimum size of the conductors shall be 7/0.30 with black and white cores. Cores shall be individually numbered (number and text) along the entirety of the cable.

50.3.11.3 Telemetry Terminals
Approved knife switch terminal strips shall be installed and, located within the allocated section of the switchboard in which the telemetry equipment will be installed. Telemetry terminals shall be a minimum size 2.5 mm².
APPENDIX A – WATER PUMPING STATIONS -MECHANICAL EQUIPMENT - ACCEPTED PRODUCTS AND MATERIALS

Refer to SEQ WS&S D&C Code for Sewage Pumping Station Mechanical Equipment

<table>
<thead>
<tr>
<th>EQUIPMENT FUNCTION</th>
<th>ACCEPTED COMPONENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actuators</td>
<td>Rotork IQ Range</td>
</tr>
<tr>
<td></td>
<td>Auma</td>
</tr>
<tr>
<td>Pump – Horizontal Centrifugal (back pull out design)</td>
<td>KSB ABS SOUTHERN CROSS TKL</td>
</tr>
<tr>
<td>Pump - Vertical Centrifugal</td>
<td>KSB ABS SOUTHERN CROSS TKL</td>
</tr>
<tr>
<td>Pump – Multistage</td>
<td>GRUNDFOS CRN range</td>
</tr>
<tr>
<td></td>
<td>GRUNDFOS HYDRO MPC PACKAGE UNITS</td>
</tr>
<tr>
<td></td>
<td>XYLEM e-SVN RANGE</td>
</tr>
<tr>
<td></td>
<td>XYLEM HYDROVAR PACKAGE UNITS</td>
</tr>
<tr>
<td>Pump – Submersible in line type</td>
<td>GRUNDFOS SP BM RANGES</td>
</tr>
<tr>
<td></td>
<td>SOUTHERN CROSS SC RANGE</td>
</tr>
<tr>
<td></td>
<td>XYLEM LOWARA</td>
</tr>
<tr>
<td>Pump – Vacuum</td>
<td>BUSCH Model R5 Series with oil heater</td>
</tr>
<tr>
<td></td>
<td>BUSCH MINK series pumps (dry rotary lobe)</td>
</tr>
<tr>
<td></td>
<td>Nash Liquid Ring Vectra Series</td>
</tr>
</tbody>
</table>
**APPENDIX B – WATER PUMPING STATIONS ELECTRICAL EQUIPMENT, ACCEPTED PRODUCT AND MATERIALS FOR PRIME LIST**

Refer to SEQ WS&S D&C Code for Sewage Pumping Station Electrical Equipment

<table>
<thead>
<tr>
<th>EQUIPMENT FUNCTION</th>
<th>ACCEPTED COMPONENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actuators</td>
<td>Rotork IQ Range</td>
</tr>
<tr>
<td></td>
<td>Auma</td>
</tr>
<tr>
<td>Ammeters / voltmeters</td>
<td>Crompton Instruments</td>
</tr>
<tr>
<td></td>
<td>NHP</td>
</tr>
<tr>
<td>Annunciator panels/Operator panels/Touch Panels</td>
<td>Omron</td>
</tr>
<tr>
<td></td>
<td>Red Lion</td>
</tr>
<tr>
<td></td>
<td>Siemens</td>
</tr>
<tr>
<td></td>
<td>Magelis</td>
</tr>
<tr>
<td>Battery</td>
<td>Panasonic or equivalent</td>
</tr>
<tr>
<td>Cable – Submersible</td>
<td></td>
</tr>
<tr>
<td>Cable trays and ladder</td>
<td>Ramset-Fastrak</td>
</tr>
<tr>
<td></td>
<td>Burndy</td>
</tr>
<tr>
<td></td>
<td>Unistrut</td>
</tr>
<tr>
<td>Cable Glands –Brass</td>
<td>Utilux Chrome Brass</td>
</tr>
<tr>
<td></td>
<td>Cable Accessories</td>
</tr>
<tr>
<td>Cable glands</td>
<td>Plastic</td>
</tr>
<tr>
<td></td>
<td>Stainless Steel</td>
</tr>
<tr>
<td>Cable lugs</td>
<td>Utilux</td>
</tr>
<tr>
<td></td>
<td>Cable Accessories</td>
</tr>
<tr>
<td></td>
<td>CABAC</td>
</tr>
<tr>
<td>Cable marking system</td>
<td>Critchley</td>
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<tr>
<td></td>
<td>Graftoplast</td>
</tr>
<tr>
<td></td>
<td>Partec</td>
</tr>
<tr>
<td></td>
<td>Brady</td>
</tr>
<tr>
<td>Cable –Submersible</td>
<td>Australian Cable Manufacturers EPR/EPR</td>
</tr>
<tr>
<td></td>
<td>OLEX</td>
</tr>
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<td>MultiTrode</td>
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## APPENDIX C – STANDARD DRAWINGS

**DRAWING NUMBERS (Revision numbers not shown)**

### SEWAGE PUMP STATIONS

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<td>UP TO 5.5 kW</td>
<td>TOUCH PANEL DESIGN</td>
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<td>954-6</td>
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C. CoGC Supplementary Trenchless Specification
Specifications

Supplementary Trenchless Specification
1. Supplementary Trenchless Specification

1.1 General

This Specification defines the minimum technical requirements for Microtunnelling and Horizontal Directional Drilling (HDD) works undertaken on City of Gold Coast’s (CoGC) projects.

This document must be read in conjunction with the Project Specification.

1.1.1 Standards and Related Specifications

Materials, workmanship, testing methods and reporting must comply with the latest revisions of relevant standards, codes, regulations and guidelines.

Works to which this Specification is applicable must comply with, but not be limited to, the latest edition of the following codes, standards and other referenced material listed below.

**International Standards**

- AS/NZS ISO 14000: Environmental Management Systems
- ASTM D6910-04: Marsh Funnel Viscosity of Clay Construction Slurries
- ANSI/API 5DP: Specification for Drill Pipe

**Australian Standards**

- AS 1012: Methods of Testing Concrete (all parts)
- AS 1289: Methods of Testing Soils for Engineering Purposes (all parts)
- AS 1379: Specification and Supply of Concrete
- AS 1418: Cranes, Hoists and Winches
- AS 1442: Carbon Steels and Carbon-manganese Steels – Hot Rolled Bars and Semi-finished Products
- AS 1478: Chemical Admixtures for Concrete, Mortar and Grout - Methods of Sampling and Testing Admixtures for Concrete, Mortar and Grout.
- AS 1554: Structural Steel Welding
- AS 1579: Arc-welded Steel Pipes and Fittings for Water and Wastewater
- AS 1726: Geotechnical Site Investigations
- AS 2032: Installation of PVC Pipe Systems
- AS 2033: Installation of PE Pipe Systems
- AS 2073: Methods for Testing of Expanding Admixtures for Concrete, Mortar and Grout
- AS 2350: Methods for Testing Portland and Blended Cements
- AS 2550: Cranes, hoists and winches Safe Use
- AS 2566: Buried Flexible Pipelines
- AS 3500: Plumbing and Drainage
- AS 3600: Concrete Structures
AS 3678 Structural Steel – Hot – Rolled Plates, Floor-plates and Slabs
AS 3972 Portland and Blended Cement
AS 4020 Testing of Products for use in contact with Drinking Water
AS 4041 Pressure Piping
AS 4129 Fittings for Polyethylene pipes (PE) for Pressure Applications
AS 4130 Polyethylene (PE) for Pressure Applications
AS 4133 Methods of Testing Rock for Engineering Purposes
AS 4673 Cold-formed Stainless Steel Structures
AS 4774-1 Work in Compressed Air and Hyperbaric Facilities; Part 1: Work in Tunnels, Shafts and Caissons
AS 4902 General Conditions of Contract for Design and Construct
AS 4994 Temporary Edge Protection
AS/NZS 3750 Paints for Steel Structures - High-build epoxy (two-pack)
AS/NZS 3862 External Fusion-bonded Epoxy Coating for Steel Pipes
AS/NZS 4058 Precast Concrete Pipes (Pressure and Non-pressure)

Additional Codes
Water Services Association of Australia Codes

Other References
PPI (2012). Handbook of Polyethylene Pipe, Chapter 12 – Horizontal Directional Drilling. 2nd Ed., updated 2012, the Plastics Pipe Institute, the Society of the Plastics Industry, Inc.
Huey D. P., Hair J. D. and McLeod B. K. “Installation Loading and Stress Analysis Involved With Pipelines Installed By Horizontal Directional Drilling”, Figure 1
1.1.2 Order of Precedence

Where a discrepancy exists between the Drawings, this Supplementary Specification and the other CoGC specifications the Contractor must seek clarification from the Superintendent.

This Supplementary Specification must take precedence over any other standard, code or guideline, but must not diminish any requirement of a standard, code or guideline to which compliance is required by law within the jurisdiction of the work being performed.

All other applicable standards, codes & specifications referred to by documents that form part of this specification must be complied.

1.1.3 Definition of Terms

*Table 1-1 - Definition of Terms*

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Act</td>
<td>The QLD Workplace Health and Safety Act (2011) and Regulations (2011)</td>
</tr>
<tr>
<td>Annular Space</td>
<td>The volume/space between the outside radius of the jacking pipe and the native material.</td>
</tr>
<tr>
<td>Attitude (MTBM)</td>
<td>The attitude of the MTBM is the position differences in the horizontal and vertical plane across the articulated point of the machine.</td>
</tr>
<tr>
<td>Carrier Pipe</td>
<td>The inner pipe forming part of the permanent pipeline, installed within the casing pipe.</td>
</tr>
<tr>
<td>Casing Pipe</td>
<td>Installed using trenchless methods to provide initial support to the excavated bore, prior to installation of the carrier pipe. May also be installed to provide additional protection to the permanent carrier pipe.</td>
</tr>
<tr>
<td>Casing Spacer</td>
<td>A band fitted around the carrier pipe at set spacing to prevent it making contact with the casing pipe. Usually dressed with runners that allow the carrier pipe to be pushed / pulled into place within the casing pipe.</td>
</tr>
<tr>
<td>Conductor Casing</td>
<td>A large casing usually installed at the entry or exit points of the HDD alignment to provide borehole support in weak or granular geological strata.</td>
</tr>
<tr>
<td>Contingency Plan</td>
<td>A plan to mitigate the risk of an activity. The plan usually allows for backup procedures, emergency response and post-disaster recovery.</td>
</tr>
<tr>
<td>Contract</td>
<td>The legally binding agreement between two or more parties for doing or not doing something specified.</td>
</tr>
<tr>
<td>Contractor</td>
<td>An organisation that is bound to carry out and complete the works under the Contract.</td>
</tr>
<tr>
<td>Contingency Plan</td>
<td>A plan to mitigate the risk of an activity. The plan usually allows for backup procedures, emergency response, and post-disaster recovery.</td>
</tr>
<tr>
<td>Design Documentation</td>
<td>Drawings, specifications and other design documentation (including design standards, design or durability reports and calculations) in computer readable and written forms prepared by the Designer for the purposes of the Trenchless works under the Contract.</td>
</tr>
<tr>
<td>Term</td>
<td>Definition</td>
</tr>
<tr>
<td>-------------------------------------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Designer</td>
<td>A professional engineer (RPEQ) who is appointed by the Contractor to carry out design and to issue instructions regarding standards, specifications and techniques to be observed in the construction of this project.</td>
</tr>
<tr>
<td>Drawings</td>
<td>Drawings prepared by the Designer(s) for the purpose of illustrating the design requirements for the works under the Contract.</td>
</tr>
<tr>
<td>Earth Pressure Balancing</td>
<td>An excavation control system used to apply counter balancing earth pressure to the material at the face to minimize or eliminate heave and subsidence. The counter balancing force is maintained between the active and passive earth pressures.</td>
</tr>
<tr>
<td>Earth Pressure Balance Micotunnelling</td>
<td>Typically used in water charged soils or rock ground conditions where the excavated material is cut and crushed into a damp granular material. This material is removed by a screw conveyor and muck handling cars. This method is not as effective as the slurry method in high hydrostatic and high rock strength conditions. This system requires man access.</td>
</tr>
<tr>
<td>Entry and Exit Seal</td>
<td>Seals which are formed around the MTBM entry and exit pits / shafts to prevent pressurised ground and water rushing into the pits / shafts.</td>
</tr>
<tr>
<td>Geotechnical Baseline Report</td>
<td>The GBR describes the “Ground Reference Conditions” at the location (alignment as shown in the GBR) of the proposed alignment. The Baseline Conditions presented in GBR represent what is assumed to be encountered for the purpose of defining ‘indications of the Contract’. The provision of a baseline in the Contract is not a warranty that the baseline conditions will, in fact, be encountered. It is therefore not appropriate for the Principal or Contractor to conclude that baseline statements are warranties.</td>
</tr>
<tr>
<td>Ground Loss</td>
<td>Ground loss is defined as the volume of material that has been excavated in excess of the theoretical design volume of excavation.</td>
</tr>
<tr>
<td>Gyro</td>
<td>A non-conventional surveying instrument used to determine the orientation of true north by locating the meridian direction.</td>
</tr>
<tr>
<td>Gyro Campaign</td>
<td>The use of a gyro instrument to determine the position of the MTBM and the alignment of the tunnel relative to true north.</td>
</tr>
<tr>
<td>Horizontal Directional Drilling (HDD)</td>
<td>HDD is a trenchless method for installing a product that serves as a conduit for liquids, gasses, or as a duct for pipe, cable, or wire line products. It is a multi-stage process consisting of site preparation and restoration, equipment setup, and drilling a pilot bore along a predetermined path and then pulling the product back through the drilled space. When necessary, enlargement of the pilot bore hole may be necessary to accommodate a product larger than the pilot bore hole size. This process is referred to as back reaming and is done at the same time the product is being pulled back through the pilot bore hole.</td>
</tr>
<tr>
<td>Hydro-lock</td>
<td>Is a condition that occurs when the circulation from the bore is lost and the formation is resistant to fracturing or absorption of the drilling fluid, creating a hydraulic cylinder in the ground.</td>
</tr>
<tr>
<td>Hydrofracture</td>
<td>Inadvertent drilling fluid release through the geological strata to the surface.</td>
</tr>
<tr>
<td>Instrumentation and Monitoring</td>
<td>Process of gathering, reducing, interpreting and reporting of data obtained from the installed instrumentation system as specified on the Drawings and Design</td>
</tr>
</tbody>
</table>
### Intermediate Jacking Station(s)

A fabricated steel cylinder fitted with hydraulic jacks, which is incorporated into a pipeline between two casing or jacking pipe segments. Its function is to provide additional thrust to overcome resistive skin friction of the MTBM and pipeline and to distribute the jacking forces over the pipe string on long drives. Its function is to provide additional thrust to overcome resistive skin friction of the MTBM and pipeline and to distribute the jacking forces over the pipe string on long drives.

### Jacking

The action of pushing a pipeline into position.

### Jacking Frame

A structural component, fitted with hydraulic cylinders that is used to push the MTBM and casing or jacking pipe into the ground. The jacking frame distributes the thrust load to the casing or jacking pipe and the reaction load to the shaft wall or thrust block.

### Jacking Ring

A steel ring / plate that is placed against the end of the jacking pipe against which the jack operates and that is intended to ensure that the jacking forces are spread over the end face of the pipe.

### Jacking Wall

A wall, usually temporary, constructed to take the reaction from hydraulic jacks when microtunnelling and distribute them evenly against the rear wall of the launch pit.

### Jacking / Launch / Entrance Shaft

A vertical excavation from which trenchless technology equipment and pipe are launched and driven.

### Lead Pipe

A pipe that has a rebated end over which the trailing end of the tail shield is fitted and that is intended to be the first pipe to be used in the jacking process.

### Lift (Shaft / Pit)

The incremental construction height completed as the shaft / pit progresses downward.

### Makeup Torque

The recommended torque forces required to joint each threaded drill pipe connection.

### Man-made Obstruction

A man-made object in the ground, which impedes or prevents HDD progress.

### Marsh Funnel

A device for measuring viscosity by observing the time it takes a known volume of liquid to flow from a cone through a short tube.

### Microtunnel Boring Machine (MTBM)

A remote controlled, steerable, laser guided tunnel boring machine consisting of an articulated boring machine shield and a rotating cutter head. Personnel entry into the MTBM is not required for the routine operation of the MTBM.

### Microtunnelling

A remote controlled and guided pipe jacking process that provides earth pressure balance in addition to applying hydrostatic counterbalancing pressure to the face. The jacked pipe provides continuous support to the tunnel.

### Natural obstruction

A natural object in the ground, which impedes or prevents pipe installation progress.

### Operator

Suitably trained or qualified person who operates machinery, an instrument or other equipment.

### Overcut

The radial distance between the excavated perimeter of the outermost gauge cutter and the outside radius of the MTBM.

### Permit

A document that controls an activity that is considered high and not able to be commenced without completing important requirements.
Pilot Tube Microtunnelling

Typically used in dry soils or soft rock conditions. The system drills a pilot hole from the launch pit to the reception pit. This pilot hole is then enlarged to the required size of the tunnel. As the hole is enlarged it can be lined by jacking a casing pipe or the carrier pipe into place.

Pipe Jacking

Construction of a pipeline by hydraulically jacking consecutive sections of jacking pipe through the ground behind a shield or TBM.

Principal

City of Gold Coast

Project Manager

A person nominated by the Contractor responsible for the construction of the contract.

Receiving / Exit Shaft

A vertical excavation from which trenchless technology equipment is received and removed.

Red Line Drawings

Original, as constructed drawings marked up in red detailing the as-built data.

Safe Work Method Statement

A document summarising the work required for an activity. This document summarises the hazards and the required measures to control and minimise safety risks.

Separation Plant

An elaborate system of separating excavated ground from the transportation fluid. Such a plant would employ shakers, screens, hydro cyclones or centrifuges to achieve this solid / fluid separation.

Slurry Microtunnelling

Typically used in water charged soils or rock ground conditions where the excavated material is cut and crushed into a slurry. This slurry is pumped out of the tunnel via pipes. This is a closed tunnelling system and has the potential to apply continuous pressure to the face.

Specification

This document, that specifies, in a complete, verifiable manner, the requirements, design, behaviour, or other characteristics of a system, component, product, result, or service and, often, the procedures for determining whether these provisions have been satisfied.

Superintendent

An individual appointed by the Principal to perform two functions:
- Be the Principal's agent for the works under the Contract;
- Administer the Contract fairly and perform certain certifier requirements.

Superintendent’s Representative

A person nominated by the Superintendent, to act on behalf of the Superintendent.

Trenchless Construction

Installation of new, or replacement of, underground infrastructure with minimal disruption to surface environment, traffic, business and other activities.

1.1.4 Abbreviations and Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>ASTT</td>
<td>Australasian Society for Trenchless Technology</td>
</tr>
<tr>
<td>AS / NZS</td>
<td>Australian / New Zealand Standard</td>
</tr>
<tr>
<td>ASS</td>
<td>Acid Sulphate Soils</td>
</tr>
<tr>
<td>AS</td>
<td>Australian Standard</td>
</tr>
</tbody>
</table>

Table 1-2 - Description of Acronyms
### Acronym | Description
--- | ---
ANSI | American National Standards Institute
API | American Petroleum Institute
CCTV | Closed Circuit Television
CAD (3D DXF/DWG) | Computer Aided Drafting (saved format)
CoGC | City of Gold Coast (Council)
DBYD | Dial Before You Dig
GBR | Geotechnical Baseline Report
GRP | Glass Reinforced Plastic
HDPE | High Density Polyethylene Pipe
ID | Inside Diameter
IFC | Issued for Construction
ISO | International Standards Organisation
ITP | Inspection and Test Plan
MTBM | Microtunnel Boring Machine
NATA | National Association of Testing Authorities
N/A | Not Applicable
OD | Outside Diameter
$P_{\text{average}}$ | Average Pressure
$P_{\text{max}}$ | Maximum Pressure
$P_{\text{min}}$ | Minimum Pressure
QA | Quality Assurance
ROP | Rate of Penetration
RPEQ | Registered Professional Engineer Queensland

#### 1.1.5 Principal Drawings
Refer to Attachment 2 - Sewer Rising Main Drawings

#### 1.1.6 Alternative Arrangements
The Contractor may propose alternative methods, plant, equipment or materials to complete the works under the contract provided that the proposal achieves:

- The minimum requirements; and
- The minimum requirements to an approved alternative standard.

Any deviation from this Supplementary Specification or a referenced document must be approved in writing by the Superintendent. The Contractor must submit to the Superintendent details of any proposed Alternative Arrangements with appropriate supporting information to allow the proposed alternatives to be assessed. The Contractor must allow 4 weeks for approval of any change to this Specification.
1.1.7 Quality Assurance

Construction activities must be carried out in accordance with the provisions of the Contractor’s Quality System, which must comply with the requirements of AS/NZS ISO 9001. The Contractor’s Quality System must cover all elements of a design and construct project including but not limited to planning, approvals (if required), procurement, design, construction, testing and handover.

1.1.8 Environment

All construction activities must be carried out in accordance with the provisions of the Contractor’s Environmental Management policy and project approved environmental management plan, which must comply with the requirements of AS/NZS ISO 14001.

1.1.9 Approvals

Project approvals are typically managed by CoGC.

In some instances the Contractor and the Principal may need to jointly seek an approval due the requirement of the approval conditions. For example an approval to drill under a road or railway will need “for construction” drawings and design. In this case the Contractor will need to work with the Principal to submit the required information to conclude the approval.

The Contractor must adhere to any approval conditions that the asset owner specifies. The Contractor must refer to the Project Specific Specification for required approvals.

1.1.10 Geotechnical Baseline Report

A Geotechnical Baseline Report (GBR) must be completed for the project and the resulting information must be provided by the Contractor. The GBR must provide sufficient information to enable the Contractor to assess the project, and specifically make informed decisions regarding the methods proposed to complete the Works.

No warranty is expressed or implied that any information, opinions or conclusions, given in any factual or interpretive ground investigation report, supplied by the Principal, will present a complete or accurate picture of the whole of the Site.

1.1.11 Restoration

Following the tunnelling/drilling operations, the Contractor must demobilise equipment and restore the worksite to its original condition. This includes reinstating any disturbed ground surface to its original standard.

As a minimum all excavations must be backfilled and compacted to 95% Standard Compaction (AS1289.5). Landscaping must be restored to its original condition. All cuttings, slurry and drilling fluids must be disposed of by the Contractor to approved sites. All temporary shafts / pits are required to be backfilled to 95% Standard Compaction (AS1289.5) and all concrete removed to a minimum depth of 2m from the surface.

Where operations have affected, disturbed, damaged or destroyed undeveloped land or structures the Contractor is responsible to reinstate to original conditions. This work must conform to the authority’s standards and the approval of the Superintendent.

1.1.12 Quality Records and Handover Documents

The Contractor must submit the as-built package in hard copy and electronic format.
The Contractor must keep records of all operations, and all such data as directed by the Superintendent and the Project Specification. These records will form part of the As-Built data.

The Contractor is required to submit as-built records in accordance with the requirements set out in the Project Specification.

Non-Conformances

If any part(s) of the Works are discovered or suspected not to conform to this Specification then:

- The Contractor must, within seven days of discovery or receipt of the Superintendent’s request for further information, notify the Superintendent of the proposed repair methodology and provide calculations or additional information necessary to verify that the proposed repair must achieve the same level of performance as the original design would have if constructed correctly; and
- The Superintendent must be deemed to have accepted that the Contractor’s proposal(s) once seven days has elapsed from the time the Superintendent received the Contractor’s proposal, unless the Superintendent rejects the proposal with a clear statement describing the reason for the rejection, or requests additional information within the seven days.

Inspection and Test Plan (ITP)

The Contractor must prepare and submit for approval by the Superintendent at least four (4) weeks prior to the commencement of Works, an Inspection and Test Plan for the works in accordance with the requirements of the relevant specifications.

The contractor must provide the Superintendent at least 48hrs notice of a required visual inspection, witness point verification or hold point release.

1.1.13 Testing and Commissioning

Hydrostatic Testing

The Contractor is required to conduct the hydrostatic test of each carrier pipe within the works under the Contract. The Contractor must engage a NATA certified testing authority to conduct the hydrostatic testing. The test must conform to the required specifications and Australian Standards.

Leakage Testing

For specific leakage testing requirements refer to the requirements identified in the specific Scope of Works. This may include vacuum testing.

Chlorination Testing

When chlorination testing is required the test and reports must be provided by a NATA certified testing authority in accordance with Australian Standards and WSA Water Code of Australia 2003. All equipment used in the testing process must be calibrated in accordance with the relevant standards.

The Contractor’s Hydrostatic and Chlorination Testing Procedure must take into account the safe and environmentally friendly disposal of the test water.

1.1.14 Client Representation

The works under the Contract may be delivered with a Technical Surveillance Officer on site to ensure the works are executed safely, in an environmentally friendly manner and to an acceptable quality standard.
availability and need for onsite client representation must be based on the project size, contract value and project risk and will be outlined in the Project Specific Specification. The Contractor must allow the Technical Surveillance Officer access to all the site.

1.2 Microtunnelling and Pipe Jacking

Microtunnelling is defined as a trenchless construction method for installing pipelines which is:

- Controlled: The microtunnel boring machine (MTBM) must be operated from a control panel at the surface. The system must simultaneously install pipe as spoil is excavated and removed. Personnel entry is not required for routine operation;
- Guided: The guidance system must reference a laser beam projected onto a target in the MTBM and must be capable of installing the pipes to the required tolerance for line and grade;
- Jacked: The process of constructing the pipeline must be by consecutively pushing pipes and the MTBM through the ground using a jacking system for thrust; and
- Supported: Continuous pressure must be provided to the face of the excavation to balance ground, groundwater and earth pressures.

Microtunnelling can be divided into three categories defined by the excavation technique and the material handling systems on the MTBM. The categories include Slurry Microtunnelling, Earth Pressure Balance Microtunnelling and Pilot Tube Microtunnelling.

1.2.1 Design

The Contractor is responsible for the design and construction of all works for the microtunnel including any temporary works and temporary pit / shaft supporting structures. All design assumptions regarding subsurface conditions, microtunnel lining requirements, groundwater and other factors, are the responsibility of the Contractor.

Based on the alignment shown in the Principal Drawings, the Contractor must design and size the microtunnel to accommodate all temporary and permanent works.

The microtunnel design must be certified by a RPEQ engineer and must be submitted to the Superintendent for review prior to commencement of work. The Contractor must not proceed with any work until the Contractor’s design has been accepted by the Superintendent. Acceptance of the Contractor’s design by the Superintendent in no way diminishes the responsibility of the Contractor for the design.

The Contractor is responsible for submitting the following design elements for approval prior to commencing work:

- Where the permanent works are to accommodate thrust arrangements, these must be designed to ensure the permanent works are not damaged;
- The microtunnelling alignment;
- Permanent tunnel and shaft design to consider lateral loading from seismic events;
- Collaboratively working with the Principal’s permanent infrastructure functionality and permanent design team to ensure the overall project achieves the intent;
- The thrust support frame and shaft must be designed to withstand the maximum forces expected for the tunnelling system while ensuring that these forces are within the manufacturer’s allowable jacking forces and deflection tolerances for the jacking pipe;
- The design and execution of the tunnelling machine and processes;
• The design of the cutter head to be used and the associated cutter tools;
• Verifying the suitability of the specified pipe for the methodology proposed with respect to jacking during installation (if required);
• The selection of a suitable jacking pipe for the methodology proposed with respect to jacking during installation;
• The design of intermediate jacking stations and associated pits (if required);
• The planning and use of slurry fluids, jacking lubrication fluids, polymer drilling fluids, tunnel grout and tunnelling consumables;
• The design and use of the guidance and steering system to achieve the design alignment both horizontally and vertically;
• Theoretical settlement calculations and the development of an acceptable ground loss percentage needs to be produced. The operation of the MTBM needs to conform to the established ground loss percentage;
• Any design amendments necessary to ensure that the construction techniques proposed are in compliance with the permanent design; and
• The design of all temporary works associated with the trenchless construction, including but not limited to the pit / shaft support (including access ladders and pipe fixings), crane pads and access roads or laydown areas.

The tunnel design must take account of all potential impacts on all existing infrastructure and underground features, including but not limited to: impacts from ground movement, seismic activity, clearance to features, settlement / heave and any changes in the groundwater table resulting from the works, either temporarily during construction or permanently as a result of the construction.

All designs must ensure the safe operation and use of plant, equipment and materials handling under all expected loadings such as ground pressure, superimposed loads and thrust forces.

**Jacking Pipe**

Prior to construction, the Contractor must submit to the Superintendent for approval, calculations showing the anticipated installation forces to be imposed on the jacking pipe. These calculations are required to take into account jacking loads, joint configuration, stress transfer, joint seal design, frictional forces, ground conditions, groundwater, angular deflection and any fluids used in the installation process.

The Contractor must take all precautionary measures to avoid damaging the jacking pipe during the installation process. In particular, the Contractor must ensure that the magnitude of loadings imparted onto the jacking pipe does not result in buckling, spalling or cracking of the jacking pipe and excessive deflection or improper functioning of the pipe joints.

**Carrier Pipe**

The Contractor must submit to the Superintendent fo details showing the transportation, handling, storage, installation and testing of the carrier pipe. All details must adhere to the manufacturer’s guidelines.

**Design Collaboration**
The Contractor and Principal must collaboratively work to ensure that all pipeline design aspects have been adequately considered including but not limited to Microtunnelling Installation and the Infrastructure’s Permanent Operation.

**Safe Man Access**

During the design and planning phase of the microtunnelling solution, the Contractor must consider the safe access into the tunnel and to the machine. The size of the tunnelling pipe will dictate if man access is possible and safe, and the microtunnelling system must take this into account. Safe man access is usually facilitated at 900mm in diameter and above.

Microtunnelling system elements that will require man access include changing cutter head tools; operating survey systems such as long drive and curve systems; maintaining lubrication systems; installing and maintaining intermediate jacking stations; and outer annulus grouting.

In microtunnelling, where man access is not appropriate, the aforementioned points will not be available to the solution meaning shorter drives and no ability to curve the alignment.

All access to areas where access and atmosphere is a risk must be completed according to the Confined Space Code of Practice (2011) Workplace Health and Safety Queensland, Queensland Government.

**1.2.2 Equipment**

**Plant**

All trenchless construction operations must be performed using specialist equipment. All plant must be of a good standard and the Superintendent must be permitted to inspect the proposed plant. All plant must comply with the equipment assessment / inspection criteria as listed below:

- Plant is required to be in good safe working order;
- Plant is required to have a good service history; and
- Plant is required to be fit for purpose.

The Contractor’s management plans must detail a system for daily checking and resolving of issues with the supplied plant and equipment. The Contractor must supply key critical spares to ensure that the all equipment achieves a 90% working availability target.

**Microtunnel Boring Machine (MTBM)**

The MTBM and ancillary equipment must be suitable for all local conditions and geological conditions expected. The design and selection of the MTBM and ancillary equipment is the sole responsibility of the Contractor. The MTBM must be robust with adequate safety margins for the anticipated duty, designed and manufactured to comply with all relevant safety standards and legislation.

The external diameter of the machine must be designed to produce minimum overcut and the necessary clearance between the outside of the jacking pipe and excavated ground. The overcut of the tunnelling shield must not exceed 30mm or more than 2% of the pipe OD (whichever is smaller). The Contractor must ensure the leading edge of the jacking pipe is protected when connected to the MTBM.

Wherever possible hydraulic piping must be of rigid metal tubing, the use of flexible hose must be kept to a minimum. Hydraulic equipment must be designed to operate at up to twice the working pressure.
Arrangement for extraction, transport and disposal of spoil must be appropriate for the material to be handled. All operating functions of the MTBM, including rate of advancement, must be in the control or direction of the MTBM operator.

The MTBM must be capable of excavation beneath the water table while ensuring face stability at all times. The efficiency of the MTBM is the responsibility of the Contractor. The Contractor must provide adequate resources and equipment to achieve an MTBM availability greater than 90%.

**Microtunnel Boring Machine Characteristics**

The preferred methodology is a sealed tunnelling system with the ability to balance the earth / water pressure at the face with the use of compressed air, tunnelling conditioning agents or slurry. Control must be such that the pressure can be adjusted to suit changing face conditions and can be maintained at all times within 10% of the required pressure. Proposals for trenchless construction methodologies different to those nominated may be considered subject to approval.

The Contractor is responsible for selecting the suitable cutter head, tools and tunnelling conditioning agents for the anticipated geological conditions.

The jacking walls and jacking structure must be designed to take the additional forces required to propel the TBM forward with the face pressurised.

Tail seals must be designed to withstand the maximum hydrostatic pressure at the tunnel invert, plus additional pressure from propulsion and slurry, with an adequate safety margin. They must prevent ingress of water, slurry and other materials into the finished lining.

The MTBM as a minimum must be fitted with the following instruments and controls:

- Face pressure gauges;
- Cutterhead rotation speed, direction, torque and thrust gauges;
- Slurry flows and pressure gauges (slurry machine);
- Screw rotational speeds and pressure drops (earth pressure balance);
- Electrical power;
- Advance rates;
- A means of measuring and recording the volume of material excavated per pipe; and
- Cutterhead door aperture status (where fitted).

**Jacks**

Each set of jacks in the launch pit must be fitted with suitably calibrated pressure gauges in good working order and such that actual jacking forces can be read at any time during the jacking operation.

The load from one ram or combination of rams must be limited to avoid damage to the lead pipe. The jacking load must be transferred to the jacking pipe through a jacking ring, which must be sufficiently rigid to ensure even distribution of the load.

The jacks must measure jack thrust pressures, stroke position and stroke speed.

**Separation Plant**

Slurry microtunnelling projects rely on the drilling slurry to cut, mix, suspend cuttings and transport this slurry back to the surface. This slurry is then required to be reused once all the cuttings have been removed from it. This cyclic process is important to ensure the cutting and removal of spoil is efficient.
Once the slurry returns to the launch pit it is pumped into the separation plant to separate the excavated material from the slurry. The Contractor must design an appropriate slurry recycling system to efficiently remove the excavated material from the slurry. The Contractor’s separation plant must adopt one or more of the following systems to adequately reuse the slurry:

- Coarse screen shaker (+440 microns).
- Desander (+100 microns).
- Fine screen shaker (44-74 microns or larger).
- Mud cleaner (44-77 microns or larger).
- Desilters (15 microns or larger).
- Centrifuge (4-8 microns and smaller).

Once the excavation slurry has been passed through the separation plant the slurry must be clean enough to be reused in the cyclic process. The separation plant must be designed to keep up with tunnel production to ensure that there are no necessary delays.

An alternative to a separation system that may be employed by the Contractor is a series of weirs and storage tanks which enable the excavated solids to sink to the bottom of the tanks. These tanks then need to be cleaned for disposal at the approved facility.

**Crane or Lifting Plant**

Lifting plant must be appropriately employed by the Contractor. The Contractor must ensure that experienced personnel with the required certificate of competency operates the lifting equipment at all times. All crane operation must be in accordance to Cranes, hoists and winches Safe Use (AS 2550).

In the case where the Contractor chooses to use an excavator to lift plant and materials the hydraulic cylinders must be fitted with burst protection valves to the Australian Standard: Cranes, Hoists and Winches (AS 1418).

### 1.2.3 Personnel

Appropriately trained and experienced personnel are required for the delivery of the works. Table 1-3 below summarises the minimum training and experience required for key personnel. Details of key personnel experience must be provided to the Superintendent for approval prior to commencing the Works.

A site supervisor who is thoroughly knowledgeable of the equipment and microtunnelling procedure must be present at the job site at all times. The site supervisor must be present to address immediate microtunnelling concerns, health and safety and environmental issues.

**Table 1-3 - Personnel**

<table>
<thead>
<tr>
<th>Microtunnelling Role</th>
<th>Minimum Experience in Role (Years)</th>
<th>Minimum Training / Qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager</td>
<td>5</td>
<td>Minimum Higher Education Diploma</td>
</tr>
<tr>
<td>Microtunnelling Supervisor</td>
<td>5</td>
<td>Rig and fluid training</td>
</tr>
<tr>
<td>MTBM Operator</td>
<td>3</td>
<td>Rig and fluid training</td>
</tr>
<tr>
<td>Microtunnelling Engineer</td>
<td>2</td>
<td>Minimum Higher Education Diploma</td>
</tr>
<tr>
<td>Microtunnelling Surveyor</td>
<td>4</td>
<td>Registration on the SBQ</td>
</tr>
<tr>
<td>Separator Operator</td>
<td>1</td>
<td>Fluid training</td>
</tr>
</tbody>
</table>
1.2.4 Materials

Permanent materials must fully comply with this specification and the documents referenced herein.

Any deviation must be approved in writing by the Superintendent.

Jacking Pipe

In a microtunnelling operation jacking pipe must be employed as a casing pipe to house a high pressure fluid pipeline or as a carrier pipe in a low pressure or gravity fluid pipeline. Table 1-4 below describes the typical uses of jacking pipe in the water industry.

Table 1-4 - Jacking pipe type and usage

<table>
<thead>
<tr>
<th>Type</th>
<th>Casing / Carrier pipe</th>
<th>Permanent Uses (Typically Gravity)</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRP</td>
<td>Casing or Carrier Pipe</td>
<td>Storm Water/Trunk Main/Sewer</td>
</tr>
<tr>
<td>Steel</td>
<td>Casing Pipe</td>
<td>N/A</td>
</tr>
<tr>
<td>Concrete</td>
<td>Casing or Carrier Pipe</td>
<td>Storm Water/Trunk Main</td>
</tr>
<tr>
<td>Polymer Concrete</td>
<td>Casing or Carrier Pipe</td>
<td>Storm Water/Trunk Main/Sewer</td>
</tr>
<tr>
<td>HDPE Lined Concrete</td>
<td>Casing or Carrier Pipe</td>
<td>Storm Water/Trunk Main/Sewer</td>
</tr>
<tr>
<td>Vitrified Clay</td>
<td>Casing or Carrier Pipe</td>
<td>Storm Water/Trunk Main/Sewer</td>
</tr>
</tbody>
</table>

The Contractor must source and use jacking pipe to the appropriate standard as outlined in Table 1-5 below.

Table 1-5 - Jacking pipe standards

<table>
<thead>
<tr>
<th>Type</th>
<th>Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>GRP</td>
<td>DIN 16869 &amp; DIN 19565</td>
</tr>
<tr>
<td>Steel</td>
<td>To achieve temporary works loadings</td>
</tr>
<tr>
<td>Concrete</td>
<td>AS/NZS 4058</td>
</tr>
<tr>
<td>Polymer Concrete</td>
<td>DIN 54815-1/2 &amp; prEN14636-1/2</td>
</tr>
<tr>
<td>HDPE Lined Concrete</td>
<td>AS/NZS 4058</td>
</tr>
<tr>
<td>Vitrified Clay</td>
<td>EN 295</td>
</tr>
</tbody>
</table>

For tunnels 900mm in diameter or greater lubrication ports are required in every 5th pipe. The lubrication ports must be spaced evenly around the jacking pipe circumference at 120 degrees and be complete with a sealed one way valve.

The Contractor must appropriately choose a jacking pipe jointing and packer system to suit the pipe’s purpose and the tunnel alignment (allowable joint deflection). The Contractor must consider these important design and operable features of the jacking pipe when completing the design requirements.

The Contractor must handle the jacking pipe as per the project specification and manufacturers guidelines.

Intermediate Jacking Stations

Under certain circumstances it may be necessary to provide one or more intermediate jacking stations within a single jacked length between the launch and reception pits. Such a station must consist of a pair of modified jacking pipes. In order to protect and form the joint between these pipes, the Contractor must provide cylindrical
mild steel sleeves of wall thickness at least 12 mm and of such a length that they overlap the pipes for a
distance of at least 150 mm on either side of the joint. The intermediate jacking station must be complete with
seals to prevent ingress of pressurised ground and water.

Intermediate jacking pipes are fitted out from within the tunnel and therefore are only used in tunnel diameters of
900mm or greater.

The Contractor must allow to use an interjacking pipe every 100m of the drive length or unless justified and
approved by the Superintendent under the design process.

Microtunnelling Consumables

The Contractor must use materials in a safe and responsible manner. All materials used in the microtunnelling
operation must be approved by the Superintendent.

The Contractor must ensure that chemicals and hydrocarbons are used according to CoGC’s accepted
environmental practises complete with control measures to mitigate risk.

The Contractor must ensure that the tunnelling fluids and chemicals that have the potential to come into contact
with the ground are biodegradable, safe to water bodies and fire resistant.

1.2.5 Project Execution

The Contractor must maintain control of site operations at all times. The Contractor has ultimate responsibility
for site safety, the environment, quality workmanship and the satisfactory completion of the work as authorised
under the Contract.

Site Setup

The Contractor must set the launch and reception sites up in accordance with the approved site layout drawing
which as a minimum must cover the following key aspects:

- Perimeter fencing in the allowed location;
- Site topsoil stockpile complete with erosion and sediment control;
- Entry and exit points;
- Pedestrian walkways and appropriate exclusion zones around cranes or moving plant;
- Equipment locations and movement zones;
- Any underground or overhead power lines and the appropriate exclusion zone; and
- Shaft / pit location.

Shaft / Pit Sinking

Tunnel launch and reception shafts / pit must be designed and constructed to allow the safe operation of plant,
equipment and handling of materials and to withstand all loadings imposed by ground pressure, superimposed
loads from surface structures and the maximum anticipated MTBM thrust forces.

Where permanent works accommodate the thrust arrangements, these must be designed so as not to damage
the Permanent Works.

At the end of the works, temporary shaft / pit walls must be removed to a level of 2m below finished site surface
level.
The shaft / pit layout drawings must be designed to accommodate the following key elements in the microtunnelling operations:

- The construction methodology including specified construction Lifts suited to the geology;
- The general arrangement of the plant and materials in the shaft;
- The safe access and egress details (a primary and a secondary means);
- Atmosphere testing and emergency plan;
- The safe zone when lifts are occurring;
- Ventilation;
- The service lines (ventilation, slurry pipes, water, compressed air pipes and power cables) and fixings in the shaft; and
- Floor and drainage details.

The Contractor must provide supporting shaft design documents.

The Contractor must build the shafts to the following tolerances:

- Horizontally +/- 50mm; and
- Vertically to a maximum divergence of 1:300.

All shafts require handrails and toe boards to the Australian Standard AS 4994.

All shafts and pits require safe primary and secondary means of access at all times.

The Contractor must provide shaft or pit covers when the site is unattended or unless approved by the Superintendent.

Construction of Entry and Exit Seals

Entry and exit seals on the launch and reception walls must be installed for the launch and reception of the machine. These seals must be designed to withstand hydrostatic and slurry pressures either during the launch and reception, throughout the tunnelling operations and once the tunnelling has been completed.

Tunnelling Set-up

The Contractor must verify that the jacking cradle and MTBM are set online, grade and level prior to launching the machine.

Tunnelling

During tunnelling the Contractor must ensure that the following conditions are met:

- Jacking forces are within the allowable loads accepted by the jacking pipe manufacturer and the design checks undertaken;
- The jacking pipe joint deflections are with the allowable angles stipulated by the jacking pipe manufacturer;
- Tunnel and MTBM access is conducted as per the documentation, specifications and standards;
- The tunnel excavation doesn’t exceed an acceptable ground loss percentage in line with calculations;
- The tunnel and MTBM follows the designed alignment within the tolerances specified within;
- The tunnel only commences when there is adequate jacking pipe available; and
- The Contractor must conduct the microtunnelling operation according to the Guide to Best Practice for the Installation of Pipe Jacks and Microtunnels published by the Pipe Jacking Association.
Lubrication

Where outer annulus lubrication of the pipe is required by the thrust calculations, pipe lubrication must be carried out by injecting a suitable, pressurised lubricant through preformed holes in the jacking pipe or at the cutting edge of the microtunnel boring machine.

Drilling fluids used must be environmentally sound and biodegradable.

Outer annulus lubrication is only employed when man access is possible.

Tunnelling Guidance

The MTBM must have an appropriate guidance and steering system to ensure the alignment is achieved to the design requirements and to the tolerances.

The tunnelling guidance system must provide the following information at a minimum frequency of two second intervals:

- MTBM distance from the launch shaft / pit;
- MTBM roll;
- MTBM inclination; and
- MTBM attitude across the articulated section of the machine.

Details of the proposed guidance and steering system must be forwarded to the Superintendent for approval, prior to works commencing.

There are typically three MTBM guidance systems to choose from in the survey of a microtunnelling operation. These guidance systems and the criteria that the Contractor must choose one from are described in Table 1-6 below.

**Table 1-6 - MTBM guidance systems**

<table>
<thead>
<tr>
<th>Drawing Details</th>
<th>Drive Length</th>
<th>Drive Type</th>
<th>Minimum Tunnel Diameter</th>
<th>Survey Technique</th>
<th>Requires Man Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laser Target System</td>
<td>&lt; 200m</td>
<td>Straight</td>
<td>Any</td>
<td>Conventional</td>
<td>No</td>
</tr>
<tr>
<td>Theodolite based Survey System</td>
<td>&gt; 200m</td>
<td>Straight or Curved</td>
<td>900mm</td>
<td>Conventional</td>
<td>Yes</td>
</tr>
<tr>
<td>MTBM Gyro System</td>
<td>&gt; 200m</td>
<td>Straight or Curved</td>
<td>900mm</td>
<td>Non-Conventional</td>
<td>Yes</td>
</tr>
</tbody>
</table>

The accurate survey and guidance of the MTBM and the tunnel is paramount to the success and end use of the tunnel. The Contractor must employ experienced tunnel surveyors to ensure the best results. The Contractor must employ a tunnel survey audit as described in the Table 1-7 below.

**Table 1-7 - Microtunnelling survey audit requirements**

<table>
<thead>
<tr>
<th>Microtunnelling Survey Conditions</th>
<th>Audit Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tunnel Length</td>
<td>Man Access</td>
</tr>
<tr>
<td>----------------</td>
<td>------------</td>
</tr>
</tbody>
</table>

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<table>
<thead>
<tr>
<th>Microtunnelling Survey Conditions</th>
<th>Audit Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tunnel Length</td>
<td>Man Access</td>
</tr>
<tr>
<td>&lt; 200m</td>
<td>No</td>
</tr>
<tr>
<td>&lt; 200m</td>
<td>Yes</td>
</tr>
<tr>
<td>201-400m</td>
<td>Yes</td>
</tr>
<tr>
<td>&gt;400m</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Alignment Tolerances

The location of the MTBM must be checked and recorded at least twice per installed pipe and the position recorded against the design grade on the tunnelling shift report. This information must be provided to the Superintendent on a daily process.

Where the drill is out of alignment based upon the tolerances listed below drilling must stop immediately. The drilling must not recommence until directed by the Superintendent. The Contractor is responsible for all corrective works and associated costs needed to correct the alignment of the proposed tunnel.

Under no circumstances must the Contractor take corrective action without the approval of the Superintendent.

The jacked pipe (conduit) must be installed in conformance with the horizontal and vertical alignment as shown on the drawings subject to the allowable construction tolerances as listed in Table 1-8 below.

**Table 1-8 - Allowable construction tolerances**

<table>
<thead>
<tr>
<th>Activity</th>
<th>Limits / Tolerances</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal</td>
<td>± 50 mm</td>
<td>N/A</td>
</tr>
<tr>
<td>Vertical</td>
<td>± 30 mm</td>
<td>N/A</td>
</tr>
<tr>
<td>Tunnel Grade</td>
<td>± 0.25%</td>
<td>No back fall and no ponding.</td>
</tr>
</tbody>
</table>

Spoil Removal and Separation

The excavation of cut ground and disposal arrangements must be capable of dealing with the full range of materials expected. Generally the disposal system must accommodate material produced by the MTBM. The spoil removal system must be such that it does not become clogged, jammed or damaged by materials delivered from the tunnelling operation.

The disposal of the excavated material in solid or liquid form is the responsibility of the Contractor. The Contractor must be aware of any contamination present, including Acid Sulphate Soils, and have in place the required testing, handling, treatment & disposal procedures.

Pipe Damage
When there is any indication that the installed pipe has sustained damage, the Contractor must stop all work, notify the Superintendent immediately and investigate the damage. The Superintendent must, within 72 hours, confirm whether if the pipe installation is or is not in compliance with the specifications.

**Interventions**

Man access to the tunnel and MTBM can be summarised into two cases: under normal atmospheric conditions and under compressed air conditions. In normal atmospheric conditions the Contractor must access the tunnel according to the Confined Space Code of Practice (2011) Workplace Health and Safety Queensland, Queensland Government. When compressed air access is required the Contractor must adhere to AS 4774 Work in Compressed Air and Hyperbaric Facilities.

**Grouting**

Either of the following annular spaces may require pressure grouting as per the works under the Contract:

1. The annulus between the jacking pipe and the cut ground; and
2. The annulus between the product pipe and the jacking pipe.

When the tunnel diameter is 900mm in diameter or greater the annulus between the jacking pipe and the cut ground must be grouted. This grouting must be completed incrementally along the tunnel until one of the following conditions is met:

- The grout pressure reached the hydrostatic pressure outside the pipes plus 1 bar. The pressure gauge must be located at the delivery nozzle;
- The grout volume discharged is greater than or equal to the theoretical outer annulus of one jacking pipe; and
- Grout is visible at any of the next set of grout ports.

If either grouting function is required, the Contractor must submit a procedure for approval to undertake the grouting to ensure that the theoretical volume of the annular space is filled, there is no damage caused by the grouting and no grout release occurs.

The type of grout used must consider heat of hydration, potential environmental effects (e.g. aquifers, polymer vs. cementitious, hydrophilic) and likelihood of fracture.

**1.2.6 Settlement Monitoring**

The Contractor must monitor the effects of tunnelling construction at the surface, including all ground movements and the effects on all structures influenced by the works under the Contract. The survey must be carried out by a surveyor in accordance with the Settlement Monitoring Plan. The tunnelling method must be suitable for achieving limited movement at the surface directly above the tunnel alignment. Surface movement either up or down must not exceed 5mm beneath existing services including roads and 10mm beneath undeveloped land. The Contractor is be fully responsible for any damage to nearby structures; equipment or infrastructure resulting from the tunnelling works, and must take all reasonable steps to ensure that such damage does not occur. Theoretical settlement calculations demonstrating compliance with these requirements must be submitted to the Superintendent at least 4 weeks prior to commencing the Works.

Daily movement monitoring must include as a minimum the following components:

- Installation of monitoring points along and perpendicular to the tunnel alignment. Each set of surveying points must have one point located on the centre line and 2 either side at an offset distance of 5m and
10m from the centre line. The survey points must be at intervals along the centreline of a maximum of 30m to monitor and interpret expected movements;

- Movement monitoring must be undertaken daily within a plan distance of 30m (each way) of the tunnel face whilst the tunnel is advancing;
- In the event that instability of the surface is observed (a breach of the 5 / 10mm thresholds), advancement of the pipe tunnelling operation must be suspended and the Superintendent must be immediately informed; and
- Monitoring must be referenced to stable survey stations located outside the zone of influence of the works and not subject to ground movement.

When passing under road or rail the Contractor must conform to the relevant authority’s settlement requirements.

### 1.2.7 Documentation

Under the QLD Workplace Health & Safety Act (2011) and Regulations (2011) the Contractor must ensure the health and safety of the workers. Under the Act and Regulations, to ensure the worker’s health and safety, the Contractor must provide a safe system of work, safe plant and structures, a work environment without risks and training, information, instruction / supervision relating to the work.

The Contractor must submit all necessary documentation as required to comply with the requirements of the Act to the Superintendent at least 4 weeks prior to commencing the Works.

Notwithstanding this requirement the Contractor must submit the following documentation to the Superintendent at least 4 weeks prior to commencing the works:

- **Work Plans:**
  - Settlement Monitoring Plan;
  - Lifting Plan;
  - Plant Suitability and Maintenance Plan;
  - Risk and Contingency Management Plan;

- **Work Procedures:**
  - Site establishment;
  - Construction of the crane support slab / pad;
  - Pit / shaft construction (if applicable);
  - Jacking wall / jacking support structure construction;
  - Tunnelling / pipe installation;
  - Tunnel access;
  - Carrier pipe installation procedure (if applicable);
  - Annulus grouting of the overcut;
  - Annulus grouting between the casing and the carrier pipe;
  - MTBM head intervention / cutter change (under free air or compressed air);
  - Welding of casing / carrier pipe (steel welding, HDPE pipe welding, HDPE sheet welding);
  - MTBM surveying and surveying audit;
  - The demobilisation of the equipment and site;

- **Safe Work Method Statements:**
  - Operation of a crane;
- Operation of the MTBM;
- Operation of the slurry system;
- Operation of the water treatment plant;
- Work at heights;
- Work in a confined space;
- Hot works;
- Work at night under artificial light; and
- Lifting.

**Contingency Plans**

The Contractor must prepare and implement an approved contingency plan dealing with the key project and/or microtunnelling risks identified. As a minimum the Contractor must have defined plans complete with equipment and materials on standby to mitigate against the following microtunnelling risks:

- Shaft/pit collapse;
- Tunnel collapse;
- Shaft/pit flooding;
- Tunnel flooding;
- Major MTBM mechanical failure;
- Settlement or heave scenarios;
- Serious safety or environment incidents;
- High water inflows at the face of MTBM which prevents access to the pressure chamber for cutter inspection and replacement; and
- Higher jacking forces than expected.

**Construction Records**

The Contractor must maintain and make available the following construction records:

- Shaft and tunnelling records;
- Geological records;
- Ground support records (if applicable);
- Tunnelling data – jacking pressures, rotation pressure, slurry flow rates, rotation velocity, line, level, advance rates, shove pressures and earth pressures;
- Quantities of consumables used;
- Plant used;
- Labour used;
- Materials used;
- Gas monitoring details;
- Environmental details (water treatment, noise, dust and sediment controls);
- The diameter and type of pipe and pipe joints used;
- Individual pipe identification by location; and
- Delivered jacking pipe dimension and damage checks.
1.3 Horizontal Directional Drilling (HDD)

1.3.1 Design

The HDD project must be designed in accordance with this Specification and the referenced documents by a person suitably qualified and having experience with the design considerations required for this type of work. The design considerations must include, but not necessarily be limited to:

- Temporary works;
- Pipe / Drill rod bending radii;
- Torque and drag analysis;
- Steering capability of the proposed method/equipment;
- Drilling fluid performance;
- Tensile loads (expected and maximum allowable);
- Hydrofracture predictions & control; and
- Pipeline materials properties (typically steel, HDPE or PVC) & operations requirements (lifespan and loads).

The Principal Drawings must be used as a guide to confirm that the crossing is possible to be delivered via HDD methods. The Contractor must not to rely on the Principal Drawings as being the built solution as it is the Contractor’s responsibility for the final alignment and design, and any temporary works design(s) required.

The Contractor’s HDD design must be certified by a RPEQ engineer and must be submitted to the Superintendent for review prior to commencement of work. The Contractor must not proceed with any work until the Contractor’s design has been accepted by the Superintendent. Acceptance of the Contractor’s design by the Superintendent in no way diminishes the responsibility of the Contractor for the design.

Design Collaboration

The Contractor, Superintendent and Principal must collaboratively work to ensure that all pipeline design aspects have been adequately considered and analysed across the two key project phases including horizontal directional drilling installation and the permanent pipeline operation.

1.3.2 Equipment

Plant

All trenchless construction operations must be performed using specialist equipment. All plant must be of a good standard and the Superintendent must be permitted to visit the premises of the storage, manufacture or refurbishment of proposed specialist plant for the purpose of inspection. All plant must comply with the equipment assessment / inspection criteria as listed below:

- Plant is required to be in good safe working order;
- Plant is required to have a good service history; and
- Plant is required to be fit for purpose.

As a minimum the HDD Contractor must supply the following plant:

- HDD drill rig;
- Surface fluid pump;
- Excavator;
• Fit for purpose lifting machine for drill rod and pipes;
• A separation system;
• Bentonite mixing plant;
• Power generator;
• Hot works plant; and
• Storage tanks.

The HDD Contractor’s management plans must detail a system for daily checking and resolving of issues with the supplied plant and equipment. The Contractor must supply key critical spares to ensure that the HDD drilling equipment achieves a 90% working availability target.

Drill Rig

The drill rig must be adequately sized to achieve the loads (thrust, pull and torque) concluded in the HDD Contractor’s design. Typical drill rig specifications are shown in Table 1-9.

Table 1-9 - Typical HDD drill rig capability (NASTT 2008)

<table>
<thead>
<tr>
<th></th>
<th>Small Rigs</th>
<th>Medium Rigs</th>
<th>Large Rigs (Maxi)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thrust/Pullback</td>
<td>&lt; 40,000 lbs</td>
<td>40,000 – 100,000 lbs</td>
<td>&gt; 100,000 lbs</td>
</tr>
<tr>
<td>Maximum Torque</td>
<td>&lt; 40,000 ft-lbs</td>
<td>40,000 – 20,000 ft-lbs</td>
<td>&gt; 20,000 ft-lbs</td>
</tr>
<tr>
<td>Rotational Speed</td>
<td>&gt; 130 rpm</td>
<td>90 - 210 rpm</td>
<td>&lt; 210 rpm</td>
</tr>
<tr>
<td>Carriage Speed</td>
<td>&gt; 100 ft/min</td>
<td>90 - 100 ft/min</td>
<td>&lt; 90 ft/min</td>
</tr>
<tr>
<td>Carriage Drive</td>
<td>Chain, Cylinder, or Rack &amp; Pinion</td>
<td>Chain, or Rack &amp; Pinion</td>
<td>Rack &amp; Pinion with or without Cable Assist</td>
</tr>
<tr>
<td>Drill Pipe Length</td>
<td>5 - 10 ft</td>
<td>10 - 30 ft</td>
<td>30 - 40 ft</td>
</tr>
<tr>
<td>Drilling Distance</td>
<td>≤ 700 ft</td>
<td>≤ 2000 ft</td>
<td>≤ 8,200 ft</td>
</tr>
<tr>
<td>Power Source</td>
<td>&lt; 150 hp</td>
<td>150 - 250 hp</td>
<td>&gt; 250 hp</td>
</tr>
<tr>
<td>Mud Pump</td>
<td>&lt; 75 gpm</td>
<td>50 - 200 gpm</td>
<td>&gt; 200 gpm</td>
</tr>
<tr>
<td>Weight of Drill Rig</td>
<td>&lt; 15,000 lbs</td>
<td>&lt; 60,000 lbs</td>
<td>&gt; 60,000 lbs</td>
</tr>
<tr>
<td>Rig Footprint Area (width × length)</td>
<td>3 ft × 10 ft to 7 ft × 20 ft</td>
<td>7 ft × 20 ft to 8 ft × 45 ft</td>
<td>&gt; 8 ft × 45 ft</td>
</tr>
<tr>
<td>Recommended Work Area Requirements (width × length)</td>
<td>20 ft × 60 ft</td>
<td>100 ft × 150 ft</td>
<td>150 ft × 250 ft</td>
</tr>
</tbody>
</table>

Lifting Plant

Lifting plant must be appropriately employed by the Contractor. The Contractor must ensure that experienced personnel with the required certificate of competency operates the lifting equipment at all times. All crane operation must be in accordance to AS 2550 Cranes, hoists and winches Safe Use.

In the case where the Contractor chooses to use an excavator to lift plant and materials the hydraulic cylinders must be fitted with burst protection valves to the Australian Standard: AS 1418 Cranes, Hoists and Winches.
1.3.3 Personnel

Appropriately trained and experienced personnel are required for the delivery of the works. Table 2-10 below summarises the minimum training and experience required for key personnel. Details of key personal experience must be provided to the Superintendent for approval before the works commence.

A HDD supervisor who is thoroughly knowledgeable of the equipment, drilling and HDD procedures must be present at the job site during the entire installation and be available to address immediate concerns, and health and safety issues.

Table 1-10 - Key HDD personnel training and experience

<table>
<thead>
<tr>
<th>HDD Role</th>
<th>Minimum Experience in Role (Years)</th>
<th>Minimum Training / Qualification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager</td>
<td>5</td>
<td>Minimum Higher Education Diploma</td>
</tr>
<tr>
<td>HDD Supervisor</td>
<td>5</td>
<td>Rig and fluid training</td>
</tr>
<tr>
<td>HDD Driller</td>
<td>3</td>
<td>Rig and fluid training</td>
</tr>
<tr>
<td>HDD Engineer</td>
<td>2</td>
<td>Minimum Higher Education Diploma</td>
</tr>
<tr>
<td>HDD Steerer</td>
<td>2</td>
<td>Survey equipment training</td>
</tr>
<tr>
<td>HDD Mudman</td>
<td>1</td>
<td>Fluid training</td>
</tr>
</tbody>
</table>

1.3.4 Materials

Permanent materials must fully comply with this Supplementary Specification, project specification and the documents referenced herein.

Any deviation must be approved in writing by the Superintendent.

The Contractor must ensure that chemicals and hydrocarbons are used according to CoGC’s accepted environmental practises complete with control measures to mitigate risk.

The Contractor must ensure that the drilling fluids and chemicals that have the potential to come into contact with the ground are biodegradable, safe to water bodies and fire resistant.

1.3.5 Execution

The Contractor must maintain control of site operations at all times. The Contractor has ultimate responsibility for site safety, the environment, quality workmanship and the satisfactory completion of the work.

HDD Site Setup

The HDD contractor must mobilise to site and setup the site to best facilitate the works. The Contractor must confine all activities to the designated work areas which include the orientation of the entry and exit sides of each crossing based on access and pipe stringing areas.

The Contractor must set the entry and exit sites up in accordance with the approved site layout drawing which as a minimum must cover the following key aspects:

- Perimeter fencing in the allowed location;
- Site topsoil stockpile complete with erosion and sediment control;
- Entry and exit pits;
Pedestrian walkways and appropriate exclusion zones around cranes or moving plant;
Equipment locations and movement zones; and
Any underground or overhead power lines and the appropriate exclusion zone.

**Welding and Jointing**

Butt Welds must be used for all pipe joints of all pipe materials that are pulled through the HDD alignment. Other methods of jointing including electrofusion, clamped, or proprietary bell/spigot type joints are not permitted without written approval from the Superintendent.

Pipe specifications, weld procedures, & welder qualifications must be provided to the Superintendent for approval prior to procurement of any materials, or commencement of the works.

**HDPE Pipe**

For HDPE pipe welds must be debeded externally to improve pipe pullback.

HDPE welding must be conducted only by pre-qualified welders. HDPE butt welding quality checks must be done in accordance with pipe specification documents referenced in this document, Quality Assurance systems and AS 2033 Installation of Polyethylene Pipelines.

**PVC Pipe**

PVC pipe must meet the material specifications required by the referenced standards and be of the fusible type, supplied with a manufacturer’s recommendation for butt fusion welding.

**Steel Casing**

For installation over long drill segments steel casing may be employed to provide additional strength to resist installation loads.

The steel pipe must be welded by certified welders pre-qualified to undertake the weld procedure. Welds must be tested in accordance with AS 1554.1. A minimum of 1 in 10 welds must be tested using Ultrasonic or Radiographic techniques, and all welds visually inspected.

The yield strength and wall thickness of steel casing must be chosen by the Contractor to take into account the buckling, bending and tensile forces that it will be subjected to in the casing pipe pull. These calculations must be checked and verified by the design RPEQ.

The Contractor must verify that there is no weld slag left internally at the joints that will damage the carrier pipes during installation.

**Fluid Control**

The Contractor must use HDD drilling fluid to efficiently support the borehole and carry the cuttings away in solution to the surface. The drilling fluid must be water based bentonite that is environmentally safe and conforms to the relevant legislation. All chemical fluid additives must be inert to the environment and the Contractor must maintain an up to date Chemical register and have SDS documents available onsite.

Fluid design, performance and monitoring are the responsibility of the Contractor. The Contractor must submit a Fluid Design and Management Procedure that details the design and required functionality of the fluid. The Fluid Design and Management Procedure must be approved by the Superintendent prior to the commencement of works. The fluid must be tested a minimum of three times a shift to ensure optimum performance. The Contractor must record details of all fluid used in the system including quantities of each additive.
The fluid must optimally perform and must be tested and verified against the design in the following areas:

- Viscosity;
- PH;
- Fluid Weight;
- Gel Strength;
- Fluid loss;
- Water hardness; and
- Calcium content.

The Contractor must be in close contact with their fluid supplier’s technical department to ensure that optimum performance is established and maintained.

The Contractor must communicate via the Fluid Design and Management Procedure how the fluid design and management will minimise hydrofracture events, hole collapse and hydro-lock.

In the event that a drilling fluid fracture to the river bed or other environmentally sensitive areas occurs, the Contractor must cease drilling and notify the Superintendent. The Contractor must wait at least 30mins, inject a quantity of drilling fluid with a viscosity exceeding 120 seconds as measured by a Marsh Funnel and then wait another 30 minutes. If the mud fracture or returns loss continues, the contractor must cease operations, and submit proposals to the Superintendent for review, outlining satisfactory rectification.

**Fluid Separation System**

The Contractor’s separation system must be adequately sized to handle the throughput of the drilling fluid. The separation system must be complete with screens and hydrocyclones to separate the solids from liquid. If required the Contractor must provide a centrifuge to further separate the solids from liquids.

**Drilling, Reaming, Conditioning**

The Contractor must incrementally perform drilling tasks to prepare the bore hole for the casing pipe pull. The process must follow the following stages:

- Drill the and steer the pilot hole along the approved alignment;
- Ream the pilot hole out to the specified diameter per the Contractor’s design and guide shown in Table 1-11; and
- Condition and clean the borehole until the Contractor and the Superintendent is satisfied that the hole is clean and ready for the casing pipe pull.

**Pilot Hole**

In the event that the pilot does deviate from the bore path by more than the tolerance requirements, the Contractor must notify the Superintendent and the Superintendent may require the Contractor to pull-back and re-drill from the location along the bore path prior to the deviation.

Drill bits must be in good working order.

**Reaming**

Upon successful completion of pilot hole, The Contractor must ream the bore hole, using the appropriate HDD tooling, to a size controlled by Table 1-11 below.

Reaming tools must be in good working order.
Table 1-11 - Product diameter and reamed diameter recommended relationship (NASTT 2008)

<table>
<thead>
<tr>
<th>Product Diameter</th>
<th>Reamed Diameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 8” (&lt; 200mm)</td>
<td>Diameter of product + 4” (100mm)</td>
</tr>
<tr>
<td>8” – 24” (200 – 600mm)</td>
<td>Diameter of product x 1.5</td>
</tr>
<tr>
<td>&gt;24” (&gt;600mm)</td>
<td>Diameter of product + 12” (300mm)</td>
</tr>
</tbody>
</table>

**Hole Conditioning**

Conditioning of the borehole must be conducted when the reaming has been completed. This operation must remove any excess cuttings still left within the hole and to improve the condition and stability of the borehole and the borehole walls.

Conditioning reaming tools must be in good working order.

**Pipe Pull Back**

At the completion of the hole opening and the hole conditioning the Contractor must commence the casing pull back (if required), followed by the carrier pipe pull back. The pipe pull back is a critical operation and the following must be controlled by the Contractor:

- If the Contractor’s design requires the casing pipe to be filled for a preferred buoyant reaction then the Contractor must plan and execute this process seamlessly;
- If the Contractor needs to work continuously during this operation then the Contractor must seek extended hour working from the Superintendent 6 weeks prior to the commencement the operation; Appropriate lighting may need to be provided; and
- The Contractor must plan for the handling, storage and disposal of the displaced drilling fluid during pipe pull back.

In the event that pipe becomes stuck, the Contractor must cease pulling operations to allow any potential hydrolock to subside and must recommence pulling operations. If pipe remains stuck, the Contractor must notify the Superintendent.

**Pipe damage**

When there is any indication that the installed pipe has sustained damage, the Contractor must stop all work, notify the Superintendent immediately and investigate the damage. The Superintendent may take up to 72 hours to approve or determine if the pipe installation is not in compliance with the specifications.

**Drill Pipe**

The Contractor must supply drill pipe that is in good condition complete with Ultrasonic assessments to demonstrate their condition. The drill pipe must be assessed against the ANSI/API SPECIFICATION 5DP Specification for Drill Pipe and a report provided demonstrating conformance. The drill pipe and Makeup torques must be submitted to the Superintendent and operated according to the manufacturer’s guidelines. The Contractor must measure the allowable 3 and 10 joint radii for the drill pipe in real time and record it on the daily steering report. The Contractor must ensure that the drill pipe conforms to its allowable bending radius at all times.
Annular Pressure Monitoring

The Contractor’s design must include a theoretical calculation of hydrofracture for each HDD installation. This calculation must be graphed against chainage and vertical elevation. The graph must include plotted lines representing the following parameters:

- The topographic surface;
- The vertical bore hole alignment;
- The minimum pressure required to create fluid returns in the entry pit \( (P_{\text{min}}) \);
- The maximum allowable pressure to avoid hydrofracturing \( (P_{\text{max}}) \); and
- The Contractor’s design must prove that \( P_{\text{min}} \) must remain lower than \( P_{\text{max}} \) including a factor of safety allowance of 1.5.

During the drilling of the pilot hole the Contractor must plot the actual annular pressure on to the theoretical graph mentioned above in real time. The Contractor must act accordingly if \( P_{\text{min}} \) approaches \( P_{\text{max}} \). Measures such as cleaning the hole, reducing the fluid pressure, reducing the rate of penetration (ROP) must be implemented.

Downhole Assembly

The Contractor must use fit for purpose downhole equipment. The equipment must be supported by the manufacturers or local agents. All downhole equipment must be accompanied with service records / reports and proof that they are in good working order and any threaded joints are torqued to the appropriate Makeup torque.

Pulling heads and swivels must be designed to a maximum operating tensile load with an appropriate factor of safety. These limitations must be provided to the Superintendent via a manufacture’s or an approved agent’s report.

Grouting

In conjunction with the Principal the Contractor must determine if annulus grouting is required. In determining if grouting is required the following elements must be assessed:

- Surface settlement;
- Pipe buckling from ground and hydrostatic loads;
- Drill path erosion and drainage;
- Resistivity;
- Heat transfer; and
- Permanent operation.

In the case that the HDD requires the annulus between the casing pipe and the carrier pipe to be grouted the Contractor must provide a procedure for approval. A cementitious material must be used and the grouting pressure must not exceed the \( P_{\text{max}} \) and any pressure limitation of the carrier pipe.

Pipe Cleaning and Gauging

At the completion of the carrier pipe pull the carrier pipes must be pigged and flushed clean. A number of cleaning passes may be required until clean water remains in the carrier pipes. The gauging pig must be sized to the internal diameter of each carrier pipe according to the project specific specification.

The Contractor must complete this work and use a fit for purpose cleaning pig and gauging pig complete with manufacture’s certificates.
Alignment Tolerances

The HDD bore path must follow the approved designed alignment and conform to the allowable tolerances depicted in Table 1-12 below. The alignment must be constructed on the project specific centre lines and agreed to by the Superintendent and Principal.

Table 1-12 - HDD tolerances

<table>
<thead>
<tr>
<th>Horizontal Drilling Alignment Tolerance</th>
<th>Allowable Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Horizontal Tolerance from Designed Alignment</td>
<td>± 300mm</td>
</tr>
<tr>
<td>Vertical Tolerance from Designed Alignment</td>
<td>± 300mm</td>
</tr>
<tr>
<td>Gradient (including entry angle and exit angle)</td>
<td>± 3%</td>
</tr>
<tr>
<td>Horizontal Tolerance from Planned Surface Exit</td>
<td>3m</td>
</tr>
</tbody>
</table>

1.3.6 Survey

Surface Survey

The Contractor must establish survey benchmarks on each side of each HDD installation. These survey benchmarks must be preserved and maintained by the Contractor. The Contractor must control and use these points under their approved Project Quality Plan as requested in the Contract Management Plan Requirements.

The Contractor must initially survey the centre line of the proposed HDD crossings prior to works commencing. This must be registered as the base line data and tabled. Then the Contractor must survey the alignment every week during construction to ensure that there is no detrimental impact of the installation.

HDD Survey and Guidance

Depending on the length, depth, topography and characteristics of the proposed crossings the HDD survey must adopt a walkover or wireline system to guide the borehole along the designed alignment.

Three readings per rod is required during the drilling of the pilot hole, registering inclination, azimuth, length and the orientation of the bent sub. This collected information must be converted and plotted into a real time as-built alignment drawing referencing the actual position of the borehole compared with the designed alignment. This plot must be submitted to the Superintendent daily, or as requested, for review.

In addition to the walkover and the wireline HDD guidance electromagnetic systems there are two guidance methods that are an extension of the wireline system. These are described below and usually implemented on long crossings where the introduction of a surface coil magnetic field is not possible or magnetic interference is significant:

Intersect Method

This HDD guidance method involves two drill rigs operating from both sides of the crossing. The method facilitates the merge of one rig’s tooling drilling into the other rig’s drilled hole by means of an electromagnetic transmitter and a receiver.

Optical Gyroscope

This HDD guidance method uses optical gyroscopes the angular speed of light photon and accelerometers to measure drill head motion. Using these inputs Horizontal Directional Drilling Specification the method is then able to determine azimuth, roll and pitch without the use of electromagnetics.
The Contractor must ensure proper calibration of all equipment before commencing directional drilling operation and provide proof of calibration documentation to the Superintendent.

**Infrastructure and PUP Protection**

The works must not cause damage to the overlying and adjacent infrastructure and Public Utility Plant (PUP). Ground movements include the effects of excavation and groundwater drawdown induced subsidence and other activities.

Prior to commencing any construction work within the construction site, condition surveys must be undertaken and recorded in the Settlement Management Plan. Where possible the Contractor must conduct weekly settlement monitoring along the HDD alignment. These results must be submitted to the Superintendent.

**As-Built**

As-built drawings of horizontal directional drilling must be prepared, certified as to their accuracy and submitted by the Contractor to the Superintendent.

The Contractor must provide the Superintendent a complete set of As-Built Plans showing all bores (successful and failed) within 30 calendar days of completing the work. The Contractor must ensure that the plans are dimensionally correct copies of the Contract plans and include roadway plans and profiles, cross-sections, boring locations and subsurface conditions as directed by the Superintendent. The plans must show appropriate elevations in terms of meters above/below Australian Height Datum (mAHD).

As-built drawings must be submitted in accordance with the requirements set out in the project specification.

The Contractor must include bore notes on each plan stating the final bore path diameter, product diameter, drilling fluid composition, composition of any other materials used to fill the annular void between the bore path and the product, or facility placed out of service. If the product is a casing, the size and type of carrier pipe placed within the casing must be recorded as part of the work.

1.3.7 **Documentation**

Under the QLD Workplace Health & Safety Act (2011) and Regulations (2011) the Contractor must ensure the health and safety of the workers. Under the Act and Regulations, to ensure the worker’s health and safety, the Contractor must provide a safe system of work, safe plant and structures, a work environment without risks and training, information, instruction / supervision relating to the work.

The Contractor must submit all necessary documentation as required to comply with the requirements of the Act to the Superintendent at least 4 weeks prior to commencing the Works.

Notwithstanding this requirement the Contractor must submit the following documentation to the Superintendent at least 4 weeks prior to commencing the works:

- **Work Plans:**
  - Settlement Monitoring Plan;
  - Lifting Plan;
  - Plant Suitability and Maintenance Plan;
  - Risk and Contingency Management Plan;

- **Work Procedures:**
  - Site establishment;
  - Horizontal Directional Drilling;
  - Fluid Design and Management;

Notwithstanding this requirement the Contractor must submit the following documentation to the Superintendent at least 4 weeks prior to commencing the works:

- **Work Plans:**
  - Settlement Monitoring Plan;
  - Lifting Plan;
  - Plant Suitability and Maintenance Plan;
  - Risk and Contingency Management Plan;

- **Work Procedures:**
  - Site establishment;
  - Horizontal Directional Drilling;
  - Fluid Design and Management;
Conductor Casing Installation;
Horizontal Directional Drilling Surveying;
Casing pipe welding (or jointing);
Carrier pipe welding (or jointing);
Pipe pull back (including overbend details);
Annulus grouting (if required);
Hydrostatic and Chlorination;
The demobilisation of the equipment and site;

Safe Work Method Statements:
Operation of a crane;
Operation of the HDD rig;
Operation of the slurry system (including all pumps);
Work at heights;
Work in a confined space;
Hot works;
Work at night under artificial light; and
Lifting

Contingency Plans
The Contractor must prepare and implement an approved contingency plan dealing with the key HDD risks identified in the risk register. As a minimum the Contractor must have defined plans complete with equipment and materials on standby to mitigate against the following HDD risks:

Fluid loss;
A hydrofracture event;
Hydro-lock (loss of fluid circulation);
Hole collapse;
Fluid pit overflow;
Hydrocarbon spill;
Drill pipe or bottom hole assembly failure; and
Serious work safety incidents in remote areas.

Construction Records
The Contractor must maintain and make available the following construction records:

Rig Log (Pilot, Reaming and Conditioning);
Steering Log;
Rate of Penetration Chart (ROP);
Annular Pressure Graph;
Pipe Pull Back Logs (Casing and Carrier);
Filling and Pre-Hydro Test Logs;
Grouting Logs;
Plotted Pilot Hole As-built (real time);
Welding Logs;
Resources; and
Settlement Logs.
D. STANDARD DRAWINGS AND SPECIFICATIONS
STANDARD DRAWINGS AND SPECIFICATIONS

Unless specifically amended in this documentation, all Works must be undertaken in accordance with the requirements of the current edition of the Principal’s Standard Specifications and Drawings:


• The SEQ WS&S D&C Code can be obtained from the following website: http://www.seqcode.com.au.

• City of Gold Coast Water’s Water and Sewerage Network – Supplementary Mechanical and Electrical Specifications (Refer to Attachment B).

• Gold Coast City Council Standard Specification SS1 – Specification for Construction of Sewerage Mains and Associated Works

• Gold Coast City Council Standard Specification SS3 – Specification for Clearing and Grubbing for Infrastructure, Roadways and Designated Areas

• Gold Coast City Council Standard Specification SS4 – Specification for Earthworks and Imported Topsoil

• Gold Coast City Council Standard Specification SS7 – Specification for Unbound Pavements

• Gold Coast City Council Standard Specification SS8 – Specification for Asphalt Surfacing

• Gold Coast City Council Standard Specification SS9 – Specification for Spray Sealing


Works not adequately covered by the above Standard Specifications must be delivered in accordance with the following standards:

• Australian Standards/British Standards/American National Standards/Institute Standards.

• Current Manufacturer’s Standards and Specifications.