SS10

SEWAGE TREATMENT PLANT

PLANNING, DESIGN, CONSTRUCTION, COMMISSIONING AND ASSIMILATION SPECIFICATIONS

MASTER VERSION

VERSION Sept 2018
# TABLE OF CONTENTS

## 1 SECTION 1 OVERVIEW

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>OVERVIEW</td>
</tr>
<tr>
<td>1.2</td>
<td>SECTION 2 - DESIGN AND PLANNING</td>
</tr>
<tr>
<td>1.3</td>
<td>SECTION 3 – INTEGRATION</td>
</tr>
<tr>
<td>1.4</td>
<td>SECTION 4 – ASSEMBLY</td>
</tr>
<tr>
<td>1.5</td>
<td>SECTION 5 – MATERIALS</td>
</tr>
<tr>
<td>1.6</td>
<td>SECTION 6 – AUDITING</td>
</tr>
<tr>
<td>1.7</td>
<td>GLOSSARY</td>
</tr>
<tr>
<td>1.8</td>
<td>ABBREVIATIONS</td>
</tr>
</tbody>
</table>

## 2 SECTION 2 - DESIGN AND PLANNING

<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>OVERVIEW</td>
</tr>
<tr>
<td>2.2</td>
<td>PLANNING AND DESIGN – ALL WATER AND SEWAGE ASSETS</td>
</tr>
<tr>
<td>2.3</td>
<td>ENGINEERING DRAWINGS</td>
</tr>
<tr>
<td>2.4</td>
<td>ACTS, REGULATIONS AND LOCAL LAWS</td>
</tr>
<tr>
<td>2.5</td>
<td>DESIGN APPROVAL</td>
</tr>
<tr>
<td>2.6</td>
<td>ASSET MANAGEMENT OBJECTIVES</td>
</tr>
<tr>
<td>2.7</td>
<td>WORKPLACE HEALTH AND SAFETY COMPLIANCE</td>
</tr>
<tr>
<td>2.8</td>
<td>CUSTOMER SERVICE STANDARDS</td>
</tr>
<tr>
<td>2.9</td>
<td>SEWAGE TREATMENT PLANTS – DESIGN REQUIREMENTS</td>
</tr>
<tr>
<td>2.9.1</td>
<td>Design, Drafting and Documentation</td>
</tr>
<tr>
<td>2.9.2</td>
<td>Engineering Responsibility</td>
</tr>
<tr>
<td>2.9.3</td>
<td>Overall Design</td>
</tr>
<tr>
<td>2.9.4</td>
<td>Visits to Site- Detailed Design</td>
</tr>
<tr>
<td>2.9.5</td>
<td>Finished Levels and Other Design Constraints</td>
</tr>
<tr>
<td>2.9.6</td>
<td>Design Criteria</td>
</tr>
<tr>
<td>2.9.7</td>
<td>Design Deliverables</td>
</tr>
<tr>
<td>2.9.8</td>
<td>Project Design Management Plan</td>
</tr>
<tr>
<td>2.9.9</td>
<td>Detailed Design Certification</td>
</tr>
<tr>
<td>2.9.10</td>
<td>Design Submittals</td>
</tr>
<tr>
<td>2.9.11</td>
<td>Contractor's Project Drawings</td>
</tr>
<tr>
<td>2.9.12</td>
<td>Hazard Identification and Operability Studies and Reports</td>
</tr>
<tr>
<td>2.9.13</td>
<td>Hazardous Area Classification and Report</td>
</tr>
<tr>
<td>2.9.14</td>
<td>Noise Surveys and Reports</td>
</tr>
<tr>
<td>2.9.15</td>
<td>Safety of Machinery Report</td>
</tr>
<tr>
<td>2.9.16</td>
<td>Failure Modes and Effects Analysis Report</td>
</tr>
<tr>
<td>2.9.17</td>
<td>Renewals Forecasting and Operations and Maintenance Cost Projections Report</td>
</tr>
<tr>
<td>2.9.18</td>
<td>Functional Description Statement</td>
</tr>
<tr>
<td>2.9.19</td>
<td>Operational Software</td>
</tr>
<tr>
<td>2.9.20</td>
<td>Design Report</td>
</tr>
<tr>
<td>2.9.21</td>
<td>Hazard Analysis and Critical Control Points (HACCP)</td>
</tr>
<tr>
<td>2.9.22</td>
<td>Risk Elimination in Design</td>
</tr>
<tr>
<td>2.9.23</td>
<td>Asset Management</td>
</tr>
<tr>
<td>2.9.24</td>
<td>Asset Design Life</td>
</tr>
<tr>
<td>2.9.25</td>
<td>Operability, Functionality &amp; Maintainability</td>
</tr>
<tr>
<td>2.9.26</td>
<td>Specific Requirements – Choice of Materials</td>
</tr>
<tr>
<td>2.9.27</td>
<td>Access to Components and Equipment</td>
</tr>
<tr>
<td>2.9.28</td>
<td>Operational Manuals, Operational Procedures and Maintenance Manuals</td>
</tr>
<tr>
<td>2.9.29</td>
<td>Operational Manuals</td>
</tr>
<tr>
<td>2.9.30</td>
<td>Maintenance Manuals</td>
</tr>
<tr>
<td>2.9.31</td>
<td>Equipment Schedules and Lists, Parts Listings and Technical Data</td>
</tr>
<tr>
<td>2.9.32</td>
<td>Operator / Maintainer Training Requirements</td>
</tr>
<tr>
<td>2.9.33</td>
<td>Training Plan</td>
</tr>
<tr>
<td>2.9.34</td>
<td>Training Modules</td>
</tr>
<tr>
<td>2.9.35</td>
<td>Vendor/ Supplier Information</td>
</tr>
<tr>
<td>2.9.36</td>
<td>Initial Maintenance Strategy</td>
</tr>
<tr>
<td>2.9.37</td>
<td>SAP Asset Management System</td>
</tr>
<tr>
<td>2.9.38</td>
<td>Special Tools and Support Equipment</td>
</tr>
<tr>
<td>2.9.39</td>
<td>Consumables, Initial Critical Spare Parts and Spare Parts</td>
</tr>
<tr>
<td>2.9.40</td>
<td>Renewals Forecasting and Operations and Maintenance Cost Projections</td>
</tr>
<tr>
<td>2.9.41</td>
<td>Process Unit Requirements</td>
</tr>
<tr>
<td>2.9.42</td>
<td>Scour, General Purpose and Drainage Pump Stations</td>
</tr>
<tr>
<td>2.9.43</td>
<td>Chemical Storage and Handling Systems</td>
</tr>
</tbody>
</table>
SECTION 3 – INTEGRATION REQUIREMENTS

3.1 SS10 WATER AND SEWAGE INFRASTRUCTURE REQUIREMENTS

3.1.1 Introduction

3.1.2 Water and sewage Asset Delivery - Inspections, Bonds, Emergency Repair Bond, Fees And Charges

3.1.3 City of Gold Coast Inspections

3.1.4 Factory Acceptance Testing – Mechanical Installations

3.1.5 Inspections Checking And Testing – Electrical Installations

3.1.6 Maintenance - After Hours Emergency Repair - Bond

3.2 ASSET DATA REQUIREMENTS

3.2.1 Asset and Equipment Numbering and Naming

3.2.2 Non-Linear Assets

3.2.3 Drawings

3.2.4 Checking Of Drawings Prior To Submission

3.2.5 Engineering Drawing - Application Checklist

3.2.6 Design Calculations

3.2.7 Submission Of Engineering Drawings/Job Specification

3.2.8 Re-Submission Of Engineering Drawings And Job Specification

3.2.9 Approvals Subject To Amendments

3.2.10 Approved Engineering Drawings

3.2.11 Mechanical and Electrical Drawings

3.3 WATER, RECYCLED WATER AND SEWAGE NETWORK SCADA

3.3.1 SCADA Control Philosophy

3.3.2 Water System - SCADA

3.3.3 Wastewater System - SCADA

3.4 OPERATING AND MAINTENANCE MANUALS (EXCLUDING TREATMENT PLANTS)

3.4.1 Submission and Acceptance Of Manuals

3.4.2 Skill Levels

3.4.3 Training

3.5 DECOMMISSIONING INCLUDING TREATMENT OF ABANDONED/OBsolescent ASSETS

3.5.1 Retention of Decommissioned Infrastructure and Remains In City of Gold Coast Ownership

3.5.2 Removal of Decommissioned Infrastructure and Remains In City of Gold Coast Ownership

3.5.3 Removal of Decommissioned Infrastructure and Is Sold By City of Gold Coast

3.6 HANDOVER –ACCEPTANCE OF ASSETS

3.6.1 Water and sewage Projects and Developments

3.6.2 Wastewater Treatment Plant Projects

3.7 VALUATION AND CAPITALISATION

3.8 ENGINEERING DRAWINGS - APPLICATION CHECKLIST

3.9 SPECIFIC INTEGRATION REQUIREMENTS – TREATMENT PLANTS

3.9.1 Handover Deliverables

3.9.2 Plant Information Portal

3.9.3 Work As Constructed Drawings

3.9.4 Progressive Recording of As Constructed Drawing Information

3.9.5 Review and Acceptance of As-Constructed Information

3.9.6 Certification of As Constructed Information

3.9.7 As-Constructed Information and Defects Liability Period

3.9.8 Schedules and Lists

3.9.9 Training Modules

3.9.10 Vendors/Suppliers

3.9.11 Maintenance Schedules

3.9.12 SAP Asset Management Schedule

4 SECTION 4 – ASSEMBLY
<table>
<thead>
<tr>
<th>Section</th>
<th>Title</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>COMMON REQUIREMENTS – ALL ASSETS</td>
<td>108</td>
</tr>
<tr>
<td>4.1.1</td>
<td>Definitions</td>
<td>108</td>
</tr>
<tr>
<td>4.1.2</td>
<td>Compliance with Requirements of Standards</td>
<td>108</td>
</tr>
<tr>
<td>4.1.3</td>
<td>ACTS, REGULATIONS AND LOCAL LAWS</td>
<td>109</td>
</tr>
<tr>
<td>4.1.4</td>
<td>Packing, Marking and Identification (Asset Numbering)</td>
<td>109</td>
</tr>
<tr>
<td>4.1.5</td>
<td>Factory Acceptance Testing</td>
<td>109</td>
</tr>
<tr>
<td>4.1.6</td>
<td>Safety</td>
<td>109</td>
</tr>
<tr>
<td>4.1.7</td>
<td>Assets – Typical Size of</td>
<td>110</td>
</tr>
<tr>
<td>4.1.8</td>
<td>Corrosion Protection (Excludes Treatment Plants – Own Clause)</td>
<td>111</td>
</tr>
<tr>
<td>4.2</td>
<td>COMMON ASSEMBLY REQUIREMENTS – CIVIL: ALL WATER AND SEWAGE ASSEMBLY</td>
<td>112</td>
</tr>
<tr>
<td>4.2.1</td>
<td>Existing Services</td>
<td>112</td>
</tr>
<tr>
<td>4.2.2</td>
<td>Clearing and Grubbing</td>
<td>112</td>
</tr>
<tr>
<td>4.2.3</td>
<td>Erosion And Sediment Control</td>
<td>113</td>
</tr>
<tr>
<td>4.2.4</td>
<td>Care Of Real Property Survey Pegs</td>
<td>113</td>
</tr>
<tr>
<td>4.2.5</td>
<td>Care Of Existing Fences</td>
<td>113</td>
</tr>
<tr>
<td>4.2.6</td>
<td>Work Within Private Property</td>
<td>113</td>
</tr>
<tr>
<td>4.2.7</td>
<td>Work Within Road Reserves</td>
<td>113</td>
</tr>
<tr>
<td>4.2.8</td>
<td>Setting Out Work</td>
<td>114</td>
</tr>
<tr>
<td>4.2.9</td>
<td>Excavation</td>
<td>114</td>
</tr>
<tr>
<td>4.2.10</td>
<td>Trench Construction</td>
<td>116</td>
</tr>
<tr>
<td>4.2.11</td>
<td>State-Controlled Roads</td>
<td>118</td>
</tr>
<tr>
<td>4.2.12</td>
<td>Jointing Of Pipes and Associated Fittings</td>
<td>118</td>
</tr>
<tr>
<td>4.2.13</td>
<td>Jointing of PE Pipes and Fittings</td>
<td>119</td>
</tr>
<tr>
<td>4.2.14</td>
<td>Wrapping of Flanges and Mechanical Joints</td>
<td>120</td>
</tr>
<tr>
<td>4.2.15</td>
<td>Pipe Welding</td>
<td>121</td>
</tr>
<tr>
<td>4.2.16</td>
<td>Earthing Of Pipes During Construction</td>
<td>125</td>
</tr>
<tr>
<td>4.2.17</td>
<td>Boring And Jacking</td>
<td>125</td>
</tr>
<tr>
<td>4.2.18</td>
<td>Grouting Around Pipelines</td>
<td>127</td>
</tr>
<tr>
<td>4.2.19</td>
<td>Thrusts and Reception Pits</td>
<td>127</td>
</tr>
<tr>
<td>4.2.20</td>
<td>Restoration Works</td>
<td>128</td>
</tr>
<tr>
<td>4.2.21</td>
<td>‘As-Constructed’ Submission</td>
<td>128</td>
</tr>
<tr>
<td>4.2.22</td>
<td>Water Mains – City of Gold Coast Records Tolerance</td>
<td>128</td>
</tr>
<tr>
<td>4.2.23</td>
<td>Measurement And Payment</td>
<td>129</td>
</tr>
<tr>
<td>4.3</td>
<td>COMMON ASSEMBLY REQUIREMENTS – MECHANICAL INSTALLATIONS</td>
<td>131</td>
</tr>
<tr>
<td>4.3.1</td>
<td>Scope</td>
<td>131</td>
</tr>
<tr>
<td>4.3.2</td>
<td>Valves</td>
<td>131</td>
</tr>
<tr>
<td>4.3.3</td>
<td>Submersible Pump Units</td>
<td>132</td>
</tr>
<tr>
<td>4.3.4</td>
<td>Vacuum Generator / Pumps</td>
<td>134</td>
</tr>
<tr>
<td>4.3.5</td>
<td>Pump Maintenance And Repair Requirements</td>
<td>134</td>
</tr>
<tr>
<td>4.3.6</td>
<td>Safety</td>
<td>134</td>
</tr>
<tr>
<td>4.3.7</td>
<td>Specific Maintenance Requirements For Pump Wells Wet Wells</td>
<td>134</td>
</tr>
<tr>
<td>4.3.8</td>
<td>Pump Backup Requirements</td>
<td>134</td>
</tr>
<tr>
<td>4.3.9</td>
<td>Piping Equipment</td>
<td>135</td>
</tr>
<tr>
<td>4.3.10</td>
<td>Equipment And Plant Access</td>
<td>140</td>
</tr>
<tr>
<td>4.3.11</td>
<td>Mechanical Ventilation</td>
<td>141</td>
</tr>
<tr>
<td>4.3.12</td>
<td>Air Conditioners, Exhaust Fans, Wall Mounted Fans And Roof Mounted Fans</td>
<td>142</td>
</tr>
<tr>
<td>4.3.13</td>
<td>Odour Control</td>
<td>143</td>
</tr>
<tr>
<td>4.4</td>
<td>SPECIFIC ASSEMBLY REQUIREMENTS – CIVIL &amp; MECHANICAL TREATMENT PLANTS</td>
<td>144</td>
</tr>
<tr>
<td>4.4.1</td>
<td>General Requirements</td>
<td>144</td>
</tr>
<tr>
<td>4.4.2</td>
<td>Standards</td>
<td>145</td>
</tr>
<tr>
<td>4.4.3</td>
<td>General Mechanical Component Requirements</td>
<td>147</td>
</tr>
<tr>
<td>4.4.4</td>
<td>Pipework And Fittings</td>
<td>153</td>
</tr>
<tr>
<td>4.4.5</td>
<td>Valves</td>
<td>155</td>
</tr>
<tr>
<td>4.4.6</td>
<td>Pipework Installation</td>
<td>158</td>
</tr>
<tr>
<td>4.4.7</td>
<td>Stop Boards, Slide Gates, Stop Logs And Penstocks</td>
<td>159</td>
</tr>
<tr>
<td>4.4.8</td>
<td>Penstock And Valve Actuators</td>
<td>163</td>
</tr>
<tr>
<td>4.4.9</td>
<td>Pumps</td>
<td>164</td>
</tr>
<tr>
<td>4.4.10</td>
<td>Band Screens</td>
<td>171</td>
</tr>
<tr>
<td>4.4.11</td>
<td>Screenings Handling Equipment</td>
<td>175</td>
</tr>
<tr>
<td>4.4.12</td>
<td>Grit Removal And Handling Facilities</td>
<td>177</td>
</tr>
<tr>
<td>4.4.13</td>
<td>Dewatered Screenings And Grit Conveyors</td>
<td>179</td>
</tr>
<tr>
<td>4.4.14</td>
<td>Self Loading Bins</td>
<td>180</td>
</tr>
<tr>
<td>4.4.15</td>
<td>Emergency Bin</td>
<td>181</td>
</tr>
<tr>
<td>4.4.16</td>
<td>Air Blowers And Compressors</td>
<td>181</td>
</tr>
<tr>
<td>4.4.17</td>
<td>Electric Motors</td>
<td>183</td>
</tr>
<tr>
<td>4.4.18</td>
<td>Safety Showers And Eyewash Stations</td>
<td>185</td>
</tr>
<tr>
<td>4.4.19</td>
<td>Lifting Equipment</td>
<td>186</td>
</tr>
<tr>
<td>4.4.20</td>
<td>Corrosion Protection Treatment Plants</td>
<td>187</td>
</tr>
<tr>
<td>4.4.21</td>
<td>Building Specification</td>
<td>191</td>
</tr>
</tbody>
</table>
5 SECTION 5 – MATERIALS

5.1 COMMON MATERIAL REQUIREMENTS

5.1.1 Scope

5.1.2 Standards and Codes
5.2 COMMON MATERIAL REQUIREMENTS – CIVIL WATER AND SEWAGE INSTALLATIONS ….. 319
  5.2.1 Acts, Regulation, By-Law And Joint Committee .................................................. 319
  5.2.2 Bedding Material ................................................................................................... 319
  5.2.3 Backfilling ............................................................................................................ 319
  6.4.1 FACTORY ACCEPTANCE TESTING - MECHANICAL INSTALLATIONS ….. 360
  6.4.2 Pressure Pipe Fittings .......................................................................................... 360
  6.4.3 Polyethylene Pipe Sleeking and Marker Tape ....................................................... 360
  6.4.4 Jointing Systems .................................................................................................. 360
  6.4.5 Valves .................................................................................................................. 360
  6.4.6 Protective Coating ............................................................................................... 360
  6.5.1 City of Gold Coast Inspections ........................................................................... 350
  6.5.2 Specific FAT Requirements ................................................................................ 350
  6.5.3 Chemical System Testing ................................................................................... 350
  6.5.4 Pressure Pipe Fittings .......................................................................................... 350
  6.5.5 Components ........................................................................................................ 350
  6.5.6 Polyethylene Pipe Sleeking and Marker Tape ...................................................... 350
  6.5.7 Jointing Systems .................................................................................................. 350
  6.5.8 Valves .................................................................................................................. 350
  6.5.9 Protective Coating ............................................................................................... 350

5.3 COMMON MATERIAL REQUIREMENTS - MECHANICAL INSTALLATIONS ….. 333
  5.3.1 General ................................................................................................................ 333
  5.3.2 Structural Steel .................................................................................................... 333
  5.3.3 Treatment Plant Pipework And Fittings ............................................................... 333
  5.3.4 uPVC Pipe And Fittings ...................................................................................... 333
  5.3.5 Ductile Iron (DI) Pipe ........................................................................................ 333
  5.3.6 Steel Pipe ............................................................................................................ 333
  5.3.7 Glass Reinforced Plastic Pipe (GRP) Pipe .......................................................... 333
  5.3.8 MDPE Pipe ......................................................................................................... 333
  5.3.9 Reinforced Concrete Pipe ................................................................................... 333
  5.3.10 ABS Pipe ......................................................................................................... 333
  5.3.11 Copper Pipe ...................................................................................................... 333
  5.3.12 Polyethylene Pipe Sleeking .............................................................................. 333
  5.3.13 Above Ground Installations .............................................................................. 333
  5.3.14 Treatment Plant Valves .................................................................................... 333
  5.3.15 Pumping Equipment ......................................................................................... 333
  5.3.16 Pump Wells, Wet Wells and Valve Pits ............................................................. 333
  5.3.17 Hoisting Equipment .......................................................................................... 333

6.1 COMMON AUDITING REQUIREMENTS ................................................................. 350
  6.1.1 City of Gold Coast Inspections ........................................................................... 350
  6.2 SPECIFIC TESTING REQUIREMENTS - WATER ............................................. 352
  6.2.1 Hydraulic Pressure Testing Of Water Mains ......................................................... 352
  6.2.2 Water Quality Testing ......................................................................................... 352
  6.2.3 Dual Water Service Commissioning And Tests ................................................ 352

6.3 SPECIFIC TESTING REQUIREMENTS - WASTEWATER ..................................... 355
  6.3.1 Testing Of Gravity Sewers and Maintenance Shafts ............................................. 355
  6.3.2 Air Testing General ............................................................................................ 355
  6.3.3 Air Testing – Pressure ....................................................................................... 355
  6.3.4 Air Testing – Vacuum ....................................................................................... 355
  6.3.5 Ovally Testing .................................................................................................... 355
  6.3.6 Closed Circuit Colour TV Inspection (CCCTV) ................................................ 355
  6.3.7 Testing Of Pressure Mains ................................................................................ 355
  6.3.8 Manhole And Wet Well Testing ......................................................................... 355
  6.3.9 Cleaning Of Sewerage Reticulation System ....................................................... 355
  6.3.10 Certification Of Concrete And Warranty For Protective Coating Of Wet Wells 355
  6.3.11 SPECIFIC TESTING REQUIREMENTS - LAYING OF STEEL PIPE ............. 355
  6.3.12 Pipe Welding .................................................................................................... 355

6.4 COMMON TESTING REQUIREMENTS –MECHANICAL INSTALLATIONS ….. 360
  6.4.1 Factory Acceptance Testing - Mechanical .......................................................... 360
  6.4.2 Specific FAT Requirements ................................................................................ 360
  6.4.3 Chemical System Testing ................................................................................... 360
  6.4.4 Pressure Pipe Fittings .......................................................................................... 360
  6.4.5 Components ........................................................................................................ 360
  6.4.6 Protective Coating ............................................................................................... 360

6.5 COMMON TESTING REQUIREMENTS – ELECTRICAL INSTALLATIONS ....... 361
  6.5.1 Prior Delivery Inspections And Tests ................................................................. 361
  6.5.2 Testing Documentation Requirements ............................................................... 361
  6.5.3 Factory Acceptance Tests -Electrical ............................................................... 361
  6.5.4 Control and Instrumentation System ................................................................... 361
  6.5.5 Electric Motors ................................................................................................. 361
  6.5.6 Protective Devices ............................................................................................ 361
Section 1 Overview

SS10 Water and Sewage Infrastructure Requirements

Section of SS10

<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 1</td>
<td>SS10 Synopsis</td>
</tr>
<tr>
<td>Section 2</td>
<td>Planning and Design</td>
</tr>
<tr>
<td>Section 3</td>
<td>Integration</td>
</tr>
<tr>
<td>Section 4</td>
<td>Component Design and Assembly</td>
</tr>
<tr>
<td>Section 5</td>
<td>Materials</td>
</tr>
<tr>
<td>Section 6</td>
<td>Auditing</td>
</tr>
</tbody>
</table>

Revision Register

<table>
<thead>
<tr>
<th>Date</th>
<th>Reference Section</th>
<th>Description of Revision</th>
<th>Author</th>
<th>Authorised by</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sept 10</td>
<td>All</td>
<td>Issue for STP projects</td>
<td>LW</td>
<td>LW</td>
</tr>
</tbody>
</table>
1.1 Overview
SS10 provides Developers, Consultants, Project Managers with the standards and specifications necessary to design, construct and handover water and sewage assets. SS10 has been broken into sections:

- Overview & Glossary
- Design and Planning
- Integration
- Assembly
- Materials
- Auditing
- Drawings

1.2 Section 2 - Design and Planning
The "Planning and Design" section describes the City of Gold Coast over-arching principles and guidelines to be applied to the planning and design of all water and sewage related assets as outlined below:-

- Water and Recycled Water
- Pipes
- Pump Stations
- Reservoirs
- Chlorination Stations
- Wastewater
- Gravity Mains & Manholes
- Pressure Mains
- Pump Stations
- Treatment plants
- Odour Control Stations

1.3 Section 3 – Integration
This section defines City of Gold Coast requirements for the integration management of new assets including data formats, asset management data, system control, fees and charges. It will define standards for:

- Data formats
- Asset Register Information
- Asset numbering and naming conventions
- Asset Maintenance Schedules
- Control philosophies
- SCADA/Telemetry/Communications
GCW SS10 SECTION 1 SYNOPSIS

- Configuration and System Integration with City of Gold Coast systems
- Handover of assets
- Decommissioning
- Evaluation & Capitalisation

1.4 Section 4 – Assembly

“Assembly” describes the physical requirements (specifications) for typical infrastructure and should be read in close conjunction with “Design and Planning” section. A list of the drawings and their respective numbers is located in Appendices A, B, C and D for reference. It should also be noted that a number of Australian Standards form parts of this document and must be referred to for details of materials, workmanship and construction procedures.

1.5 Section 5 – Materials

This section is provides users with a list of preferred materials and equipment for construction and design. The information within this section should be considered when selecting equipment.

1.6 Section 6 – Auditing

Testing and quality objectives make up the majority of the auditing section. The check lists attached as an appendix to the auditing section should be used and all hold points considered.

1.7 Glossary

<table>
<thead>
<tr>
<th>CCCTV</th>
<th>Closed Circuit Colour Television (CCCTV) are camera devices used to capture colour images on a set path. CCCTV is useful for pipeline inspection and other confined spaces.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dual Reticulation</td>
<td>Two separate pipe networks – one supplies drinking (potable) water and the other supplies recycled (Class A+) water</td>
</tr>
<tr>
<td>Linear Assets</td>
<td>Refers to static assets such as pipes, valves, Ts, bends, junctions, manholes, maintenance pits, pump station (building) and reservoir storage structures that are geographically distributed.</td>
</tr>
<tr>
<td>Non-linear</td>
<td>Non-linear assets include items such as electrical switchboards, water and sewage pumps, telemetry and other treatment plant components.</td>
</tr>
<tr>
<td>Maintenance</td>
<td>Work carried out to keep assets in working condition. Refer to the ‘C of GC Mechanical and Electrical Specification 9.4 and 9.5’ for inspection items.</td>
</tr>
</tbody>
</table>
| On Maintenance  | Following an “On maintenance” inspection, assets are placed on maintenance for a period of twelve (12) months, from the date of formal notification by City of Gold Coast. During this period, responsibility and liability for rectification of defects and for any damage that may occur lies with the developer, not the City of Gold Coast. Steps should be taken to prevent damage. For more information and a complete list of on maintenance inspection items refer to ‘C of GC Mechanical}
### GCW SS10 SECTION 1 SYNOPSIS

<table>
<thead>
<tr>
<th>Off Maintenance</th>
<th>The purpose of the “Off maintenance” inspection is to ensure that the constructed works have performed satisfactorily during the maintenance period and that any omissions and defects have been rectified. The Consultant is responsible for ensuring that the works are presented in accordance with the approved Engineering Drawings/Job Specification and accepted Engineering practice prior to requesting an “Off Maintenance” inspection. For a complete list of off maintenance inspection items refer to ‘C of GC Mechanical and Electrical Specification 9.5’.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potable Water (PW)</td>
<td>Water treated to a standard suitable for drinking and cooking</td>
</tr>
<tr>
<td>PLC</td>
<td>Programmable Logic Controller – these are devices equipped with a logic processor that monitors input signals (digital-[On or Off] and analog- [a value often a %]) and outputs digital or analogue control signals to control a process.</td>
</tr>
<tr>
<td>Recycled Water (RW)</td>
<td>Highly treated (Class A+) wastewater suitable for use for specific purposes; for example toilet flushing and irrigation of gardens and lawns.</td>
</tr>
<tr>
<td>SCADA</td>
<td>Supervisory Control and Data Acquisition – term is used to describe the control system used by operators to control and monitor the process of water and sewage reticulation, treatment and recycled water pumping.</td>
</tr>
<tr>
<td>Sewer</td>
<td>Pipeline or other construction, usually buried, designed to carry sewage/wastewater from more then one source.</td>
</tr>
<tr>
<td>Sewerage</td>
<td>Network of pipelines and ancillary works that conveys sewage to a treatment works or other place of disposal.</td>
</tr>
<tr>
<td>Sewage</td>
<td>See wastewater</td>
</tr>
<tr>
<td>Wastewater</td>
<td>Spent or used water with dissolved or suspended solids, discharged from homes, commercial establishments, farms, and industries.</td>
</tr>
<tr>
<td>Reticulation sewer</td>
<td>For the collection of wastewater from individual properties and conveyance to trunk sewers or to a point of treatment. Generally DN 100 to DN 300</td>
</tr>
<tr>
<td>Trunk Sewer</td>
<td>Principle sewer of a catchments system that drains to the point of treatment. Generally larger than DN 300.</td>
</tr>
<tr>
<td>City of Gold Coast Standard Drawings</td>
<td>These drawings are indexed in Appendix A,B &amp; C to this specification.</td>
</tr>
</tbody>
</table>
1.8 Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASHRAE</td>
<td>American Society of Heating, Refrigerating and Air-conditioning Engineers</td>
</tr>
<tr>
<td>ASS</td>
<td>Acid Sulfate Soils</td>
</tr>
<tr>
<td>CAD</td>
<td>Computer Aided Drafting</td>
</tr>
<tr>
<td>CPEng</td>
<td>Chartered Professional Engineer</td>
</tr>
<tr>
<td>CPT</td>
<td>Cone Penetration Test</td>
</tr>
<tr>
<td>DCS</td>
<td>Distributed Control System</td>
</tr>
<tr>
<td>EPA</td>
<td>Environment Protection Agency</td>
</tr>
<tr>
<td>FRP</td>
<td>Fibre Reinforced Plastic</td>
</tr>
<tr>
<td>GCCC</td>
<td>Gold Coast City Council</td>
</tr>
<tr>
<td>GRP</td>
<td>Glass Fibre Reinforced Plastic</td>
</tr>
<tr>
<td>AW</td>
<td>City of Gold Coast</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographic Information System</td>
</tr>
<tr>
<td>HACCP</td>
<td>Hazard Analysis and Critical Control Points</td>
</tr>
<tr>
<td>HAZCHEM</td>
<td>Hazardous Chemicals</td>
</tr>
<tr>
<td>HAZOP</td>
<td>Hazard and Operability</td>
</tr>
<tr>
<td>HMI</td>
<td>Human Machine Interface</td>
</tr>
<tr>
<td>ICA</td>
<td>Instrumentation, Control and Automation</td>
</tr>
<tr>
<td>ITP</td>
<td>Inspection and Test Plan</td>
</tr>
<tr>
<td>ITR</td>
<td>Inspection and Test Report</td>
</tr>
<tr>
<td>MCC</td>
<td>Motor Control Centre</td>
</tr>
<tr>
<td>MHC</td>
<td>Maximum Hydraulic Capacity</td>
</tr>
<tr>
<td>MLC</td>
<td>Motor Load Centre</td>
</tr>
<tr>
<td>NATA</td>
<td>National Association of Testing Authorities</td>
</tr>
<tr>
<td>NB</td>
<td>Nominal Bore</td>
</tr>
<tr>
<td>NPER3</td>
<td>National Professional Engineer Register – Level 3</td>
</tr>
<tr>
<td>OCF</td>
<td>Odour Control Facility</td>
</tr>
<tr>
<td>OPEX</td>
<td>Operational Expenditure</td>
</tr>
<tr>
<td>OH&amp;S</td>
<td>Occupational Health and Safety</td>
</tr>
<tr>
<td>PC</td>
<td>Personal Computer</td>
</tr>
<tr>
<td>PCEMP</td>
<td>Project Environmental and Constructional Management Plan</td>
</tr>
<tr>
<td>PLC</td>
<td>Programmable Logic Controller</td>
</tr>
<tr>
<td>PST</td>
<td>Primary Sedimentation Tank</td>
</tr>
<tr>
<td>PTA</td>
<td>Preliminary Treatment Area</td>
</tr>
<tr>
<td>QAS</td>
<td>Quality Assurance System</td>
</tr>
<tr>
<td>RCM</td>
<td>Reliability Centred Maintenance</td>
</tr>
<tr>
<td>RPEQ</td>
<td>Registered Professional Engineer Queensland</td>
</tr>
<tr>
<td>SCA</td>
<td>Switchgear and Controlgear Assembly</td>
</tr>
<tr>
<td>SCADA</td>
<td>Supervisory Control and Data Acquisition</td>
</tr>
<tr>
<td>SPT</td>
<td>Standard Penetration Test</td>
</tr>
<tr>
<td>UPS</td>
<td>Uninterruptible Power Supply</td>
</tr>
<tr>
<td>UHMWPE</td>
<td>Ultra High Molecular Weight Polyethylene</td>
</tr>
<tr>
<td>WHS</td>
<td>Workplace Health and Safety</td>
</tr>
<tr>
<td>WLC</td>
<td>Whole of Life Cost</td>
</tr>
<tr>
<td>STP</td>
<td>Wastewater Treatment Plant</td>
</tr>
</tbody>
</table>
2 Section 2 - Design and Planning

2.1 Overview
This Section is segregated as follows:-

a) Planning and Design requirements for all asset classes.
b) Planning and Design requirements for all Sewage Treatment Plants.

2.2 Planning and Design – All Water and sewage Assets

General
All water and sewer supply system mains shall be designed in accordance with the following provisions:

a) The current Department of Natural Resources and Water ‘Planning Guidelines for Water and Wastewater’
b) SEQ Water Supply and Sewage Design and Construction Code.
c) City of Gold Coast general criteria as set out in these Guidelines and City of Gold Coast Standard Specifications and Drawings that are based on the Desired Standards of Service

The designer shall note the Queensland Workplace Health and Safety - Guide to the workplace health and safety obligations of designers of structures and the design shall include the required Safety

2.3 Engineering Drawings
Submission of drawings shall comply with drawing standards summarized in Section 3 clause “Drawings”.

2.4 Acts, Regulations and Local Laws

a) The Contractor shall comply with all Acts, Local Laws and Regulations having jurisdiction over work under the Contract and shall be fully responsible for any breaches thereof.

b) Notwithstanding the requirements of this specification the whole of the work under the Contract shall be executed in conformity with the relevant sections of the Water Act 2000 (as amended), the Environmental Protection Act, the Environmental Protection Regulation, the Workplace Health and Safety Act and any Construction Safety Plans required by this Act and all other Queensland and Australian Acts and Regulations.

c) The Contractor is advised that City of Gold Coast has Occupational Health and Safety Guidelines that shall be reviewed and used as appropriate. These Guidelines are available for viewing at City of Gold Coast Nerang centre.

2.5 Design Approval
All designs shall be approved by either a:

1. A RPEQ registered engineer in Queensland in the relevant discipline of engineering applicable to the design provided.
2. A NPER3 nationally registered engineer in the relevant discipline of engineering applicable to the design provided.
3. An internationally recognised qualification provided substantiation of documentation is provided and is equivalent to a NPER3 qualification.

2.6 Asset Management Objectives

A. Life Cycle Cost Minimisation

The fundamental objective of City of Gold Coast asset management processes is to ensure that the business provides services at the lowest possible whole-of-life cost, whilst also ensuring that the provision of those services has minimal negative impact on the community, the environment and both occupational and public safety. To achieve these objectives, all designs for new or reconfigured AW assets must have considered the balance between initial capital cost and the long term operation and maintenance costs. Minimising the recurrent costs of maintenance and operation through careful design and equipment selection shall be the main design objective. All designs should ensure that future energy and chemical consumption is minimised. Where possible, designers and constructors should ensure that City of Gold Coast commitment to a reduction in its ‘carbon footprint’ is considered in all parts of the process. Asset solutions which differ from the specified requirements of this document may be offered by the specifier or designer for consideration where a robust case can be made for an improved whole of life cost outcome. However, City of Gold Coast is under no obligation to consider or accept any alternative solutions.

B. Life Cycle Costs

When considering life cycle costs, the term life cycle refers to the overall system or functional unit thereof and not the life of the individual component parts. If a component is likely to be replaced one or more times during the economic life of the system, the life cycle cost of that component part shall be considered as the sum of the costs of the original component and all of its replacements. The component having the necessary functionality and the greatest life per dollar cost (inclusive of acquisition, maintenance and operation costs) is therefore the preferred component.

In selecting the materials for construction and fabrication of structures and incorporation into components and equipment, the design shall consider the durability, expected economic life of the components and equipment and required maintenance for the express conditions at the Plant. AS2312 shall be used as a guide.

The design intent includes a requirement to achieve a level of durability that will allow the Plant to reach its assumed economic life as stated above with minimal operating and maintenance costs. The Contractor shall, in the Design Report, demonstrate how this and other design intent shall be achieved.

Where the anticipated service life of an item of equipment is shorter than the specified economic life of the Plant, it shall be demonstrated to the satisfaction of the Superintendent that the choice of such equipment, allowing for its replacement one or more times during the life of the Plant, will support optimising the life cycle cost of the Plant. This analysis need only consider the Works undertaken by the Contractor in the context of the Plant but does not include an analysis of the whole of the Plant.

In optimising the life cycle cost of the Works undertaken by the Contractor in the context of the Plant, the cost of chemicals shall be included. It should also be noted that designs for new assets shall not adversely affect the life cycle cost of any existing City of Gold Coast assets and designers shall be able to demonstrate, if requested, that adequate consideration has been given to this matter. Where requested by City of Gold Coast a net present value analysis shall be provided. Criteria for the analysis will be provided by the Superintendent.

C. Asset Design Lives

It is recognised that all water and sewage systems have component parts with differing design lives. However, all water and sewage systems 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 the table below:

**Table: Typical Minimum Design Lives**

<table>
<thead>
<tr>
<th>Item</th>
<th>Minimum Design Life (yrs)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Pipelines</strong></td>
<td></td>
</tr>
<tr>
<td>Fibre Reinforced Cement (FRC)</td>
<td>60</td>
</tr>
<tr>
<td>Reinforced Concrete - plastilined (RC)</td>
<td>80</td>
</tr>
<tr>
<td>Mild Steel Cement Lined (MSCL)</td>
<td>80</td>
</tr>
<tr>
<td>Mild Steel unlined (MSUL)</td>
<td>50</td>
</tr>
<tr>
<td>Cast Iron Cement Lined (CICL)</td>
<td>80</td>
</tr>
<tr>
<td>Ductile Iron Cement Lined (DICL)</td>
<td>80</td>
</tr>
<tr>
<td>Cast Iron unlined (CIUL)</td>
<td>50</td>
</tr>
<tr>
<td>Polyethylene (PE)</td>
<td>80</td>
</tr>
<tr>
<td>Fusion-Bonded Medium-Density Polyethylene (FBMDPE)</td>
<td>80</td>
</tr>
<tr>
<td>Polypropylene (PP)</td>
<td>80</td>
</tr>
<tr>
<td>Unplasticized Polyvinyl Chloride (uPVC)</td>
<td>80</td>
</tr>
<tr>
<td>Glass Reinforced Plastic (GRP)</td>
<td>80</td>
</tr>
<tr>
<td><strong>Cathodic Protection</strong></td>
<td></td>
</tr>
<tr>
<td>Ground Beds</td>
<td>10</td>
</tr>
<tr>
<td>Bonding Cables</td>
<td>80</td>
</tr>
<tr>
<td>Electrical Systems</td>
<td>20</td>
</tr>
<tr>
<td><strong>Drains</strong></td>
<td></td>
</tr>
<tr>
<td>Earthworks</td>
<td>150</td>
</tr>
<tr>
<td>Concrete Linings</td>
<td>50</td>
</tr>
<tr>
<td>Drainage Inlets/Outlets (rock)</td>
<td>20</td>
</tr>
<tr>
<td>Drainage Inlets/Outlets (concrete)</td>
<td>50</td>
</tr>
<tr>
<td>Drainage Culverts (concrete)</td>
<td>80</td>
</tr>
<tr>
<td><strong>Storages/Tanks/Reservoirs/Ponds</strong></td>
<td></td>
</tr>
<tr>
<td>Earth Fill Storages/ponds</td>
<td>100</td>
</tr>
<tr>
<td>Reservoirs (reinforced concrete)</td>
<td>80</td>
</tr>
<tr>
<td>Reservoirs (steel)</td>
<td>50</td>
</tr>
<tr>
<td>Process Vessels (reinforced concrete)</td>
<td>80</td>
</tr>
<tr>
<td>Process Vessels (steel)</td>
<td>50</td>
</tr>
<tr>
<td>FRP/GRP/Plastic tanks</td>
<td>25</td>
</tr>
<tr>
<td><strong>Buildings</strong></td>
<td></td>
</tr>
<tr>
<td>Concrete</td>
<td>80</td>
</tr>
<tr>
<td>Brick Veneer</td>
<td>55</td>
</tr>
<tr>
<td>Steel</td>
<td>50</td>
</tr>
<tr>
<td><strong>Structures</strong></td>
<td></td>
</tr>
<tr>
<td>Reinforced Concrete (major)</td>
<td>80</td>
</tr>
<tr>
<td>Reinforced Concrete (minor)</td>
<td>50</td>
</tr>
<tr>
<td>Steel</td>
<td>50</td>
</tr>
<tr>
<td>Aluminium</td>
<td>60</td>
</tr>
<tr>
<td>Timber</td>
<td>40</td>
</tr>
<tr>
<td>Stairs and Platforms</td>
<td>25</td>
</tr>
<tr>
<td>Protective coatings on steelwork</td>
<td>20</td>
</tr>
<tr>
<td>Protective coatings on concrete</td>
<td>20</td>
</tr>
<tr>
<td><strong>Rocks</strong></td>
<td></td>
</tr>
<tr>
<td>Earthworks</td>
<td>150</td>
</tr>
<tr>
<td>Bitumen</td>
<td>30</td>
</tr>
<tr>
<td>Gravel</td>
<td>30</td>
</tr>
<tr>
<td><strong>Mechanical and Electrical Equipment</strong></td>
<td></td>
</tr>
<tr>
<td>Pumps Large (&gt;300kW)</td>
<td>60</td>
</tr>
<tr>
<td>Pumps Medium (&gt;20kW&lt;300kW)</td>
<td>40</td>
</tr>
<tr>
<td>Pumps Small (&lt;20kW)</td>
<td>20</td>
</tr>
</tbody>
</table>
## D. Component and Equipment Selection

Preference shall be given to the selection of equipment that meets the following criteria whenever possible:

- Compliance with the Accepted Suppliers List
- Simplicity in concept and operation
- Sturdiness of manufacture
- Suitability to its operating environment
- Interchangeability and commonality with other equipment
- Modularity
- Low preventative maintenance requirements
- Maintenance support availability
- Spares availability for the life of the component
- Energy efficiency
- Parts and consumables efficiency
- Lowest long term ownership costs
- Lowest ‘carbon footprint’ during manufacture and delivery
- Functionality, Operability, Maintainability and Reliability
- All designs shall be able to demonstrate an effective consideration of:
  - Functionality – efficiency of operation; suitability for intended function
  - Operability – safety in operating environment; low requirement for operator intervention; ease of use, flexibility in operation
  - Maintainability – ease of access and general preventative maintenance; ease of troubleshooting; capability of undertaking maintenance without environmental or OH&S risk; availability of parts; minimised mean time to repair, modularity

<table>
<thead>
<tr>
<th>Component/Equipment</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motors Large (300kW)</td>
<td>60</td>
</tr>
<tr>
<td>Motors Medium (20kW&lt;300kW)</td>
<td>40</td>
</tr>
<tr>
<td>Motors Small (&lt;20kW)</td>
<td>20</td>
</tr>
<tr>
<td>Compressors</td>
<td>30</td>
</tr>
<tr>
<td>Gantry Cranes</td>
<td>80</td>
</tr>
<tr>
<td>Hoists/Winches</td>
<td>50</td>
</tr>
<tr>
<td>Passenger/Goods Lifts</td>
<td>50</td>
</tr>
<tr>
<td>Hydraulic Systems</td>
<td>30</td>
</tr>
<tr>
<td>Electrical Switchgear/Switchboards</td>
<td>25</td>
</tr>
<tr>
<td>Electrical Cabling</td>
<td>25</td>
</tr>
<tr>
<td>PLC’s and Electronic Devices</td>
<td>15</td>
</tr>
<tr>
<td>Diesel Generators (standby)</td>
<td>30</td>
</tr>
<tr>
<td>Fire Protection Systems</td>
<td>20</td>
</tr>
<tr>
<td>Security Systems</td>
<td>15</td>
</tr>
<tr>
<td>Telecommunications equipment</td>
<td>10</td>
</tr>
<tr>
<td>Fixed radio equipment</td>
<td>10</td>
</tr>
<tr>
<td>Instrumentation</td>
<td>10</td>
</tr>
<tr>
<td>Chemical Dosing Systems</td>
<td>15</td>
</tr>
<tr>
<td>Chemical Feeders and Hoppers</td>
<td>25</td>
</tr>
<tr>
<td>Filters</td>
<td></td>
</tr>
<tr>
<td>Aeration Diffuser Membranes</td>
<td>5</td>
</tr>
<tr>
<td>Ultrafiltration Membranes</td>
<td>6</td>
</tr>
<tr>
<td>Valves</td>
<td></td>
</tr>
<tr>
<td>Valves =&gt;300mm</td>
<td>40</td>
</tr>
<tr>
<td>Valves &lt;300mm</td>
<td>20</td>
</tr>
<tr>
<td>Pressure Reduction Valves</td>
<td>25</td>
</tr>
<tr>
<td>Fencing/Gates</td>
<td></td>
</tr>
<tr>
<td>Security/Boundary incl. gates</td>
<td>30</td>
</tr>
<tr>
<td>Motorised Gates</td>
<td>20</td>
</tr>
</tbody>
</table>
d) Reliability – automated operation, maximised mean time between failures, early failure detectability where possible, provision for redundancy in the event of a failure to prevent overall system failure.

The selection of equipment shall take into consideration such aspects as the Mean Time Between Failure (MTBF) and the Mean Time to Repair (MTTR) critical parts, availability of spare parts and support, capacity of the equipment to perform its function on an ongoing basis and the methods of control available for the equipment. Equipment selection shall take into consideration maintainability and serviceability, expected service life and replacement with the aim of minimising total life cycle costs of the plant across its anticipated economic life.

Each item of equipment shall be capable of operating continuously at its duty cycle to its maximum capacity (equal to or greater than the specified or normal duty capacity) without premature failure.

E. Asset Availability and Redundancy
Consideration must be given to the ability of a system or functional units to continue to provide service potential after a component failure or whilst component parts are maintained, renewed or replaced. All designs shall minimise downtime for the life of the assets and suitable levels of redundancy shall be incorporated into systems to ensure continued service potential where City of Gold Coast Customer Service Standards and regulatory and statutory compliance obligations may be adversely affected. For example, in a wastewater pump station a standby pump shall be installed.

F. Combined Operations and Maintenance
Components and equipment shall be designed to enable operational maintenance by the Principal’s staff to be maximised. Design shall minimise confined spaces in accordance with all relevant safety legislation and the Principal’s Standards.

2.7 Workplace Health and Safety Compliance
The Works shall comply fully with all WH&S requirements as defined by all relevant safety legislation and the policy and guidelines of the Principal. A copy of the Principal’s Workplace Health and Safety Policy Guidelines and Procedures will be made available to the Contractor by the Superintendent after request.

The costs of meeting WH&S compliance requirements are the responsibility of the Contractor and shall be included in the Contract Sum.

2.8 Customer Service Standards
City of Gold Coast services include:

Planning, design, construction and maintenance of water and sewage infrastructure
- Water and sewage transport and treatment
- Specialised customer services including trade waste management, environmental education and operation of a 24-hour customer service centre
- Ongoing quality and environmental management programs

City of Gold Coast has established customer service standards in three key performance areas:
- Quality of water supply
- Continuity of water supply
- Effective Transport Of Wastewater

2.9 Sewage Treatment Plants – Design Requirements

2.9.1 Design, Drafting and Documentation

Requirements
The Contract Works include all aspects of preparing preliminary and detailed design including surveys and studies, preparing reports, drafting drawings and preparing documentation. The work shall include, but not be limited to:

Detailed design, drafting and documentation with the provision of the design submittals comprising calculations, drawings and documentation of all of the following elements:

- All process assessments and hydraulic analysis for the Works;
- All mechanical equipment for the Works;
- Concrete structures and exposed surface protection requirements against chemical attack for the new components and all associated work for the Works;
- All steel structures including floors, walls, roofs and their supporting framing for the Works;
- All steel framed buildings including walls, and roofs and the supporting framing for the Works;
- All building services for the Works;
- All pressure and gravity pipework and appurtenances for the Works;
- All other civil and structural elements including but not limited to access roads, hard standings, stairways, landings and platforms, and fencing for the Works;
- All electrical equipment including power, control, instrumentation and automation systems for the Works; and
- All site improvement and landscaping elements for the Works.
- Revision of the detailed design submittals, following review(s) by the Superintendent; and
- Documentation and fees for all approvals required.

2.9.2 Engineering Responsibility

The Contractor shall be responsible for the provision of a detailed design which satisfies the specified performance requirements contained in the Contract Documents. The Contractor’s detailed design shall be such that the Works can be constructed and the completed Works operated safely whilst capable of being easily and effectively maintained.

The Contractor shall be responsible for obtaining all the necessary Statutory Approvals from the relevant authorities and for paying all fees in connection with obtaining such approvals.

All facilities shall be designed to comply with the appropriate Australian and Queensland Building Regulations, Workplace Health and Safety Regulations and any other current legislation.

The Contractor shall be responsible for the provision of:

The detailed engineering design and documentation of all process, hydraulic, structural, civil, mechanical, electrical, instrumentation, control and automation elements and systems necessary to provide the Works as outlined by the Specifications and as described in the Contract Documents; The assessment and selection of proprietary equipment and elements of the Works; and Detailed engineering design and documentation of the integration of the Works with the existing Plant services.
Regular design review sessions shall be arranged by the Contractor to co-ordinate the implementation of this phase of the Contract Works during the preliminary and detailed design phases of the Contract. These design reviews shall involve the Contractor and relevant key suppliers and the Superintendent. Nothing at these meetings shall vary the Contract unless/until a formal Variation is raised by the Superintendent. At relevant stages of the development of the design, briefing sessions for stakeholders shall be held by the Contractor to promote constructive feedback through the Superintendent. These sessions shall ensure that designs are developed in accordance with the requirements of the Contract Documents, together with the general expectations of the Principal.

2.9.3 Overall Design

Designers of all aspects of the systems to be provided shall be competent and experienced in the type of Works being designed, have received adequate training and have adequate resources throughout the duration of the Project.

Each of the design functions; process, hydraulic, structural, civil, mechanical, electrical, instrumentation, control and automation, shall be led by appropriately qualified competent and experienced staff (certified RPEQ and/or NPER3) and assisted by qualified Quality, Risk, Safety Environmental and Process personnel. Evidence substantiating compliance with this requirement of the Contract shall be provided to the Superintendent for assessment of compliance at establishment of the teams and any change to the teams and in the event of any concerns being raised by the Superintendent.

The Contractor shall ensure that any item of the Works supplied shall be fit for purpose, meeting the requirements of the Contract Documents which incorporate the Principal’s Workplace Health and Safety requirements, together with all current Australian Health and Safety Legislation and Standards. The Contractor shall also ensure that the duties of those who design, manufacture, import or supply any part of the Works or equipment in connection therewith are fulfilled in respect of the Queensland Workplace Health and Safety requirements including the regulations and any other safety regulations imposed by law or by any authorised body empowered to make such regulations.

The Contractor shall undertake the following risk assessment procedures:

- Hazard Identification (HAZID) Study of the new and modified components of the Works;
- Construction Hazard Analysis Implication Review (CHAIR) Study of the new and modified components of the Works;
- Hazard and Operability (HAZOP) Study of the new and modified components of the Works;
- Confined Spaces / Hazardous Area Study of the new and modified components of the Works;
- Environmental Risk Assessment; and
- Hazardous Substances Assessments.

The detailed design shall embody the best engineering practice within the water industry such that it:

- Facilitates inspection, cleaning, maintenance and repair;
- Ensures satisfactory operation under all specified service conditions;
- Provides efficient, reliable operation for the specified design life; and
- Provides safe working conditions for all operational and maintenance personnel.

The Contractor shall ensure that the structures, materials, plant and equipment provided have:

- Good reliability;
- A low maintenance requirement and a low frequency of operator intervention;
- Low operating costs;
- Good operability and ease of maintenance (e.g. accessibility, ease of process control);
- A low environmental impact (e.g. odour, vehicular movements); and
- The least whole of life cost (WLC).

Structural, civil, mechanical and electrical design shall comply with all relevant Australian and, where applicable, International Standards.
2.9.4 Visits to Site- Detailed Design
Visits to site for the detailed design of the Works under the Contract shall be conducted in accordance with the work programme generated by the Contractor and reviewed by the Superintendent. The Principal anticipates that numerous visits to site will be required to produce a detailed design that meets the requirements of the Contract Documents.

However, access may not be possible, or may be denied, should the Contractor’s personnel or consultants arrive on site without prior arrangements having been made with and agreed to by the Superintendent.

2.9.5 Finished Levels and Other Design Constraints

- Concept Design Levels and Level Constraints
  Refer to Project Brief for details.
  - Height Restrictions
  Refer to Project brief for details.
  - Stormwater Management and Floodplain Restrictions
  Refer to Project brief for details.
  - Permanent Installation Vibration Levels
  Refer to Project brief for details.
  - Permanent Installation Noise Levels
  Refer to Project brief for details.

2.9.6 Design Criteria
The design criteria for the Works shall be stated in the Project Brief.

The operating environment of the components and equipment supplied and installed under the Works is sub-tropical with the Plant being located near the coast. The atmosphere is expected to be corrosive, humid and with exposure from direct and intense sunlight, driving rain and hail.

The equipment supplied and installed under the Works shall be capable of satisfactory unattended operation within the ambient air temperature range 0° to +45°C and up to a relative humidity of 100 % (condensing). The altitude is less than 100 m.

The environmental and climatic conditions local to the Works are expected to be considered highly aggressive with particular attention needed in the design, specification and selection of all materials and items of equipment in an attempt to eliminate or minimise the effect and impacts. In particular:

- All fixtures and fittings shall be Grade 316 stainless steel. Walkways and channel covers shall be of aluminium or GRP construction. Covers shall be in sizes able to be easily lifted by one man; be hinged where regular inspection is required; have sufficient handles for lifting and for transportation, be air sealed; be fitted with stainless steel fixings and fittings which shall be recessed or otherwise designed to prevent tripping.
Electrical and electronic systems, equipment and devices shall be suitable for an Industrial Electromagnetic Compatibility (EMC) environment, enabling them to operate in such an environment within a defined margin of safety, and at design levels and performance, without suffering or causing unacceptable degradation as a result of electromagnetic interference. Measures shall be put in place, by the Contractor, to ensure that the Works are protected from the elements as well as other Plant processes both during construction and when in service.

2.9.7 Design Deliverables
As a minimum the Design Deliverables shall include, but not necessarily be limited to:

- Process design;
- Hydraulic design;
- Odour and corrosion control design;
- Mechanical design;
- Civil and structural design;
- Equipment design;
- Electrical, instrumentation, control and automation design for all systems, treatment processes, materials handling, storage and pumping systems;
- Project drawings;
- Design Report;
- HAZIP Study Report;
- CHAIR Study Report;
- HAZOP Study Report;
- Hazardous Areas Classification Report;
- Noise Survey Report;
- Safety of Machinery Report;
- Failure Modes and Effects Analysis Report;
- Renewals Forecasting and Operations and Maintenance Cost Projections Report;
- Functional Description Statement;
- Operational Software.

Reports, excluding the Design Report, shall comprise, to the extent applicable and relevant the following parts:

- Table of Contents;
- Criteria, parameters and methods used;
- Description of approach;
- Test procedures, analysis and results;
- Qualitative description and comments on results;
- Findings, conclusions and recommendations;
- Reference lists including codes, standards and manuals;
- Appendices;
- Drawings; and
- Any other relevant information.

Design deliverables shall be presented in digital and paper format and shall be fully indexed. Digital copies shall be provided as MS Word files for draft documents, and as both a PDF and MS Word file for the final “As-Built” record. PDF format design documents shall be provided via USB’s. The page sizes shall be single sided A3 for drawings and single sided A4 for reports and other documentation.

The front sheet of each submission shall include the title of the Project, Principal’s name, Contractor’s name and shall include reference, date, Contractor’s signature and any other relevant information. Drawings submitted as part of the design documents shall be A3 size and one copy shall be folded and bound into the relevant part of the calculations where relevant. Every page of design calculations shall
be numbered and dated, initialled by both the designer and checker and, for the paper copy, bound in order in rigid two ring binders. The whole of the design calculations shall be fully indexed.

Two (2) hard copies of each item, plus the electronic version(s) shall be submitted to the Superintendent. An electronic copy of the final version of each item in one PDF file and all of the native files comprising the item shall be incorporated in the electronic Plant Information Portal.

2.9.8 Project Design Management Plan

At the outset of the design phase a Project Design Management Plan (PDMP) shall be developed by the Contractor which includes procedures for control of changes from agreed baselines in either the preliminary or the detailed design. This part of the PDMP shall be compliant with AS/NZS3907 – Configuration Management, include deviation and waiver procedures and provide clearly defined procedures for the authorisation of design changes.

2.9.9 Detailed Design Certification

The Contractor shall ensure that all design work is certified by fully qualified and experienced engineers. Appropriate certifying engineers shall be either:

- An RPEQ registered engineer in Queensland in the relevant discipline of engineering applicable to the design provided; or
- An NPER3 nationally registered engineer in the relevant discipline of engineering applicable to the design provided; or
- An internationally recognised qualification provided substantiation of documentation is provided and is equivalent to a NPER3 qualification.

2.9.10 Design Submittals

If requested by the Superintendent, design calculations shall be provided for review prior to procurement, fabrication or construction of the relevant part of the Works.

Drawings and documentation shall be sufficiently detailed to cover all aspects of construction. Full details of all services, fittings, fixtures and finishes as well civil, structural, hydraulic, mechanical, pipework, instrumentation and electrical requirements shall be included.

Designs, drawings, documentation and management plans shall be submitted for the Superintendent’s review at the following Project stages:

- Preliminary Design;
- Detailed designs prior to procurement or implementation;
- “Issued For Construction”;
- Start-up and / or Pre-commissioning; and
- “For commissioning”.

“As Constructed” drawing review is detailed in the clause termed “Handover Submittals”.

2.9.11 Contractor's Project Drawings

All Project Drawings prepared by the Contractor including those prepared by sub-contractors, suppliers and vendors shall be drawn in the Principal’s drawing frame. All Project Drawings shall be prepared in accordance with the requirements of the relevant SAA codes and good engineering drawing practice. They shall be produced at A1 size but will be required to be used and fully legible at A3. A logical set of drawing numbers based within the Principal’s drawing numbering system and revision numbering system shall be developed in consultation with the Superintendent. All drawings shall be clearly drawn to scale by competent draftspersons, in AutoCAD® format version 2004.

Three (3) A3 sets of paper prints of final detailed design drawings shall be submitted to the Superintendent for review. Three (3) A3 sets of paper prints of any revision of the final detailed design drawings shall also be submitted to the Superintendent for review. A CD of all ‘Preliminary Design’ and
'Issued For Construction (Final Detailed Design)' drawings shall be provided to the Superintendent. This requirement applies equally to the work and drawings of all sub-contractors and vendors.

The Contractor shall produce, as a minimum, the following drawings and documentation, together with all others required to safely operate and maintain the Works.

The Contractor shall submit hard copies of the following information to the Superintendent for review and acceptance, together with any others specified under the specific Contract requirements herein. The following shall apply to all components of the Works.

- **Process**
  - Process Flow Diagram(s);
  - Process/Control Philosophy;
  - Process Control Diagram(s); and
  - Process and Instrumentation Diagrams (P&IDs).
- **Civil and Structural including Architectural and Building Services**
  - Site layout drawings;
  - General Arrangement drawings;
  - Architectural drawings for buildings;
  - Building services drawings including heating, potable water, wastewater, air conditioning, ventilation and lighting;
  - Process drainage drawings including process water and chemical bund drainage;
  - Site hydraulic profile drawings;
  - Structure drawings including plans, elevations and details;
  - Underground / buried pipework drawings including pipework in below ground chambers;
  - Underground services drawings;
  - Building drawings;
  - Foundation detail drawings;
  - Reinforced concrete detailing drawings; and
  - Landscaping drawings.
- **Mechanical**
  - General Arrangement drawings;
  - Coordination with other services drawings; and
  - Valve schedules.
- **Electrical**
  - Motor list including rating (kW), speed, make, model;
  - Single line diagrams;
  - Coordination with other services drawings;
  - General layout of the plant and building drawings;
  - Schematic and connection diagrams;
  - Earthing diagrams;
  - Power schematic drawings for all sub circuits;
  - Control schematics;
  - Cabling block diagram(s);
  - Cable schedules;
  - Communication cabling schematics;
  - Functional Description Statement detailing the Process/Control Philosophy;
  - Drawings for each instrument loop;
  - 'Architecture' Drawings for the Plant’s PLC system or Distributed Control System (DCS);
  - Drawings for each PLC/DCS panel and installation;
  - PLC/DCS IO Schedules;
- **General arrangement/assembly drawing(s) and coordination with other services**
  - Instrument installation drawings;
  - Panel instrumentation piping and wiring diagrams;
  - Multicore cable / tubing routing drawings;
  - Switchboard building layout drawings;
• Schematic cable schedules in accordance with the block cable diagram;
• Manufacturer’s specific literature for each item of equipment or Software supplied;
• Software programme listing for the PLC/DCS in electronic format only. Programmes shall be commented to assist understanding for future maintenance or modifications;
• Plant installation drawings;
• Instrument schedules; and
• Completed instrument data sheets.

The general arrangement and P&IDs shall be provided to the Superintendent for review early in the design phase.

The Contractor shall provide all drawings required in support of planning applications; general arrangement drawing(s) and co ordination with other services.

Electrical schematics shall be based on a drawing “template”, prepared by the Contractor and reviewed by the Superintendent, such that schematics for similar equipment are similar, e.g. all schematics for starters regardless of supplier shall appear similar.

2.9.12 Hazard Identification and Operability Studies and Reports

As an integral part of the preliminary and detailed design activities, the Contractor shall complete a HAZID Study followed by HAZOP Study on the proposed detailed design or alteration to an asset.

The HAZID Study shall be a high level HAZOP Study and shall be used to identify potential hazards such that they can be ‘designed out’ during the initial design stages.

The HAZID Study and the later HAZOP Study shall be carried out by competent personnel who have knowledge of the properties of the processes and the equipment, in consultation, as appropriate, with safety personnel and the Superintendent. The HAZID Study and the later HAZOP Study shall be carried out using software supplied by the Contractor and to the review of the Superintendent, to record the outcomes of the studies.

The HAZID Study shall be carried out following submission of the initial P&IDs and initial general arrangement and layout drawings.

The HAZOP Study shall be carried out following the close-out of all HAZID Study actions, together with the submission of the finalised P&ID’s and finalised general arrangement and layout drawings.

The Contractor shall submit a detailed report, together with separate HAZID Study and HAZOP Study action lists, defining the actions required to be investigated / designed and / or re-designed to either eliminate or reduce to As Low As Reasonably Practicable (ALARP) all identified hazards to the Superintendent for review. The Contractor shall allow in the Contract Sum to revise the report to incorporate the Superintendent’s comments which will be consolidated comments from the Superintendent and the Principal’s staff. The revised report shall be submitted to the Superintendent for review.

The Contractor shall ensure completion and close-out of the HAZOP Study actions as one of the requirements of project completion and provide final reports to the Superintendent for acceptance.

All costs associated with completing the HAZID Study and the HAZOP Study associated with the Works are the responsibility of the Contractor and shall be included in the Contract Sum.

2.9.13 Hazardous Area Classification and Report

The Contractor shall undertake a detailed area classification, using an accepted method in accordance with the appropriate Australian Standards, for the new and modified existing components of the Works. Such a method shall analyse and classify the internal and external environments where explosive gas
atmospheres may occur so as to facilitate the proper selection and installation of apparatus to be used safely in that environment, taking into account gas groups and temperature classes.

In the event that existing non-hazardous areas become zoned as hazardous, through the addition of odour control covers (or other STP augmentation actions) the Contractor shall replace / retrofit existing plant / instrumentation to ensure compliance with the produced hazardous area assessment.

The area classification shall be carried out by competent personnel, who have knowledge of the properties of flammable materials, the processes and the equipment, in consultation, as appropriate, with safety, electrical, mechanical and other engineering personnel.

The area classification shall be carried out following submission of the initial P&ID’s and initial general arrangement and layout drawings.

The Contractor shall submit a detailed report, together with supporting drawings, defining the classification of all areas forming part of any new work, together with existing areas affected by the Works to the Superintendent for review. The Contractor shall allow in the Contract Sum to revise the report to incorporate the Superintendent’s comments which will be consolidated comments from the Superintendent and the Principal’s staff. The revised report shall be submitted to the Superintendent for review.

All costs associated with completing a detailed hazardous area classification, together with implementing the design requirements associated with the works are the responsibility of the Contractor and shall be included in the Contract Sum.

2.9.14 Noise Surveys and Reports
Refer to Contract Specification/Design Brief for relevant information

2.9.15 Safety of Machinery Report
The Contractor shall undertake an investigation and prepare a report on the safety of machinery in accordance with AS4024.1. The report shall be submitted to the Superintendent.

2.9.16 Failure Modes and Effects Analysis Report
The requirements for the Failure Modes and Effects Analysis Report will be provided in Contract Specification/Design Brief.

2.9.17 Renewals Forecasting and Operations and Maintenance Cost Projections Report
The requirement for the Renewals Forecasting and Operations and Maintenance Cost Projections Report will be provided in Contract Specification/Design Brief.

2.9.18 Functional Description Statement
The Functional Description Statement, which shall be a comprehensive set of descriptions of the function/operation of the Works and its major components and key items of equipment detailing the process/control philosophy, shall be submitted to the Superintendent for review prior to the full HAZOP Study. The Contractor shall incorporate any of the Superintendent’s comments into the Functional Description Statement following the HAZOP Study and re-submit it to the Superintendent for review.

Where necessary, the Functional Description Statement shall be revised and two (2) copies of the final Functional Description Statement resubmitted to the Superintendent for review before testing and commissioning commences. An electronic copy of the final Functional Description Statement in one PDF file and all of the native files shall be incorporated in the electronic Plant Information Portal.
2.9.19 Operational Software

The design shall provide documentation to fully describe the standard and bespoke software for both the PLC/DCS including, but not necessarily limited to:

- **Software Overview**  An overview of all software modules including detailed written descriptions ie Functional Design Specification.
- **Module Descriptions**  A complete description of each software module including a detailed written description of variables etc. and associated logic diagrams (including full operation and rung comments).
- **Operating Instructions**  A complete set of operating procedures including system generation, loading, configuration, start-up, on-line modification, shutdown, backup, virus protection and general trouble shooting.
- **Operator’s Instructions**  A complete set of operating procedures for all function supplied and/or configured.
- **Database Listings**  Complete database listings of all configured software.
- **Input / Output Listings**  Complete Input / Output listings including cross-referencing data etc.
- **Displays**  Written descriptions of each display including details of both static and dynamic information representation.
- **Two (2) bound A4 hard copies and one (1) electronic copy on CD-ROM of all PLC/DCS code as appropriate, the supporting files and sequence diagrams, and the SCADA project and libraries where a PLC hardware platform is adopted shall be submitted to the Superintendent for review. The Contractor shall incorporate any changes necessary and resubmit two (2) bound hardcopies and one electronic copy on CD-ROM to the Superintendent for review.

The final documentation shall be incorporated into the electronic Plant information Portal.

2.9.20 Design Report

The Contractor shall prepare and submit a draft detailed Design Report to the Superintendent for review at the stage of 75 % detailed design completion. The draft Design Report shall include the following:

- **Table of Contents**;
- **Introduction and scope of the work**;
- **Legislative requirements**;
- **Basis of design**;
- **The basis of the process design**;
- **The basis of the hydraulic design**;
- **The design criteria for the mechanical equipment**; and
- **The design criteria for the electrical equipment**;
- **Description of design approach**;
- **Design criteria, parameters and methods used**;
- **Design constraints**;
- **Operation and control philosophy**;
- **Asset management requirements and life cycle costs**;
- **Drawing and specification lists**;
- **Design calculations, schedules, analyses and results**;
- **References including codes, standards and manuals used in the design**;
- **Noise, HAZOP Study, HAZIP Study, CHAIR Study, Safety of Machinery, Failure Modes and Effects Analysis and Renewals Forecasting and Operations and Maintenance Cost Projections Reports as appendices**; and
- **Any other relevant information**.

The Contractor shall receive comments from the Superintendent on the draft Design Report which will be consolidated comments from the Superintendent and the Principal’s staff. The Contractor shall incorporate the Superintendent’s comments and submit a final draft Design Report for review at 100 % detailed design completion. The Contractor shall receive comments from the Superintendent on the final
draft Design Report which will be consolidated comments from the Superintendent and the Principal’s staff.

The Contractor shall incorporate the Superintendent’s comments and submit two (2) copies of the final Design Report to the Superintendent. An electronic copy of the final Design Report in one PDF file and all of the native files shall be incorporated in the electronic Plant Information Portal.

2.9.21 Hazard Analysis and Critical Control Points (HACCP)
Refer to Contract Specification/Design Brief for details.

2.9.22 Risk Elimination in Design
During the design stage, the Contractor shall address and minimise operational, maintenance, workplace, health and safety and environmental risks during construction and throughout the service life of the works by eliminating risk in design.

All aspects of the design including hydraulic, process, structural, mechanical, electrical, instrumentation, control and automation shall be reviewed to ensure safety and prevention of damage to structures, equipment or environment under normal, breakdown (failure modes) and maintenance operation.

Plant areas that are routinely entered by the Principal’s operations and maintenance staff shall be designed so that they are not defined by the Principal as a confined space. Facilities to ensure this requirement shall include as a minimum dual entry / exit provisions, internal access and walkway space, natural ventilation and, if enclosed, forced ventilation.

The Contractor shall seek to identify all material hazards and aim to eliminate those hazards during the design phase. Hazards to be assessed shall include:

- Physical, e.g. noise, radiation, light, vibration, flooding, collapse;
- Chemical, e.g. poisons, dusts;
- Biological, e.g. Bacteria, viruses, plants, parasites;
- Gaseous, e.g. H2S, explosive gases such as methane;
- Mechanical / electrical, e.g. slips, trips and falls, tools, electrical equipment, equipotential earthing, electrocution; and
- Psychological, e.g. fatigue.

If elimination of the hazard by design is not possible or feasible, then this shall be minimised by using the most effective method, in the following preference order:

- Substituting the system of work or machinery with a safer solution;
- Isolating the hazard;
- Minimising the risk by introducing engineering controls, e.g. guard rails, scaffolding;
- Minimising the risk by adopting administrative controls, e.g. warning signs, safe work practices; and / or
- Using personal protective equipment, e.g. safety glasses, earmuffs.

If no single control is sufficient to properly and adequately mitigate the hazard, a combination of the above controls shall be put in place by the Principal’s operations and/or maintenance procedures to minimise the risk to the ALARP level.

Where hazard mitigation is proposed to rely on control or procedure measures, the Contractor must record in the Design Report that physical means were investigated and found to be impractical. This shall be clearly demonstrated in the quality management system and records for the Project through the quality plan, procedures, design calculations and documentation, verification process and check lists and the change records. Where control strategies are utilised all shall be documented and training shall be provided as necessary. The controls and/or procedural measures are to be clearly identified and
incorporated in the Functional Description and Standard Operating Procedures in the Operations and Maintenance Manuals.

This risk assessment process shall:

- Adopt a life cycle approach that considers construction, installation, commissioning, operation, maintenance, repair and demolition of the asset being designed;
- Adopt a consultative approach with relevant stakeholders, as deemed suitable by the Principal, including designers, constructors, operators, interested third parties, maintenance staff and workplace health and safety personnel;
- Include facilitated risk assessment workshops utilising appropriate risk assessment techniques; and
- Identify and adopt risk control measures which reflect the hierarchy of controls listed above.

The Contractor shall ensure that risks assessments are conducted in conjunction with the Superintendent at the:

- Preliminary design stage to identify and eliminate significant design, construction, installation, operation, maintenance, repair and demolition health and safety risks; and
- Detailed design stage to identify modifications necessary to reduce construction, installation, operational, maintenance, repair and demolition hazards. It shall be to full ‘HAZOP’ Study detail.

### 2.9.23 Asset Management

**Overarching Principles**

Each STP is a key asset of the Principal. Accordingly the Principal views the smooth assimilation of new assets into its systems and processes as an essential project outcome. A major determinant of this is the quality and nature of supporting documents and information provided to accompany the assets before and after handover.

### 2.9.24 Asset Design Life

For typical minimum design lives of plant components, refer to clause “Asset Management Objectives” in Section 2 General Design Requirements. The actual figures to be adopted shall be determined during the Endorsement process. Mechanical and electrical equipment may be assessed on an hours run basis rather than a period of years.

### 2.9.25 Operability, Functionality & Maintainability

The design shall take into consideration the number, type and positioning of components and equipment and how this may impact on the operations and maintenance of the Plant.

The factors to be considered in designing for operability and maintainability include:

- **Standardising:** Using Australian and International Standards for all equipment;
- **Accessibility:** Quantifying the number of parts requiring removal in order to replace a given component, and access requirements for maintenance, including removal, and operations such as inspections, oil changes etc;
- **Commonality:** In order to maximise equipment knowledge and to reduce spare parts holdings, the selection of components and equipment shall consider the commonality of equipment across the whole of the Principal's operations and between equipment items;
- **Modularity:** To reduce replacement time, wherever possible sub-assemblies shall be modularised to allow for quick removal and replacement; and
- **Resilience and Redundancy:** Suitable levels of system resilience and redundancy shall be incorporated into the components and equipment to ensure continued operation in the event of component or equipment failure or maintenance down time.

Generally, decisions on whether or not standby components or equipment is required shall be determined by the criticality of that specific process unit with regard to the impact on the functional output...
in respect of continuity of Plant operations and process quality / performance. Legislative or regulatory requirements and / or guidance shall be considered and implemented in any standby component or equipment decision process. Where proprietary equipment is provided the Contractor, in conjunction with the supplier, shall identify the critical items of equipment that may induce failure of the process unit and shall provide stand-by equipment as part of the Contractor’s design.

In arriving at decisions on standby provision, the new Works must be considered as separate systems and standby shall be provided at the point in that system that provides lowest whole life cost (WLC).

System redundancy and resilience shall be subject to the review of the Superintendent.

The layout of all components and equipment shall take into account it’s maintenance requirements.

Notwithstanding the above, it shall be a general requirement that the overall design and layout of the Works shall minimise adverse environmental impact. Such measures may include:

- Covering of tanks where necessary;
- Minimisation of odour releases and noise emissions;
- Sympathetic colour schemes;
- Boundary fencing; and
- Planting schemes / landscaping.

All components and equipment shall be designed to permit:

- Safe and easy operation and maintenance; and
- Removal for maintenance, repair or replacement.

Interconnecting pipework and cables shall have adequate flexibility, i.e. quick release mechanical couplings to allow the removal of components and equipment items without damage to either. A safe working environment shall be provided at all times with adequate ventilation and permanent safety monitoring installed, as required.

Materials, consumables, or items, which require replacement during the designed service life, shall be designed / located to allow easy and safe access / replacement, e.g. luminaries shall be positioned to allow easy lamp replacement.

Means of isolation for maintenance shall be clearly identified, readily accessible and positioned to avoid any hazards in operation.

The Contractor must ensure that information in the way of drawings, risk assessments and method statements for all associated Operational and Maintenance activities are included as part of the Operation and Maintenance Manuals.

All relevant information from each HAZID Study Report, HAZOP Study Report and Hazardous Area Classification Report must also be included as part of the Plant Information Portal.

This information must be available on site during all commissioning activities and the initial operating and testing periods.

When making design choices, the manning strategy outlined above shall be taken into account, so that accurate WLC decisions can be made.

Where more than one process unit is used, the ability to take one unit out of service for maintenance and cleaning shall be provided. All process units, vessels and tanks should include the provision to allow their emptying, this facility can utilise hired plant to affect drainage if this offers a best WLC arrangement.

During such normal planned maintenance, the required discharge performance / standard of the Work must be met. The Contractor shall demonstrate how he has provided for this situation.
Where localised controls are provided for the Works, the control and monitoring of each process shall be fully integrated into the existing site based PLC/DCS system whether or not the control is provided by a proprietary control panel or a PLC.

The operability and functionality of all existing components, equipment and systems to be integrated into or with the new Works, shall not be detrimentally affected by the Contractor’s design, construction, testing and commissioning activities.

2.9.26 Specific Requirements  Choice of Materials
Substitution of any materials specifically required by the Contract Documents shall be subject to the review of the Superintendent based on the substitute being equal or better for the service conditions.

Components and equipment in general shall be constructed of materials suitable for use in the environment in which they are to operate and in the case of pumps, with regard to the fluid to be pumped.

The Contractor shall comply with the instructions of manufacturers / suppliers in respect of use, application or installation of any materials, goods etc, required to complete the Contract. These instructions shall be applicable to the prevailing climate and environment.

Structural members for stairs and walkways, grids and stair treads, handrails and kick plates shall be aluminium and / or GRP/FRP. Ladders shall be avoided wherever possible and strong preference shall be given to stairways. Ladders shall only be used with the written approval of the Superintendent.

2.9.27 Access to Components and Equipment
All components, equipment and services shall be designed to enable effective and safe entry to all areas for maintenance. Where access is required to tanks, silos or to any component or item of equipment requiring any maintenance or inspection etc., the Contractor shall provide all necessary permanent stairways, landings, walkways, guardrails, safety barriers, etc. A non-slip surface shall be provided at the top, and bottom of all fixed stairways. Mats shall not be used for non-slip surfaces; textured epoxy paint surfaces are preferred for flat concrete surfaces and chequer plate or grille flooring is preferred for aluminium or steel surfaces.

Access routes through the Plant shall be free of all hazards. Positioning of components and equipment must be designed to ensure that maintenance and operations personnel have sufficient access to perform their functions in a safe manner. Headroom shall be provided to meet WH&S requirements and in no case in a clearance cross section anywhere along a walkway, landing or stairway be less than 2.2 m.

Appropriate access and clearances shall be provided to ensure equipment can be safely lifted into and out of the facility. Lifting equipment with appropriate safe working load capacity shall be provided where WH&S requirements preclude manual handling. The maximum weight of manually-removable covers and grating panels shall be 18 kg. Buildings in which lifting equipment is provided shall be of an adequate height to allow lifting above other items of equipment and onto vehicles.

Adequate hose down facilities shall be provided for process units, tanks, bunds, chemical storage areas, work bays etc. Lifebuoys shall be provided on all unroofed water retaining structures.

Where the expected inspection or maintenance periods exceed one year, access using portable scaffolding or stepladders maybe acceptable, but only where the maximum height above floor level is not greater than 2.5 m, and where adequate floor space allows the positioning of such access equipment as a result of manual handling regulations.
The shutting down main process plant items and/or streams to gain access for routine maintenance (more often than twice per year) will not be acceptable.

2.9.28 Operational Manuals, Operational Procedures and Maintenance Manuals
The Contractor shall prepare Operational Manuals, Operational Procedures and Maintenance Manuals for the systems and facilities delivered under the Works.

Preparation and submission of Operational Manuals, Operational Procedures and Maintenance Manuals in a form complying with the Principal's requirements will expedite the process of checking of the submitted draft Operational Manuals, Operational Procedures, Maintenance Manuals and ancillary information by the Superintendent and subsequently allow for prompt acceptance of the submitted information.

The costs associated with this work on Operational Manuals, Operational Procedures and Maintenance Manuals shall be included in the Contract Sum.

2.9.29 Operational Manuals
The Operational Manuals shall be divided into two distinct sections. The first section shall provide initial familiarity and understanding including all control settings etc. required for normal plant operation. The second section is to provide more detailed instructions including such areas as fault/alarm response, individual controls operation, software operation etc.

Two (2) hard copies of the draft Operational Manuals shall be submitted to the Superintendent for review no later than twenty (20) working days prior to the commissioning of each facility, system, component and/or item of equipment (e.g. switchboard; pumping equipment, or valves/pipework) associated with the Works.

Where necessary to suit the Contractor’s late changes to the work or if the Superintendent provides comments, the draft Operational Manuals shall be revised and two (2) copies of the Operational Manuals resubmitted to the Superintendent before testing and commissioning commences. An electronic copy of the final Operational Manuals in one PDF file and all of the native files shall be incorporated in the electronic Plant Information Portal.

Operational Manuals shall include, but not necessarily be limited to:

Introduction
This section shall contain a brief description of the equipment/system operation and function and should include a pictorial general arrangement illustration of the system and/or equipment.

Operating Strategy and Instructions
This section shall contain a description of the recommended operating strategy each facility, system, component and/or item of equipment associated with the Works together with comprehensive instructions relating to the installation, operation, removal and testing of the individual item of equipment. It shall also include any applicable special handling instructions.

The operating strategies and instructions shall include, but not necessarily be limited to:

- Description of Operations;
- Start-up Procedures;
- Normal Shut-down Procedures;
- Extended Shut-down Procedures;
- Emergency Shut-down Procedures;
- Adverse Event management; and
- Functional Descriptions.
As part of the development of normal and contingent operating plans, data requirements for management and ongoing improvement are to be identified.

As a separate volume in the manual, the Electrical Power and Control, Instrumentation and Automation Systems information shall include, but not necessarily be limited to:

- The functional description of all electrical systems;
- The functional description of all instrumentation;
- The functional description of the PLC/DCS;
- The configuration of all software;
- The set-up of all configurable devices, including instrumentation; and
- The information on the SCADA system where applicable including graphics, tag databases, trends, and reports.

Troubleshooting Guidelines

A comprehensive set of troubleshooting scenarios to allow systematic identification of performance and functional problems.

Operational Procedures

The Contractor shall provide Operational Procedures for any facilities, systems, components or items of equipment included in the Works that warrant comprehensive or particular instructions relating to the installation, operation, removal or re-installation.

Two (2) hard copies of each draft Operational Procedure shall be submitted to the Superintendent for review no later than twenty (20) working days prior to the commissioning of each facility, system, component and/or item of equipment (e.g. switchboard; pumping equipment, or valves / pipework) associated with the Works.

Where necessary to suit the Contractor’s late changes to the work or if the Superintendent provides comments, the draft Operational Procedures shall be revised and two (2) copies of the Operational Procedures resubmitted to the Superintendent before testing and commissioning commences. An electronic copy of the final Operational Procedures in one PDF file and all of the native files shall be incorporated in the electronic Plant Information Portal.

2.9.30 Maintenance Manuals

Two (2) hard copies of the draft Maintenance Manuals shall be submitted to the Superintendent for review no later than ten (10) working days prior to the commissioning of each facility, system, component and/or item of equipment (e.g. switchboard; pumping equipment, or valves / pipework) associated with the Works.

Where necessary to suit the Contractor’s late changes to the work or if the Superintendent provides comments, the draft Maintenance Manuals shall be revised and two (2) copies of the Maintenance Manuals resubmitted to the Superintendent before testing and commissioning commences. An electronic copy of the final Maintenance Manuals in one PDF file and all of the native files shall be incorporated in the electronic Plant Information Portal.

Maintenance Manuals shall include, but not necessarily be limited to:

Vendor/Supplier Maintenance Information

This section shall include the detailed printed instructions from the vendor or supplier for special maintenance activities such as component repair/replacement and overhaul etc. Only information (specification sheets, parts listings, component drawings, exploded views, etc.) which is relevant to the equipment supplied shall be included with the Vendor/Supplier maintenance information. General marketing information and catalogues will not be accepted by the Superintendent.
Information shall be provided for all components or items of equipment included in the Works.

**Maintenance Activities, Tasks and Schedules**
This section shall include detailed instructions for special maintenance activities such as component repair/replacement and overhaul etc. The maintenance activities, tasks and schedules shall be tabulated in spreadsheet format and shall be arranged in a format suitable for uploading into the Principal's SAP Asset Management system.

As a separate volume in the manual, the Electrical Power and Control, Instrumentation and Automation Systems information shall include, but not necessarily be limited to:

- The equipment list for all electrical systems;
- The equipment list for all instrumentation;
- The equipment list for the PLC/DCS;
- The fault diagnosis and modification of all custom software; and
- The maintenance, fault-finding and repair of all equipment down to circuit board level.

**Special Handling and Safety Instructions**
This section shall include detailed descriptions of any special handling techniques which are required and shall also include detailed descriptions of all safety requirements applicable to the equipment/system.

**Reference Drawing List**
This section shall contain a list (no hard copy drawings included) of all applicable drawings related to the system/equipment in question, including where appropriate, general arrangement, process and instrumentation diagrams, schematic diagrams and exploded view/component drawings, etc.

**2.9.31 Equipment Schedules and Lists, Parts Listings and Technical Data**
The Contractor shall provide Equipment Schedules and Lists, Parts Listings and Technical Data for all components and items of equipment included in the Works.

Only information (specification sheets, parts listings, etc.) which is relevant to the equipment supplied shall be included with the Equipment Schedules and Lists, Parts Listings and Technical Data. General marketing information and catalogues will not be accepted by the Superintendent. The information shall be segregated to clearly identify the individual equipment with a table of contents and a summary page.

Two (2) hard copies of the draft Equipment Schedules and Lists, Parts Listings and Technical Data shall be submitted to the Superintendent for review no later than ten (10) working days prior to the commissioning of each facility, system, component and/or item of installed equipment (e.g. switchboard; pumping equipment, or valves/pipework) associated with the Works.

Where necessary to suit the Contractor’s late changes to the work or if the Superintendent provides comments, the draft Equipment Schedules and Lists, Parts Listings and Technical Data shall be revised and two (2) copies of the Equipment Schedules and Lists, Parts Listings and Technical Data resubmitted to the Superintendent before testing and commissioning commences. In addition to the two (2) hard copies, all Equipment Schedules and Lists, Parts Listings and Technical Data information shall be supplied in electronic format suitable for inclusion in the Principal’s Plant Information Portal.

**Equipment Schedules and Lists**
Equipment schedules and lists shall contain a comprehensive and complete listing of all components and items of equipment including a brief description of its function and the design specification for its
operation. This listing shall use the Principal’s allocated equipment identification code and the Plain English Name reviewed by the Superintendent for each component or item of equipment.

**Parts Listings**

Parts listings shall contain a comprehensive and complete listing of all parts for the components and equipment provided by the Contractor. This listing shall use the Principal’s allocated equipment identification code and the Plain English Name reviewed by the Superintendent for each component or item of equipment.

**Technical Data**

Technical data shall comprise all applicable technical and/or reference data for the specific equipment and components which is installed. This data shall include the following information:

- Manufacturer;
- Model;
- Serial number;
- Size;
- Power;
- Rating;

In general, the information required in this section will be nameplate type data which describes the item in use. Reference data such as pump performance curves shall also be included where applicable.

2.9.32 Operator / Maintainer Training Requirements

At the completion of design, and in conjunction with the Superintendent, the Contractor shall identify the training needs for the Principal’s staff. The Contractor shall develop a draft Training Plan supported by draft Training Modules for the Principal’s management, operational and maintenance staff.

Training provided by the Contractor shall be given to the appropriate Plant Operations and Maintenance personnel prior to facility, system or component commissioning. The Principal’s policy is to train Plant operators and maintainers to National Accredited Certificate 3 level with the Open Learning Institute.

Two (2) hard copies and one (1) electronic copy of the draft Training Plan shall be submitted to the Superintendent for review no later than forty (40) working days prior to the start of commissioning. The Contractor shall revise the draft Training Plan as required and shall resubmit it to the Superintendent for review.

Two (2) hard copies of the draft Training Modules shall be submitted to the Superintendent for review no later than twenty (20) working days prior to the commissioning of each facility, system, component and/or item of equipment associated with the Works.

Where necessary to suit the Contractor’s late changes to the work or if the Superintendent provides comments, the draft Training Modules shall be revised and two (2) copies of the Training Modules resubmitted to the Superintendent before commissioning commences. An electronic copy of the final Training Modules in one PDF file and all of the native files shall be incorporated in the electronic Plant Information Portal.

2.9.33 Training Plan

Details of the Training Plan shall include, but not necessarily be limited to:

- Objective and outline of content of the training session(s);
- Personnel to be trained; and
- Proposed timing of training session(s) and links to project implementation (such as commencement, community engagement, construction completion, commissioning, etc).
The costs of developing such Training Plans are the responsibility of the Contractor and shall be included in the Contract Sum.

2.9.34 Training Modules
The Contractor shall prepare Operational Training Modules and Maintenance Training Modules for each facility, system, component and/or item of equipment in the Works.

Operational Training Modules shall each be a separate document, shall be based on facilities or areas within the Plant and shall include, but not necessarily be limited to:

- Description of Operations;
- Start-up Procedures;
- Normal Shut-down Procedures;
- Extended Shut-down Procedures;
- Emergency Shut-down Procedures; and
- Adverse Event Management.

Maintenance Training Modules shall each be a separate document, shall be based on facilities or areas within the Plant and shall include, but not necessarily be limited to:

- Description of Operations;
- Routine/Preventative/Scheduled Maintenance;
- Corrective Maintenance; and
- Restart Procedures.

2.9.35 Vendor/Supplier Information
The Vendor/Supplier details for each component or item of equipment and where different from this, the recommended suppliers of spare parts and special tools shall be provided by the Contractor in a detailed schedule. These details shall include:

- Company name;
- Company address;
- Contact person;
- Email and internet details; and
- Telephone and facsimile numbers.

Two (2) hard copies of the draft Vendor/Supplier Information shall be submitted to the Superintendent for review no later than five (5) working days prior to the commissioning of each facility, system, component and/or item of equipment associated with the Works.

Where necessary to suit the Contractor’s late changes to the work or if the Superintendent provides comments, the draft Vendor/Supplier Information shall be revised and two (2) copies of the Vendor/Supplier Information resubmitted to the Superintendent before commissioning commences. An electronic copy of the final Vendor/Supplier Information in one PDF file and all of the native files shall be incorporated in the electronic Plant Information Portal.

2.9.36 Initial Maintenance Strategy
The Contractor’s detailed design shall include the derivation of the initial maintenance strategy based generally on Reliability Centred Maintenance (RCM) principles.

To this end, the Contractor’s detailed design shall include a Failure Modes and Effects Analysis. Where details of equipment are not fully identified prior to construction commencing, generic failure modes shall be used.

An initial maintenance strategy shall be developed by the Contractor with a view to achieving the greatest business risk reduction per maintenance dollar spent. To this end, the initial maintenance
strategy shall comprise a blend of preventive, predictive and reactive strategies, determined for each item of equipment.

For each failure mode associated with an item of equipment, a maintenance regime shall be developed with consideration for the business risk posed by the failure mode, the maintenance options for addressing the failure mode including “do nothing”, the cost of each maintenance option and the risk reduction achieved by that option. The preferred option shall be that returning the greatest risk reduction per maintenance dollar. The maintenance strategy for the item of equipment is the sum of the optimal regimes for each of the equipments failure modes.

The initial maintenance strategy development shall be fully documented including the reasoning behind the specification of maintenance activities. It shall include schedules covering preventive/predictive activity, lubrication and “housekeeping” functions. It shall also include the schedules addressing spare parts detailed below. The initial maintenance strategy shall be developed consistent with the asset hierarchy and equipment numbering.

Two (2) hard copies of the draft Maintenance Strategy shall be submitted to the Superintendent for review no later than twenty (20) working days prior to the commissioning of each facility, system, component and/or item of equipment associated with the Works.

Where necessary to suit the Contractor’s late changes to the work or if the Superintendent provides comments, the draft Maintenance Strategy shall be revised and two (2) copies of the Maintenance Strategy resubmitted to the Superintendent before commissioning commences. An electronic copy of the final Maintenance Strategy in one PDF file and all of the native files shall be incorporated in the electronic Plant Information Portal.

2.9.37 SAP Asset Management System

The final asset hierarchy (facilities, systems, components and items of equipment), numbering and naming shall be prepared at the completion of design in a tabular format. The initial maintenance strategy shall be developed consistent with this asset hierarchy, numbering and naming and shall also be prepared at the completion of design and included in this tabular format. The related maintenance activities, tasks and schedules shall also be prepared at the completion of design and included in this tabular format.

The requirements referred to above in the Contract Document shall define the nature and characteristics of asset attribute data to be provided for each asset. This may include both physical attribute data and asset accounting data, such as that required to support valuation and depreciation calculations.

The format of the spreadsheets suitable for direct uploading to the Principal’s SAP Asset Management System is shown in the examples that are included in Attachment K.

Two (2) hard copies of the draft SAP Asset Management System Schedules shall be submitted to the Superintendent for review no later than twenty (20) working days prior to the commissioning of each facility, system, component and/or item of equipment associated with the Works.

Where necessary to suit the Contractor’s late changes to the work or if the Superintendent provides comments, the draft SAP Asset Management System Schedules shall be revised and two (2) copies of the SAP Asset Management System Schedules resubmitted to the Superintendent before commissioning commences. An electronic copy of the final SAP Asset Management System Schedules in one PDF file and all of the native files shall be incorporated in the electronic Plant Information Portal.

2.9.38 Special Tools and Support Equipment

Where equipment being installed under the Contract requires special tools 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 and their cost shall be included in the Contract Sum.
Where plant or instruments have hand held programming devices / software, e.g. ultrasonic instruments, valve actuator, etc., the Contractor shall provide the Superintendent with any such device / software. Where multiple instruments require the same programming device / software application, one device / software application shall be provided for each group of five instruments.

2.9.39 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 initial maintenance strategy.

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

- All air compressors;
- All pumps and motor drives;
- All valves and actuators;
- Filters;
- Motor control centres;
- Emergency generator;
- Control system including PLC / DCS components;
- PLC / DCS 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.

Spares and consumables shall be stored securely until they are handed over to the Superintendent as part of the Handover Deliverables.

2.9.40 Renewals Forecasting and Operations and Maintenance Cost Projections

Data and information sufficient to determine a renewals annuity for the capital equipment shall be provided with the design. This data and information shall be of sufficient resolution to facilitate renewals planning at asset level and allow roll up to give a renewals cost forecast over a 40 year horizon.

The designer, having established operating and maintenance requirements, shall produce projections of staffing requirements by discipline and projected costs for operation and maintenance of the plant including consumables (power, chemicals, etc). The anticipated cost of the Principal’s labour will be provided to the Contractor by the Superintendent. The cost projections should extend to the Principal’s planning horizon of 25 years and include for any replacement or rehabilitation of equipment which it is anticipated will be required in that time.
2.9.41 Process Unit Requirements

Standards

Materials supplied, work carried out and testing performed under this section shall comply with the requirements of the following Standards to the extent that they are relevant and not overridden by these Contract Documents.

Australian Standards

AS/NZS1170.1 Structural Design Actions – Permanent, Imposed and Other Actions
AS/NZS1170.2 Structural Design Actions – Wind Actions
AS/NZS1170.4 Structural Design Actions – Earthquake Actions in Australia
AS1657 Fixed Platforms, Walkways, Stairways and Ladders – Design, Construction and Installation
AS1692 Steel Tanks for Flammable and Combustible Liquids
AS1940 The Storage and Handling of Flammable and Combustible Liquids
AS3780 The Storage and Handling of Corrosive Substances
AS4024 Safety of Machinery
AS4142.1 Fibre Ropes – Care and Safe Usage
AS4142.3 Fibre Ropes – Man Made Fibre Rope for Static Life Rescue Lines
AS4323.1 Stationary Source Emissions – Selection of Sampling Positions
AS/NZS4576 Guidelines for Scaffolding, Appendix F Industrial Safety

Other Standards and Guidelines

The following Australian Codes of Practice apply to the Contract Works:


The following International Standards apply to the Contract Works:

BS4994 Specification for Design and Construction of Vessels and Tanks in Reinforced Plastics
BS EN 13121.3 GRP Tanks and Vessels for Use Above Ground - Design and Workmanship.
ASTM D3464-96 Standard Test Method for Average Velocity in a Duct Using a Thermal Anemometer

2.9.42 Scour, General Purpose and Drainage Pump Stations

General Requirements

Each scour, general purpose or drainage pump station shall, as required as part of the Contractor’s design for the safe, efficient and effective operation, maintenance, repair, removal and replacement, comprise:

- Suitably sized wet well;
- Interconnected valve chamber for the discharge or above ground installation for the discharge valves;
- All necessary civil / structural work;
- Pumping units;
- Discharge pipework and valves;
- All associated mechanical components and equipment;
- Fall protection at the pump and man access locations; and
- Electrical, control, instrumentation and automation components and equipment.

All pumps, control, protection and monitoring equipment shall be provided with output signals in accordance with the Principal’s standards. Such output signals shall be input to the Plant’s PLC/DCS and shall form part of the operating control system as required as part of the Contractor’s design.
**Pump Station General Arrangement**

The general arrangement of each pump station shall be determined as part of the Contractor design and shall take into account at least the following:

- The connected structures to establish the pump well depth. The normal top water level (TWL) shall be below the level of the incoming pipeline/s;
- The process requirements of the connected structures to establish the pump well active volume;
- The pump station location and any relevant site constraints;
- The provision of extensive benching in the base of the pump well to minimise the stored volume at bottom water level (BWL) and thereby maximise the removal of solids from the pump well during each pump’s operational cycle;
- The provision of truck access to the pump station for pumping unit removal and re-installation;
- Discharge pressure main arrangement; and
- General operations and maintenance personnel access around the pump station and surrounding area. Stepping over discharge pipework and/or pressure mains to readily access all parts of the pump station will not be accepted by the Superintendent.

**Pump Well and Valve Chamber**

The concrete structure for each pump well and valve chamber if included shall comply with the requirement of Contract Specification/Design Brief. The incoming pipework and valves for each pump well shall comply with the requirement of SS10 Parts 4 and 5.

The Contractor shall provide double isolation on all incoming pipelines for each pump well. This shall take the form of a sluice valve external to the pump well and a knife gate valve internal to the pump well on each incoming pipeline to allow for the future safe maintenance of the pump well and the bolted into place equipment (i.e. pump discharge stands).

The internal concrete structures in each pump well shall include a protective coating, reviewed by the Superintendent, over the whole of the walls and any benching for corrosion protection and ease of maintenance in accordance with Contract Specification/Design Brief. Where odour collection covers are to be fitted, the concrete surfaces under the covers may then be subject to a more corrosive environment and shall be suitably protectively lined with a coating in accordance with SS10 Parts 4 and 5.

**Pumping Units**

The Contractor shall supply a minimum of two pumping units (duty and standby or lead and follow as appropriate) for all pump stations in the Plant. The number of pumps will be determined by the Contractor’s design. The Contractor shall install the pumping units for all pump stations in the Plant with the exception of drainage pumping units in valve pits, flow meter pits and the like where the installation of a single pumping unit and a separate non installed spare pumping unit is required.

It would be preferable if all of the drainage pumping units in valve pits, flow meter pits and the like had the same duty point and physical arrangement to allow for a common spare pumping unit to be provided by the Contractor.

Each pumping unit in this application shall be a submersible pump. Each submersible pump shall be selected based upon a stable head quantity characteristic curve (i.e. negative gradient from zero flow to end-of-curve) and shall be non-overloading under all operating conditions.

**Fall Restraint**

The submersible pumps and associated mechanical equipment for each pump well shall comply with the requirement of SS10 Parts 4 and 5.
Each wet well and valve chamber opening shall be provided with a personnel safety netting system. The safety net shall be made from black polyethylene rope complying with AS4142.3 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/NZS4576 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 the pump removal.

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

Discharge Pipework and Valves

The discharge pipework and valves for each pump station shall comply with the requirements of SS10 Sections 4 and 5.

2.9.43 Chemical Storage and Handling Systems

General Requirements

Where required, as part of the Contractors design, the delivery, storage, handling (to include waste collection) and dosing (to include monitoring, control and calibration) of all chemicals shall be in accordance with all current and relevant legislation, industry best practice and to the Superintendent’s review.

The quantities of chemicals to be stored on site shall allow, unless otherwise specifically noted, a minimum of 14 days between deliveries. The quantity shall consider the rate of use and, for chemicals used in small quantities, a sensible minimum which may result in deliveries at a much greater interval than 14 days shall be provided. The potential degradation of chemicals in storage shall be taken into account in sizing the storage facilities.

Where the average chemical consumption exceeds 2000 L in the specified delivery period, or the delivery size is greater than 2000 L, two or more storage tanks shall be provided. The minimum combined working volume of the two tanks shall be 130% of the minimum storage volume as defined by the average chemical consumption rate and specified minimum storage period, or the minimum chemical delivery volume (whichever the greater).

Where the average chemical consumption is 2000 L or less in the specified delivery period, or the delivery size is 2000 L or less, a single tank may be provided. The minimum working volume of the duty tank shall be 130 % of the minimum storage volume as defined by the average chemical consumption rate and specified minimum storage period, or 130 % of the minimum chemical delivery volume (whichever the greater). Where a single storage tank is provided, facilities for the safe storage and use of the chemical must be included (e.g. using bulki-boxes or equivalent) as a part of the chemical storage system to account for periods when the storage tank is not available.

Aluminium sulfate shall treated as a Class 8 corrosive material for the purposes of the design and installation of any storage, transfer and dosing facility.
The Contractor shall provide chemical storage filling pipelines lines with industry and supplier standard fittings so as to facilitate the supply of chemicals by the Principal’s standard suppliers under existing delivery agreements. A list of the Principal’s current preferred suppliers will be provided by the Superintendent on request from the Contractor.

All Class 8 chemical storage and dosing areas shall be contained within a railed chain wire security fenced area. All flammable chemical storage and dosing areas shall also be contained within a railed chain wire security fenced area.

Each chemical storage tank shall be provided with labelling and identification numbers as well as placard and comprehensive safety labelling.

All costs associated with the handling and storage of chemicals shall be the responsibility of the Contractor and shall be included in the Contract Sum.

*Corrosive Material Requirements*

The minimum requirements for the storage and handling of Class 8 corrosive materials shall be as detailed in AS3780.

Sodium hypochlorite and sodium hydroxide storage tanks shall be protected from direct sunlight by the provision of a roof structure and shade cloth or similar attached to the chain wire fence.

Sodium hydroxide storage tanks shall be lagged and fitted with heat tracing equipment where appropriate.

Where chemicals are used as part of the Contractor’s design, the scope of work for each chemical storage facility shall include the fabrication and supply of the transfer pump units and all integral equipment required for the operation in the intended service, but not be limited to:

- Chemical storage tanks as required.
- Each chemical storage tank shall include:
  - Ultrasonic level indicators for remote and local indication; and
  - High level switch;
  - Filling, overflow and drainage pipework;
  - Interconnecting pipework; and
  - Isolation valves.

*Flammable Material Requirements*

The flammable chemicals storage tanks shall be designed to AS1692 and AS1940, and any other applicable Australian Standards. Specific attention is drawn to underground storage requirements specified in AIP CP4, refer clause 5.12.1 in AS1940. Fixed and portable fire fighting equipment shall be provided.

Where used and if required, bulk storage of ethanol, methanol and other such flammable chemicals shall be located underground. Systems designed for ethanol shall be suitable for rapid conversion to methanol, and vice versa. Service water shall be used to dilute the dosed substrate before it leaves the storage area to ensure that the mixture is not flammable. Provision of suitable pressure and vacuum protection equipment for the tank shall be provided.

*Corrosive Material Transfer or Dosing Requirements*

Where chemicals are used as part of the Contractor’s design, the scope of work for each chemical transfer facility shall include the fabrication and supply of the transfer pump units and all integral equipment required for the operation in the intended service, but not be limited to:
• Interconnecting pipework;
• Isolation valves;
• Transfer or dosing pumps and associated equipment on a mounting skid including:
  • Pumps suitable for the nature and quantity of material to be transferred or dosed
  • Pipework;
  • Isolation valves;
  • Back-pressure valves;
  • Pulsation dampers;
  • Pressure relief valves;
  • Flow monitoring and measurement devices; and
  • Calibration tubes; and
• Continuous secondary containment pipework.

The Contractor shall provide continuous secondary containment pipework where the chemical transport pipework is located external to the bunded area/s, runs along the side of the bund/s or where a leak could otherwise escape to the environment. The secondary containment pipework shall drain to a suitable bunded area and shall have leak detection catch-pots and level switch(s).

All non-chemical and/or non-hazardous waste liquors shall be returned to a scour, general purpose or drainage pump station for return to the head of the Plant.

2.9.44 Odour Collection Components

General Requirements

The scope of the Works shall include all components to form a fully-functioning odour collection system. This shall include, but not necessarily be limited to, the provision of:

• FRP/GRP odour collection covers to all (new, existing and upgraded) elements of the structures which carry influent or screened and degritted wastewater or wastewater related material;
• Associated FRP/GRP or Grade 316 stainless steel edge support beams where required;
• Weighted air inlet dampers and other components as may be required to maintain a long-term minimum [-50] Pa negative pressure under the odour collection covers at the design extraction rates;
• FRP/GRP odour collection ductwork from all (new, existing and upgraded) elements of the structures which carry influent or screened and degritted wastewater or wastewater related material to the downstream odour control facility (OCF);
• Odour collection ductwork support structures;
• Odour collection ductwork instrument access structures;
• All holding down and assembly fasteners and fittings, gaskets and sealants to ensure joints and interfaces can be made air tight materials, and site consumables required; and
• All required monitoring instruments.

The Superintendent will consider alternate materials for the odour collection covers such as marine grade aluminium provided that the Contractor can provide examples of like covers that have successfully been in service for five (5) years. The odour collection covers shall be providing effective odour collection and shall not display undue corrosion cognisant with their age and the required design life for these odour collection covers.

The Contractor shall provide, to the satisfaction of the Superintendent:

• General arrangement drawings of the odour collection covers, odour collect ductwork and all associated components;
• Shop fabrication drawings of the odour collection covers including connection details to existing structures where relevant;
• Shop fabrication drawings of any support structures for the odour collection covers; and
• Shop fabrication drawings of the odour collection ductwork;
• Shop fabrication drawings of all support structures for the odour collection ductwork; and
• Engineering support (i.e. assistance during installation, commissioning and training).
FRP/GRP materials shall be designed using the published long-term (50 year) modulus for the material.

The Contractor's design shall comply with and include for all works required as part of the following standards:

• AS/NZS1170.1 for dead and live loads/actions and load/action combinations;
• AS/NZS1170.2 for wind loads/actions;
• AS/NZS1170.4 for earthquake loads/actions;
• BS4994 Cat 1 with any relevant Australian Standard taking precedence if current at the time. AS 2634 is now obsolete and shall not be used;
• BS EN 13121-3;
• ASTM D3464-96;
• AS1657 for access; and
• AS4323.1 for air balancing points and ductwork velocity measurement for balancing.

The Contractor shall ensure at least the following activities are included in the scope of work for the design of the odour collection covers:

• The detailed structural design of the FRP/GRP/Superintendent accepted alternate odour collection cover components and the FRP/GRP odour collection ductwork components. The design shall accommodate movements in the covers from an appropriate range of temperatures, which shall not be less than the design temperature range specified for the Plant;
• The detailed structural design of all fixings shall ensure that the arrangement does not result in excessive stress concentrations, which may lead to cracking of any FRP/GRP components before expiry of the required physical life;
• A check of the actual volume under the odour collection covers to assess its impact on the total odorous air flow calculations;
• The detailed structural design of each access platforms where access is required to equipment for operation and maintenance;
• The provision of the whole of the design calculations for independent review;
• The undertaking of all studies and the provision of all documents and deliverables, as defined within the scope of the Project Specification;
• The provision of a complete set of fully detailed drawings (produced using a computer aided drafting system (CAD) in accordance with the Principal's standards) from which installation can be implemented. These shall include general arrangement drawings imparting key dimensions, levels, etc.;
• The assessment of all design loadings at the nominated connection points to the existing structures. The Contractor shall also be responsible for ensuring the design of the bolts (and number of bolts), has allowed adequate edge distances for bolts placed into existing structures;
• The provision of final air balancing, pressure and flow details;
• The provision of full specifications for all equipment, materials, etc., proposed to be used;
• The interaction and iteration if required to determine and confirm to the Contractor’s design details with third parties; and
• Compliance with the Principal’s asset numbering and naming system.

The work shall involve, but not necessarily be limited to, the following procurement, manufacturing and delivery tasks:

• Manufacture/fabrication of the FRP/GRP/Superintendent accepted alternate odour collection cover components and the FRP/GRP odour collection ductwork components;
• Factory inspection and testing of the components;
• All packaging and delivery of the components to site;
• Unloading of the components from transport at site; and
• Manufacture/fabrication of each access platforms where access is required to equipment for operation and maintenance.

The on-site work shall include, but not necessarily be limited to:
The supply and application of corrosion coatings to all concrete surfaces below the odour collection covers which will be in contact with wastewater related gasses;

The installation of the edge support beams and the odour collection covers including weighted air inlet dampers and other components and monitoring instruments;

The testing of leakage out of the fully installed odour collection covers to demonstrate the odour capture rate. The leakage testing shall be quantitative in nature deriving a specific leakage rate, in addition to qualitative testing (such as smoke testing);

The construction of the foundations for the odour collection ductwork supports and odour collection ductwork instrument access structures;

The installation the odour collection ductwork supports and odour collection ductwork instrument access structures;

The installation of the odour collection ductwork including dampers and other components and monitoring instruments;

Over pumping, plant shutdowns or other works required to apply corrosion resistant barriers to existing concrete structures;

The designer’s support (i.e. assistance during training and commissioning);

Operator training;

The commissioning of the odour collection covers including the weighted air inlet dampers and other components and monitoring instruments; and

The commissioning of the odour collection ductwork including the dampers and other components and monitoring instruments.

Where possible the Contractor shall allow for access at odour collection cover level to ensure the need for access platforms is minimized. If ground level access for operation and maintenance is not reasonably practicable, access platforms shall be provided to the satisfaction of the Superintendent.

The odour collection covers shall include, to the satisfaction of the Superintendent, all necessary:

Access hatches, where access would be required, for entry into the covered structures to allow reasonable access to instrumentation, electrical and mechanical equipment or for inspection and sampling purposes;

Inspection hatches;

Fresh air inlets;

Odour collection off-take points including flanged duct connections to allow for the connection of odour collection ductwork;

Penstock / slide gate covers;

Allowances for any penetrations (e.g. instrument access, maintenance, cut around existing equipment, etc); and

Connections for pressure relief valves if required and all monitoring instruments.

**Odour Collection Cover Design Requirements**

**Odour Collection Cover Materials**

The material of construction for odour collection covers and / or supports shall conform to the following:

Inherently corrosion resistant under the conditions that might reasonably be assumed to exist in and around the STP (example – resistant to UV, strong cleaning chemicals, chlorine and acids, moulds and fungus, rodent attack, bird droppings, etc.);

Have low reflectivity at external surface;

Be designed to minimise the potential for water ponding;

Easy to repair/modify by non-specialists using readily available materials and processes;

Accommodate expansion and contraction accounted caused by climatic conditions without excessive flexure or movement that would impair the performance of the covers (including leakage) and ducts;
• Have a design life as detailed in SS10 Section 2. All components shall provide a physical life to match this life with the Contractor’s specified routine minimum preventative maintenance; and
• Components shall be resistant to mechanical damage from common accidental events (e.g. dropped hand tools and the like).

Relocation of Components and Items on Existing Structure

The following components and items on existing structures can be relocated to suit the odour collection covers but only with express agreement with the Superintendent during the detailed design:

• Light poles and selected instruments; and
• Portions of guardrail (handrail) and access platforms.

Odour Collection Cover Bearing Length

Where possible the odour collection covers shall be designed to land on a minimum of 100 mm of concrete wall, concrete walkway or other concrete support component. The concrete structures shall be designed for this preferred arrangement.

Where 100 mm of concrete is not available, the Contractor shall supply FRP/GRP or Grade 316 stainless steel support angles or channels as appropriate to supplement the concrete landing width.

Domed Odour Collection Cover Profile

Domed (non-flat) odour collection covers shall be designed with a profile designed to minimise the height above the coping level of the relevant structure. The additional volume below the domed odour collection covers and above the coping level resulting from the curved profile shall not be excessive. Cover profiles with lower headspace will be considered an advantage.

High intensity rainwater run-off must also be considered in design of the odour collection covers. The Contractor shall be responsible for incorporation of suitable measures to deal with control of rainwater runoff from the covers in the design. Where appropriate and only where agreed with the Superintendent, this may include measures to take rainwater into the covered structures.

Pressure Rating

The Contractor shall be responsible for the design of the odour collection covers but must note the following minimum requirements:

• The allowance in the design for pressure under the odour collection covers shall be -500 Pa with an adequate margin for typical variation in fan flow of a safety factor of at least 3;
• An operating pressure of at least -50 Pa shall be provided under normal operation;
• All covers shall be trafficable and suitable for a single person to walk on unsupported; and
• The structural design shall also consider loading scenarios where potential negative pressures due to blockage of the air inflow points occurs.

Structural Loading for Odour Collection Covers

All odour collection covers shall be designed with safety of all personnel during manufacture, transportation, installation, commissioning, operation and decommissioning in mind. The Contractor shall demonstrate during detailed design that each aspect has been considered.

Notwithstanding the loads specified above Contractor shall confirm the structural adequacy of the odour collection covers under all potential extraction, wind loading and superimposed load (e.g. from maintenance, rain, hail, etc.) combinations. Supporting calculations shall be provided to confirm the above scenarios have been assessed correctly.

Odour Collection Cover Structural Supports
The Contractor shall design and supply all necessary supports for the covers. Any support under the cover shall be either FRP/GRP or Grade 316 stainless steel. This applies to such locations as the gaps between walls for the water paths through the new and/or existing mechanical equipment.

Entry and Inspection Hatches

Hatches of minimum dimensions 0.6 m x 0.6 m square shall be provided. The area around the hatch should be flat on at least one side of the hatch to enable the Principal’s staff to gain safe access. This flat section shall incorporate fibreglass sleeve sections to enable aluminium handrail stanchions to be inserted. The intent is so that this entire flat section of cover can be protected by guard railing to limit personnel access onto the covers. The hinged section of the hatch shall have quick-release Grade 316 stainless steel latches.

The hatch design shall allow for appropriate sealed openings for all applicable power and/or signals cables. The opening shall be a notched opening with Lurethane (red) / Linatex or similar accepted sealing flap. The Contractor shall detail their proposal for this section of work for review by the Superintendent.

Instrument Hatches and Installation Points

The Contractor shall allow reasonably for hatches in the odour collection covers for accessing instruments. The Contractor shall detail suitable openings / hatches and connection points to suit the instruments once they are finalized.

Odorous Air Characteristics

The design odorous air characteristics used for design shall be that applied for the OCF inlet concentrations as defined in Contract Specification. If the Contractor’s design is such that loads on a particular unit will be considerably higher, the Contractor shall take this into account when designing and when selecting materials and equipment.

Temperature Ratings

The ambient temperature at site may vary between 0 to 45 Degrees Celsius in the shade. Surface temperatures are likely to exceed this and should be accounted for in the design.

The odour collection covers shall be exposed to direct sunlight. Incident solar radiation loadings shall be determined by the Contractor in accordance with the geographical location of the Works. The Contractor shall provide documentary evidence of resistance to accelerated aging/long term solar exposure for any flowcoat / gelcoat systems proposed for the work.

Earthquake Loading

The Contractor shall refer to AS1170 Part 4 for these loads.

Wind Loadings

The Contractor shall refer to AS1170 Part 2 for these loads.

Gaskets and Sealants

All gaskets, regardless of where they are used, should conform to the following:

- Resistant to UV and other conditions that might reasonably be assumed to exist in the Plant (eg bird droppings, acidic conditions, cleaning chemicals, disinfectant, etc);
- If self-adhesive strips are applied, they should maintain its adhesive properties for the design life of the odour collection covers without more than a 20% loss of adhesion compared with new strip;
Neoprene (or equivalent) gaskets should be suitably compressible, air tight and return to their original shape when load is removed;

- Gaskets/sealants should be able to be removed and replaced if they become damaged with commonly available chemicals and/or hand tools;
- Instructions for installation of replacement gaskets shall be provided in the Maintenance Manual; and
- The physical design life of gaskets should match that of the odour collection covers. If not, a replacement schedule and spares must be provided with the approximate cost of such replacement guaranteed and noted as part of the Tender submission.

**Air Inlets**
If required to sustain negative pressure under various operational scenarios, odour collection covers shall be fitted with appropriately designed weighted air inlet damper. The dampers shall be designed to maintain a minimum static negative pressure under the covers of at least -50 Pa at varying fluid movement conditions.

**Fixings, Handles and Associated Fittings**
Fixings should be suitable for under cover use (i.e. be able to withstand corrosion) and the use of dissimilar metals which may lead to galvanic corrosion shall be avoided.

Design life of all fixings should exceed that of the odour collection covers (25 years minimum); and expansion joints, cap plates, sliding joints etc. should be constructed of materials which do not deteriorate to a condition which compromises design performance over the physical life for which the Works are to be designed.

**Chemical Resistance**
Notwithstanding the concentrations which have been measured/calculated/estimated, the Contractor should design for peak gaseous H₂S of 250 ppm and shall advise the chemical resistance of the covers to condensate of low pH (range 1 to 5 pH units).

**Personnel Protection**
Equipment shall be guarded in accordance with the requirements of the Queensland Workplace Health and Safety Regulations and Guidelines and AS4024.

Guards shall be strong enough to withstand personnel and other loads during regular operation, maintenance and inspection activities.

Appropriate workplace health and safety warning signs complying with AS1319 shall be fastened to all equipment.

**Fasteners and Seals**
All nuts, bolts, washers and other fastening components used for odour collection covers shall be in Grade 316 stainless steel. The holding down bolts/anchors shall be Grade 316 stainless steel. Anti-galling paste shall be used on all threaded mating surfaces.

All elastomeric materials shall be in Nitrile rubber or EPDM, and consistent with the operating conditions, long-term exposure to direct sunlight and the required equipment design life.

**Odour Collection Ductwork Design Requirements**
Odour Collection Ductwork Routes
The Contractor shall select odour collection ductwork routes which allow suitable access, but also ensuring that the total pressure drop of the odour ductwork, and thus the odour educt fan size is minimised. The Contractor shall consider all access and maintenance requirements in selecting the
ductwork routes, ensuring that any maintainable equipment can be adequately removed using suitable lifting gear without impinging on, or requiring removal of ductwork.

Ductwork routes shall take into account, as far as reasonably practicable, the possible future addition of odour collection covers of the existing PSTs, the associated odour collection ductwork and the future expansion of the new OCF to treat the additional air flow.

Where the ductwork is required to transverse roadways or other access routes, ducting shall be run over the roadway and supported by an overhead duct gantry with a minimum 6 m clearance all provided as part of the Works.

Use of underground ductwork to transfer odorous air to the OCF may be accepted by the Superintendent provided that the Contractor can demonstrate how the ductwork will be drained and, when required, the internal surfaces can be cleaned.

Ductwork shall be provided with flanged joints at a maximum spacing of 12 m unless a dispensation is provided in writing by the Superintendent to increase this spacing to 18 m. In no circumstance shall sections of ductwork longer than 18 m be constructed and installed in the Works. The flanged joints do not need to comply with the requirements for pipework flanges (flange thickness and fastener diameter) unless structural requirements dictate that such ‘heavy flanges’ and fasteners are required.

Ductwork Velocity
The Contractor shall select odour collection ductwork diameters which result in appropriate ductwork velocities and which for the odour ductwork routes selected ensure that the total pressure drop of the odour ductwork, and thus the odour educt fan size is minimised.

The maximum velocity of airflow in the ductwork shall not exceed 10 m/s anywhere in any ductwork under normal operating conditions.

A sufficient number of air flow measurement points and permanent air flow measurement shall be provided in the ductwork to facilitate proper testing and commissioning of the air collection systems. At least one balancing point (consisting of the number of sample ports specified in AS4323.1) shall be provided for each extraction point, branch duct and main header duct.

All air flow measuring points shall be located in readily accessible positions and in straight / levelled ductwork. All balancing dampers shall have positive means of locking after flow balancing has occurred.

All air flow measuring points shall be placed at the reliant number of ‘hydraulic diameters’ upstream or downstream from any bend or air control device as required AS4323.1. Where the abovementioned required distance cannot be achieved the Contractor shall design, supply and install straightening vanes or diffusing grids to achieve stable flow conditions at the flow measuring point.

Materials of Construction
All ductwork shall be constructed from FRP, and conform to the following:

- Inherently corrosion resistant under the conditions that might reasonably be assumed to exist in and around the STP (example – resistant to UV, strong cleaning chemicals, chlorine and acids, moulds and fungus, rodent attack, bird droppings, etc);
- Have low reflectivity at external surface;
- Easy to repair/modify by non-specialists using readily available materials and processes;
- Accommodate expansion and contraction accounted caused by climatic conditions without excessive flexure or movement that would impair the performance of the covers and ducts;
- Have a design life of all ducting and associated fittings (i.e. expansion joints, dampers, etc.) as detailed in SS10 Section 2. All components shall provide a physical life to match this life with the Contractor’s specified routine minimum preventative maintenance; and
• Expansion joints shall be required to be designed and installed as needed to cope with thermal movement of the ductwork.

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) an airtight isolation damper shall be provided in addition to the air flow control damper.

Duty / standby fan sets 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.

All actuated dampers 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.

Flow control dampers
Flow control dampers will be constructed with a Grade 316 stainless steel stem, fibreglass gate and Grade 316 stainless steel handle and locking mechanism. Flow control dampers shall be located for ease of access and operability in locations that can easily be operated from walkway / ground level. Where it is unavoidable dampers may be located in overhead duct runs provided a means of operation from ground level is developed by the Contractor. Use of chains to address this requirement shall not be acceptable. There shall be at least one flow control damper supplied on each off-take branch.

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 walkway/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. 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 outside of the damper.

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 electric actuator such as manufactured by Rotork (or technically equivalent and reviewed by the Superintendent). 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.

Ductwork Supports
Ductwork supports and saddles shall be fabricated from black steel, all hot dip galvanised after fabrication. Ductwork supports shall be designed by a rational method to limit combined stress in the ductwork to an appropriate level, which shall not under any combination of loads exceed the 50-year modulus of the ductwork material. Calculations shall be performed (and issued to the Superintendent) before fabrication commences to demonstrate that this requirement shall be met.

Each ductwork support shall accommodate movement of the ductwork without scraping of the gel coat against the support.

No on site cutting or welding of hot dip galvanised sections will be permitted unless the component is re-hot dip galvanised after modification.

Condensation Drains
Automatic ductwork condensation drainage facilities at low points of the ductwork shall be provided to automatically drain condensed liquids from the ductwork to liquid disposal points accepted by the Superintendent. Under no circumstance shall the liquid be discharged onto concrete elements or to the environment. It shall be discharged in such to a fully contained and collected area where it can be returned to the wastewater treatment stream.

Ductwork shall be designed to fall to suit drain location.

Condensate drains shall be automatic draining type with an ‘S’ bends or similar installed to prevent ingress of air.

Fasteners and Seals
All nuts, bolts, washers and other fastening systems used for odour collection ductwork including flanges shall be in Grade 316 stainless steel. All ductwork support hold down and assembly fasteners shall be Grade 316 stainless steel. Fasteners used for the ductwork supports and clamps shall be Grade 316 stainless steel. Anti-galling paste shall be used on all threaded mating surfaces.

Any elastomeric materials shall be in Nitrile rubber or EPDM, and consistent with the operating conditions, long-term exposure to direct sunlight and the required equipment design life.

2.9.45 Odour Control Facility

General Scope of Work
Where one or more odour control (or treatment) facilities are required, the Contractor shall design, supply, fabricate, manufacture, deliver, construct, install, commission and performance test each odour control facility (OCF). Each OCF provided by the Contractor shall include, but not be limited to, the following components to achieve a fully working and monitored facility:

- All foundations, footings, pits, bunds, slabs, plinths and any other civil and structural work as is required to mount and secure the OCF components and items of equipment;
- All components and items of mechanical and electro-mechanical equipment required for the OCF;
- All electrical and electro-mechanical components required for the OCF;
- All instrumentation required for the OCF;
- All electrical power, control and instrumentation wiring for all components and items of equipment required for the OCF; and
• All Plant PLC/DCS programming necessary for all components and items of equipment required for the OCF.

For each OCF provided, the Contractor shall supply and install at least the following additional components:

• All holding down fasteners required for the facility;
• Access platforms and hand railing where required for safe access for maintenance of all components and items of mechanical and electro-mechanical equipment and each instrument;
• Sample points such as are required to operate, maintain and performance test the facility;
• All drainage points and condensate traps associated with the scrubbers and the ductwork;
• All safety equipment required as a result of any scrubber systems including but not limited to PPE, safety showers and eye-wash basins;
• Connections to all Plant services as are required for the facility;
• Mountings for lightning protection where required;
• Lightning protection for the discharge stack;

If required as part of the Contractor’s fully functioning OCF, the Contractor shall provide chemical storage and dosing facilities in accordance with the requirements of SS10 Section 3 and 4 and the requirements later in this section. In addition to those requirements, the following additional requirements apply:

• Where required to prevent flow restriction issues with certain types of chemicals, the Contractor shall provide heaters, trace heating and lagging as required to tanks, cabinets and transfer/dosing pipelines; and
• The Contractor shall provide all safety equipment required as a result of any chemical storage, transfer and dosing systems including but not limited to PPE, safety showers and eye-wash basins.

The Contractor’s design shall comply with and include for all works required as part of the following standards:

• AS/NZS1170.1 for dead and live loads/actions and load/action combinations;
• AS/NZS1170.2 for wind loads/actions;
• AS/NZS1170.4 for earthquake loads/actions;
• BS4994 Cat 1 with any relevant Australian Standard taking precedence if current at the time. AS 2634 is now obsolete and shall not be used;
• BS EN 13121-3
• ASTM D3464-96; and
• AS1657 for access.

The Contractor shall ensure at least the following activities are included in the scope of work for the design of the OCF:

• The process design for the OCF;
• The mechanical and electrical design for the mechanical, electro-mechanical and electrical components and items of equipment for the OCF and the discharge stack;
• The civil and structural design for the civil and structural components of the OCF and the discharge stack;
• The detailed structural design of each access platforms where access is required to equipment for operation and maintenance;
• The undertaking of all studies and the provision of all documents and deliverables, as defined within the scope of the Project Specification;
• The provision of the whole of the design calculations for independent review;
• The provision of a complete set of fully detailed drawings (produced using CAD in accordance with the Principal's standards) from which installation can be implemented. These shall include general arrangement drawings imparting key dimensions, levels, etc.;
• The provision of final head loss and flow details;
• The provision of full specifications for all equipment, materials, etc., proposed to be used;
The interaction and iteration if required to determine and confirm to the Contractor’s design details with third parties; and
Compliance with the Principal’s asset numbering and naming system.

The design shall accommodate movements in the process unit structures and interconnection ductwork from an appropriate range of temperatures, which shall not be less than the design temperature range specified for the Plant.

The design of fixings shall ensure that the arrangement does not result in excessive stress concentrations, which may lead to cracking of any FRP/GRP components before expiry of the required physical life.

The Contractor shall provide, to the satisfaction of the Superintendent:

- General arrangement drawings of the OCF, the discharge stack and all associated components;
- Shop fabrication drawings of the OCF, the discharge stack and all associated components;
- Shop fabrication drawings of any support structures for the OCF and all associated components; and
- Engineering support (i.e. assistance during installation, commissioning and training).

FRP/GRP materials shall be designed using the published long-term (50 year) modulus for the material.

The on-site work shall include, but not necessarily be limited to:

- The construction of the foundations, footings, pits, bunds, slabs, plinths and any other civil and structural work for the OCF;
- The supply and application of corrosion coatings to all exposed concrete surfaces potentially in contact with chemicals;
- The installation of the OCF including the discharge stack and monitoring instruments;
- Cut-in work to the existing Plant where required;
- Setting to in operation and pre-commissioning of any chemical storage and dosing equipment;
- Operator training;
- The designer’s support (i.e. assistance during training and commissioning);
- The commissioning of the OCF including the monitoring instruments; and
- Any mandatory specific Statutory safety approval and administrative requirements.

In addition to the common components, the provided odour control system shall conform to the following requirements which are specific to its technology (or technologies for a hybrid system).

**Odour Control Facility, General Requirements**

The following is a description of the general scope of work detailing some of the necessary components and equipment. It is provided to establish the Principal’s requirements for the nominated components and item of equipment. Its inclusion does not limit the scope of supply and installation of any new odour control facility (OCF) for the Works.

The OCF provided shall possess at least the following common components.

**Pre-Treatment Units**

Odorous air drawn from the covered/contained areas is expected to contain contaminants such as airborne grit and light screenings, humidity and condensate and other material commonly encountered at wastewater treatment plants.

Pre-treatment units (e.g. pre-filters) shall be provided to protect downstream units from such incoming material where necessary to maintain optimum OCF performance and preserve the design life of the units, internals or media.

**Primary Scrubbing Unit/s**
A primary scrubbing unit or units shall be provided, along with all ancillaries and equipment required for a fully functioning system, to treat, under normal operation, odorous air from the covered/contained areas to the stack discharge quality detailed above.

The primary scrubbing unit or units shall be one or a hybrid of the following technologies to achieve the stack discharge requirement on a 100%ile basis:
- Wet-chemical scrubber;
- Biological scrubber (note area source biofilter will not be accepted due to an unsatisfactory means of discharge); or
- Adsorption, dry chemical or other media-based.
The OCF may achieve the discharge criteria through more than one scrubbing stage. Further requirements associated with each technology are detailed later in this Section.

Redundancy & Secondary Odour Control Unit(s)
The OCF shall include sufficient redundancy such that the full foul air flow can be treated to the specified stack discharge quality when any one of the primary scrubbing units is unavailable for any reason.

A secondary scrubbing unit such as a media-based system, such as activated carbon, used as a ‘polisher’ in a 2-stage system under normal operation, shall not be considered, sufficient redundancy due to the possibility that the media will be close to exhaustion when failure of the primary scrubbing train occurs.

Acceptable forms of redundancy shall include:
- ‘n+1’ redundancy on the primary scrubbing train, defined as having one more than the minimum number of units available to share the full flow, but with the system being capable of treating the full flow with ‘n’ units on line; or
- A dedicated standby media system capable of lasting for at least 4 weeks online at full airflow. Design loading shall consider both average and peak load and shall assume the unit operates at least 10% (67.2 h in 672 h) at its peak concentrations.

Apart from the ‘4 weeks online’ design criteria above, units used or designated for redundancy shall conform as the others to all aspects of this Project Specification.

Redundant units must be ready to operate at satisfactory efficiency at all times. Ductwork and dampers shall be provided and configured accordingly. Upon failure of a primary scrubbing unit, the redundant unit(s) shall be called to operate automatically without operator assistance. This process shall trigger an alarm on the Plant’s PLC/DCS.

Educt Fans
Air shall be drawn through the OCF by educt fans.

Two (2) No educt (or extraction) fans operating duty / standby each capable of handling 100% of the overall system design flow shall be provided. The design of each fan shall take into account all pressure losses including, but not be limited to, losses through odour collection cover inlet and outlets, ductwork, dampers, scrubbing units, fittings and the stack. The Contractor shall make allowance for a pressure of at least -100 Pa at the odour collection cover extraction point within their pressure loss calculations. An appropriate safety margin shall be provided in selecting the educt fans.

The Contractor shall provide all robust, durable and accessible (from platform level) isolation and non-return dampers necessary to allow reasonably foreseeable system maintenance without the need to shut down the OCF.

Acoustic enclosures shall be provided if required to comply with the noise requirements in the Contract Specification.
The Contractor shall consider carefully and allow for any hazardous area zoning requirements.

**Interconnecting Ductwork and Discharge Stack**

The Contractor shall provide all inter-connecting ductwork, dampers and ductwork supports required for a fully functional system including:

- A bypass allowing the educt fans to draw air around each of the upstream scrubbing units to allow for bypass of these process unit;
- A bypass allowing the educt fans to discharge air around each of the downstream scrubbing units to allow for bypass of these process unit to the discharge stack inlet; and
- 1 No free standing stack shall be provided discharging gas to atmosphere at least 3 m higher than the tallest structure nearby (within a 100 m radius) or 15 m above ground level whichever is the highest.

The efflux velocity from the discharge stack shall be in excess of 15 m/s.

**Odour Control Facility, Biological Treatment Systems - General Requirements**

Any biological treatment system provided by the Contractor shall include, but not be limited to, at least the following components:

- Scrubbing vessels complete with all relevant packing and internals;
- Wetting or liquor recirculation system;
- Nutrient storage and dosing system;
- Instruments and monitoring equipment;
- Scrubber blowdown infrastructure including a chemical dosing system or dilution system such as is necessary to ensure the scrubber blowdown is returned to the main flow at a suitable location at pH 6 or better;
- Safety equipment and showers as required by the Contract Documents as if the material was a Class 8 Hazardous Material;
- Sample points; and
- All other ancillary equipment as required for a fully functional system.

**Odour Control Facility, Chemical Scrubbing Systems - General Requirements**

Any wet chemical scrubbing provided by the Contractor shall include, but not be limited to, at least the following components:

- One or more scrubbing vessels;
- Sidestream catalyst reactors if deemed appropriate;
- Chemical storage and dosing facilities;
- Fully functional water softening facility;
- Instruments and monitoring equipment;
- Services and recirculation pipework;
- Blowdown infrastructure;
- Safety equipment and showers as required by the relevant Australian Standard for the chemical used;
- Sample points; and
- All other ancillary equipment for a fully functional scrubbing system.

**OCF, Chemical Scrubbing Systems - Chemical Handling Requirements**

Where chemicals shall be used as part of the Contractor's design, the scope of work for each chemical dosing facility shall include the fabrication and supply of the dosing pump units and all integral equipment required for the operation in the intended service, but not be limited to:

- Day storage tanks where required. Each day storage tank shall include:
  - Ultrasonic level indicators for remote and local indication; and
  - High level switch;
  - Interconnecting pipework;
Isolation valves;
Dosing pumps and associated equipment on a mounting skid including:
• Pipework;
• Isolation valves;
• Back-pressure valves;
• Pulsation dampers;
• Pressure relief valves;
• Flow monitoring and measurement devices; and
• Calibration tubes;
• Continuous secondary containment pipework (where required); and
• Dosing cabinets (where required).

The Contractor shall provide continuous secondary containment pipework where the chemical transport pipework is external to the chemical bund area/s, runs along the side of the bund/s or where a leak could otherwise escape to the environment. The secondary containment pipework shall drain to the chemical bund area and shall have leak detection catch-pots and level switch(s).

All non-chemical and / or non-hazardous waste liquors shall be returned to a scour, general purpose or drainage pump station for return to the head of the Plant.

Chemical Day Storage Tanks
Each chemical day storage tank shall be suitable for the chemical to be stored. Each chemical day storage tank shall hold 24 hours supply of the chemical being dosed.

Each tank shall be properly cleaned and leak tested and suitably protected from ingress of foreign material prior to delivery.

A suitable contents level indicator calibrated in L shall be provided. The float and indicator shall be suitable for the chemical being stored.

In addition, a tank mounted ultrasonic level indicator together with a display at the local transmitter which shall be sited in an accessible position adjacent to the chemical day storage tank and be protected from the sun.

All Class 8 chemical day storage and dosing areas shall be contained within a railed chain wire security fenced area. Sodium hypochlorite and sodium hydroxide day storage tanks shall be protected from direct sunlight by the provision of a roof structure and shade cloth or similar attached to the chain wire fence.

Sodium hydroxide day storage tanks shall be lagged and fitted with heat tracing equipment where appropriate.

Each chemical day storage tank shall be provided with labelling and identification numbers as well as placard and comprehensive safety labelling.

Chemical Dosing Pumps
A minimum of two (2) number diaphragm dosing pumps shall be supplied for each dosed chemical, operating duty / standby.

The dosing pumps shall be either:
• Housed in a sealed, clear dosing cabinet with a drain into the chemical bund via dosing cabinet leak detection catch-pots and level switch; or
• Housed in a chemical bund.

The dosing pumps shall have self venting dosing heads to prevent the accumulation of gases, which would inhibit the pumping action and therefore change the dosing rate of the pumps. The speed of the dosing pumps shall be paced with the plant flow at the relevant dosing point.
The digital pumps shall be powered by 240V ac supply which accepts:

- An analogue signal for variation of output automatically for Plants with a DCS or which have a PLC based control system which is remaining with analogue control; or
- A signal through a Profibus connection for variation of output automatically for Plants which have a PLC based control system that has adopted Profibus control.

The Contractor shall supply and install suction strainers before the pumps. These strainers shall be of suitable material unaffected by sodium hypochlorite - (not stainless steel) with a maximum opening of 1 mm. The Contractor shall supply and install appropriate isolation valves before and after each strainer.

Dosing pumps shall be of sufficient rated capacity with adequate turn down to achieve the complete range of flow rate requirements as specified in the new OCF design.

The metering pumps shall be direct motor driven of the hydraulically actuated diaphragm type, suitable for metering service, with an actuated or servo stroke controller and an adjustable micrometer stroke control range of 10:1. Each pump shall have a repeatable metering accuracy of better than ± 1 percent in the stroke length range of 10 % to 100 %.

The metering pumps shall be complete and include all accessory equipment as maybe required. At a minimum, each pumping unit shall have a corrosion-resistant mounting base, totally-enclosed gear reciprocating drive, flat teflon disk diaphragm liquid end, easily removable check valves, and adjustable stroke control.

Each pump shall be fitted with a suction strainer, a pressure gauge on the discharge, a check valve, a pulsation dampener pressure sustaining valve, an electromagnetic flowmeter and inlet and outlet isolation valves. There shall be an internal relief valve built in to protect each pump.

Each pulsation dampener shall be suitably designed and sized for the displacement of the discharge pressure of each pump such that the fluctuation of the discharge pressure is limited to +/- 10 %.

Dosing pumps shall be installed so that they have a flooded suction at all storage levels, and are readily accessible for operation and maintenance.

Chemical Dosing Pipework and Valves

All chemical pipework and manifolds shall be Schedule 80, grey, UV resistant, PVC. Joints shall be solvent welded using the manufacturer’s recommended solvents and methods. Joints that leak during commissioning shall be heat welded using equipment recommended by the pipe work manufacturer. Pipework greater than 50 mm in internal diameter shall be flanged using Grade 316 stainless steel backing ring type flanges. Pipework equal to or smaller than 50 mm in internal diameter shall be provided with dismantling joints (barrel unions or flanged joints) to allow the pipework to be dismantled for major maintenance.

All dosing pipework shall be secondary contained (ie a pipe in a pipe or a pipe in a watertight duct) from the dosing pump location to the dosing point.

The pipework shall include all process, instrument and drainage connections, together with all necessary fixtures and fittings associated with all equipment and instrumentation.

Pipework systems shall be designed and constructed with proper support, flexibility, normal accessibility for operation, maintenance and thorough cleaning and drainage through low points without disassembly.

The use of nipples shall be kept to an absolute minimum. Threaded unions shall be used to join pipework lengths equal to or smaller than 50 mm in internal diameter and be provided to enable easy access, removal and replacement of components and fittings.
The pipework shall terminate with flanged connections (for pipe greater than 50 mm in internal diameter) or threaded unions (for pipe equal to or less than 50 mm in internal diameter) at the edge of the dosing skid.

The access and valving shall allow for the flushing and drainage of the suction and discharge lines without dismantling of the lines on the pump sets.

Each pump suction line shall be provided with a 6 mm vent tube to release any gas accumulation. The vent tube shall be installed rising continuously to the storage tank. Suction and discharge pipework shall be arranged with continuous falls away from the pump to avoid vapour locking.

All pipework shall be supported at intervals in accordance with the manufacturer’s recommendations, with due allowance made for thermal expansion. Expansion loops and/or flexible joints shall be provided where necessary to meet this requirement. Pumps and other equipment shall not be relied upon for pipe support. In-line equipment, pumps and non-plastic valves shall be supported independently of the pipework. Pipelines are to be installed in such a manner that no trip hazards are created. Where this is not possible suitable / accepted safety ramps shall be provided.

Valves shall be manufactured by either George Fisher, Praher or Stubbe and be rated at NP 16 or NP 12 as appropriate. Valves shall have union type connectors or flanges appropriately rated for the valve.

Pipework and dosing lines carrying sodium hydroxide shall be fitted with heat-tracing equipment which shall operate to ensure that 32% sodium hydroxide will not reach freezing / crystallisation point.

Chemical Dosing Calibration
A suction draw down column type calibration cylinder shall be provided to measure pump performance. Calibration cylinders shall be of sufficient volume to allow 2 minutes pump operation at maximum flow.

Calibration cylinders shall be of suitable material and size fitted with an end cap and vent connection returning back to the edge of the skid to be continued to the storage tank by others. The calibration cylinder shall be permanently calibrated and marked in appropriate units to suit the requirements of the pump performance test.

Electromagnetic Flowmeters
Electromagnetic flowmeters shall be provided for each of the dosing lines. The electromagnetic flowmeters shall have no control function, and are used for fault finding / performance monitoring only.

Solenoids
Solenoids shall be manufactured by either Asco (No. 1) or Burkett (No. 2). Other manufacturers’ solenoids shall not be used unless specifically reviewed by the Superintendent. Solenoid valves will only be permitted on pipework sizes up to 38 mm internal diameter.

Bolting and Fasteners
All fasteners external to the dosing pumps and all other components shall be manufactured from Grade 316 stainless steel. Holding down fasteners shall be Grade 316 stainless steel. Anti-galling paste shall be used on all threaded mating surfaces.

OCF, Adsorption, Media-based or Dry Chemical Systems - General Requirements
Any adsorption or media-based facility provided by the Contractor shall include, but not be limited to, at least the following components:

- Scrubbing vessel(s) as required to achieve the discharge requirements complete with first fill of carbon;
- Inlet Pre-filters and Heater units to reduce gas relative humidity levels to those specified by the media supplier to achieve maximum adsorption efficiency and / or media life;
- Instruments and monitoring equipment;
- Sample points; and
All other ancillary equipment as required for a fully functional system.

Odour Control Facility, Specific Design Requirements

General Requirements

All FRP/GRP vessels shall be designed, installed and commissioned in accordance with BS4994 or the superseding British Standard document.

Wet Chemical Scrubbing

Wet scrubbing systems shall be vertical – counter current packed tower systems specifically designed to treat the air flow and contaminant load detailed in the Contract Specification.

In the event that a single stage cannot treat the load without pre-treatment, a pre-scrubber (such as a venturi or similar) shall be used to reduce the load prior to treatment in a packed tower wet chemical scrubber.

Use of advanced catalytically enhanced wet chemical scrubbing systems (such as the Odorgard™ process) is acceptable and encouraged where economic or operational advantage can be demonstrated.

For wet chemical scrubbing systems the following specific requirements shall apply:

- Differential pressure measurement across packing, demister and total unit shall be provided.

Demister

A demister shall be supplied to remove liquid droplets from the treated gas stream; the demister shall be either:

- Knitmesh or composite knitmesh / chevron plate type in packed towers; or
- Chevron plate in venturi pre-scrubbing type systems.

Use of mass transfer packing material as a demister will not be accepted by the Superintendent.

Liquid Distributor

The liquid distributor shall be trough and weir type (Norton or equivalent). Distribution systems comprising of spray bars or spray nozzles will not be accepted.

Mass Transfer Packing

High mass transfer efficiency, low pressure drop packing shall be provided.

Column Sump

The column sump shall have a minimum liquid residence time of 5 minutes. Liquid residence times lower than this will not be accepted.

Recirculation System

The following shall be provided by the Contractor as a minimum:

- The recirculation system shall provide sufficient hypochlorite mass flow to prevent sulfur deposition in the tower under all operating modes;
- Duty / standby recirculation pumps shall be provided;
- An in-line mixer shall be provided to ensure suitable mixing of dosed chemical prior to sampling by pH / ORP dual validation probes;
- Sodium hydroxide and sodium hypochlorite dosing injection points (dosing into the column sump will not be accepted);
- Dual validation pH and ORP probes complete with low flow switches and associated instrumentation;
- An Electromagnetic flowmeter to monitor recirculation liquid flow rate; and
- For Odorgard™ scrubbing systems, an automated reactor bypass system interlocked on pH and ORP.

Odorgard™ Reactor

If an Odorgard™ reactor is provided by the Contractor, the following minimum requirements shall apply:
- The reactor shall be a certified pressure vessel;
- A bursting disk shall be fitted (to allow controlled venting of oxygen gas back into the packed tower). An alarm shall be raised if the bursting disc is used. A minimum of 2 spare bursting discs shall be supplied as part of the scrubber scope of supply. The use of a pressure relief valve will not be accepted;
- The vessel shall be constructed from FRP. The use of stainless steel in the construction of the vessel or catalyst basket will not be accepted; and
- Differential pressure monitoring of the reactor shall be provided.

**Biotrickling Filters**

Recirculation type or non recirculation type biotrickling filters are both acceptable.

Biotrickling filters shall be provided with a downstream activated carbon adsorption system to achieve the required ‘OU’ discharge level.

All supplied biotrickling filters shall be combined (or two stage) autotrophic / heterotrophic systems to ensure downstream carbon consumption is minimised.

In recirculation type systems the following minimum requirements apply:

- Duty / standby recirculation pumps shall be provided;
- Dual validation pH and conductivity probes complete with low flow switches and associated instrumentation shall be provided; and
- An electromagnetic flowmeter to monitor recirculation liquid flow rate shall be provided. Differential pressure measurement across each unit shall be provided.

The media proposed to be installed in the biotrickling filter shall have an asset life of not less than 5 years.

Where possible the unit shall utilise Plant service water for irrigation / makeup water. It is the Contractors responsibility to ensure the Plant service water is suitable for this purpose.

The Contractor shall, via calculation, determine the effects of the return of low pH blowdown liquors to the works, with respect to effects on inlet alkalinity. If required, a neutralisation or dilution system shall be provided to prevent adverse effects on the Plant’s inflow alkalinity.

**Carbon Units**

Annular bed, dual bed or deep bed designs are acceptable. Where an up flow design is proposed to be provided, the Contractor shall provide to the Superintendent calculations and demonstrated experience that carbon bed fluidisation will not occur.

Carbon units shall be designed with due consideration to all incoming contaminants. Units designed purely on hydrogen sulphide with respect to bed life and/or empty bed contact time (EBCT) will not be accepted.

For carbon units utilised as a primary odour control system or polishing unit, a minimum carbon bed life of 1 year under continuous use is required (under average load).

For carbon units used as standby facilities to the primary odour control system, a bed life of 4 weeks under the loading conditions specified above shall be required.

Carbon units shall be designed to cater for the peak measured contaminant load and duration without odour breakthrough.

Carbon filter units shall be provided with the following as a minimum:
- Inlet air humidity control system (heater) to reduce incoming relative humidity to less than 80% (or level required by carbon manufacturer to maximise performance). Heaters shall be provided with all required control and safety features to prevent overheating / fire risks;
- Differential pressure measurement across each bed;
- Carbon sampling ports at 25%, 50%, 75% and 90% of bed depth;
- All manway / access required to allow for removal / replacement of the carbon media;
- Where it is anticipated that compounds which result in exothermic adsorption reactions will be adsorbed in concentrations and quantities sufficient to result in bed overheat, bed overheating detection by means of exhaust steam temperature rise or carbon monoxide / carbon dioxide concentration rise shall be fitted and coupled to a bed quench system;
- Carbon beds shall be designed and configured so that full odour control can be achieved while bed change out is occurring. Designs utilising multiple vessels or compartmentalised vessels will be acceptable only if it can be shown that the carbon bed being changed is positively isolated from the air flow passing through the remainder of the system;
- Analysis certificates shall be provided by the Contractor to the Superintendent that show that the activated carbon is new and free from adsorbed chemicals. Analysis certificates provided by the activated carbon manufacturer or supplier will not be acceptable for this purpose; and
- Upon installation of fresh carbon intro the vessels on site, the Contractor shall undertake a program of settling the carbon into place and removing any carbon fines generated during transport or installation of the carbon. The Contractor shall provide a detailed description of the process to be undertaken and shall not undertake the process until accepted by the Superintendent.

**Odour Control Facility – Design Summary**

Table OCF Design Summary stipulates in detail the requirements of the OCF to be provided.

<table>
<thead>
<tr>
<th>Item</th>
<th>Process Stage</th>
<th>Sub-Category</th>
<th>Design Criteria</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>General Requirements for Ductwork, Dampers, Fans and Ancillary Equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Ductwork</td>
<td>Material of construction</td>
<td>FRP/GRP</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Design standard</td>
<td>BS4994 Cat 1 or equivalent current Australian Standard.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Duct design velocity</td>
<td>Velocity shall not to exceed 10 m/s anywhere in the duct system.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bypass ductwork</td>
<td>(Contractor’s design) Shall be provided to allow fans to draw air from OCF Inlet to stack inlet if all scrubbing units are unavailable. Bypass duct shall have a device (eg orifice plate) to simulate pressure drop across bypassed unit/s.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Dampers</td>
<td>Design</td>
<td>(Contractor’s design) Multi leaf with external linkage as a minimum. Flanged to allow removal for maintenance. Shell shall be fabricated of the same material as ductwork.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Location of isolation dampers</td>
<td>Isolation Dampers shall be provided and configured so each pre-treatment/filter or scrubbing unit can be isolated for maintenance.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>Discharge Stack</td>
<td>Design</td>
<td>(Contractor’s design) FRP, Free Standing</td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>Process Stage</td>
<td>Sub-Category</td>
<td>Design Criteria</td>
<td>Notes</td>
</tr>
<tr>
<td>------</td>
<td>---------------</td>
<td>--------------</td>
<td>-----------------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Discharge 15m above OCF plinth. Design generally as BS 4994 Cat.1 (or equivalent Australian standard) with good engineering practice in respect of stress levels and deflection</td>
<td></td>
</tr>
<tr>
<td>Flow capacity of discharge stack</td>
<td></td>
<td></td>
<td>100% of OCF design flow</td>
<td></td>
</tr>
<tr>
<td>Escape velocity</td>
<td></td>
<td></td>
<td>15 m/s minimum</td>
<td></td>
</tr>
<tr>
<td>Silencer</td>
<td></td>
<td></td>
<td>A silencer is not desired but shall be included in discharge stack structure if required to prevent undue noise. Shall be constructed of suitable material to prevent corrosion by normal and abnormal operation of the upstream equipment.</td>
<td></td>
</tr>
<tr>
<td>Manways</td>
<td></td>
<td></td>
<td>Manway for internal inspections at discharge stack base. Manways shall be minimum 800 mm diameter fabricated from clear transparent material. Manways are to be provided with handles to facilitate safe removal.</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>Condensate drain facility. Provision of mounting for lightning protection.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td>Access to higher level equipment as necessary</td>
<td>Equipment shall be placed close to or at ground level wherever possible, with air piped to ground level.</td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>Extraction Fans</td>
<td>Material of construction</td>
<td>(Contractor’s design)</td>
<td>Able to achieve design life for mechanical equipment stipulated in SS10-Section 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of fans</td>
<td>2 No, operating duty/standby</td>
<td>Contractor shall ensure that sufficient design consideration is given to fan sizing and the design of the feed ductwork. Design should include straight lengths of ductwork or straighteners to ensure the fan</td>
</tr>
<tr>
<td>Item</td>
<td>Process Stage</td>
<td>Sub-Category</td>
<td>Design Criteria</td>
<td>Notes</td>
</tr>
<tr>
<td>------</td>
<td>---------------</td>
<td>--------------</td>
<td>-----------------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fan motors</td>
<td>High efficiency</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fan drives</td>
<td>Direct coupled motor using variable speed drives.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Automatic non-return dampers required to prevent back-driving of out of service fans.</td>
<td>Isolation dampers shall be provided downstream of the non-return dampers to allow removal for maintenance.</td>
</tr>
<tr>
<td>1.5</td>
<td></td>
<td>Bulk storage tank design criteria</td>
<td>Tanks to provide 14 days storage of chemical based on average load</td>
<td>Day tanks will be filled from bulk storage tanks elsewhere on site</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Specification</td>
<td>Tanks shall be designed to BS4994.1987 Cat 1 or equivalent Australian Standard</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Minimum volume per tank</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manways</td>
<td>All manways shall be provided with handles formed from 20 mm dia hot dip galvanised steel bar to allow safe removal.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Tank fittings and instrumentation</td>
<td>Each tank shall also be fitted with: make up connection, drain, calibration return connection, tank interconnection ports, bypass magnetic indicator, overflow, level transmitter with remote and local indication, high level switch and one outlet connection as a minimum.</td>
<td>All tank connections shall be flanged. Flat-bottomed tanks shall be installed on a mat of resilient material, minimum thickness 12.5 mm and compatible with the tank contents to ensure that the floor of the tank is evenly supported. Tanks drain and base shall be designed so the tanks can be completely drained, leaving no residual liquid.</td>
</tr>
<tr>
<td>1.6</td>
<td></td>
<td>Chemicals</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dosing control</td>
<td>PID loop pH controlled sodium hydroxide dosing PID loop ORP controlled sodium hypochlorite dosing 2 no pH probes to be</td>
<td>pH / ORP adjustment of recirculation liquor “No-Flow” switch on quality measurement line to inhibit dosing on “no-flow”</td>
</tr>
<tr>
<td>Item</td>
<td>Process Stage</td>
<td>Sub-Category</td>
<td>Design Criteria</td>
<td>Notes</td>
</tr>
<tr>
<td>------</td>
<td>---------------</td>
<td>--------------</td>
<td>-----------------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Additional requirements – secondary containment</td>
<td>used for dual validation 2 no ORP probes to be used for dual validation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Secondary containment to all chemical lines (draining to chemical bund) via dosing cabinet leak detection catch-pots. The secondary containment shall completely shroud the pipework and associated fittings. The containment shall be designed such that the process line can be readily accessed for maintenance. The pipework shall be routed above ground with routes planned to avoid personnel thoroughfares and electrical equipment.</td>
<td>The joints in the secondary containment shall be kept to a minimum and visual access shall be provided in order to detect the location of leaks. If proprietary circular containment systems are used, where these do not require trace heating and lagging, they shall include the facility to replace/repair the process line without the need to replace the complete secondary containment.</td>
</tr>
<tr>
<td>1.7</td>
<td>Chemical Dosing Systems –</td>
<td>Location</td>
<td>Suitably bunded area</td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>Process Stage</td>
<td>Sub-Category</td>
<td>Design Criteria</td>
<td>Notes</td>
</tr>
<tr>
<td>------</td>
<td>---------------</td>
<td>--------------</td>
<td>-----------------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number</td>
<td>Per dosing point, 2 per chemical (operating duty/standby).</td>
<td>Auto changeover on low flow or pump failure and on hours run</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Type</td>
<td>(Contractor’s design)</td>
<td>The pumps shall be capable of providing the required turndown for P&amp;ID stability, as required by the performance test. Electromagnetic flow on quality measurement line to inhibit dosing on “no-flow”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control (sodium hydroxide)</td>
<td>PID loop pH control</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Control (sodium hypochlorite)</td>
<td>PID loop ORP controlled with 2 No OPR probes for dual validation</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Additional requirements</td>
<td>Dosing pumps, associated pulsation dampers, pressure relief valves etc will be housed in a sealed, clear dosing box. With a drain into the chemical bund.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Preferred type</td>
<td>Positive displacement, variable speed, variable stroke length</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Duty</td>
<td>Wetted parts and seals suitable for pumped fluids</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Capacity</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td>1.8</td>
<td>Water Softeners (shall be correctly sized and provided for any chemical scrubbing system)</td>
<td>Capacity</td>
<td>(Contractor’s design)</td>
<td>Any water softener shall be sufficiently sized to cope with the peak demand of the scrubbing system and associated plant.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Influent hardness load</td>
<td>Up to 300ppm Total Hardness</td>
<td>Shall be confirmed by Contractor prior to Contractor design</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Capacity</td>
<td>(Contractor’s design)</td>
<td>Sized suitably to handle average and peak demand</td>
</tr>
<tr>
<td>1.9</td>
<td>Electrical and Instrumentation</td>
<td>Instrumentation</td>
<td>See Instrumentation Tables</td>
<td></td>
</tr>
</tbody>
</table>

**Page 64 of 376**
<table>
<thead>
<tr>
<th>Item</th>
<th>Process Stage</th>
<th>Sub-Category</th>
<th>Design Criteria</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Monitoring on OCF inlet and between scrubbing stages</td>
<td>Hydrogen sulphide analyser (duty only) as a minimum.</td>
<td>Electrochemical cell shall be provided with a gas conditioning unit to ensure cell is operating within manufacturer guaranteed conditions. The gas conditioning unit shall not affect the concentration of hydrogen sulphide.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Monitoring prior to adsorption or media-based systems</td>
<td>Online VOC analyser (PID type) required as a minimum</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Monitoring on discharge stack</td>
<td>Hydrogen sulphide analyser (2 of, duty/standby)</td>
<td>Analyser capable of reading accurately to 10ppb H2S.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Monitoring on discharge stack (additional for chemical systems)</td>
<td>Chlorine monitoring shall also be provided as a minimum</td>
<td>Chlorine sensor – electrochemical cell with suitable gas conditioning unit</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recirculation pump drives</td>
<td>Variable speed and operated on a duty / standby basis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Recirculation pump motors</td>
<td>High efficiency</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dosing pump drives</td>
<td>Variable speed, variable stroke length and operated on a duty / standby basis</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dosing pump motors</td>
<td>High efficiency</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 2.0 Chemical Scrubbing Systems

#### 2.1 Chemical Scrubbing Vessels – General Requirements

<table>
<thead>
<tr>
<th>Item</th>
<th>Design Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material of construction</td>
<td>(Contractor design) FRP Suitable for sodium hydroxide, sodium hypochlorite and citric acid solutions</td>
</tr>
<tr>
<td>Design standards for FRP vessels</td>
<td>BS4994 Cat 1 or equivalent current Australian Standard.</td>
</tr>
<tr>
<td>Vessel pressure drop</td>
<td>(Contractor’s design) Pressure drop should not exceed 150 mm water gauge through any scrubbing stage</td>
</tr>
<tr>
<td>Connections</td>
<td>Connections shall be easily removable for maintenance access.</td>
</tr>
<tr>
<td>Vessel manways</td>
<td>A manway shall be provided where required to allow access to all internal equipment requiring</td>
</tr>
<tr>
<td>Item</td>
<td>Process Stage</td>
</tr>
<tr>
<td>------</td>
<td>---------------</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 2.0 Chemical Scrubbing Systems

#### 2.2 Chemical Scrubbing Systems – Venturi Scrubbers with Disengagement Vessel

<table>
<thead>
<tr>
<th>Item</th>
<th>Process Stage</th>
<th>Sub-Category</th>
<th>Design Criteria</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Vessel</td>
<td>(Contractor design) Low pressure drop, high recirculation rate Venturi</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Design standards</td>
<td>BS4994 Cat 1 or equivalent current Australian Standard.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Particulate removal</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Design throat velocity</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of high pressure recirculation sprays</td>
<td>Minimum 2 (Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Material of construction</td>
<td>FRP suitable for sodium hydroxide, sodium hypochlorite and citric acid solutions (Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Manways</td>
<td>There shall be a manway provided on the venturi for venturi nozzles maintenance access. Venturi nozzles to be easily removable for maintenance access.</td>
<td>Manways shall be 800 mm diameter fabricated from clear transparent material. Manways shall be provided with suitable handles to facilitate safe removal.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Type</td>
<td>Cyclone or spray tower type are both acceptable (Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maximum gas loading rate</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of disengagement vessel spray headers</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Demister</td>
<td>(Contractor’s design)</td>
<td>The Contractor shall</td>
</tr>
<tr>
<td>Item</td>
<td>Process Stage</td>
<td>Sub-Category</td>
<td>Design Criteria</td>
<td>Notes</td>
</tr>
<tr>
<td>------</td>
<td>---------------</td>
<td>--------------</td>
<td>-----------------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>ensure (by adequate design of the demister) that zero carryover of sulphur from the venturi to any second stage occurs.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of plate demister spray cleaning headers</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sump residence time</td>
<td>Minimum 3 minutes</td>
<td></td>
</tr>
<tr>
<td>Manways</td>
<td></td>
<td>There shall be manways provided on the disengagement pot for maintenance access at sump and mist eliminator levels</td>
<td>Manways shall be 800mm diameter fabricated from clear transparent material. Manways shall be provided with suitable handles to facilitate safe removal.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Disengagement Vessel Requirements</td>
<td>Vessel</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Type</td>
<td>Cyclone or spray tower type are both acceptable (Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of disengagement vessel spray headers</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Demister</td>
<td>(Contractor’s design)</td>
<td>The Contractor shall ensure (by adequate design of the demister) that zero carryover of sulphur from the venturi to the second stage occurs.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number of plate demister spray cleaning headers</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sump residence time</td>
<td>Minimum 3 minutes</td>
<td></td>
</tr>
<tr>
<td>Manways</td>
<td></td>
<td>There shall be manways provided on the disengagement pot for maintenance access at sump and mist eliminator levels</td>
<td>Manways shall be 800mm diameter fabricated from clear transparent material. Manways shall be provided with suitable handles to facilitate safe removal.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>General Requirements</td>
<td>Operation</td>
<td>Continuous</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Solids loading</td>
<td>The Contractor shall be responsible for</td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>Process Stage</td>
<td>Sub-Category</td>
<td>Design Criteria</td>
<td>Notes</td>
</tr>
<tr>
<td>------</td>
<td>---------------</td>
<td>--------------</td>
<td>-----------------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>assessing the solids loading based on previous experience with similar Venturi installations.</td>
<td>The venturi shall be configured to partially oxidise H₂S to precipitate sulphur to reduce chemical requirement.</td>
<td></td>
</tr>
<tr>
<td>Dosing</td>
<td>pH and ORP control and adjustment as a minimum</td>
<td>(Contractor’s design) Contractor shall set bleed/make-up water to achieve maximum use of dosed chemical</td>
<td>Purge of reaction products laden liquor to drain</td>
<td></td>
</tr>
<tr>
<td>Venturi liquor dump flowrate</td>
<td>Wetted parts and seals suitable for pumped fluids and aggressive, abrasive suspended solids up to 4% wt/wt Non-metallic, compression moulded glass reinforced thermosetting plastic using vinyl ester, and polyester resins or equal. Selected to provide corrosion resistance to the scrubber liquor, and to liquids from pH 1 to pH 13, up to 12.5% w/w sodium hypochlorite solution and aggressive solids up to 4%wt/wt</td>
<td>Liquor will contain sulphur, biosolids (carry over) and various carbonates. Solids present are highly abrasive and adversely affect pump seals that would normally be acceptable on a packed tower scrubbing system. Use of single mechanical seals will not be accepted.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recirculation pumps – additional requirements</td>
<td>Dosing pumps shall be sized at a minimum of 2 times peak dosing rate.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2.0 Chemical Scrubbing Systems

2.3 Chemical Scrubbing Systems – Packed Towers

<table>
<thead>
<tr>
<th>Type</th>
<th>Design standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Contractor’s design)</td>
<td>BS4994 Cat 1 or equivalent current Australian Standard</td>
</tr>
</tbody>
</table>

Note: 3 No. 800 dia access manholes required per scrubber. Manways shall be 800mm diameter fabricated from clear, transparent material. Manways shall be provided with suitable
<table>
<thead>
<tr>
<th>Item</th>
<th>Process Stage</th>
<th>Sub-Category</th>
<th>Design Criteria</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Demister</td>
<td></td>
<td>Knitmesh pad (KnitMesh\textsuperscript{\textregistered}) or equivalent. Removal of 99% of all liquid particles above 10 microns</td>
<td>handles to facilitate safe removal. The use of mass transfer packing as a demister will not be accepted</td>
<td></td>
</tr>
<tr>
<td>distributor</td>
<td></td>
<td>V-notch weir</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packing type</td>
<td></td>
<td>High efficiency packing, Q-Pac or equivalent (Contractor’s design)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Packing height</td>
<td></td>
<td>(Contractor’s design)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sump volume and hold-up</td>
<td></td>
<td>The sump shall be of sufficient capacity to prevent overflow during fan and/or re-circulation pump shutdown.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recirculation pumps – additional requirements</td>
<td></td>
<td>Provided and Operating duty/standby Dosing pumps shall be sized to cope with 5 times peak loading rate</td>
<td>Auto changeover on low flow or pump failure and on hours run Suction basket strainers shall not be provided Acoustic enclosure as required to achieve noise specification</td>
<td></td>
</tr>
</tbody>
</table>

2.4 Chemical Scrubbing Systems — Odorgard\textsuperscript{\textregistered} reactors

| Volume of catalyst | Contractor design in line with Orica guidelines |                                                                                                       |                                                                                           |
| Type of catalyst   | Odorgard\textsuperscript{\textregistered} 73-2 nickel oxide based. 750 hr\textsuperscript{-1} (In line with Orica guidelines) (Contractor’s design) Polypropylene lined FRP (Contractor’s design) BS4994 Cat 1 or current equivalent current Australian Standard. | Reactor shall be a certified pressure vessel as per Orica guidelines Use of a pressure relief valve in lieu of a reactor |                                                                                           |
| Hourly space velocity |                                                                                                       |                                                                                                       |                                                                                           |
| Reactor material of construction |                                                                                                       |                                                                                                       |                                                                                           |
| Reactor design basis |                                                                                                       |                                                                                                       |                                                                                           |
| Safety             | Vessel shall be fitted with bursting disc |                                                                                                       |                                                                                           |


<table>
<thead>
<tr>
<th>Item</th>
<th>Process Stage</th>
<th>Sub-Category</th>
<th>Design Criteria</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Catalyst protection</td>
<td>vented to column sump. Disc rated at 1.5 * recirculation pump dead head discharge pressure. (Contractor’s design)</td>
<td>bursting disk does not meet minimum safety standards and will not be accepted. The Contractor shall provide calculations to show the bursting disk and associated vent line has been sized in accordance with Orica guidelines with respect to oxygen production rate in abnormal operation. Bursting disk shall be fitted with operation detection</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bioscrubbing vessels</td>
<td>Automated reactor bypass system triggered on low-low pH / ORP as per control philosophy.</td>
<td></td>
</tr>
<tr>
<td>3.0</td>
<td>Biological System Detailed Requirements</td>
<td>3.1 Detailed Requirements: Bioscrubber (Recirculation Type)</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Type</td>
<td>Recirculation system with pH control and nutrient dosing</td>
<td>Design standard to ensure equipment can withstand the negative pressure imposed and low pH solutions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Design standards</td>
<td>Vessel to be designed BS4994.1987 CAT 1 or equivalent Australian Standard</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>No. of parallel units</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operation</td>
<td>Continuous</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Diameter</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Gas loading rate</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Liquid loading rate</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Materials of construction</td>
<td>Column and associated process equipment shall be manufactured of materials suitable for at least sulphuric acid solutions at pH 1. (Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td>Bioscrubbing</td>
<td>Demister</td>
<td>(Contractor’s design)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Item</td>
<td>Process Stage</td>
<td>Sub-Category</td>
<td>Design Criteria</td>
<td>Notes</td>
</tr>
<tr>
<td>---------------------------</td>
<td>---------------</td>
<td>--------------</td>
<td>---------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Vessel Internals</td>
<td></td>
<td>Distributor</td>
<td>1No. V-notch weir type</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Packing</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Packed height</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td>pH Control</td>
<td></td>
<td>Type</td>
<td>(1) Chemical dosing, or (2) Modified effluent makeup &amp; blowdown rate</td>
<td>The Contractor shall ensure that the pH of the bed remains at a level suitable for sufficient autotrophic and heterotrophic bacterial growth to ensure guarantee removals are met.</td>
</tr>
<tr>
<td>Nutrient dosing</td>
<td></td>
<td>Type</td>
<td>(Contractor’s design)</td>
<td>The Contractor shall provide a nutrient dosing system as required.</td>
</tr>
<tr>
<td>Sump and blowdown</td>
<td></td>
<td>Scrubber sump volume and hold-up</td>
<td>(Contractor’s design) Scrubber sump shall be of sufficient capacity to prevent overflow discharge on pump or fan shutdown</td>
<td>The bioscrubber sump shall allow be designed to allow timed discharge of accumulated sloughed biomass.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Scrubber bleed flowrate</td>
<td>(Contractor’s design)</td>
<td>Blowdown of bio-scrubber by-products to drain</td>
</tr>
<tr>
<td>Recirculation pumps</td>
<td></td>
<td>Location</td>
<td>Each bio-scrubbing column</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Number</td>
<td>2 No. per bio-scrubber</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operation</td>
<td>Duty/standby</td>
<td>Auto changeover on low flow or pump failure and on hours run</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Type</td>
<td>Centrifugal</td>
<td>Wetted parts and seals suitable for pumped fluids</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Capacity</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td>Isolation Dampers</td>
<td></td>
<td>Dampers</td>
<td>Isolation dampers shall be provided on the inlet and outlet of each bio-scrubbing unit.</td>
<td></td>
</tr>
<tr>
<td>Bypass Ductwork</td>
<td></td>
<td>Bypass ductwork, dampers and orifice plate shall be provided around each bio-scrubbing unit.</td>
<td>Each by-pass duct shall have an orifice plate to simulate pressure drop across by-passed unit.</td>
<td></td>
</tr>
</tbody>
</table>

### 3.2 Detailed Requirements: Bioscrubber (Non-Recirculation Type)

<p>| Bio-scrubbing vessels     |               | Type         | Bioway Purspring or equivalent                                                    |                                                                                                                                       |
|                          |               | Design standards | Vessel to be designed | Design standard to                                                                                           |</p>
<table>
<thead>
<tr>
<th>Item</th>
<th>Process Stage</th>
<th>Sub-Category</th>
<th>Design Criteria</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>BS4994.1987 CAT 1 or equivalent Australian Standard</td>
<td>ensure equipment can withstand the negative pressure imposed and low pH solutions</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No of units in parallel</td>
<td>(Contractor’s design)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Operation</td>
<td>Continuous</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Diameter</td>
<td>(Contractor’s design)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Gas loading rate</td>
<td>(Contractor’s design)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Liquid loading rate</td>
<td>(Contractor’s design)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Materials of construction</td>
<td>Column and associated process equipment shall be manufactured of materials suitable for at least sulphuric acid solutions at pH 1. (Contractor’s design)</td>
</tr>
<tr>
<td>Bioscrubbing Vessel Internals</td>
<td></td>
<td>Demister</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Distributor</td>
<td>Spray type</td>
<td>(Contractor’s design)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Packed beds</td>
<td>3 no packed beds in series per column</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Packing type</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Packed height</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Start-up Recirculation pumps</td>
<td>Location</td>
<td>Skid mounted for ease of transport</td>
<td>The Contractor shall provide a skid mounted recirculation pump and sump system to be maintained on site for bioreactor re-start up / re-seeding operations. The skid mounted system shall be fully self-contained, with all quick filling/release connections for connection to bioscrubbers provided.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Operation</td>
<td>Duty / standby</td>
<td>Auto changeover on low flow or pump failure and on hours run</td>
</tr>
<tr>
<td>Item</td>
<td>Process Stage</td>
<td>Sub-Category</td>
<td>Design Criteria</td>
<td>Notes</td>
</tr>
<tr>
<td>------</td>
<td>---------------</td>
<td>--------------</td>
<td>-----------------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Type</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flowrate</td>
<td>(Contractor’s design)</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Duty</td>
<td>Wetted parts and seals suitable for pumped fluids</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bioscrubber liquor discharge</td>
<td>Capacity</td>
<td>(Contractor’s design)</td>
<td>The Contractor shall provide low pH liquor discharge neutralisation equipment if required.</td>
</tr>
<tr>
<td></td>
<td>Isolation dampers</td>
<td>Dampers</td>
<td>Isolation dampers shall be provided on the inlet and outlet of each bio-scrubbing unit.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bypass ductwork</td>
<td>Bypass ductwork, dampers and orifice plate shall be provided around each bio-scrubbing unit.</td>
<td>Each bypass duct shall have orifice plate to simulate pressure drop across bypassed unit.</td>
<td></td>
</tr>
</tbody>
</table>

### 4.0 Detailed Requirements: Adsorption, Media-based and Dry Chemical Systems

<table>
<thead>
<tr>
<th>Inlet pre-filter</th>
<th>Dehumidifier</th>
<th>Number of units in parallel</th>
<th>Vessel material of construction</th>
<th>Type of adsorption media</th>
<th>Empty bed contact time</th>
<th>Media life span</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Contractor’s design)</td>
<td>Casing fabricated from Grade 316L stainless steel Heating element(s) materials of construction (Contractor design) to provide 10 year minimum operating life between replacement</td>
<td>(Contractor’s design)</td>
<td>FRP designed to BS4994 1987 Cat 1 or equivalent current Australian Standard, or Grade 316L stainless steel.</td>
<td>(Contractor’s design)</td>
<td>Minimum 2.5 seconds at full flow and minimum redundancy</td>
<td>Under normal</td>
</tr>
<tr>
<td>Item</td>
<td>Process Stage</td>
<td>Sub-Category</td>
<td>Design Criteria</td>
<td>Notes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>------</td>
<td>---------------</td>
<td>--------------</td>
<td>-----------------</td>
<td>-------</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Isolation Dampers</td>
<td>operation, minimum 12 months life time (design to reflect 11 months at average design load, 1 month at peak load)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Isolation Dampers</td>
<td>Isolation dampers shall be provided on the inlet and outlet of each adsorption unit.</td>
<td>Single blade butterfly dampers are acceptable if space allows.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 2.9.46 HACCP Plan

In accordance with Gold Coast Water’s HACCP philosophy, the Plant design shall be capable of performing comfortably within specified requirements in order that corrective actions can be commenced before a failure occurs that is required to be reported to EPA. During the proving period, City of Gold Coast operating philosophy will be to operate the Plant to meet target HACCP limits which will be set by City of Gold Coast at an early stage of Plant operation.

In-line monitoring of the following parameters shall be provided:

**Table – PROCESS PARAMETERS**

<table>
<thead>
<tr>
<th>Process Stream</th>
<th>Parameter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wastewater Treatment Plant</td>
<td>Conductivity</td>
</tr>
<tr>
<td>Preliminary Treatment Area (Degritted Sewage)</td>
<td>pH</td>
</tr>
<tr>
<td>Bioreactor (mixed liquor)</td>
<td>Temperature</td>
</tr>
<tr>
<td></td>
<td>Nitrate (2 of each)</td>
</tr>
<tr>
<td></td>
<td>Ammonia (2 of each)</td>
</tr>
<tr>
<td>Secondary Effluent (From secondary clarification)</td>
<td>Turbidity</td>
</tr>
<tr>
<td>Tertiary Effluent (from tertiary filtration)</td>
<td>Turbidity (for each tertiary filtration unit)</td>
</tr>
<tr>
<td>Class B Recycled Water (from disinfection)</td>
<td>Free Chlorine</td>
</tr>
<tr>
<td>Odour Control Unit - Foul Air</td>
<td>Hydrogen Sulphide</td>
</tr>
<tr>
<td>Odour Control Unit –Discharge</td>
<td>Hydrogen Sulphide</td>
</tr>
<tr>
<td>Recycled Water Treatment Plant</td>
<td>Free Chlorine</td>
</tr>
<tr>
<td>Mn Filter Feed</td>
<td>pH</td>
</tr>
<tr>
<td>Mn Filter Product</td>
<td>Turbidity (for each Mn filtration unit)</td>
</tr>
<tr>
<td>Ultrafiltration feed</td>
<td>Free chlorine</td>
</tr>
<tr>
<td>Ultrafiltration</td>
<td>Particle counter</td>
</tr>
<tr>
<td>UF product water</td>
<td>Transmembrane pressure</td>
</tr>
<tr>
<td>UV</td>
<td>Particle count (each train and common discharge). Turbidity</td>
</tr>
<tr>
<td>Spent CIP return streams</td>
<td>Ultraviolet Intensity</td>
</tr>
<tr>
<td>Class A+ Reservoir Feed</td>
<td>Conductivity</td>
</tr>
<tr>
<td></td>
<td>pH</td>
</tr>
</tbody>
</table>
Instruments for monitoring turbidity, chlorine and secondary effluent nutrients, shall be located in a suitably located, purpose designed room. Instruments chosen for monitoring shall be suitably sensitive and accurate, designed for their operating environment, easy to repair and maintain, and at all times, located as close to probe site as possible in order to minimise sampling loop distance. City of Gold Coast aims for brand continuity and will provide detail in regard to preferred manufacturer and model numbers of instruments to be installed. All data generated will be recorded and trended on a SCADA system with remote access.

HACCP certified facilities aim to meet quality specifications at all times and aim to reduce risks. The STP and RWTP must allow for flexibility in operation to assist in meeting specification and reduce risks. This will include ability to exercise adjustment to activities such as inflow, RAS, WAS, DO and disinfectant dosing to mitigate the risk of undesirable influent and uneven flows.

The Merrimac STP Water Quality Management and HACCP Plan will be made available to Proponents to indicate philosophy, activities, critical/operational limits and monitoring and/or control measures which were identified for that Plant. Similar provisions will be required for all new STP and RWTP.

### 2.9.47 Process Requirements

#### Greenhouse Gas And Nutrient Limits

Proponents are required to provide details of the estimated greenhouse gas emissions generated through the STP and RWTP treatment processes, including, but not limited to, consideration of:

- Direct emissions from the treatment process
- Chemical usage (substrate)
- Energy usage within STP and RWTP operations

### 2.9.48 Process Selection

The STP treatment process is required to incorporate both biological nitrogen removal and biological phosphorus removal. The process shall include additional chemical dosing as required to maintain compliance with the specified recycled water quality criteria.

Carousel, compartmentalised secondary treatment process and membrane bioreactor configurations will be considered.

The RWTP treatment process shall, as a minimum, incorporate both ultrafiltration and UV disinfection to ensure compliance with Queensland Water Recycling Guidelines (December 2005) requirements for Class A+ recycled water.

### 2.9.49 Performance Standards

Refer to specific project requirements, as per design brief.

### 2.9.50 Recycled Water Standards

Refer to specific project requirements, as per design brief.

### 2.9.51 Biosolids Standards

Refer to specific project requirements, as per design brief.

### 2.9.52 Odour Control Requirements

Refer to specific project requirements, as per design brief.

### 2.9.53 Standby Power Requirements

Refer to specific project requirements, as per design brief.

### 2.9.54 Handover and Process Proving

Refer to specific project requirements, as per design brief.

The Plant will be required to comply with the EPA Guidelines (Odour Impact Assessment from Developments, July 2004). These guidelines require odour control within the Plant to limit odours to less than 2.5 Odour Units at the nearest odour sensitive place, 99.5 percentile based on 60 minute averaging.
2.9.55 Influent Characteristic Limits

Class B/Class A+ Recycled Water
Total Nitrogen
The Class B Recycled Water Quality Criteria specified herein shall be achieved regardless of the recorded influent wastewater quality provided:
The median Influent COD/Influent Total Nitrogen >7.2 based on unfiltered 24-hour composite samples of influent wastewater, and,
The median Refractory Nitrogen (TKNus) < 1.7 mg/L where TKNus = Class B Recycled Water TKN – Class B Recycled Water Ammonia as determined from filtered 24-hour composite samples.
All samples testing for assessment of these conditions shall be undertaken by a NATA certified laboratory.
Where condition (a) or (b) are exceeded for a “short-term” or “long-term” period (as defined in the EPA licence), exceedance of the specified total nitrogen limit for the same period (and only that period) will be acceptable.
Where condition (a) or (b) are exceeded on an ongoing basis, and result in exceedance of the plant’s total nitrogen limit, approved additional works required to achieve compliance with the specified total nitrogen limit would constitute a scope change.
Other variations in influent quality will not be adequate grounds for consideration of a scope change to achieve the specified recycled water quality.

Class A+ Recycled Water
Total Dissolved Salts (TDS)
The use of processes specifically for the removal of TDS is not anticipated as part of either the STP or RWTP. However, to ensure that the Recycled Water remains suitable for irrigation of gardens and crops, the maximum TDS which may be added through the STP and RWTP processes will be specified prior to Detailed Design.
The treatment process shall not contribute more than 300 mg/L of TDS to the Class A+ recycled water.

2.9.56 Plant Efficiency
The operating Plant will be required to meet guaranteed values of efficiency in a number of parameters. Specific parameters shall be:
Power consumption.
Proponents shall define their inclusions in each of the categories below:
- Process Fixed consumption (kW)
- Process Variable consumption (kWh/ML)
- Pump stations other than in-process pumping. An operating regime will be provided during the design development phase
- Polyelectrolyte use in sludge dewatering (kg/dry solids tonne)
- Biosolids cake moisture content (%)
- Chemical consumption (individual chemical use in processes and overall use) (kg/kg influent nutrient)

2.9.57 Structural Design Criteria
Structural design criteria shall include recognition of the following sections.

General Structural Design Criteria
All structures shall be designed and constructed to comply with the latest Australian Standards, the Building Code of Australia, the requirements of the Gold Coast City Council, and all State and Federal Government Acts and the requirements Contract Specification.
All components and items of equipment shall be designed with appropriate access. This shall include walkways, guard raling, access ports, stairs, ladders and any other access methods necessary. Stairs, not ladders, shall be used where routine access is likely to be necessary. Ladders shall only be used where specifically necessary and reviewed by the Superintendent on a case by case basis. Ships ladders shall not be used. Guardrails shall not be used for supporting fittings, equipment, pipework, conduits or any other equipment.

Structures shall be designed so that convenient access may be attained by tankers, crane trucks, cranes, delivery vehicles, maintenance vehicles and the like.

Structures shall include drainage points.

Concrete structures in aggressive environments shall include a protective coating or lining, reviewed by the Superintendent, over the complete affected zones for corrosion protection and ease of maintenance. Where odour control covers are to be fitted, the concrete surfaces under the covers may then be subject to a corrosive environment and shall be suitably protectively coated, to at least 400 mm below low water level, with a coating in accordance with SS10 Section 4 and 5.

Where concrete structures are or may be in contact with aggressive soils or ground-waters, suitable protection shall be provided. Where painted, coated or hot dip galvanised steel structures are or may be in contact with aggressive soils or ground-waters, suitable protection in accordance with SS10 Section 4 and 5 shall be provided. Such protection shall be subject to approval by the Superintendent.
3 Section 3 – Integration Requirements

3.1 SS10 Water and sewage Infrastructure Requirements

3.1.1 Introduction
This section defines City of Gold Coast requirements for the Integration Requirements of all water and sewage asset classes. It defines standards for-
- Data formats
- Asset Register Information Requirements
- Asset Numbering and Naming Conventions (SD 22)
- Asset Maintenance Schedules Required
- System and Equipment Control philosophies for each asset class
- Fees and Charges
- SCADA/Telemetry/Communications
- Handover of assets (QP22)
- Decommissioning including Treatment of Abandoned/Obsolescent Assets
- Valuations for Capitalisation of Assets

Council’s Development Guidelines, Standard Specifications and Standard Drawings shall take precedence over the Department of Natural Resources and Water Planning Guidelines and the WSAA Water Supply Code and Drawings and its Dual Water Reticulation Supplement.

3.1.2 Water and sewage Asset Delivery - Inspections, Bonds, Emergency Repair Bond, Fees And Charges Applicable

Deliverables and Fees
The applicant is responsible for the supply and installation of all equipment and materials. This also includes civil works, pumps, electrical cabinet and associated wiring, level control, telemetry and internal pipework. The applicant is responsible for payment of all fees associated with the fit out, including those for the power and water connections. The approval shall be conducted in accordance with OPW approval. The works shall be carried out in accordance with engineering drawings and City of Gold Coast standard drawings.

Mechanical & Electrical Design and Inspection
The design of the mechanical and electrical facilities shall be submitted for endorsement prior to commencement of any work. The submission shall include:
- A copy of the radio survey report
- An “Origin Energy” application for power, fully completed, for signing by City of Gold Coast as the owner
- A water connection application, fully completed and paid for

The applicant shall pay the schedule fee to City of Gold Coast for the review of the electrical/mechanical design, inspection and internal City of Gold Coast works for central system SCADA modifications. Payment shall be made prior to City of Gold Coast undertaking this work.

3.1.3 City of Gold Coast Inspections
During the construction phase the Consultant is expected to have adequate inspection systems in place and is responsible for exercising reasonable skill and diligence to ensure that the works are constructed in accordance with the approved Engineering Drawings. Notwithstanding the Consultants
responsibility City of Gold Coast will conduct Inspections generally as set out in section SS10 AUDITING. The mandatory Inspection Checklists used by City of Gold Coast or Sewer, Water (both potable and recycled) and “On-Maintenance” and “Off-Maintenance” are included as attachments to this section. A set of optional comprehensive checklists containing “Hold/Witness” Point for Sewer and traditional Potable Water Reticulation and Dual Water System, are included in CHECKSHEET 1A,1B 1C and 1D. These checklists can be used for further enhancing the quality of the final products received by the City of Gold Coast. Use of these checklists is recommended but not mandatory.

City of Gold Coast” On Maintenance” Inspection
The purpose of the “On Maintenance” inspection is to ensure that the Development has been completed in accordance with the approved Engineering Drawings and City of Gold Coast requirements. Refer to SS10 - AUDITING for more information

City of Gold Coast “Off Maintenance” Inspection
The purpose of the “Off Maintenance” inspection is to ensure that the constructed works have performed satisfactorily during the “Maintenance Period” (normally 12 months). and that omissions and defects have been rectified. Refer to SS10-AUDITING for more information.

3.1.4 Factory Acceptance Testing – Mechanical Installations
Factory Acceptance Tests (FAT) shall be completed to the satisfaction of AW before the equipment will be released for delivery. For a full list of FATs refer to SS10-Section 6 -AUDITING.

3.1.5 Inspections Checking And Testing – Electrical Installations
Tests and inspections will include, but will not necessarily be limited, to the following: -
- Inspection of switchboards, cubicles and other items fabricated from sheet metal when assembled prior to wiring.
- Inspection of completed switchboards, cubicles and other items, after completion of wiring and prior to delivery.
- Factory Acceptance Tests –see below.

Testing Documentation Requirements
A complete test document must be prepared in advance of performing any Factory Acceptance or Site Acceptance testing. This document will cover all of the control and SCADA functionality required by the system. The object of this document will be that when testing is complete, then the system will 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, FAT is to use the actual PLC/RTU hardware where possible and will simulate all field devices. SAT is to use the actual installed equipment and will be the testing required before commissioning commences.
See Section 6 “Auditing” for detailed requirements.

Factory Acceptance Tests
Factory Acceptance Tests (FAT) shall be completed to the satisfaction of AW before the equipment will be released for delivery. The Contractor shall notify the Superintendent 5 working days prior to the tests and the Superintendent will nominate a witness list to attend or will inform that no witness’s will be attending.
See Section 6 “Auditing” for detailed requirements.

Site Acceptance Tests, Commissioning and Inspections
Site Acceptance Tests (SAT) shall be done prior to commissioning. The City of Gold Coast Inspector may also wish to confirm that the items tested and inspected comply with the requirements by further testing.
The City of Gold Coast representative shall witness checks and tests. An electrical test sheet shall be completed and submitted to City of Gold Coast as required.
A written report shall be submitted to the Superintendent. See Section 6 “Auditing” for detailed requirements.

3.1.6 Maintenance - After Hours Emergency Repair - Bond

The maintenance period for these works is twelve (12) months. A bond to the value of 5% of the total cost shall be held over this period. City of Gold Coast will carry out any emergency repair work required after it is placed “On Maintenance”. Should it be determined that a failure was attributable to faulty materials or workmanship, the cost of rectification shall be borne by the developer. Any non-emergency work required due to faulty materials or workmanship shall be carried out by the developer’s representatives.

3.2 Asset Data Requirements

3.2.1 Asset and Equipment Numbering and Naming

The Principal and its business unit AW have developed a standard asset and equipment numbering and naming protocol which shall be applied throughout the Project. Assets, components and equipment shall be assigned to 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/DCS systems), on component and items of equipment labelling and in the operations and maintenance manuals. The adoption of any other numbering and naming system other than the Principal’s numbering and naming system is not permitted.

The Principal’s SAP Asset Hierarchies Definition, QEMS Procedure SD-22 ‘Asset Hierarchy and Numbering Definition’ and Any drawings, documents and other deliverables that do not follow the Principal’s numbering and naming convention will be rejected by the Superintendent.

Linear assets
As Constructed Data Format

As constructed data submitted to City of Gold Coast for approval shall be supplied as outlined 'Standard Electronic Format for As Constructed Data’ June 2006 www.goldcoastcity.com.au/attachment/publications/tlg_addendum.pdf. Strict adherence to this format is required as AW uses automated systems to download the asset data automatically into the GIS Spatial Data systems (MapInfo) and linked Asset Management System (SAP).

3.2.2 Non-Linear Assets

Asset Hierarchy System

Assets shall be labelled in accordance to ‘SD-22 Asset Hierarchy and Numbering Definition’. AW will provide Asset Numbers for Pump Stations and Reservoirs.

Asset Handover

The handover of assets is to be provided in accordance with procedures outlined in ‘SD-06 Asset Handover of Infrastructure’ and as per this specification SS10.

Asset Attribute Data and Asset Maintenance Requirements

When new assets are acquired they shall be registered within City of Gold Coast system Valuation and Capitalisation

Following successful commissioning of the asset, assets are to be valued for C of GC to add the capitalised amounts to the accounting systems in compliance with ‘Capitalisation Policy 2006’.

3.2.3 Drawings

Engineering Drawings

Engineering Drawings prepared by the Consultant shall be submitted for all water supply, wastewater reticulation and other works associated with the Development. Generally Drawings will consist of the following:-
(a) Water Reticulation
Water Reticulation Plan
Pipe size, type and class
Water main alignments
Valve, hydrant and other fittings locations
Longitudinal sections for 250mm and larger mains
Water supply pump station details
Minor reservoir details
Live connection requirements and associated details
Conduits
Property services and location of reticulation mains connection point
Easement location

(b) Wastewater Reticulation
Sewer Reticulation Plan
Pipe size, type and class
Sewer main alignments
Manhole locations, type, drop and lid type
House connection type and level
Longitudinal sections of each line
Sewer pump station details
Live connection requirements and associated details.
Equivalent populations, flow and design capacity
Easement location

Generally the scales for water main drawings shall be 1:10; 1:500; 1:2000 etc and multiples thereof. Longitudinal Sections at a scale of 1:1000 Horizontal and 1:100 Vertical shall be provided for all 250mm diameter and larger water mains and may be required for smaller size mains where existing and proposed service conflicts exist.

3.2.4 Checking Of Drawings Prior To Submission
All Engineering Drawings submitted to City of Gold Coast for approval shall be checked and signed by the Consultant. City of Gold Coast does not provide a comprehensive checking service for checking Drawings in detail and it is the Consultant’s responsibility through its Quality Assurance procedures to ensure that Drawings are in accordance with State Government and City of Gold Coast Standards, Acts, By-Laws and Regulations.

3.2.5 Engineering Drawing - Application Checklist
“The Engineering Drawing - Application Checklist” (refer CHECKSHEET 1A) shall be completed and included in the original submission. This checklist summarises City of Gold Coast minimum requirements. It is intended that this checklist will assist in the preparation of the required Engineering Drawings.

3.2.6 Design Calculations
City of Gold Coast requires that the Consultant’s Engineering Design be fully documented and include appropriate calculations to allow interpretation of the design decisions. Generally calculations will include:-
Water Supply or Sewerage Pump Stations
Water Reservoir
Water quality,

3.2.7 Submission Of Engineering Drawings/Job Specification
Engineering Drawings/Job Specification shall be lodged with City of Gold Coast and include:-
“Engineering Drawing Application Checklist” Form fully completed (refer attachment to this section)
“Application for Approval of Engineering Drawings For Subdivision Works” Form fully completed (refer Attachment)
Two (2) copies of each Engineering Drawing and one (1) copy of the Job Specification. The Engineering Drawings should be one A1 size and one A3 size
Any relevant supporting documentation
Details of any non-conforming design and reasons for proposing its use
Live connection design details for water supply and sewer reticulation. The details shall be sufficient to enable early costing by City of Gold Coast for the connection.

3.2.8 Re-Submission Of Engineering Drawings And Job Specification
Where Engineering Drawings and/or Job Specification are Not Approved, they require re-submission which shall include:-
Covering letter quoting City of Gold Coast file reference and reference to previous submission;
Two (2) copies of each Amended Engineering Drawing and one (1) copy of the Amended Job Specification with amendments clearly identified. The Engineering Drawing size shall comply with relevant sections of SS10.
Any relevant supporting documentation;
Details of any non-conforming design and reasons for proposing its use;
Relevant fees paid.

3.2.9 Approvals Subject To Amendments
Where Engineering Drawings and/or Job Specification are Approved Subject to Minor Amendments, City of Gold Coast may request the following:-
Two (2) copies of each amended Engineering Drawing with amendments clearly identified.
Any relevant supporting documents

3.2.10 Approved Engineering Drawings
Following the stamping by City of Gold Coast of the Engineering Drawings as approved, one (1) copy will be retained by City of Gold Coast and one (1) copy forwarded to the Consultant.
The only Engineering Drawings to be used for construction shall be those based on the City of Gold Coast stamped and approved copy forwarded to the Consultant.
City of Gold Coast shall provide a quotation for work associated with water supply and sewerage reticulation live connections as detailed on the approved Engineering Drawings. This quotation shall remain firm for 60 days.
The Developer shall conform to the requirements of Section 5.0 of Water Resources Commission Sewerage Guidelines and where necessary be responsible for the submission in City of Gold Coast name of an application for a licence to discharge sewerage pump station overflows.

3.2.11 Mechanical and Electrical Drawings
The following requirements shall apply to all mechanical and electrical plant and equipment, pipework, fabricated steelwork, etc to be supplied.
The Contractor/Developer shall at any relevant portion of the works or commencement of manufacture of equipment or placing firm orders for any components, submit to City of Gold Coast, for approval, three (3) copies of drawings as herein specified. Works shall not proceed on the manufacture or supply of equipment, components or structure, until the relevant drawings have been submitted and accepted by City of Gold Coast.
Should additional information and/or drawings or any amendments to the previously submitted drawings, be required, the Contractor/Developer shall supply in triplicate the additional information and/or drawings or amended drawings within a period of two (2) weeks of being requested to do so.
All Drawings shall be prepared using computer-aided drafting. Drawings shall be submitted in the following formats. Drawings shall be supplied on DVD in AutoCad (.DXF), (.DWG) and (.PDF) format as well as paper (minimum size A3).
Complete manufacturing drawings shall be submitted to the Contract Superintendent for approval prior to manufacture of switchboards, motor control centres, distribution boards and the like.
The drawings shall include a complete equipment schedule such as brand, supplier, quantities, equipment labelling, catalogue number, model number, power rating (kW), type and size.

A. **General Arrangements**

Sectional arrangements in sufficient detail to allow all components to be identified, all tolerances, clearances and fits necessary for the adjustment, dismantling and re-assembly of equipment components, shall be shown. Any other drawings necessary for complete understanding of installation, operating and maintenance of the particular item of equipment.

In addition, where the total number of drawings is five or greater, a complete listing, in an Excel or Word spreadsheet format, indicating drawing numbers and a specific description shall be included.

**B. Drawings Size and Title Block**

All drawings associated with the Contract shall be the same size as the full size Contract Drawings. Title blocks may be arranged to suit the requirements of the particular contractor or sub-contractor, but each title block shall carry the following information:

- Name of Purchaser: City of Gold Coast
- Name of Project: Pump Station A78
- Description of work to which drawing refers (including equipment item number where applicable)
- Drawing number:
- Manufacturer’s name:
- Designer
- Approver
- Revision number
- Date
- Registered Professional Engineer Queensland number
- Scale
- A North arrow (where applicable)
- Date

**C. Drawing Numbers**

The Contractor in consultation with City of Gold Coast shall be allocated drawing numbers for use on his own and Sub-Contractor’s drawings. Drawing numbers shall be supplied by City of Gold Coast Asset Technical Data Officer. While other drawing numbers may be shown in the title block, the numbers allocated by City of Gold Coast to the Contractor and subsequently any subcontractor shall be the prime and prominent drawing number. It shall be located in the bottom right hand corner of the title block. This drawing number shall be the reference used in all communications.

**D. Shop Drawings**

All drawings shall be clearly drawn to scale by competent draftsmen 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.

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

**E. Fabricated Steel Metal Work**

General arrangement drawings showing leading assembly dimensions and piece marks of all components; detailed fabrication drawings of all members and components: details of all joints and fixings. The drawings shall set out details of all surface preparation 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, they must 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 Specification.

**F. Fabricated Proprietary Equipment**

General arrangement drawings of equipment, including where necessary to fully describe the equipment, sectional and sub-assembly drawings: 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, blockouts, and connections to external process lines and services. Full details of integral piping shall be given. Full details of surface preparation and protective coatings for all components are to 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 are to 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.

**G. 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 and built-in anchorage for pipe supports, cable trays, duct work, etc., and the location of all built-in pipework, electrical conduits, penstock frames, etc, and where permitted, location and size of blockouts for equipment and services.

**H. Acceptance Of Drawings**

Acceptance by the City of Gold Coast of any drawing, method of work or any information regarding materials and equipment which the Contractor proposes to supply, 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 on account of the failure or partial failure or inefficiency of any plan or method of work or material and equipment so accepted. Such acceptance shall be considered to mean that the Superintendent has no objection to the Contractor using, upon his own full responsibility, the plan or methods of work proposed or supplying the materials and equipment proposed. Acceptance of the Contractor’s drawings shall not relieve the Contractor of his full responsibility to comply with the requirements of the Contract Drawings and Specification.

**I. “As Constructed” Drawings**

NB: Read in conjunction with “Operations and Maintenance Manuals” as changes here will affect the supply of these manuals.

The Contractor shall provide the Superintendent with two (2) electronic copies on CD/DVD in Autocad DXF and DWG and PDF format and one neatly and legibly marked set of Contract Drawings A1 size. Also include all necessary supplementary drawings issued by or accepted by the City of Gold Coast, showing all dimensions and all changes in the location or arrangement outline or details of the works.
The Certificate of Practical Completion will not be issued until this set of ‘As Constructed’ Drawings is submitted and accepted. The Contractor shall set aside one set of full size drawings and one copy of the amended drawings for this purpose. These drawings shall be marked up by the Contractor as the work progresses. All drawings submitted by the Contractor for the approval of City of Gold Coast pursuant to the requirements of this Contract shall, after completion of construction, be amended to show in detail the ‘as constructed’. This requirement applies also to all Sub-Contractors. Such amendments, as are necessary to depict in detail the as constructed condition, shall be carefully and accurately prepared by competent draftsman. Where an as-built condition requires a drawing to be amended, then all related drawings influenced by this amendment shall similarly be amended. Upon completion of all amendments, copies of each drawing prepared pursuant to the requirements of this Contract, each clearly marked adjacent to the title block ‘As Constructed’ Drawing and electronic copies, shall be delivered to the City of Gold Coast prior to the issue of the Certificate of Practical Completion. The cost of preparing and printing the above as constructed drawings, notwithstanding that some amendments may have been required as the result of instructions issued by the Superintendent, shall be deemed to be included in the Contract Amount. Should it be found, subsequent to the issue of the Certificate of Practical Completion, that the Contractor has failed to amend all or some of the Drawings as required above, then City of Gold Coast may proceed to have the necessary amendments carried out without further reference to the Contractor. All costs associated with obtaining information and carrying out these amendments will be deducted from any moneys otherwise owing to the Contractor under the terms of this Contract, provided that the reason for such amendment was not as a result of an instruction given by the Superintendent ordering additional works after the issue of the Certificate of Practical Completion. The Contractor may during the Defects Liability Period be called upon to further amend the ‘as constructed’ drawings should it be found necessary for the Superintendent to order modifications to the work. On project completion and before ‘Practical Completion’, one set of laminated drawings is to be issued to site.

J. Electrical Manufacturing Drawings

Complete drawings including 3 phase power schematic or "Single Line diagram", drive schematics, control and communication schematics, switchboard construction drawings etc shall be submitted for acceptance prior to manufacture of switchboards, motor load centres, distribution boards and the like. In a table format, drawings shall detail construction details, equipment electrical ratings, distribution system protective device co-ordination with sizes and settings of protective devices, cable types and sizes and lengths. Note: Software printouts or spreadsheets showing calculations on current carrying capacity, voltage drop, let-through energy (I²t) and earth fault loop impedance shall be submitted to the Superintendent when requested should drawing information need clarification. Protection Relay settings should be included in a separate protection study report where HV protection relays are required.

At the time at which drawings are submitted for review and acceptance, complete data including type test certificates and samples where required and catalogue information on all electrical equipment covered by the drawings shall be submitted. Complete equipment schedule information shall also be provided at that time. The submittal shall list the manufacturer, trade name and model (where applicable) and any other information that may be required by the Superintendent in identifying the item and determining its acceptability.

Site Record Drawings

A neatly marked set of site record drawings, detailing interconnections shall be maintained. Drawings shall be kept current with the work as it progresses and shall be subject to inspection at any time.

Schematic Diagrams
Correct circuitry with all details, wire numbers and cross-referencing, including telemetry connections shall be provided. In addition, cubicle design, equipment layout and specifications shall all be detailed in full.

Results of the radio surveys shall also be recorded in text on the ‘as constructed’ drawings for Water and sewage pump stations, Reservoirs or any equipment installed requiring telemetry.

\textit{K. Electrical Drawings}

System Diagrams (single line diagram) shall include the following:

- Busbar size and capacity
- Circuit breaker rating
- Switch and fuse ratings
- Circuit numbers
- Cable sizes, type and installation details
- Voltage drop and maximum demand details
- Protection relay data and settings
- Equipment Schedule with Catalogue numbers and manufacturer
- HV Switchgear (RMUs, Switchboards)
- Transformers (if applicable)
- LV Switchboards (MSBs, MLCs, MCCs, DBs)
- Power Factor Correction Units
- Harmonic Filters
- UPSs

Single Line Diagrams and Switchboard General Arrangement drawings need to detail the information described in AS/NZS 3439.1 Clause 5.1.

3.3 Water, Recycled Water and sewage Network SCADA

3.3.1 SCADA Control Philosophy

Overview

Developers will need to consider the burden effect on adjoining infrastructure. The developer will be responsible for seamless integration with existing infrastructure and incorporating and necessary system changes to downstream infrastructure and to highlight any possible changes to adjoining infrastructure.

3.3.2 Water System – SCADA

General

City of Gold Coast currently has a large telemetry network monitoring the water reticulation system based upon the Radtel Series 5000 telemetry equipment. The network utilises UHF radio networks with three repeater sites. The system utilises multiple master stations located at the following City of Gold Coast and SEQ water sites:

- Southport Depot
- Molendinar Water Treatment Plant – SEQ water
- Mudgeeraba Water Treatment Plant – SEQ water

All new telemetry equipment supplied shall be capable of seamlessly integrating with 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 stations shall be capable on initiating reports to the system masters on change of state of digital inputs, significant change of analogue inputs and alarm conditions. All telemetry stations shall be polled periodically by the master station to determine the current state of their inputs and outputs.
**Pump Stations**

All water pumping stations shall have a radio telemetry unit installed as per this specification. A radio telemetry unit, antenna and associated equipment to monitor the pump station shall be supplied and installed. The telemetry unit shall be a Radtel Series 5000 system or approved equivalent as detailed in this specification in Section 3. The telemetry unit shall have sufficient I/O capacity to undertake the monitoring and operating tasks outlined in the specification. Where the RTU is to be solar powered, sufficient solar panels and battery backup is required to operate the system for 48hrs without sun. Solar panels shall be located where shadows are minimised.

Water pump stations will normally be controlled by supervisory control via the central “Radtel” SCADA HMI application with control signals relayed to Remote Telemetry Units (RTUs). The central HMI application will be receiving reservoir level signals and through logic processing control the system. Pressure boosting pump stations will normally have their operation controlled locally using pressure switches or pressure transducers feeding signals to a local PLC. Remote control and supervision of alarms by telemetry would be the main function of the central HMI application.

Each pump station control mode will be specified at design stage either by the contract superintendent or an accompanying technical specification. Most pump stations will conform to the standard typical drawings provided in Section 3, but detailed design and RTU programming will be required for every pump station.

For detailed installation requirements refer to SS10 – ASSEMBLY REQUIREMENTS

### 3.3.3 Wastewater System - Scada

**General**

City of Gold Coast currently has a large telemetry network monitoring the wastewater system based upon the RTUNet Kingfisher Series II telemetry equipment. The network utilises UHF radio networks with three repeater sites. The system utilises multiple master stations with the City of Gold Coast main monitoring site located at Molendinar.

All new telemetry equipment supplied for wastewater sites shall be capable of seamlessly integrating with 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 stations 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 to determine the current state of their inputs and outputs will periodically poll all telemetry stations. All stations must be capable of being reprogrammed remotely via the radio network.

**Pump Stations**

Wastewater pump stations shall include a radio telemetry unit as specified. City of Gold Coast uses peer-to-peer communications to implement scheduling of wastewater pump stations. New equipment installed under this specification shall allow peer-to-peer communication with existing and supplied equipment.

Wastewater pump stations will normally be controlled locally by the RTU but with supervisory control via the central “CiTect” SCADA HMI application selectable. The central HMI application will be receiving wet well level signals and monitor all alarms.

Most pump stations will conform to the standard typical drawings provided in Section 3, but detailed design including RTU/PLC programming will be required for any pump station that doesn’t conform to the standard drawings.

For detailed installation requirements refer to SS10 – ASSEMBLY REQUIREMENTS

### 3.4 Operating And Maintenance Manuals (Excluding Treatment Plants)
An operating and maintenance manual covering the work of all mechanical and electrical equipment supplied including a manual covering the odour (biofilter) bed if installed, shall be submitted by the Contractor or Developer.

The operating and maintenance manuals shall be an essential part of the equipment supplied. The supply and delivery of equipment will be regarded as incomplete until the draft operating and maintenance manuals have been submitted and approved. They must be in the correct format, with the specified content, collated into a unified and indexed operating and maintenance manual. A Certificate of Practical Completion will only be issued on compliance.

3.4.1 Submission and Acceptance Of Manuals

A. Submission of Draft Manual

At least four (4) weeks prior to practical completion, the Contractor or Developer shall submit one hard and two (2) electronic copies of a draft operating and maintenance manual to City of Gold Coast for approval. They shall include each item or group of similar items of equipment to be supplied in the correct format. If the draft manual is accepted, it will be so endorsed by City of Gold Coast and one copy returned to the Contractor or Developer. If the draft manual is accepted with notations, the Contractor shall make the required amendments and re-submit copies of the revised draft manual for appraisal.

B. Final Submission

When the draft manual has been accepted by City of Gold Coast, the Contractor or Developer shall submit one hard copy and two (2) electronic copies on CD or DVD to the City of Gold Coast.

C. Electronic Submission

All submitted material must be in a form that can be edited at a later date so that electronic manuals can be kept up to date. PDF format is not acceptable. All documentation must be in the following formats:

<table>
<thead>
<tr>
<th>Type</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>Text</td>
<td>Word</td>
</tr>
<tr>
<td>Drawings</td>
<td>AutoCAD</td>
</tr>
<tr>
<td>Diagrams</td>
<td>Visio or Word</td>
</tr>
<tr>
<td>Spreadsheets</td>
<td>Excel</td>
</tr>
</tbody>
</table>

D. Format Requirements

The final operating and maintenance manual shall be in English. The hard copy shall be submitted punched and bound in a stiff folder. Electronic copies shall be submitted on CD or DVD. Draft operating and maintenance manuals may be submitted in soft folders.

E. Material Content

Material shall be specific to the particular unit described. If a manufacturer’s standard literature is used, non-applicable material shall be removed or neatly deleted. Original material is preferred but photocopies will be accepted provided the reproduction quality, and in particular the reproduction of photographs, is of a satisfactory high standard. All manufacturers literature shall be scanned and include in the electronic version of the document. Only items of major equipment that needs to be set, configured or programmed need be supplied. Common equipments such miniature circuit breakers, isolating switches, mounting rails, control switches do not need to be provided.

F. Text and Drawings

Text shall be submitted on A4 size sheets in Arial font. Electronic text shall be submitted in both Microsoft Word (.doc) and (.PDF) format.

Drawings shall be A1 size, folded to A4 size in such a way that their title block is visible at the bottom right hand corner. A3 drawings accepted providing the detail is clear and has been approved by City of Gold Coast. Electronic drawings shall be submitted in AutoCad (.DXF) and (.DWG) and (.PDF) format.

G. Contents of Manuals

Operating and maintenance manuals shall include but not be limited to the following.
“Operation and Maintenance” manuals shall include but not be limited to providing full and detailed information regarding the design criteria and sizing of facilities; 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; and safety and housekeeping procedures.

G1 - 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.

G2 - Cover and Face Sheets
The cover and face sheets shall include the following information, suitably arranged:
City of Gold Coast
Name of Plant (e.g. Pump Station A78)
Contract number
Name of equipment
Operating and Maintenance Manual
Contractor’s name and address for service calls
This information is also required on the spine of the manual.

G3 - Electronic Linking
Where applicable all Drawing Reference Numbers shall electronically link to the applicable drawing. Where applicable all SAP asset numbers shall electronically link to the appropriate data sheet and maintenance instructions.
The table of contents shall electronically link to the relevant section and/or page.

G4 - Table of Contents
The table of contents shall indicate the content and arrangement of the operating and maintenance manual and asset listings.

G5 - 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
Name of Plant (e.g. Pump Station A78)
Contract number
Equipment name (and number if applicable)
Date of contract
Equipment type, model number, serial number
Manufacturer’s name
Equipment supplier’s name, address and telephone number and website details.

G6 - Nameplate Data
Where applicable, sheets shall be included showing nameplate data as required by separate sub-clauses of the Specification.

G7 - 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, 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 of the Specification
Reference drawings list
All other information necessary to fully specify the item of equipment
Equipment supplier’s name, address and telephone number and website details

G8-Data Sheets for Component Equipment
For each item of equipment that is a component of equipment included in this Specification, 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 & fax number, email and web site addresses
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.
Special Tools and Test Equipment List
Warranty Data Information and Drawings

G9- Operating Instructions
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
Visual checks and observations that should be made routinely to ensure equipment is operating satisfactorily
Diagnostic and trouble-shooting techniques, where applicable, to determine probable causes of operating difficulties or alarm situations

G10-Maintenance Instructions
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
Testing procedures
Visual checks and observations that should be made routinely to ensure equipment is operating satisfactorily
Diagnostic and trouble-shooting techniques, where applicable, to determine probable causes of operating difficulties or alarm situations
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.
Testing procedures.

G11-Dismantling Instructions
Dismantling 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. The instructions shall be supplemented by comprehensive exploded view drawings or photographs.

Maintenance Charts - Maintenance chart/s showing a complete listing of all equipment supplied and installed under the Contract shall be included in the drawings. The chart 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.

G12-Spare Parts Lists
Spare parts lists with cross-references to sectional drawings shall include:
- Part name
- Part number (identification for ordering of spares)
- Number required
- Material of construction
- Availability
- Supplier and contact details

3.4.2 Skill Levels
A task and skills analysis shall be instigated to identify the skills required to operate and/or maintain the system, and the number of persons required.

3.4.3 Training
The Contractor will provide a proposed training concept and schedule and develop contract specifications for those items of equipment and systems for which the contractor is to provide formal training. Requirements for training should 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 City of Gold Coast during project development, video-taping and the training can be included in the construction contract.

3.5 Decommissioning Including Treatment Of Abandoned/Obsolescent Assets
For projects or developments that result in redundant assets, the following requirements are provided for planning and design purposes. Depending upon the end use of the infrastructure to be decommissioned, specific requirements exist as follows:-

3.5.1 Retention of Decommissioned Infrastructure and Remains In City of Gold Coast Ownership
If the infrastructure to be decommissioned is a pipeline (including decommissioned pressure mains), and it has been determined that the conduit is not required for other purposes (e.g., Pipe bursting for the insertion of another main), then the pipeline shall be capped and sealed at any receiving structure.
if applicable. If deemed to be a significant risk by the Project Manager they are to be either removed or filled with a low strength grout (<5 MPa), or with a similar material, or with sand.

The decommissioning of asbestos cement pipes should be initially referred to the Occupational Health & Safety Manager/Officer for guidance on it’s management.

Water retaining structures and underground tanks should be completely drained (including residual sludge), disinfected, perforated at the bottom, and filled and capped with a stable material that has been certified as free of contamination - this applies to imported fill as well as material sourced from on-site eg crushed concrete.

Any utilities such as water, electrical and SCADA, unless required for maintenance activities, are to be disconnected.

Where operational infrastructure is retained by City of Gold Coast , including any structures retained from within the asset, Asset Management is responsible for its ongoing management and maintenance.

If the item is listed on the State Heritage Register, the structure is required to comply with minimum standards of maintenance and repair (as set out in the Heritage Regulation 1999 sections 10 -18). This may require ongoing inspections and maintenance activities by Asset Management.

### 3.5.2 Removal of Decommissioned Infrastructure and Remains In City of Gold Coast Ownership

Additional requirements as follows:

With infrastructure demolition approvals will be required from Asset Management (for non-operational infrastructure only), and the Manager Service Delivery.

All structures to be removed to a depth of 1 metre below finished surface level.

If the infrastructure to be decommissioned is plant equipment such as a wastewater pumping station, all pipes entering and leaving the site are to be capped. If deemed to be a significant risk by the Project Manager they are to be either removed or filled with a low strength grout (<5 MPa), or with a similar material, or with sand.

Electrical and Mechanical Equipment to be removed and stored if identified to be useful.

All above ground debris/waste and unwanted underground plant and equipment is to be removed and disposed of off site, including all concrete structures, pipes, fittings, steelwork and other metalwork, fixings, equipment, switchboards, cubicles, power poles and any other redundant items on site nominated by the Project Manager (the Project Manager shall provide in advance for this purpose, an inventory of known unwanted items for reference, but other items uncovered at this time may be included if required).

The surface is to be reinstated to natural / design level and stabilised. Surface finish is to match finished / existing surrounds or as shown on the drawings.

The location of any remaining underground pipes and structures are to be surveyed and recorded in City of Gold Coast GIS system and SAP database.

### 3.5.3 Removal of Decommissioned Infrastructure and Is Sold By City of Gold Coast

The requirements of the above clauses apply with the addition of the following:

A contamination audit and any necessary remediation are to be undertaken to the standard determined by City of Gold Coast . This is to include post testing to confirm the effectiveness of the remediation works.

City of Gold Coast will be responsible for re-zoning of land, where required.

All sludge must be removed from the site and must not be relocated on site or buried in-situ.

After the decommissioning process is complete, the site is handed over to City of Gold Coast for the management of the sale. This is to be in the form of a Memo from the Director of City of Gold Coast , to the Manager, Group Property. Group property will require all decommissioning and remediation activities to be completed prior to acquiring management of the site.

**Documentation**

On the completion of the project all information and plans including resurveys relating to the works will be provided to City of Gold Coast for incorporation into the GIS system layers & the SAP database. The Process for any new infrastructure shall follow Procedure "SD-06 Asset Handover of Infrastructure".
3.6 Handover –Acceptance Of Assets

3.6.1 Water and sewage Projects and Developments

The date of “handover” is the date of “On Maintenance” for network assets. The date of “On maintenance” is when the following milestones have been delivered:-
Operational Control of the assets has passed to AW ie all commissioning tests complete.
“As Constructed” survey GIS drawings have been submitted.
Training is completed.
O&M manuals have been submitted with all equipment guarantees and warranties provided.

Defects Liability period begins at this “On maintenance” date irrespective of commissioning date or purchase date of equipment.
For internal AW projects and Alliance projects – project completion is when the following milestones are completed:
Asset management documentation is complete ie all asset attribute data provided, asset maintenance schedules are complete for loading into SAP.
A “handover” document transmittal is signed by Asset Management Section.
A “Project Completion Form” is submitted.

3.6.2 Wastewater Treatment Plant Projects

All the above requirements apply plus any other relevant documentation concerning:-
Proving period requirements
Support procedures during defects liability period
List of outstanding defects and correction program.
Project documentation
Any particular matters identified in the design brief.

3.7 Valuation And Capitalisation

The cost of all infrastructure funded by City of Gold Coast must be brought to account in Allconnex asset accounting system and its asset management system. SD22 “Asset Hierarchies and Numbering Definition” outlines the financial hierarchy showing the class and sub-class of the asset. The financial asset hierarchy is reproduced below for convenience.

As a guide, all components identified in the asset hierarchies in “SD 22 Asset Hierarchies and Numbering Definition ” need to be valued by identifying direct costs and allocating overhead costs in proportion to the direct values identified.

Asset accounting policy requires City of Gold Coast to review its work in progress (WIP) on a monthly basis in accordance with its “Non-Current Accounting Policy” and capitalise the costs associated with any infrastructure that has been commissioned and put into service during that period.

In order to streamline the asset capitalisation process, capital works project managers are encouraged to structure their project accounting in accordance with the Facility-Element- Component hierarchy as shown in the asset hierarchies. By following this structure, financial assets can be aggregated and added to the financial asset accounts and further aggregated to valuing assets by Class.
For Contributed assets, a set of valuation rates are used to value assets as they are added to the system through GIS. These valuation rates are subject to annual audit.

An alternative approach is for Developers to provide on-costed values for each component identified on the asset hierarchy.

3.8 Engineering Drawings - Application Checklist

Development/Project Name: Stage No:
City of Gold CoastFile No:
PROPERTY DETAILS
Real Property Description:
Address:
CONSULTANT
Company Name:.........................................................RPEQ No:……………
Address:.................................................................Phone No:……………
Contact Name:........................................................Fax No:………………

CHECK LIST ITEMS SUBMITTED
General Items.............................................. or □ N/A
Water Supply Items.............................................. or □ N/A
©Sewerage Reticulation Items.............................................. or □ N/A
Miscellaneous Items.............................................. or □ N/A
Dual Water Reticulation Items……………………………… or □ N/A
Reduced Infiltration Gravity Sewers (RIGS) Items……………………………… or □ N/A

CITY OF GOLD COAST USE ONLY:
Receiving Officers Name:
Date: .............../................./...................
Action Taken:
## A. GENERAL

### 1. ADMINISTRATION
- Application Form Fully Completed
- Approvals And Clearances:
  - Queensland Department Of Transport
  - Department of Environment
  - Downstream Drainage Discharge Rights
  - Clearance For Works Through Other Properties
  - ENERGEX/Telstra
  - Others:
- Relevant Standard Drawings Included In Application
- Schedule Of Drawings (Submitted) Attached

### 2. COMPLIANCE WITH COUNCIL APPROVALS
- Rezoning, Consent or Other Council Approval
- Provisions For Adjoining Development Requirements

### 3. All Engineering Drawings And Specifications Prepared And Signed By A Registered Professional Engineer

### 4. TITLE BLOCK ON ENGINEERING DRAWINGS
- Estate Name (If Any)
- Stage Number (If Any)
- Developers Name
- Consultants Name And Address
- Drawing Number And Sheet Number
- Scale With A Scale Bar
- Locality Description
- Origin Of Levels And Location Of Permanent Survey Marks
- Schedule Showing Date And Nature Of Amendments
- Drawing Title
- Signed Design Certification By An Experienced Designer

### 5. LOCALITY PLAN
- North Point
- Major Roads Names
- Adjacent Localities
- Development AreaOutlined And Shaded Or Crosshatched
- Scale Noted

### LAYOUT OR STAGE PLAN
- Layout Of Roads
- Approved Road Names (Road Number Not Acceptable)
- Allotment Layout
- Lot Numbers
- Access Restriction Strips
- Stage Boundaries Clearly Shown
- Existing Easements
- North Point
### B. WATER SUPPLY

#### 1. WATER RETICULATION PLANS

<table>
<thead>
<tr>
<th>Item</th>
<th>Yes</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Drafting - Drawings Include:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road Name and Road Reserve Boundaries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relevant Land Zonings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allotment Boundaries and Numbers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easements (If Applicable)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Point</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing Water Mains Including Alignment, Type and Size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed Water Mains Including:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mains Shown On Correct Alignment From Property Boundaries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe Diameter, Material and Class</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chainages (If Applicable)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bearings (If Applicable)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symbols for Fittings Clearly Shown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road Crossings - Ductile Iron - Size and Class</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrant Locations - Standard and Swabbing</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bends</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Fittings - Air Valves, Scour Valves, Swabbing Pits</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road Crossing Conduits - Future Water Services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Service Details - Class, Material (If Applicable)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Services to Parks, Entry Treatments (If Applicable)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Services Information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed and Existing Kerb and Channel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed and Existing Stormwater Drainage Including Manholes, Outlets, Overland Flow Paths etc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed and Existing Sewer Mains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed and Existing Public Utility Services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conflict Points With Other Services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical Detail Drawings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reservoirs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top Water Level (TWL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major Thrust Blocks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure Reducing Valves (PRV)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Settings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Supply Zone (High Level Areas)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Design - Complies With City of Gold Coast Design Guidelines:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow Requirements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure - Including Firefighting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage Facilities (If Required)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cover Over Mains</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 2. RESERVOIRS

<table>
<thead>
<tr>
<th>Item</th>
<th>Yes</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Drafting - Drawings Include:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locality Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle Access Details</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Horizontal Geometry</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Longitudinal Section (If Applicable) □
Cross Sections (If Applicable) □
Fencing Requirements □
Height □
Type □
Gates □
Security □
Reservoir Design Plan □
Earthworks □
Contours □
Water Levels □
Design Details - Materials, Reinforcing, Roofing etc □
Pipework - Diameter, Material and Class □
Valve Details □
Telemetry - Control Equipment, Security For Structure □
Landscaping (If Applicable) □
(b) Design - Complies With City of Gold Coast Design Guidelines □
Storage Parameters □
Capacity □
Mechanical And Electrical Requirements □
Pumps □
Pressure Control □
Vehicle Access and Site Manoeuvrability □

3. WATER SUPPLY PUMP STATIONS
(a) Drafting - Drawings Include:-
Locality Plan □
Vehicle Access Details □
Relevant Detail - Fittings etc □
Pump Station Design □
Pipework - Diameter, Material and Class □
Valve Details □
Pipe and Fitting Schedule □
Pump Description □
Pump Station Layout - Valve Box or Building □
Telemetry □
Security Fencing □
Landscaping □
(b) Design - Complies With City of Gold Coast Design Guidelines □
Pump Station Criteria □
Flow □
Head □
In Accordance with City of Gold Coast Pump Station Standard Detail Drawing □
Pump Curves □
Mechanical and Electrical Requirements □
Control Cabinet □
Overflows □
Noise Protection Provision □

E. SEWERAGE RETICULATION
### 1. SEWERAGE RETICULATION PLANS

<table>
<thead>
<tr>
<th>Drafting - Drawings Include:</th>
<th>☐ Yes</th>
<th>☐ N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approved Road Names and Road Reserve Boundaries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allotment Boundaries and Numbers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easements (If Applicable)</td>
<td></td>
<td>☐</td>
</tr>
<tr>
<td>Proposed and Existing Contours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Point</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed Sewer Mains Including:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mains Shown on Correct Alignment From Property Boundaries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe Diameter, Material, Class</td>
<td></td>
<td>☐</td>
</tr>
<tr>
<td>Chainages (If Applicable)</td>
<td></td>
<td>☐</td>
</tr>
<tr>
<td>Bearings (If Applicable)</td>
<td></td>
<td>☐</td>
</tr>
<tr>
<td>Manhole Locations - Number and Alignment</td>
<td></td>
<td>☐</td>
</tr>
<tr>
<td>House Connection Branches</td>
<td></td>
<td>☐</td>
</tr>
<tr>
<td>Flow Arrows On Each Allotment</td>
<td></td>
<td>☐</td>
</tr>
<tr>
<td>House Connection Invert Levels On Each Allotment Including House Connection Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Services Information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed and Existing Kerb and Channel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed and Existing Stormwater Drainage Including Manholes, Outlets, Overland Flow Paths etc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed and Existing Water Mains Including Hydrants and Valve etc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed and Existing Public Utility Services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conflict Points With Other Services</td>
<td></td>
<td>☐</td>
</tr>
<tr>
<td>Based on Preliminary Sewer Concept Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alignment of Mains and Access for Maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Precast Manholes Not In Areas Prone To Flooding</td>
<td></td>
<td>☐</td>
</tr>
<tr>
<td>Manholes Not In Road Carriageways, Central Medians and Roundabouts</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 2. SEWERAGE LONGITUDINAL SECTIONS (GRAVITY MAINS)

<table>
<thead>
<tr>
<th>Drafting - Drawings Include:</th>
<th>☐ Yes</th>
<th>☐ N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Longitudinal Section for Each Line</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running Chainage and Distance Between Manholes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing and Proposed Finished Surface Levels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manhole Details To Include:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manhole Type - Precast or Cast In situ</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manhole Diameter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drop Types</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cover Lid Types</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction Invert Levels - All Sewers Entering</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equivalent Population, Pipe Capacity, Design Capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe Diameter, Material, Class</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe Grades on Each Section</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete Anchor Blocks (If Applicable)</td>
<td></td>
<td>☐</td>
</tr>
<tr>
<td>Location of Each Section - Private Property, Road etc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sewer Line and Manhole Numbers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>House Connections for Each Allotment on Sewer Line To Include: Diameter</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Invert Level</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Junction Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flood Level (If Applicable)</td>
<td></td>
<td>☐</td>
</tr>
</tbody>
</table>
### 3. SEWERAGE LONGITUDINAL SECTIONS (PRESSURE MAINS)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Yes</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Drafting - Drawings Include:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Longitudinal Section for Each Line</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running Chainage and Distance Between Pump Station and Receiving Main</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing and Proposed Finished Surface Levels</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Equivalent Population, Pipe Capacity, Design Capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe Diameter, Material, Class</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe Grades on Each Section</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete Anchor Blocks (If Applicable)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Location of Each Section - Private Property, Road etc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sewer Line Manhole and Pump Station Numbers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Receiving Manhole Protection</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flood Level (If Applicable)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thrust Blocks (If Applicable)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Datum Shown on Long Sections</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Invert Level of all other Underground Services - Stormwater, Water, Public Utilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Design - Complies With City of Gold Coast Design Guidelines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe Velocity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cover Over Mains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concrete Anchor Block Requirements</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### 4. SEWERAGE PUMP AND LIFT STATIONS

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Yes</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Drafting - Drawings Include:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Locality Plan</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle Access Details (If Applicable)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relevant Detail - Fittings etc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pump Station Design Including:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipework - Diameter, Material and Class</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valve Detail</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pipe and Fitting Schedule</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pump Description</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pump Station Layout - Valve Box etc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Telemetry</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asset Number and Address in Title Block</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) Design - Complies With City of Gold Coast Design Guidelines:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pump Station Criteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Head</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In Accordance With City of Gold Coast Pump Station Diagrammatic Layout</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pump Curves</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Mechanical and Electrical Requirements

- Control Cabinet
- Overflow level and location

### F. MISCELLANEOUS

#### 1. NOISE ATTENUATION WORKS

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Yes</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Earthworks / Mounds - Plan, Sections And Batter Slopes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical Barrier / Fence Details</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landscaping</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road Number Or Name</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 2. RETAINING WALLS

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Yes</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approved Road Names</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Plan Layout - Extent</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Typical Cross Section</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Foundation Details</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drainage Details</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Design Certified By Registered Professional Engineer</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 3. LANDSCAPE WORKS

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Yes</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drawings for landscape works are in accordance with City of Gold Coast Landscape Strategy Part 2 - Landscape Documentation manual and the required elements of Queensland Streets</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### 4. PUBLIC UTILITY SERVICES

(a) Drafting - Drawings Include:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Yes</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing Light Poles And Power Poles Etc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing Underground Services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed Services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alteration To Existing Services</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) Public Utility Service Drawings:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Yes</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public Utility Service Designs Sighted</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Check For Conflict With Civil Works</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### G. DUAL WATER RETICULATION SUPPLY

1. DUAL WATER RETICULATION PLANS (Potable & Recycled)

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Yes</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approved Road Name and Road Reserve Boundaries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allotment Boundaries and Numbers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easements (If Applicable)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duplex Dwelling Allotments</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Point</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Existing Water Mains including Alignment, Type and Size</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed Dual Water Reticulation Mains including:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mains shown on correct alignment from property boundaries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Trenching Type</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Symbols for Fittings Clearly Shown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road Crossings - Ductile Iron</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Page 100 of 376
<table>
<thead>
<tr>
<th>Requirement</th>
<th>Yes</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road Crossings – Polyethylene (Conduit)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrants/Flushing Points</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valves</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Fittings – Air Valves, Scour Valves, Reducers, Swabbing Pits etc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Readytap water supply connection points</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Service Details – 25 or 32mm only (If Applicable)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Services Information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed and Existing Kerb and Channel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed and Existing Stormwater Drainage Including Manholes, Outlets, Overland Flow Paths etc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed and Existing Sewer Mains</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed and Existing Public Utility Services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conflict Points With Other Services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Main cross connection location(s)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical Detail Drawings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reservoirs</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top Water Level (TWL)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Major Thrust Blocks</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure Reducing Valves (PRV)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Settings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water Supply Zone (High Level Areas)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) Design - Complies With City of Gold Coast Design Guidelines:

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Yes</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Requirements</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage Facilities (If Required)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cover Over Mains</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

H. REDUCED INFILTRATION GRAVITY SEWERAGE RETICULATION

2. REDUCED INFILTRATION GRAVITY SEWERAGE PLANS

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Yes</th>
<th>N/A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drafting – Plan/Layout Drawings Include:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Approved Road Name and Road Reserve Boundaries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Allotment Boundaries and Numbers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Easements (If Applicable)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed and Existing Contours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>North Point</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed Reduced Infiltration Gravity Sewerage mains including:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mains shown on correct alignment from property boundaries</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Manholes, Maintenance Shafts and Roding Ends – Numbered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>House Connection Branches</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Services Information</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed and Existing Kerb and Channel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed and Existing Stormwater Drainage including Manholes, Outlets, Overland Flow Paths etc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed and Existing Water Mains including Hydrants, Valves etc</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proposed and Existing Public Utility Services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conflict points with other services</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Design - Complies With City of Gold Coast Design Guidelines:-

Based on Preliminary Sewer Concept Plan

Page 101 of 376
### Alignment of Mains and Access for Maintenance
- Precast Manholes not in Areas Prone to Flooding
- Manholes, maintenance shafts or Rodding ends not in road carriageways, central medians and roundabouts (Unless authorised by AW)
- Sewer lines not to be located below retaining walls that are aligned parallel with the pipe service.
- Pipe Velocity
- Minimum grades
- Drops through manholes
- Capacity
- Cover over mains
- Concrete anchor block requirements

### Longitudinal Drawings include:
- Longitudinal Section for each line
- Running Chainage and distance between manholes
- Existing and proposed surface & invert levels
- Depth to invert
- Line numbers
- Property Descriptions
- Datum
- Grades
- Diameter, material, class
- Invert levels of all other underground services – stormwater, water, public utilities
- Manhole details to include:
  - Manhole type – Precast or In-situ
  - Manhole diameter
  - Drop types
  - Manhole numbers
  - Cover lid types
  - Junction invert levels – All sewers entering
- Maintenance shaft details to include:
  - Type of intersection (refer Dwg 597X2)
  - Bends required to connect to base section (If applicable)
- Maintenance Shaft numbers
- Junction invert levels – All sewers entering
- Kickers (vertical shaft bends) required
- Rodding End details to include:
  - Bends required to connect to base section (If applicable)
- Maintenance Shaft numbers
- Junction invert levels – All sewers entering
- House Connections for each allotment on sewer line to include:
  - Diameter
  - Invert level & depth
  - Chainage from D/S manhole
  - Flood Level (if applicable)
  - Sewer lines requiring anchor blocks/bulkheads
  - Downstream discharge manholes including all incoming sewer
3.9 Specific Integration Requirements – Treatment Plants

3.9.1 Handover Deliverables
Receipt of all handover submittals for the Works and the proven performance of the Work are non-negotiable condition precedents to the issue of a Practical Completion Certificate for the Works by the Superintendent. If the Superintendent establishes any Separable Portions, these non-negotiable condition precedents apply to each Separable Portion in turn.

Handover deliverables from the Contractor include the following:
- Plant Information Portal;
- Operational Software;
- Special Tools; and
- Initial Spare Parts.

During commissioning, or modification of the installed equipment as a result of commissioning outcomes, any modifications to the draft Operations and Maintenance Manuals and/or As-Constructed drawings shall be marked onto three (3) control copies of the draft Operations and Maintenance Manuals and/or As-Constructed drawings. Two sets of these marked up versions of the documents shall be handed over to the Superintendent at the start of commissioning irrespective of whether or not the facility or item of equipment is immediately put into operation by the Principal. The third set of the marked up versions of the documents shall be retained by the Contractor, who shall immediately proceed to amend the electronic versions of the draft Operations and Maintenance Manuals and/or As-Constructed drawings.

The Contractor shall submit final Operations and Maintenance Manuals and/or As-Constructed drawings, both electronic and hard copy versions in accordance with the requirements of the Principal’s Standard Specifications, to the Superintendent within fourteen (14) working days of the date of commissioning for each Milestone, Separable Portion or the Works, as applicable.

The Superintendent shall not grant Practical Completion for the Works until the final Operations and Maintenance Manuals and As-Constructed information applicable to the Works has been reviewed and accepted by the Superintendent. Where the Contract comprises Separable Portions, the Superintendent will not grant Practical Completion for each Separable Portion until the final Operations and Maintenance Manuals and As-Constructed information applicable to that Separable Portion has been reviewed accepted by the Superintendent.

3.9.2 Plant Information Portal
General
The Plant Information Portal shall be configured in electronic format only. The format is based on separate files in adobe acrobat format, all of which are accessible via hyperlinks from a single Plant Information Portal (based in MS Excel). Extensive cross-referencing between files (via hyperlinks) is also produced to provide rapid navigation.

Three (3) copies of the Plant Information Portal shall be provided on identical portable hard drives.

Plant Information Portal Pro-forma
A proforma for the Plant Information Portal is included in Attachment L.

Plant Information Portal Contents
The Plant Information Portal shall contain:
- Operational Manuals;
The requirements for the Operational Manuals are detailed in SS10 Section 3.

Operational Procedures
The requirements for the Operational Procedures are detailed in SS10 Section 3.

Maintenance Manuals
The requirements for the Maintenance Manuals are detailed in SS10 Section 3.

Quality Records
All test results from Factory Acceptance Testing, Site Acceptance Testing and commissioning, including all other test results associated with the Works, and the ITR and supporting documentation shall be included in the Plant Information Portal.

Functional Description Statement
The requirements for the Function Description Statement are detailed in SS10 Section 2.

Where the acceptance testing and commissioning result in changes to functionality, such changes shall be incorporated in the Functional Description Statement and the revised Functional Description Statement shall be resubmitted to the Superintendent within one month of the completion of acceptance testing / commissioning.

Operational Software
Two (2) bound A4 hard copies and two (2) electronic copies on CD-ROM of all final PLC/DCS code as appropriate, the supporting files and sequence diagrams, and the SCADA project and libraries where a PLC hardware platform is adopted shall be submitted to the Superintendent. They shall be complete with all required files and information to allow the reinstallation of the PLC/SCADA system on a new PLC/PC platform or on a new DCS platform.

The supporting documents shall be incorporated into the Plant Information Portal.

3.9.3 Work As Constructed Drawings
General Requirements
As Constructed information is required by the Principal to assure that the completed Works satisfy the following:

The finished Works is in accordance with the reviewed Project drawings, the Contractor’s Documentation and the Contract Document;
The Principal is provided with an inventory of assets being handed over to the Principal for asset management purposes. The inventory shall include, but not be limited to, item name, installed position/location, and assigned asset identification number, refer to the above requirements; and An accurate record is provided of the ‘As-Constructed’ completed Works for location, level and attribute information.

Preparation and submission of ‘As-Constructed’ information in a form complying with the requirements of this clause will expedite the process of checking of submitted ‘As Constructed’ information by the Superintendent and subsequently allow for prompt review of the submitted information.

All submitted Project Drawings shall be amended by the Contractor to show in detail the arrangement of the Works and the design detail as actually constructed. This requirement applies also to the work and drawings of all subcontractors and vendors. Such amendments as are necessary to depict in detail the as-constructed condition shall be carefully and accurately prepared by competent draftspersons. Where an ‘As Constructed’ condition requires a drawing to be amended then all related drawings influenced by this amendment shall similarly be amended.

Upon completion of relevant amendments, one copy of each drawing prepared pursuant to the requirements of this Contract Documents, each clearly marked adjacent to the title block and signed by the Contractor’s Project Manager as ‘As-Constructed drawing’, shall be submitted.

Three (3) A3 bound sets of paper prints of As-Constructed drawings shall be submitted to the Superintendent for acceptance. This requirement applies equally to the work and drawings of all subcontractors and vendors. The electronic copy of all accepted As-Constructed drawings will be incorporated in the Plant Information Portal.

Should it be found subsequent to the issue of a Practical Completion Certificate for any Portion that the Contractor has failed to amend all or some of the drawings as required above then the Contractor must promptly complete the necessary work at his expense.

3.9.4 Progressive Recording of As Constructed Drawing Information

The Contractor shall retain a single set of accepted For Construction drawings as control drawings that will be updated as each revised For Construction drawing is issued by the Contractor, onto which As-Constructed information shall be progressively recorded. These control drawings shall be clearly stamped As-Constructed in red colour. The Contractor shall keep accurate and reliable records of As-Constructed information throughout the term of the Contract and regularly enter the As-Constructed information onto the As-Constructed Drawings using red (and other coloured pens where clarity is required) pens in a neat and legible manner.

The As-Constructed Drawings shall be stored in a secure and separate location to other drawings and are not to leave the Site Office at any time until the As-Constructed changes are due to be drafted. The As-Constructed drawings shall be made available for review by the Superintendent at any time and during site meetings at the request of the Superintendent.

Where the acceptance testing and commissioning process results in changes to the components and equipment, these changes shall be incorporated into the As-Constructed drawings and made available to the Superintendent within two weeks of the completion of commissioning.

3.9.5 Review and Acceptance of As-Constructed Information

As-Constructed versions of all drawings, specifications and ancillary documentation shall be submitted for the review and acceptance by the Superintendent at regular intervals. Should any amendments be required by the Superintendent to any of the submitted As-Constructed information,
the Superintendent shall provide notification to the Contractor of the required amendments and / or revisions, and within five (5) working days of receipt of details of the required amendments from the Superintendent such amendments shall be made and As-Constructed information resubmitted by the Contractor.

3.9.6 Certification of As Constructed Information

All As-Constructed information, including As-Constructed survey information, shall be appropriately certified by a Registered Professional Engineer of Queensland (RPEQ) using the following certification statement (or similar to the satisfaction of the Superintendent).

Registered Professional Engineer of Queensland Certification

I, ………………………………. being a Registered Professional Engineer registered under the provision of the Professional Engineers Act 2002 (as amended) and a duly authorized representative of ……………(insert name of Contractor/Consultant) do hereby certify that the As-Constructed information shown herein is a true and correct record of the Works performed (including sizes, types, classes, materials, etc), and that the Works have been executed to a satisfactory standard of workmanship and in accordance with the relevant “For Construction” Engineering Drawings, all Specifications applicable to the Contract Works, relevant Australian Standard Codes of Practice, and Council’s By-Laws.
Signed ……………………………………………………………………
RPEQ No. ……………………………………………………………….Dated ………………….

As-Constructed Survey Information and Certification

As-Constructed drawings and / or information incorporating the As-Constructed survey details shall be prepared based on:

The “GCC Local Grid” coordinate system shall be adopted; and Heights shall be to Australian Height Datum.
Where agreed by the Superintendent and at the request of the Contractor, the Principal’s survey officers, through the Superintendent, shall be available to discuss As-Constructed survey data requirements with the Contractor’s nominated survey subconsultant. This may include, but not be limited to, clarification of survey conversion or adjustment factors applicable to the Allconnex region and to ensure consistency of survey coordination with the Principal’s base data requirements.

The origin of all levels and details of all survey control points or survey coordination details or notes utilized in compiling the As-Constructed survey drawings are to be noted on the As-Constructed drawings.

As-Constructed drawings incorporating as-constructed survey details shall be certified by a Registered Surveyor using the following certification statement (or similar to the satisfaction of the Superintendent):

Registered Surveyor’s Certification

I, ……………………….......….. being a Registered Surveyor registered under the provisions of the Surveyors Act 2003 (as amended) hereby certify that the vertical and horizontal locations, measurements and dimensions shown on this plan are a true and correct record of the As-Constructed information.
Signed …………………………………………………………..…………
Registered No. …………………………………Dated ………………….
3.9.7 As-Constructed Information and Defects Liability Period

Should it be found, subsequent to the issue of a Certificate of Practical Completion for all or any part of the Works, that any of the Contractor’s As-Constructed information fail to correctly represent the As-Constructed conditions, the Superintendent shall be entitled to require the Contractor to amend the As-Constructed drawings or other information and resubmit amended drawings or other information for review and approval of the Superintendent. No additional costs shall be deemed payable to the Contractor arising from or associated with activities to undertake such amendments to As-Constructed drawings or other information.

3.9.8 Schedules and Lists

The requirements for the Equipment Schedules and Lists, Parts Listings and Technical Data are detailed in SS10 Section 3,4&5.

3.9.9 Training Modules

The requirements for the Training Modules are detailed in SS10 Section 3.

3.9.10 Vendors/Suppliers

The requirements for the Vendors/Suppliers Schedules are detailed in SS10 Section 3.

3.9.11 Maintenance Schedules

The requirements for the Maintenance Schedules are detailed in SS10 Section 3.

3.9.12 SAP Asset Management Schedule

The requirements for the SAP Asset Management Schedule are detailed in SS10 Section 3.
4 Section 4 – Assembly

4.1 COMMON REQUIREMENTS – ALL ASSETS

The ‘Assembly’ section of SS10 covers specifications for the construction of water supply mains and associated works including concrete reservoirs, construction of sewer mains and associated works and mechanical and electrical installations. The guidelines in this section should be read in conjunction with relevant City of Gold Coast Standard drawings. A list of Standard drawings is included in Appendix A, B, C and D of this specification. It should also be noted that a number of Australian Standards form parts of this document and must be referred to for details of materials, workmanship and construction procedures. Lists of Australian Standards are referred to throughout this document. Council’s Development Guidelines, Standard Specifications and Standard Drawings shall take precedence over the Department of Natural Resources and Water Planning Guidelines and the WSAA Water Supply Code and Drawings and the Dual water reticulation Supplement.

4.1.1 Definitions

In these documents:

- “Standard” shall mean and include a Standard Specification, Standard Code of Practice or other Standard issued by a recognised association or body set up for the purpose.
- “Australian Standard” or the abbreviation “AS” shall mean a Standard issued by the Standards Association of Australia.
- “British Standard” or the abbreviation “BS” shall mean a Standard issued by the British Standards Association.
- “International Standard” or the abbreviation “ISO” shall mean a Standard issued by the International Standards Organisation.
- “DIN” stands for Deutsches Institut für Normung e.V. (DIN; in English, the German Institute for Standardization) is the German national organization for standardization and is that country’s ISO member body. It is the designator for a number of European standards, most often a repeat of ISO standards.
- “Council” denotes the Gold Coast City Council.
- “Contractor” denotes the person or corporation bound to execute construction and related work on behalf of a Developer or City of Gold Coast.
- “Developer” denotes the person or corporation who has been granted development approval by Council and must have had a design submission for examination by Council prepared by a Consulting Engineer.
- “Engineer” denotes a professionally qualified person discharging the responsibilities of a Registered Professional Engineer Queensland or his representative.
- “Superintendent” denotes for City of Gold Coast Projects, the person appointed under the General Conditions of Contract to undertake this role for the Contract or his nominated representative. For works on behalf of a Developer, denotes the person appointed to that role by the Developer.
- QEMS is a system of Quality Procedures by which AW standardises business processes.
- OASIS (Operational Asset Services Information System), is the database in which information about AW assets is stored.

4.1.2 Compliance with Requirements of Standards

- All items and components shall be in conformity with the requirements of the particular Standard or Standards specified. If no Standard or other requirements is specified, the requirements of
the appropriate Australian Standard or, in the absence of any Australian Standard, the
appropriate British or International Standard shall apply as if forming part of this Specification.

- If the specified requirements conflict with the Standard requirements the specified requirements
shall apply.

Note: A full list of Standards is tabulated in SS10 Section 5.

4.1.3 ACTS, REGULATIONS AND LOCAL LAWS

The Contractor shall comply with all Acts, Local Laws and Regulations having jurisdiction over work
under the Contract and shall be fully responsible for any breaches thereof.
Notwithstanding the requirements of this specification the whole of the work under the Contract shall
be executed in conformity with the relevant sections of the Water Act 2000 (as amended), the Water
Supply ( Safety and Reliability ) Act (as amended), the Environmental Protection Act, the Environmental
Protection Regulation, the Workplace Health and Safety Act and any Construction Safety Plans
required by this Act and all other Queensland and Australian Acts and Regulations.
The Contractor is advised that City of Gold Coast has Occupational Health and Safety Guidelines that
shall be reviewed and used as appropriate. These Guidelines are available for viewing at City of Gold
Coast Nerang Administration centre.

4.1.4 Packing, Marking and Identification (Asset Numbering)

All equipment shall be adequately and effectively protected against damage from moisture, brinelling,
handling or other cause during delivery and/or storage associated with the delivery process.
Each item or package shall be clearly marked and each separate portion of plant shall receive, as far as
practicable, a fitting or distinguishing mark which shall be shown on the packaging lists.
All items supplied shall be packaged so as to be stored outdoors for a period of thirty (30) days or
indoors for a period of six (6) months, unless otherwise specified.
The nominated City of Gold Coast Superintendent shall provide the contractor an SAP Asset Number
for all major components installed. The contractor shall label the item where appropriate, and record the
required details for each SAP Asset (including attribution data where requested). This information shall
be forwarded to the nominated City of Gold Coast superintendent upon the commissioning of that
particular component.
The above-mentioned process shall be conducted in accordance with QEMS procedures SD-22 and
SD-23.
It is the contractor’s responsibility to ensure SAP asset numbers have been issued for labelling and
reporting processes.

4.1.5 Factory Acceptance Testing

The equipment shall be subject to inspection by the Superintendent or his 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 City of Gold Coast. Tests shall be conducted to AS 2417 Part
2 Class C.
The Contractor / Developer 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
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
Performance tests shall be as scheduled.

4.1.6 Safety

Adequate provision must be made to effectively protect the operator and visitors from hazards. The
following must be provided:
Enclosure of the plant or installation with a fence and signs designed to prohibit the entrance of
unauthorized persons and animals;
Hand rails and guards around tanks, trenches, pits, stairwells, and other hazardous structures complying with AS1657;
Gratings or approved safety nets over pits or appropriate areas where access for maintenance is required complying with AS1657;
First aid equipment;
Protective clothing and equipment, such as self-contained breathing apparatus, gas detection equipment, goggles, gloves, hard hats, safety harnesses, etc.;
Portable blower and sufficient hose;
Provisions for confined space entry in accordance with WorkCover requirements.
 Appropriately-placed warning signs for slippery areas, non-potable water fixtures, low head clearance areas, open service manholes, flammable fuel storage areas.
The Contractor shall supply and install all mandatory, caution, prohibition, safety and danger signage as required by current legislation at all appropriate locations. Signs shall be compliant with AS 1319 and shall include, but not be limited to, the following:-

- EYE PROTECTION MUST BE WORN
- HEARING PROTECTION MUST BE WORN
- CAUTION: (message)
- SWITCHROOM—AUTHORISED PERSONNEL ONLY.
- SAFETY: (message)
- EMERGENCY SHOWER.
- DANGER(message)
- HIGH VOLTAGE.
- NO SMOKING.
- CONFINED SPACE
- HAZCHEM: (message)
- EXPLOSIVE ATMOSPHERE
- (ETC)

Above ground pipework, conduits and ducts shall be provided with identification markers indicating contents and direction of flow in accordance with AS 1345—1985. Markers shall be long life, UV resistant, self-adhesive labels and shall be subject to Endorsement.

4.1.7 Assets – Typical Size of.
This subdocument specification will cover some or all construction of:

Sewerage Reticulation and Associated Works:
- DN100 to DN300 sewers, manholes, maintenance shafts, sewerage pumping stations, house connections and associated appurtenances;
- DN100 to DN300 pressure mains and associated appurtenances where the maximum working pressure is not more than 900 kPa.

Major Sewerage Mains and Associated Works:
- DN300 to DN1200 sewers, manholes, sewerage pumping stations and associated appurtenances;
- DN300 to DN600 pressure mains and associated appurtenances where the maximum working pressure is not more than 900 kPa.

This specification covers reticulation and trunk sewerage requirements and where needed, separately specifies requirements for reticulation and trunk sewerage.

Water reticulation and associated Works:
- Traditional Potable: DN100 to DN300 water reticulation mains and associated appurtenances where the maximum working pressure is not more than 900 kPa.
- Dual water reticulations and associated Works – Potable and Class A+ Recycled:
DN63 and DN110 MDPE and DN150mm to DN300 PVC and DICL potable water reticulation mains and associated appurtenances where the maximum working pressure is not more than 900kPa;
DN100mm to DN300 PVC and DICL recycled water reticulation mains and associated appurtenances where the maximum working pressure is not more than 900kPa.

Trunk water supply mains and associated Works – Water reticulation and Dual Water reticulation:
DN300 to DN1200 water supply mains, and associated appurtenances where the maximum working pressure is not more than 900 kPa.

This specification covers reticulation and trunk water requirements and where needed, separately specifies requirements for reticulation and trunk water.

Pre-cast reinforced or prestressed concrete water supply or recycled water reservoirs.
On-ground cast insitu reinforced and prestressed concrete water supply or recycled water reservoirs.

Electrical installations and Mechanical installations.

Wastewater and Recycled Water Class A+ Treatment Plants

4.1.8 Corrosion Protection (Excludes Treatment Plants –Own Clause)

General
All new equipment, pipework systems and structures shall be given corrosion protective coatings, except the following surfaces, unless specified otherwise elsewhere:
- Pipes in trenches;
- Stainless steel and non-ferrous metals, e.g. aluminium and copper;
- Concrete;
- Machine finished surfaces which will normally be lubricated;
- Chains and sprockets;
- Polyethylene surfaces;
- ABS surfaces not exposed to sunlight;
- Brickwork; and
- Colorbond products.

All coatings shall be confirmed by the manufacturer to be appropriate for the environment in which they are to be placed.
Pipework systems, including PVC and GRP, which is mounted externally or exposed to sunlight shall be coated with a coating appropriate to the pipe material and the duty environment.
Bitumen paint shall not be accepted as an adequate corrosion protection on exposed (cast pipes and fittings.
Surface preparation for and application of the coating treatments shall be in accordance with the manufacturer’s recommendations. Contractors shall ensure that the coating thickness applied to all items is in accordance with the specification and/or manufacturers’ recommendations.
All equipment items, valves and painted pipework shall have the final finish colour as per AS2700. A manufacturer’s standard equipment colour is acceptable for proprietary equipment items.

Cathodic Protection
Where acid sulphate soils, currents from earthing systems and the like, overhead power lines or similar circumstances exist, the use of cathodic protection shall be investigated and costed for steel pipelines, die-cast flowmeter bodies etc.
Where cathodic protection is installed, accurate drawings of the location of anode beds and connections shall be produced.
4.2 COMMON ASSEMBLY REQUIREMENTS – CIVIL: ALL WATER AND SEWAGE ASSEMBLY

4.2.1 Existing Services

a) It shall be the Contractor’s responsibility to contact all public utility authorities to ascertain the location of services prior to commencing the Work under the Contract. In carrying out the Works the Contractor shall be responsible for all damage caused to any public utility whatever. Services include existing pipelines, power, communication and control cables.

b) Before undertaking any work, which may interfere with any public utility, railway, road, watercourse or tidal waters or with any structure, the Contractor shall give the required notice in writing to the Department or Authority concerned. The Contractor shall not commence the work until it has received the necessary permits and it shall carry out the work in accordance with the conditions set out in these permits.

c) If the Contractor damages any existing services it shall arrange for the relevant service authority to make good such damage and the cost thereof shall be borne by the Contractor.

d) Where the design of the Works requires alterations to existing services and such alterations are to be organised by the Contractor then the Contractor shall liaise and arrange with the relevant Department or Authority to effect such alterations and the Contractor shall pay all costs, fees, and charges of the Department or Authority.

e) All of the Contractor’s costs in performing this function shall be deemed to be included in the relevant Bill Item (if part of the Contract) and the Lump Sum of the Contract generally.

f) Prior to commencing the works on site, the Contractor shall physically locate and expose all services in the vicinity of the works and assess if there is interference with the construction of the works as designed. Excavation near existing structures, including pipelines, shall take into account the support loads provided by the earth to the existing structures. The Contractor shall ensure that any excavation near existing structures does not impact upon those structures.

g) Where existing services interfere with the works as designed the Contractor shall notify the Superintendent of the interference immediately. The Superintendent will then instruct the Contractor on how to proceed.

h) Where the design of the works is altered to overcome the existing services interference the Contractor shall undertake the work instructed.

i) Actual additional construction costs associated with the alteration of the works or services to overcome the existing services interference will be met by the Principal. No delay and disruption costs will be considered, as the additional works will be instructed in response to notification by the Contractor prior to works commencing on site.

4.2.2 Clearing and Grubbing

a) Clearing and grubbing shall be carried out in accordance with the requirements of Council’s Standard Specification SS3 and the approved Vegetation Management Plan.

b) The Contractor shall take all necessary steps to preserve vegetation along the route of the main. These steps shall include:

c) Limiting the construction disturbance area to a minimum. As a general rule, the disturbance area shall be no greater than 6.0m wide for pipes less than or equal to DN600 and 10 m wide for mains larger than DN450. Job specific limitations may be imposed within the project specification as an environmental consideration.

d) The Contractor is advised that adherence to the Council’s Planning Scheme Specific Development Code at Part 7, Chapter 36 – Vegetation Management is required when undertaking the Works. It is the Contractor’s responsibility to make all necessary enquires with the relevant Council department.

e) Superintendent approval is required prior to clearing any tree with a diameter greater than 300 mm.

f) All vegetation cleared in the course of constructing the Works shall be disposed of in accordance with the approvals. Any material that cannot be disposed of in the approved manner due to its excessive size shall be removed to an approved dump site at the Contractor’s expense.
4.2.3 Erosion And Sediment Control

The following erosion and sediment control measures shall be taken to ensure that sediment is contained within the perimeter of the disturbed area in accordance with the approved Erosion and Sediment Control Plan.

The area of disturbance shall be kept to an absolute minimum.

Topsoil shall be retained for rehabilitation purposes, (NB Stockpiles should not exceed 2 metres height, as this decreases the seed viability).

a) Runoff both external to the site and within the disturbed area shall be controlled. Clean water shall be redirected away from the disturbed area and into a stabilised overland flow path.

b) The site shall be rehabilitated quickly, ie stabilise/vegetate within fourteen (14) days of completion of works. Rehabilitation shall proceed as each stage is completed. The disturbed area shall be seeded and landscaped in line with Council’s landscaping guidelines.

c) Sediment fences shall be installed as directed by the Superintendent and shall be inspected after each rainfall event, repaired if necessary and all trapped sediment removed to a designated stockpile.

d) Stockpiled material spoiled from trenching operations shall be placed on the upslope side, away from any drainage lines. These stockpiles are to have erosion and sediment control devices in place, ie sediment fences placed around the base, and if left for an extended period, an erosion proof blanket should be used.

e) Where the path of the pipe crosses minor drainage lines extra sediment fences shall be installed or small detention basins shall be constructed.

4.2.4 Care Of Real Property Survey Pegs

a) The Contractor shall locate and mark with a white painted stake all real property survey pegs within the area likely to be disturbed by the works. The Contractor shall take care not to distribute any real property survey pegs.

b) Any existing real property survey pegs beyond the limits of earthworks or excavations under this contract, which are disturbed by the Contractor, will be replaced by the Principal's Surveyors at the Contractor's expense.

4.2.5 Care Of Existing Fences

a) Fences, other than those specifically noted for removal, shall be maintained at all times with special care taken to prevent straying of stock if grazing is carried out on adjoining lands.

b) If fences are required to be cut or moved, the Contractor shall erect temporary fences, if necessary, for stock containment as directed by the Superintendent.

c) Where fences are to be cut for access, wire shall be drawn tight to end posts, suitably strutted, and suitable gates provided, if directed, for closure after working hours or when no work is in hand on the site.

d) Any fence cut or removed during this execution of work shall be replaced and reinstated to its original alignment unless otherwise directed by the Superintendent. It is the Contractor’s responsibility to ensure that the fence is located correctly.

4.2.6 Work Within Private Property

The Contractor shall confine all work within private property to a 6.0 metre wide construction swathe unless agreed otherwise with the Superintendent. If directed by the Superintendent, the Contractor shall erect a temporary barrier fence or marker to define the limits of the construction swathe. Activities outside the limits of the construction swathe shall not be permitted without the expressed permission of the Superintendent.

It is the Contractor’s responsibility to inform private property owners of any construction activities that may affect them or their property. Notification is to occur prior to commencing these activities.

4.2.7 Work Within Road Reserves

All work within road reserves shall comply with the following:
a) Work shall proceed without interruption to traffic and any steps necessary for the protection of the public during construction shall be taken.
b) Warning signs, flashing lights and other traffic control devices shall be erected in accordance with the Traffic Management Plan.
c) Work which is likely to reduce traffic flow shall be carried out between 9.00 am and 3.00 pm only and shall be organised so as to cause minimum disruption to pedestrians and access to adjacent properties. One lane of traffic under ‘STOP-GO’ control must remain open at all times across all roads.
d) Open trenches shall be constructed to the details shown on the drawings. Trenches shall not be left open overnight.
e) Work shall be carried so as not to detrimentally affect the existing drainage provisions of the roadway.

4.2.8 Setting Out Work
The Contractor shall be responsible for setting out the centre line of the main in accordance with the survey data supplied on the drawings prior to the commencement of work. Where survey stations are installed along the Works, the Contractor shall protect these stations.

4.2.9 Excavation
Excavation for sewerage reticulation, water mains and reservoirs shall be completed to the lines, levels and profiles shown on the drawings or design documentation.

When (in the Superintendent’s opinion) weather, soil conditions, or any contingency exists that may be detrimental to pipe laying, the Superintendent may limit the length of trench opening in advance of pipe laying. In any event, unless approved otherwise by the Superintendent, the length of trench opening ahead of pipe laying shall not exceed 40 metres.

Where the Contractor over-excavates, it shall make good the over-excavation at its expense. For sewer reticulation and water mains the over excavation shall be made good with bedding material which satisfies the requirements of SS10- Common Material Requirements and which is the material immediately below Zone 1 for the Type 2 construction shown on the drawings. For reservoirs, the over excavation shall be made good with material nominated by the Design Engineer and approved by the Superintendent.

The Contractor shall at its own expense do all things necessary to divert any water interfering with the progress of the Works, keep the excavations and trenches free from water while the Works are in progress and prevent any damage to the Works by water due to floods or other causes. The Contractor shall have approved pumping gear for keeping the excavation or trenches constantly dewatered during the times the Works are in progress. Any work or material damaged by water shall be made good by the Contractor.

Where directed by the Superintendent the bottom of trenches or excavations shall be compacted prior to the placing of any bedding or concrete materials. Should (in the opinion of the Superintendent) the foundation material be incapable of effective compaction, the material shall be removed and replaced with bedding material as specified in SS10- Common Material Requirements.

If approved by the Superintendent excavated material may be used for backfill over pipes. This material shall remain the property of the Principal and any excess shall be spoiled or used as filling within the Site as directed by the Superintendent.

All excavated material which is classified by the Superintendent as unsuitable shall be removed from the Site. The cost of this work shall be deemed to be included in the relevant Bill Items (if part of the Contract) and the Lump Sum of the Contract generally.
The Contractor shall be solely responsible for the maintenance of excavations and is liable for any damage which may be caused to any public utility, conduit, etc, through the collapse of the excavation.

Any excess spoil and all unsuitable material shall be disposed of at a location where directed by the Superintendent within a 10 km radius of the site.

Unless a separate item is included in any applicable Bill of Quantities for rock excavation, the items entered in the Priced Bill of Quantities and the Lump Sum of the Contract generally shall be deemed to include full compensation for excavation of material of all types and subsequent backfill and compaction of the trench or excavation with approved material.

Excavation volumes shall be calculated using the relevant trench shown on the drawings.

Extra over for Rock:
Where a Bill of Quantities is part of the Contract and this Bill contains a separate item for excavation in rock (as defined herein), extra payment will be made for the Bill Item for all rock removed within the limits of the excavation as defined or as ordered by the Superintendent.

The quantity for payment shall be the net quantity in place within the limits of the excavation shown on the drawings. No claim for excavation in rock will be entertained unless the method of measurement is agreed in writing with the Superintendent prior to material being excavated.

Rock shall be defined as material which cannot be excavated at the rate of 15m³/hour by a hydraulic tracked excavator with engine gross power output of 148 kW at maximum RPM and a rated breakout force on the bucket of 148 kN with standard bucket. It shall be the responsibility of the Contractor to provide the excavator and bucket for this purpose at its cost. The Superintendent shall have the right to nominate an operator for the machine. In the event of disagreement with any decision made by the Superintendent in accordance with the above definition, rock shall be defined as material geologically in place of a hardness when first exposed of three or greater in the Mohr scale of material hardness. Testing of material to determine classification as rock (by the Mohr scale) shall be carried out by an approved laboratory at the expense of the Contractor.

Use of Explosives:

a) Where approved, rock may be carefully excavated by blasting procedures. Prior to commencing any blasting operation the Contractor shall obtain any blasting permit required. The depth, spacing, location, type of explosive and method of firing shall comply with any permit issued for blasting operations.

b) In the handling, storage and use of explosives, the Contractor shall comply with all state and local authority laws and by-laws, and with the AS2187 set of Standards, (SAA Explosives Code). The Contractor shall in particular comply with Section 12.2 and 12.3 1.2 of the AS2187.2 Standard (Code).

c) Where directed the Contractor shall provide measurements from a vibograph or similar instrument. If these measurements indicate that the requirements specified herein are not being complied with the Contractor shall reduce the amount of charge used or take such other action as will ensure compliance with the Code.

d) The Contractor may be required to carry out trial blasting in order that the Superintendent may determine the peak vibration effects caused by the trial charges and so limit the maximum charge to be employed. The Contractor shall be responsible for all costs associated with the supply, operation and reporting of the vibograph or similar instrument.

e) The Contractor shall give the Superintendent at least three (3) days’ notice of any intention to excavate by blasting and shall furnish full details of the location thereof and the methods it proposes to adopt. Subject to approval by the Superintendent for blasting at any location, such blasting shall be carried out only at times approved by the Superintendent.

f) The Contractor shall provide screens, barriers, mats and/or other protective devices as directed by the Superintendent to limit the effects of blasting. Notwithstanding the provision of such protective devices, the Contractor shall be responsible for any loss, damage or injury sustained by
the public, workmen, the Works and for damage to property or public utilities of any description whatsoever caused directly or indirectly by such blasting.

g) Secure storage places shall be provided for explosives and all such places shall be clearly marked with warning signs. Only persons trained and experienced in the handling of explosives shall be allowed to use them on the work under the Contract, and no shot shall be fired until a warning has been sounded and all persons within the radius of danger removed. The warning device shall give an audible warning clearly different from any other sound normally heard on the Site.

h) In the event that the vicinity of work under the Contract is accessible to the general public, the Contractor shall, before any shots are fired, post personnel about the Works in various directions to warn all persons of the danger existing and to prevent them approaching closer than safety will permit.

i) Where blasting is likely to endanger life or property, the Superintendent shall have the power to prohibit the use of explosives or prescribe and enforce such rules and regulations as it may deem necessary but the prescribing or failure to prescribe such rules and regulations shall not relieve the Contractor from any responsibility under the Contract.

j) No explosives shall be left in holes overnight.

k) Where explosives are used in rock excavation, the charges shall be so proportioned and placed that they will not loosen the rock outside of the excavation lines shown on the drawings or as provided for in the Contract. If the rock below the line or slopes designated should be loosened by blasting to such an extent as to render it (in the Superintendent’s opinion) liable to slide, fall or have a detrimental effect to the Works such loosened rock shall be removed by the Contractor. The removed material shall be made good with material acceptable to and in a manner approved by the Superintendent.

All work associated with the use of explosives shall be deemed to be included in the relevant Bill Item (if part of the Contract) and/or the lump sum of the Contract generally.

4.2.10 Trench Construction

General
Construction types are detailed on the drawings. Bedding material shall comply with the requirements of SS10 —section 5 Materials.

Excavated material shall not be used as bedding material.

Where crushed rock material nominal size 5-7mm cannot be sourced, then crushed rock nominal size 10mm is to be used and either a full trench width geotextile covering shall be placed above Bedding Zone 3 as shown in the drawings as Type 2 Construction for dry trenches, or a full geotextile wrapping shall be placed around Bedding Zones 1, 2 and 3 as shown in the drawings as Type 3 Construction for wet trenches.

Type 1 Construction

The Bedding Zones 1, 2 and 3 shall consist of crushed rock material (nominal size 5-7mm) specified in SS10-Section 5 Materials herein and shall be constructed to the details shown on the drawings.

Bedding Zone 1
This material shall be placed in the trench to the depths shown on the drawings and compacted for the full width of the trench by two passes of a vibrating plate.

Bedding Zone 2
Hand holes shall be made in Bedding Zone 1 material as detailed on the drawings. The pipe shall be laid on the compacted bed and the bedding material carefully added to fill the hand hole. Bedding Zone 2 material shall then be placed in 150mm (maximum) layers and compacted for the full trench width for each layer using hand tampers and ensuring that the Bedding Zone 2 material is in full and
even contact with the pipe and pipe joints. Hand tamping shall be carried out to ensure that no damage occurs to the pipe or to the pipe sleeving where provided.

Bedding Zone 3
Bedding Zone 3 material shall be 150mm deep for sand backfill and 300mm deep for all other backfill materials. Bedding Zone 3 material shall be placed in layers of 150mm (maximum) depth and compacted for the full width of the trench for each layer using two passes of a small vibrating plate. The trench shall then be backfilled in accordance with “Backfilling” Clause herein. Where the backfill material is classified by the Superintendent as sand, a layer of geotextile (see own clause) shall be placed as shown on the drawings. Where a 10mm bedding material is used instead of a 5/7 material, then the Bedding Zones 1, 2 and 3 shall be geotextile covered or wrapped as detailed in “Trench Construction” clause herein. Selected backfill shall be the best of the excavated material, as directed by the Superintendent, in accordance with the general requirements of Clause “Backfilling” herein.

Type 2 Construction
Type 2 Construction shall be used where, in the opinion of the Superintendent, the trench bottom is too soft or too wet to provide sufficient support for the pipe. In these circumstances additional bedding (nominal size 30mm) complying with the requirements of SS10-Section 5 Materials herein shall be placed and compacted immediately below the Bedding Zone 1 material for the full width of the trench. The depth of additional bedding shall be as directed by the Superintendent but not less than 150mm. In all other respects Type 2 Construction shall be as for Type 1 Construction.

Type 3 Construction
Type 3 Construction shall be used in locations where the Superintendent directs that Bedding Zones 1, 2 and 3 and the additional bedding are to be wrapped with geotextile as shown on the drawings. The geotextile wrapping shall comply with the requirements of Clause “Geotextile” herein. In all other respects, Type 3 Construction shall be as for Type 2 Construction.

Type 4 Construction
Type 4 Construction shall be used where shown in the drawings or at locations designated by the Superintendent where trench construction crosses a roadway. Type 4 Construction shall be to the details shown on the drawings. Bedding Zones 1, 2 and 3 shall be constructed as specified in Type 1 Construction herein. Where additional bedding for Type 4 Construction is directed by the Superintendent the requirements of Bedding Zone 2 herein shall apply. Where directed by the Superintendent that geotextile wrapping to the Bedding Zones 1, 2 and 3 and the additional bedding is to be installed the provisions of Type 4 Construction herein shall apply. Where shown on the drawings, bulkheads shall be installed on each side of the roadway crossing, at a location within the verge, to prevent the migration of embedment and backfill material.

Type 5 Construction
Type 5 Construction shall be used at the location designated by the Superintendent where trench construction is along sealed roads. Type 5 Construction shall be to the details shown on the drawings. Bedding Zones 1, 2 and 3 shall be constructed as specified in Type 1 Construction herein. Where additional bedding for Type 5 Construction is directed by the Superintendent the requirements of herein shall apply. Where directed by the Superintendent that geotextile wrapping to the Bedding Zones 1, 2 and 3 and the additional bedding is to be installed the provisions of Type 3 Construction herein shall apply.

Type 6 Construction
Type 6 Construction shall be used where shown in the drawings or at the location designated by the Superintendent where trench construction is along unsealed road shoulders. Where additional bedding for Type 6 Construction is directed by the Superintendent the requirements of Type 2 Construction herein shall apply. Where directed by the Superintendent that geotextile wrapping to the Bedding Zones 1, 2 and 3 and the additional bedding is to be installed the provisions of Type 3 Construction herein shall apply.

Type 7 Construction
Type 7 Construction shall be to the details shown on the drawings. Unreinforced concrete shall be Grade N20. Pipe floatation and heat reversion of the pipe shall be managed by the pipe layer so that the pipe installation is not damaged. The minimum width of the concrete embedment shall be as shown on the drawings. Backfill material shall be placed between the trench wall and the concrete embedment and compacted in accordance with the requirements of “Backfilling” herein.

Type 8 Construction
Type 8 Construction shall be used for all approved common trenching installations for dual water reticulation systems. Type 8 Construction shall generally be as for Type 1 Construction except that two mains shall occupy the trench as shown on the drawing. Common trenching installations shall maintain the standard depths of Bedding Zone 1 and Bedding Zone 3. For each pipe within the Zone 2 Bedding material, hand holes shall be made in Bedding Zone 1 or 2 material as appropriate and as detailed on the drawings. The pipe shall be laid individually on its compacted bed and the bedding material carefully added to fill the hand hole. Bedding Zone 2 material shall then be placed in 150mm (maximum) layers and compacted for the full trench width using hand tampers and ensuring that the Bedding Zone 2 material is in full and even contact with each pipe and pipe joint.

To facilitate two mains of larger and/or different diameters, the depth of the Bedding Zone 2 material shall be increased as appropriate for one of the pipes. For different diameter mains the larger diameter pipe shall be laid first with Bedding Zone 2 material then placed in maximum layers of 150mm thick to provide a bed for the smaller diameter main ensuring that the dual mains are laid obvert to obvert. To provide sufficient support for the pipe, where, in the opinion of the Superintendent the trench bottom is too soft or the trench is too wet or the bedding requires full geotextile wrapping or the trench is located within a road carriageway or road shoulder then the requirements for Type 2 to Type 6 Construction shall be applied to the Type 8 Construction.

Where a 10mm bedding material is used instead of a 5/7 material, then the Bedding Zones 1, 2 and 3 shall be geotextile covered or wrapped as detailed in this clause above.

4.2.11 State-Controlled Roads
Where pursuant to the Transport Infrastructure Act 1994 roads declared as State-controlled roads, bedding shall comply with this specification. Backfill, pavement, boring and jacking (where required) shall comply with the requirements of Queensland Department of Transport and Main Roads.

4.2.12 Jointing Of Pipes and Associated Fittings
General
Except as provided elsewhere in this specification, all joints shall be approved flexible joints, incorporating synthetic or natural rubber rings as specified in sub-clause “Rubber Rings” herein. In jointing pipes with rubber ring joints, the pipes shall be cleaned before jointing and care shall be taken...
to ensure that the rubber ring is maintained in a plane at right angles to the axis of the pipe. Each pipe shall be jointed as recommended by the manufacturer and each joint checked with a feeler gauge to ensure that the ring is in place. Where shown on the drawings, bends shall be used to effect horizontal or vertical changes of direction. Where bends are not shown on the drawings (and with the permission of the Superintendent) changes of direction may be effected by angling the joints, by means of short lengths of pipes, or by means of cutting pipes and using thimbles or collars to join them. All such changes of direction shall be effected in curves of uniform radius. No joint shall be angled to such an extent as to impair its effectiveness or tightness. Pipes shall be jointed in a straight line and the deflection effected after the joint has been made. The maximum deflection for any type of pipe approved for use shall not under any circumstance exceed the recommendation of the manufacturer. No pipe to fitting joint shall be angled to such an extent as to impair its effectiveness or tightness. Pipes shall be jointed in a straight line and any pipeline deflection effected after the joint. Extreme care shall be exercised to avoid damage to any external coating of the pipe when the joint is pulled together. The jacking system used in the assembly of any main shall comply with the requirements of the pipe manufacturer. A digging bucket shall not be used to push any pipe home. All spigot ends for rubber ring jointed pipes will be supplied with witness marks applied in the factory. The joint shall not be considered fully made unless the distance between the witness mark and the adjoining socket end is within the tolerance nominated by the pipe manufacturer. Where a deflection in the joint is required by the drawings or directed by the Superintendent this deflection shall be made after the joint has been fully entered and the pressure is still applied to the joint. After the completion of the joint a feeler gauge shall be used to probe the gap between spigot and socket to locate the rubber ring and the probing shall progress continuously around the joint so that the rubber ring is touched at intervals of not more than 12 mm. If there is any indication that the rubber ring has been displaced from its groove the joint shall be pulled apart and remade.

4.2.13 Jointing of PE Pipes and Fittings

General

PE pipes and fittings shall be jointed using one of the following:
- Electrofusion couplings;
- Butt welding;
- Mechanical restraint flanged fittings;
- PE stub flanges welded to the pipe or fitting with stainless steel flange plates and bolts.

Electrofusion Couplings

Only trained and certified welders shall perform the weld jointing of PE pipelines. For PE pipe systems, only approved electrofusion fittings complying with clause “Polyethylene (PE) Fittings for Mains” shall be used. In jointing the pipe with the fitting, the pipes square cut face shall be lightly bevelled and the external joint end of the pipe thoroughly scraped and cleaned to remove all oxidised material before jointing. It is recommended that the pipe and fitting be restrained during the fusion process. The manufacturer’s recommendations for fusion jointing shall be followed and care shall be 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 shall be allowed to occur before the joint restraints are removed and pipe laying continues. Each pipe joint shall be checked to ensure correct assembly and records of each electrofusion joint shall be kept. Welding pre-qualification shall be provided. The welder shall submit the proposed procedures to the Superintendent for approval prior to commencing work. A proposed procedure shall be submitted for each pipe diameter, wall thickness and material type and shall contain items listed under clause “Welding procedures” in addition to the following:
- Standard fusion time;
b) standard cooling time;
c) welding equipment to be used;
d) control box details.
e) the welding equipment to be used;
f) the name of the certified welder;
g) a pilot weld for each welding machine, pipe diameter, wall thickness and material type with a record of the parameter valves for each weld;
h) test results confirming the specification strength requirements;
i) all welding to conform to the procedure;
j) a test sampling plan to demonstrate ongoing quality;
k) retention of QA records for each weld, numbered and located on a plan.

**Butt Welding**

a) Only trained and certified welders shall perform the weld jointing of PE pipelines.
b) Butt welding may be used for all pipe sizes.
c) Welding pre-qualification shall be provided. The welder shall submit the proposed procedures to the Superintendent for approval prior to commencing work.
d) A proposed welding procedure shall be submitted for each pipe diameter, wall thickness and material type and shall contain items listed under clause “Welding Procedures” in addition to the following:
   i. the welding parameters to be used;
   ii. the welding equipment to be used;
   iii. the name of the certified welder;
   iv. a pilot weld for each welding machine, pipe diameter, wall thickness and material type with a record of the parameter valve for each weld;
   v. test results confirming the specification strength requirements;
   vi. all welding to conform to the above procedure;
   vii. a test sampling plan to demonstrate ongoing quality;
   viii. retention of QA records for each weld, numbered and located on a plan.

**Flanged PE Adaptor Fittings**

For PE pipe systems, where shown on the drawings, the connection to another pipe system shall be by a mechanical restraint fitting such as the Hawle Flange Adaptor System 2000 fitting or equal AVK fitting that can be directly attached to a flange that is drilled in accordance with AS4087 Figure B5. Approved mechanical restraint joints shall incorporate synthetic or natural rubber seals as specified in Sub clause “Rubber Rings” herein together with a grip ring with interlocking teeth. In jointing the pipe with the fitting, the pipes cut face shall be bevelled and the pipe cleaned before jointing and care shall be taken to ensure that the rubber ring and gripper ring are maintained in a plane at right angles to the axis of the pipe. Each pipe shall be jointed as recommended by the manufacturer and each joint checked to ensure correct assembly.

Jointing bolts at Class A4 shall comply with the requirements of clause “Jointing Bolts”. Flange sealing gaskets shall comply with the requirements of sub-clause “Flange Gaskets” herein.

**PE Stub Flanges**

Where PE pipe is connected to other pipe materials or to valves or is required to be dismantled, a flanged PE stub end and Grade 316 stainless steel back up plate drilled to AS4087 Figure B7 shall be used. Jointing bolts shall comply with the requirements of clause “Jointing Bolts”.

The PE stub shall be welded to the PE pipe with a butt weld complying with Clause “Butt Welding” herein.

Flange sealing gaskets shall comply with the requirements of AS1646.

**4.2.14 Wrapping of Flanges and Mechanical Joints**

**General**

All external areas of DI flanges and mechanical joints for mains of DN375 and larger and all steel main flanges and mechanical joints shall have an approved corrosion protection system applied. Systems such as the Denso Petrolatum or the Enviropeel Sprayable polymeric thermoplastic coating system or equal are suitable.
All materials and procedures shall be by a recognised manufacturer of corrosion protection systems and shall be acceptable to the pipe manufacturer. The Contractor shall use only fully trained and accredited personnel for the wrapping of flanges and mechanical couplings.

**Mechanical Joints**

Wire brush loose dirt and loose rust and clean all oil, grease and other impurities from the joint and 100mm onto the adjacent pipe. The Enviropeel system shall be applied by a purposefully designed applicator unit with a computer controlled heating and pumping unit. Gauze mesh shall be applied to flanges to minimize the migration of the coating into the flange gap. Two layers of the coating shall be applied. For Petrolatum systems apply primer to all metal surfaces. Fill between bolts and sleeve, and around bolts to top of the retaining rings with butyl mastic. Cover bolt heads, nuts and any protruding thread with butyl mastic. Commencing 100 mm clear of the butyl mastic and a minimum of 50 mm onto the factory applied coating apply flexible tape spirally with a 55% overlap and complete 100 mm past the butyl mastic on the other side or a minimum of 50 mm onto the factory applied coating.

**Flanges**

Wire brush loose dirt and loose rust and clean all oil, grease and other impurities from the flange and 100 mm onto the adjacent pipe. The Enviropeel system shall be applied by a purposefully designed applicator unit with a computer controlled heating and pumping unit. Gauze mesh shall be applied to flanges to minimize the migration of the coating into the flange gap. Two layers of the coating shall be applied. For Petrolatum systems apply primer to all metal surfaces. Mould butyl mastic between individual bolts and nuts and over the heads of bolts, nuts and screw threads, with a minimum coverage of 5 mm. Taper onto flange face to provide a suitable contour for tape wrapping. Apply section of flexible tape longitudinally over the flange, extending a minimum of 50 mm onto the pipe barrel. Ensure that each additional section overlaps the previous by 55% to ensure a double thickness of tape. Finish each side with a circumferential wrap around the pipe to lock in the ends of the tape sections applied longitudinally and continue until 100 mm onto the factory applied coating.

At flanges adjacent to concrete structures, the protective coating system shall be extended from the joint being coated to the wall of the structure. Finish each side with a circumferential wrap around the pipe to lock in the ends of the tape sections applied longitudinally and continue until 100 mm onto the factory applied coating or pipe barrel.

**Inspection**

Thoroughly inspect the finished coating to ensure that all overlaps are sealed to prevent moisture and foreign material from working in under the coating.

**4.2.15 Pipe Welding**

**Steel Pipe General**

Carry out site fabrication and welding in accordance with AS/NZS1554.1 Pipework Class 2P, the welding Procedures and the Subclauses below.

Slip-in joints are to be welded externally. A complete external weld shall in addition to the circumferential fillet weld include a run on the ground-off weld of the ‘bell’, the whole comprising a ‘joint’. Ball and socket joint pipes are to be fillet welded both internally and externally. They shall be laid with the test hole in the joint at the top. After completion of internal and external welding of the ball and socket joint pipes, air at a pressure of 200 kPa shall be applied through the test hole and soap solution applied to both internal and external welds to check for leaks. All leaks shall be repaired to the satisfaction of the Superintendent and the test hole filled with weld metal. Butt joints with Collars are to be welded externally. The two complete external welds, together with the two horizontal jointing runs in the case of split collars shall comprise a ‘collar joint’. Where pipes that are cut on-site have FBP coating, the coating shall be cut with a sharp knife to make a neat edge 50 mm clear of the welded joint before removing the coating prior to welding.

**Welding Procedures**
Qualification of Welding Procedures

Welding procedures for all fillet welds, butt welds and combination of each shall be proven qualified by the welding service provider. A schedule of qualified procedures shall be made available by the welding service provider for approval no less than ten (10) working days prior to the intended commencement date of the welding work on which the procedures will be applied. A welding procedure(s) shall be re-qualified when essential variables (as per the specified standard/code) are changed. Where several welding procedures are similar, a qualified procedure is required for each, where the essential variables (as per the specified standard/code) alter between procedures.

Welding Procedure Sheet

Each welding procedure submitted for approval shall include a welding procedure sheet containing at least the following information:

a) sketch of the joint design;
b) material(s) grade-type;
c) material thickness – all parts;
d) method of material(s) preparation;
e) welding process(es) to be used;
f) voltage and amperage;
g) number and sequence of runs;
h) classification of electrode/ wire;
i) diameter of electrode/ wire;
j) shielding gas/ gas mixture/ flux type/ classification;
k) temperature of preheat, inter run heat and post heat applications if applicable;
l) welding standard/ code and classification (ie. AS1554-1 GP or SP, AS4041 Class 1, 2 or 3);
m) unless otherwise notified, the latest edition of the relevant standard/code shall apply and is deemed the minimum standard applicable.

Welding Operators Steel Pipe

Qualification, Certification, Background Experience

Before welding operators commence welding work the following information shall be provided for each operator:

documentary evidence of qualification/ certification currently held;
trade training background;
duration of employment with current employer;
nature of current employment duties.

Identification of Welding Operators

Welding service providers shall maintain accountable records clearly identifying welding operators to each completed welded pipe joint and/or fabricated assembly/unit. The records are to be made readily available by the welding service provider on request. All weld to be stamped in accordance with the relevant Australian Standard.

Supervision of Steel Pipe Welding Work

All welding work shall be carried out under the supervision of a person who:

- holds current certification to AS1796 Cert. 10; or
- holds current certification to AS2214; or
- holds other current qualification/certification approved by City of Gold Coast.

Qualification/certification records of the supervision person(s) are to be made available by the welding service provider on request.
Inspection and Testing of Steel Pipe Welds

Inspector
All welding work inspection shall be carried out by a person who:
complies with the requirements of Clause “Supervision of Steel Pipe Welding Work” above; or
holds current Welding Technology Institute of Australia (W.T.I.A.) welding inspection certification.
Qualification/ records of the inspection person(s) are to be made available by the welding service provider on request.

Inspection
The welding service provider shall provide an inspection and test plan for the intended welding work, ten (10) working days prior to commencement of the work.
The test plan shall contain the necessary elements to assure the completed welding work complies with the standards/ codes stated in the work drawings and specifications.

Testing of Welds
Testing of welds shall be carried out by the welding service provider as follows:
for all joints welded externally and internally in accordance with the pneumatic procedure as set out below;
10% of internal and external welds by Magnetic Particle or Penetration methods in accordance with AS4037, AS1171 and AS2062.

Testing Records
The welding service provider shall maintain accountable testing records for all weld testing and provide the records upon request.

Welding Processes Steel Pipe
Where the welding service provider intends to use a welding process(es) other than those listed below in a welding procedure, the Superintendent is to be notified of the intent prior to the development of welding procedure(s) for approval:
M.M.A.W. – Manual Metal Arc Welding;
F.C.A.W. – Flux Cored Arc Welding;
G.M.A.W. – Gas Metal Arc Welding;
G.T.A.W. – Gas Tungsten Arc Welding;
O.F.G.W. – Oxygen Fuel Gas Welding;
S.A.W. – Submerged Arc Welding.

Welding Consumables Steel Pipe
All welding consumables used in welding procedures shall comply with the standards/ codes listed below unless otherwise authorized by the City of Gold Coast:
Manual Metal Arc Welding: AS/NZS4854, AS/NZS4855;
flux cored electrodes for G.M.A.W.: AS2717 Parts 1, 2 and 3;
electrodes and fluxes for Submerged Arc Welding: AS1858 Parts 1 and 2;
welding consumables for build up and wear resistance: AS2576.

Pneumatic Testing Steel Pipe

WATER AND WASTE  SS10 SECTION 4 ASSEMBLY
After completion of internal and external welding of the joint, air at a pressure of 200 kPa shall be applied through the test hole and soap solution applied to both internal and external welds to check for leaks. All leaks shall be repaired and the test hole filled with weld metal. Pipes shall be laid with the test hole at the top of the joint except for vertically deflected bends as shown on the drawings.

External Coating of Welded Steel Pipe Joints

Heat Shrink Sleeves
Welded joints shall be externally coated using heat shrink sleeves. The Contractor shall use only fully trained and experienced personnel for installation of heat shrink sleeves. Only sleeves recommended by the pipe manufacturer shall be used. Application procedure shall be as follows:

a) bevel the edges of the FBMDPE coating so that there is a tapered transition of at least 10 mm between the full coating thickness and the exposed steel;

b) remove any corrosion products on the steel and abrade the steel surface (if necessary) to produce a clean, non-corroded, roughened surface. Suitable abrasives are emery paper or a steel file;

c) clean the area to be repaired (to be free from dirt, dust and other contaminants) in accordance with the recommendations of the shrink sleeve manufacturer;

d) slightly roughen the FBMDPE coating around the repair for a minimum distance of 100 mm from the edge. Solvent wipe the FBMDPE coating with a clean cloth (acetone is a suitable solvent for cleaning);

e) apply the shrink sleeve in accordance with the application procedures of the manufacturer with the exception that the sleeve shall overlap the PBMDPE coating for a length of 100 mm on either side of the coating. Note that the specified preheat and postheat is necessary to ensure satisfactory bonding of the sleeve. A roller should be used to eliminate voids from under the sleeve;

f) after application the repair area should be tested with a high voltage detector at 15 kV in accordance with AS3894.1;

g) the repair should be visually inspected to ensure that it is in intimate contact with the pipe and that a bead of mastic has exuded from each end of the sleeve for the full pipe circumference. (If this is not in evidence additional heating is required).

Tape Wrap Coating
The Contractor may ask approval from the Superintendent to use a tape wrap coating as an alternative to the heat shrink sleeve. Approval will be given if the Contractor can demonstrate that his staffs are skilled in the application of the tap wrap system.

The Contractor shall use a tap wrap system recommended by the pipe manufacturer. Application procedure shall be as follows:

a) the steel and coating area shall be clean and dry before application of the primer;

b) using a brush, apply a thin even coat of primer onto the steel and overlapping the parent material by 100 mm;

c) allow the primer to tack dry (10–20 mins);

d) spirally apply the tape to the repair area ensuring a 100 mm overlap of the parent metal. The overlap of layers should not be less than 55% of tape width;

e) spirally apply the outerwrap to completely cover the first layer tape coating. The overlap of layers should not be less than 10% of the tape width;

f) some tension should be applied when applying the tapes to ensure that air voids, wrinkles, etc. are not present after wrapping;

g) continuity test with a high voltage detector at 15 kV in accordance with AS3894.1.

Welding of Above Ground Steel Pipes

Where welded joint pipes are to be laid above ground, no pipe-laying shall be done until end thrust blocks are 14 days old. The pipe shall then be laid and the operations timed so that the closure joint shall be welded up at pipe wall temperature of approximately 210°C.
Should the Contractor elect to weld at night to comply with temperature requirements he must supply sufficient lighting which in the opinion of the Superintendent is necessary for efficient working. The Contractor will not be permitted to start these sections unless, in the opinion of the Superintendent, he has assembled sufficient plant to enable compliance with this Specification.

Internal Pointing of Steel Pipes

All welded pipe joints shall be closed internally and the bore made uniform by internal pointing after the welding has been completed. Mortar for pointing shall be premixed and supplied by the pipe manufacturer. The internal surface to be pointed must be free of grease, oil, paint and loose or flaking material. Wet the adjacent cement mortar one hour prior to repair. The mortar shall only be applied when the ambient and mortar temperatures are below 30oC. Wipe any excess water from the area, but leave the surfaces damp. Apply an acrylic modifier approved by the manufacturer as a primer to the steel and adjacent cement mortar immediately prior to applying the mortar. This priming coat can be wet or dry when the mortar is placed. The mortar is added in the normal manner, being worked into place and compacted. The mortar is built up to the level of the existing cement mortar. As the ambient temperature increases the pot life of the mortar is reduced as defined in the manufacturer's instructions. If the mortar is left to stand a skin will develop on the mortar surface. This skin should be remixed into the mortar before use. The mortar must be allowed to dry out as recommended by the manufacturer. Note that this is opposite to that normally required for mortar. It must not be subjected to excessive heat, rain or sub-zero temperatures during the first 48 hours. It is recommended that the mortar cures for 7 days prior to service.

4.2.16 Earthing Of Pipes During Construction

Where required on the drawings, Cathodic protection systems and/or pipe earthing systems shall be installed along the pipeline in accordance with the Specification for Cathodic Protection and Earthling Systems.

The Subcontractor’s attention is drawn to AS/NZS 4853 Electrical Hazards On Metallic Pipelines in respect of providing earthing for pipes during construction activities.

4.2.17 Boring And Jacking

General

Where shown on the drawing or directed by the Superintendent, water/wastewater mains may be constructed by progressively boring and then jacking an approved enveloping pipe underneath the existing ground surface. All such boring and jacking work shall be done without disturbances to the existing surfaces. Under State-controlled roads the provisions of Clause “State Controlled Roads” herein shall apply. Works near Railway Lines shall be carried out in accordance with the Railway Authorities Specifications and Codes. All boring, jacking and pressure grouting work shall be performed by specialist personnel who are experienced with the equipment and methods proposed to be used. Alternative methods of boring and jacking may be accepted providing such methods are approved by the Superintendent in writing prior to their use. The Contractor shall ensure that all pipes, or any wrapping thereon, are not damaged during, or as a result of insertion in the enveloping pipe. The Contractor shall be responsible for thoroughly assessing ground conditions, determining boring and thrusting conditions, and all design work required. The enveloping pipe shall be thrust into the hole simultaneously as boring advances, and shall not be withdrawn after the completion of boring and jacking work. The ground shall not be excavated more than 600mm ahead of the lead pipe. The jacks shall be capable of advancing the enveloping pipe up to the face of the excavation at any time, should this be ordered.
Neither oversize boring nor water-assisted, lubricant-assisted or wet boring methods shall be used unless such methods are approved by the Superintendent. The Contractor shall ensure that the boring and jacking operation is continuous from each starting pit to the next adjacent pit. The Superintendent may direct the Contractor to provide full stand-by capacity for the Contractor's plant and equipment to ensure such continuous operation. In the event that this is ordered by the Superintendent then all costs associated therewith shall be deemed to be included in the relevant Bill Items (if part of the Contract) and/or the Lump Sum of the Contract generally. The Contractor shall provide a shield or cutting edge to protect the leading edge of the front pipe, for the purpose of jacking. Such a shield shall not exceed the outer diameter of the pipe by more than 14mm. Unless otherwise specified, the Contractor shall pressure grout the annular void between the enveloping pipe and the water/wastewater main, using an approved 5% Portland cement grout (or alternatively Flowable Fill as specified in Clause “Flowable Fill”. The Contractor shall ensure that the Manufacturer's recommended allowable external pressure and maximum external temperature for the type of pipe used is not exceeded and that excessive deflection, distortion or damage of such pipe is prevented during or as a result of pressure grouting. Floatation control of the pipe during grouting shall be carried out through filling the pipe with water to prevent any deviation from the grade or alignment shown on the drawings shall be approved only on the written approval of the Superintendent. In the case of the enveloping pipe, the minimum clearance between the water main and the enveloping pipe shall be 75mm and the minimum cover over the enveloping pipe shall be as specified under Clause “Cover to Water Mains” herein. Prior to final inspection and acceptance of the bored and jacked pipe, the Contractor shall excavate a pit at each end of the enveloping pipe, to enable line and level of the pipe to be checked. On completion, the Contractor shall take all steps necessary to prevent ingress of foreign materials to the water main and/or the enveloping pipe. 

Pipe Jacking
Micro-Tunnelling

Where shown on the drawing or directed by the Superintendent, water/wastewater mains may be constructed by pipe jacking that shall be undertaken utilising micro-tunnelling techniques. Micro-tunnelling shall, for the purpose of this document, be defined as a trenchless construction method for installing pipelines which incorporates the following features:

a) remote controlled – the micro-tunnelling boring machine (MTBM) shall be operated from a control panel at the surface. The system shall simultaneously install pipe as spoil as excavated and removed. Personnel entry is not required for routine operation;
b) guided – the guidance system shall reference a laser beam projected onto a target in the MTBM, capable of installing water mains or other types of pipelines to the required tolerance for line and grade;
c) pipe jacked – the process of constructing the pipeline shall be by consecutively pushing pipes and the MTBM through the ground using a jacking system for thrust;
d) continuously supported – continuous pressure shall be provided to the face of the excavation to balance groundwater and earth pressures.
e) The Contractor shall employ personnel who are trained in and have substantial project experience of the type of machine to be used. Details shall be provided to the Superintendent by the Contractor to support its selection of tunnelling equipment and operatives.
f) Unless otherwise specified by the Superintendent, the Contractor shall install either DICL or SCL water main in accordance with Clause “Water main Pressure Pipes” herein.

Micro-Tunnelling Equipment Requirements

A machine that is capable of the following shall carry out excavation:

i. excavating mixed face conditions;
ii. excavating materials from marine deposits to rock beneath the water table while ensuring face stability at all times.
Equipment and systems shall be designed to provide the forces necessary for the installation of the full pipe string and take into account the pipe manufacture’s recommendations on the applicable forces. The Contractor shall be responsible for the design and provision of the following items:

i. intermediate jacking stations;
ii. use of bentonite to reduce friction;
iii. steering system to achieve alignment both horizontally and vertically;
iv. control of surface settlement; and
v. control of ground water table.

All tunnelling machines shall be robust with adequate safety margins for the anticipated duty, designed and manufactured to comply with all safety standards.

The external diameter of the tunnelling machine shall be designed to produce minimum overbreak and the least necessary clearance for the proper construction of the Works.

The Contractor shall be responsible for the quality of materials used or present within the tunnelling machine and shall ensure that all materials used or present are adequate for the task they are to perform.

The Contractor shall maintain records on-site of the date, time jacking load, distance moved, relationship between load and distance moved, line and level measurements.

4.2.18 Grouting Around Pipelines

The Contractor shall grout the annular space between the bored hole and the pipeline with a suitable cement grout. The mix design shall be submitted for approval by the Superintendent prior to grouting.

4.2.19 Thrusts and Reception Pits

Thrust and reception pits and shafts shall be designed and constructed to allow the safe operation of plant, equipment and handling of materials and safely withstand all loading imposed by ground pressure, superimposed loads and the maximum anticipated thrust forces.

The permanent Works shall not be used to transfer jacking force reactions unless the component in question has been specifically designed to resist such forces. Any proposals in this regard shall be referred to the Superintendent for approval prior to implementation.

Proposals shall include calculations and sketches illustrating the proposed arrangement.

Permanent shafts or pits shall have all internal surfaces finished to the details shown in the drawings.

4.2.20 Restoration Works

Restoration of existing developed areas shall be carried out to such a standard that the finished Works shall be as near as practicable to standard of the Site prior to commencement of Works.

Photographic evidence of the original state of the existing developed area shall be provided by the Contractor to validate the restoration standard provided.

The Contractor shall be responsible for all restoration works including, but not restricted to, concrete work, footpath and pavement repairs, gardens, edging, trees, shrubs and grass.

The restoration works shall be completed within forty-eight (48) hours of the initial work being undertaken on a particular property unless agreed otherwise by the Superintendent.

Any excess material which has resulted from work under the Contract shall be removed from the Site at the Contractor's expense.

Should the Contractor fail to complete restoration to a satisfactory standard, within the specified time, then the Superintendent shall arrange to have the restoration work completed by others at the Contractor's expense.

The Contractor shall be responsible for all restoration works including, but not restricted to fences, concrete work, footpath and pavement repairs, gardens, edging, trees, shrubs and lawn to a condition equivalent to that prior to the commencement of work. In the case of grassed areas which are not lawn, restoration shall consist of the placement of 100 mm of topsoil and the spreading of a mixture of grass seed and fertiliser at the following minimum rates:

a) Green Couch (Cynodon dactylon) 20 kg/ hectare;
b) Carpet Grass (Axonopus affinis) 20 kg/ hectare;
c) fertiliser 350 kg/ hectare.
The restoration of grassed areas will not be considered as complete until 80% of the disturbed area has an established grass cover.

### 4.2.21 ‘As-Constructed’ Submission

‘As constructed’ information shall be prepared by the Contractor and shall meet the following minimum criteria:

a) be endorsed by a Licensed Consulting Surveyor with an appropriate QA standard;

b) be submitted to the Superintendent prior to acceptance of the Works on Practical Completion. Should any amendments be required by the Superintendent to the submitted ‘as constructed’ information, such amendments shall be made and resubmitted by the Contractor prior to acceptance of the Works on Practical Completion;

c) for Linear assets, such as pipes and fittings, be submitted in the format specified in City of Gold Coast current ‘Standard Electronic Format for As Constructed Data’;

d) for Non-Linear assets, such as pumping stations, be submitted in accordance with the requirements of SS10 Section 3

e) show all significant variations from the Contract Drawings (including tolerances outside those specified below);

f) where variations occur the Design Drawings are to be amended and submitted to City of Gold Coast for approval.

### 4.2.22 Water Mains – City of Gold Coast Records Tolerance

Deviations from approved design shall not exceed:

<table>
<thead>
<tr>
<th>Fittings</th>
<th>Locations ± 100 mm¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Levels</td>
<td>± 50 mm²</td>
</tr>
<tr>
<td>Lines</td>
<td></td>
</tr>
<tr>
<td>Alignment</td>
<td>± 100 mm¹</td>
</tr>
<tr>
<td>Levels</td>
<td>± 50 mm²</td>
</tr>
</tbody>
</table>

**Notes:**

- Levels should be adequate for installation of fittings. Tolerances are only critical if design levels are nominated.

#### Sewer Reticulation

The Contractor shall construct the Works within the following tolerances:

| Horizontal | + 75mm |
| Vertical   | Surface Level + 30mm¹ |
|           | Invert Level + 30mm² |
| Grade³     |                      |

**Notes:**

1 Structures.
2 Manholes.
3 Minimum design grade shall be maintained.

#### Trunk Sewers

Deviations from approved design shall not exceed:

| Manholes | Locations ± 100 mm¹ |
|          | + 100 mm² |
| Surface Levels | 25 mm |
| Lines       |           |
| Invert      | ± 25 mm³ |
| Alignment   | ± 100 mm¹ |
| Grade³      |          |
Notes:
1 Deviation should not result in conflict with any other service or structure. All services should remain within the approved service corridors.
2 Should match the adjacent finished surface.
3 Not less than minimum and not more than maximum grade. City of Gold Coast design criteria shall be achieved.

4.2.23 Measurement And Payment

Quantities in the Bill of Quantities have been computed on the following basis:

a) Water main - per plan linear metre including - excavate, supply, lay, joint, bed and backfill including tees (other than hydrant tees) thrust blocks, caps and bends. Sewer lines - per plan linear metre including - excavate, supply, lay, joint, bed and backfill pipes and fittings, junctions, manholes, maintenance shafts, pumping stations including pressure pipes and valves, fittings and thrust blocks.

b) Other items have been measured in the units indicated in the text of the items in the Bill and based on the dimensions shown on the drawings or specified elsewhere.

c) The cost of all work required by this specification including testing, supply of all materials, plant, tools, labour and all expenses necessary for the satisfactory completion of the Works shall be deemed to be included in the relevant Bill Items (if part of the Contract) and/or the Lump Sum of the Contract generally.
Consulting Engineer’s Certificate and As Constructed Certification
Development Name:…………………………. Stage No:
City of Gold Coast File No:…………………………………………………………
Works to which Certification relates:…………………………………………………
Property Details
Real Property Description:……………………………………………………………
Area of Land:
Address: 
Consultant
Company Name: 
Address:
Phone No:                                                            Fax No:

I, ………..   being a Registered Professional Engineer registered under the provision of the Professional Engineers Act 2002 (as amended) and a duly authorised representative of …………………………………………………………………………
do hereby certify that we have exercised reasonable skill, care and diligence to ascertain that the Works described above have been executed in accordance with:
  b) Good engineering practice and to a satisfactory standard of workmanship.
  c) Council’s By-Laws.
We further certify that the ‘As Constructed’ information submitted herewith (including survey information prepared by others) indicates to the best of our knowledge and belief that the completed Works represent a true and accurate record of what has been constructed within the specified tolerances required by City of Gold Coast . We further certify that all significant variations from the approved Engineering Drawings (outside the specified tolerances) have been submitted to City of Gold Coast for approval and are incorporated in the ‘As Constructed’ information.

Signature:……………. RPEQ No:………………..Date …. /…. /……..

Consulting Engineer for and on behalf of (Company): ……………..
4.3 COMMON ASSEMBLY REQUIREMENTS - MECHANICAL INSTALLATIONS

4.3.1 Scope
This specification covers the detailed design where required, supply and/or fabrication of the necessary components, installation, construction, commissioning and testing of mechanical installations for Sewage Pumping Stations, Water Pumping Stations, Reservoirs, Vacuum Sewage Pumping Stations, Variable Speed Drive Water Pumping Stations, Wastewater Treatment Plants and associated appurtenances.

4.3.2 Valves
General

See COMMON MATERIAL REQUIREMENTS – CIVIL WATER AND SEWAGE INSTALLATIONS for valve material specifications.

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;
Each valve shall be supplied with adequate bolts, nuts, washers and gaskets for connection to adjoining pipework and equipment.

Valve Design Features and Maintenance Requirements

b.1 Valve Repair
Every vital valve in the works shall be designed to enable repair or replacement without causing an overflow, surcharge, bypass or violation of statutory requirements. 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 influent flow periods. This requirement applies to shutoff and isolation valves. Provisions shall be made in the initial works design to permit repair and replacement of these types of valves.

b.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 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 recommended that the complete path of removal from in-plant location, through hatches, doors and passageways, to be checked and defined for these valve.

b.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 placement of structures and other devices, such as pad-eyes and hooks, to aid valve handling shall be considered in the initial design. This is particularly important for large and/or heavy valves 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.

b.4 Slide Gates
Consideration shall be given to providing mechanical operators or other mechanical assistance for slide gates which, due to their size or infrequent use, may not be easily removable by manual means alone.
Provisions for Isolation valves for Mixing or Flocculation Basin
Isolation valves or gates for the mixing or flocculation basin shall be designed to minimize the problems associated with operation of these devices after long periods of idleness and the resulting
build up of chemical deposits. Access and capability for cleaning debris and deposits which interfere with valve or gate closure shall be provided.

b.5 Protection from Overload

Valves subject to clogging, blockage, binding or other overloads shall be protected from damage due to the overload.

4.3.3 Submersible Pump Units

Duty Points

The duty points of the pumps shall be as stated in the detailed Project Specification or on the Project Drawings. A Guarantee Point must be given for the purposes of performance testing under AS2417-2001 – Rotodynamic pumps – Hydraulic performance acceptance tests – Grades 2 and is subject to the tolerances stated therein. Other International Standards providing a similar or better testing standard will be acceptable subject to approval.

Each pump’s duty may be achieved using variable speed drives. If necessary the pumps may be operated at a frequency greater than 50 Hz to achieve the wide range of flows required.

The pumped medium is as stated in the detailed Project Specification or on the Project Drawings.

Pump Selection

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

a) 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;

b) attain a Maximum Achievable Flow, for continuous operation, not less than 20% greater than the highest flow duty point.

Operating Speed

The nominal pump operating speed at 50 Hz shall not be greater than 1500 rpm ie 2 pole motors are not acceptable.

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.

NPSH

Each pump shall have a Net Positive Suction Head Required (NPSHR) at least 2 m less than 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.

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:

a) formation of vortices; or

b) over-heating of the motor.

Noise

The Sound Pressure Level (SPL) of each pump unit shall not exceed 80dB(A) measured on a one metre radius, measured in accordance with AS1217 – Acoustics – Determination of sound power levels of noise sources.

The use of and provision of sound attenuation enclosures 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 enclosures shall be provided.

**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 provides a water tight seal against the discharge flange of the pump.

**Reverse Rotation**

All pump motor and coupling components shall withstand, without damage, the effects of reverse rotation due to reverse flow through the pump up to 120% of normal direction rated speed.

**Pump Solids Handling Capacity**

Each pump shall be required to pump fluids with the following inclusions:

- a) frangible solids;
- b) hard solids, eg grit, sand and stones;
- c) fibrous solids, eg rags, rope and sanitary napkins; and
- d) mineral and other oils.

e) The pump shall be non-clogging and non-ragging. The Minimum Sphere Passing Capability shall be 90 mm.

**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 subcontractor shall state the maximum permissible number of starts per hour when started under the driven load and the maximum number of consecutive starts.

**Supply Variation**

The motor shall meet all the requirements of this specification with the supply voltage, 400V, within the tolerance limits listed below:

- Supply Voltage: +/- 5%
- Frequency: +/- 2%

**Insulation**

The motor shall have class F insulation, or better, with a maximum temperature rise to class B (80°C).

**Interference**

The motor shall not cause interference of any kind (including radio frequency interference) with any existing installation nor shall the motor be affected by external electro-magnetic 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 Contractor.

**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.

**Motor Protection**
The motor shall be protected from overheating by:

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

b) A moisture detection device shall be fitted in the motor stator housing and the cable termination housing.

4.3.4 Vacuum Generator / Pumps

The type of vacuum generator most appropriate shall be a Rotary Vane Vacuum pump with heater installed in the oil tank set at 80 degrees C. The heaters stop any water carry over into the oil which City of Gold Coast have found to be very high in the initial stage of a new system, until about ¾ of the catchment properties are connected. Initially the service costs are higher but in the long term they are more efficient.

The Vacuum generator operating vacuum shall be determined from the reticulation design. For further guidance please refer to the WSA 06 - 2004 CODE.

Factors such as noise, water quality and temperature shall also be considered, as well as the effect of the exhaust gases on the type of odour control filter to be installed. City of Gold Coast preferred odour control device is ODOURIDDER Biofilter system or similar refer to Draft WSA 121-2002 specification.

4.3.5 Pump Maintenance And Repair Requirements

Pump Repair

Every vital Pump in the works shall be designed to enable repair or replacement without causing an overflow, surcharge, bypass or violation of statutory requirements.

Pump Access Space

Adequate access and removal space shall be provided around all Pumps to permit easy maintenance and/or removal and replacement without interfering with the operation of other equipment. Pumps 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 pump is permissible for removal and replacement.

Pump Handling

Large pumps shall have lifting and handling equipment available to aid in the maintenance and replacement of the pumps. In addition, the placement of structures and other devices, such as pad-eyes and hooks, to aid pump handling shall be considered in the initial design. This is particularly important for large and/or heavy pumps which require special handling and lifting equipment. Means shall be provided for removal of pumps located above and below the ground level of buildings and other structures.

4.3.6 Safety

Refer to section 4 ASSEMBLY for safety requirements.

4.3.7 Specific Maintenance Requirements For Pump Wells Wet Wells

Lines feeding chemicals or process air to wet wells shall be designed to enable repair or replacement without drainage of the well.

All pump wells prior to the screen and de-gritting processes or primary settling basins shall be accessible for cleaning out settled solids. The provisions shall enable manual or mechanical cleaning of equipment on a periodic basis without causing an overflow, surcharge, bypass or a violation of statutory requirements.

All pump wells and wet wells shall be designed to enable complete dewatering in a reasonable length of time in order to minimize the component downtime for maintenance or repairs. Specific Maintenance requirements for Sump Pumps

Sump pumps shall be of a non-clog type.

Submersible pumps/motors shall be readily removable and replaceable without dewatering the wet well/tank or disconnecting any piping in the wet well.

4.3.8 Pump Backup Requirements

Each set of pumps whose failure could result in an overflow, surcharge, bypass or a violation of statutory requirements shall be provided with a backup pump. The backup equipment may be of a
different type and located at a different point, provided that the same function is performed. No single failure shall result in disabling both sets of parallel equipment. The capacity of backup pump shall be such that with any one pump out of service, the remaining pumps will have capacity to handle the peak flow.

4.3.9 Hoisting Equipment

**Purpose of the Lifting Gear**

Lifting gear in pump stations, reservoirs and treatment plants serve the following primary purposes:

a) To raise a pump to allow a blockage to be removed, after which it is lowered back into position and re-assembled. This is by far the most frequent activity. The incidence of blockages varies from site to site but can be as frequent as daily/weekly in blockage-prone pump stations.

b) To remove a pump from the pump station to be repaired or replaced.

c) To install a new pump or a pump that has been repaired.

d) To lift, remove and replace panels of floor grating over the dry well.

e) To lift submerged aerators and mixers from bioreactors.

f) To install remove switchboards in switchrooms.

g) To be available 24 hrs a day.

h) Not require the use of high tonnage mobile cranes.

i) The lifting gear is also used on occasion to remove and replace other equipment such as pipework and valves, although this activity is infrequent (once every 10 – 20 years).

**Typical Configuration**

Pump station lifting gear typically consists of a monorail beam, with a trolley-mounted hoist, mounted over an opening in the floor that is covered with panels of removable floor grating. The monorail beam passes through a doorway and extends outside the building to allow the item being handled to be set down and picked up by a truck-mounted crane.

Access to the pumps and other equipment at the bottom of the dry well is provided by a stairway including handrails, landings and toeboards to ensure safe working conditions. Additional platforms are provided where access is required to elevated equipment.

**Compliance Requirements**

The lifting equipment specified herein is intended to be standard equipment supplied by manufacturers who are fully experienced, reputable and qualified in the manufacture of such equipment.

The design, installation, testing, certification and operation of pump station lifting gear, stairways and access platforms shall comply with the following legislation, specification and standards in the following order of precedence:

a) Workplace Health and Safety Regulation 2008

b) Plant Code of Practice 2005, Workplace Health and Safety Queensland

c) AW Contract Specification

d) AW Standard Specifications

e) AS1418-2002 Cranes, Hoists and Winches, Standards Australia

f) AS2550-2002 Cranes, Hoists and Winches – Safe Use, Standards Australia

g) AS1657-1992 Fixed Platforms, Walkways, Stairways and Ladders, Standards Australia

h) SAA Wiring Rules (AS/NZS 3000)

i) AS 2549:CRANES (including hoists and winches) Glossary of Terms

Any inconsistencies between these documents shall be referred to AW for direction.

**Alignment**

The hoist shall be aligned directly over the lifting points of the pumps (or other nominated equipment) such that when the hook is lowered it aligns with the centre of the lifting point on each pump/equipment within a tolerance of 10 mm.
The lifting point on each pump/equipment shall be located in line with its centre of gravity so that the pump/equipment does not tilt or swing as it is lifted, to ensure a simple and safe method of raising and lowering the pump.

**Load Capacity (Pumps)**

The lifting gear shall have sufficient capacity to lift and remove each pump in the pump station. The total load for wastewater pumps shall include the length of the pump's electrical cable and the hoist's chain required to reach the bottom of the pump station dry well. An allowance of an additional 100 kg shall also be made for the force required to separate the seal between the pump and the adjacent pipework and the weight of any material blocked within the pump. The hoist shall be designed for a pump sized for the 2056 Planning Scheme Demand (PSD).

**Duty**

The hoist shall be suitable for continuous operation.

**Design Life**

The asset shall be designed for the following life:

- Hoist – 20 years
- Structure – 50 years
- Protective Coatings to Structure – 20 years between re-coats.

If alternatives to the design life specified above are proposed, they shall be submitted to AW for consideration with a whole-of-life costing.

**Manually Operated Hoists**

The monorail lifting gear shall have a safe working 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. The lifting gear shall comprise a chain block close coupled to a girder trolley to suit the universal column section monorails.

The lifting unit shall be operated by an endless hand chain and geared chain pulley block. All chain, hooks and blocks shall comply with the requirements of AS2321, AS3777, AS2550.1 and AS1418.

The push trolleys shall consist of steel side plates with cast iron machined plain tread wheels fitted complete with prelubricated sealed ball bearings, stub axle, dust cover and circlip. The stub axle shall be of steel and secured in the side plates to prevent its rotation.

**Electrically Driven Hoist**

The monorail shall be load tested by the Contractor to the satisfaction of AW.

The monorail hoist shall be a complete installation including all supports, necessary fixings, monorail, electrical collector wires and their supports, all control and supply wiring, runway conductors and all necessary access platforms and ladders.

The hoist gears 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.

The 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. The hoist shall have two-speed operation. High speed operation shall be provided for lifting equipment out of the dry well/reactor/switchroom. Low speed operation shall also be provided to "inch" the load either up or down to enable alignment of the equipment. The hoist shall maintain a constant hoisting speed regardless of the load being lifted.

**Control**

The hoist shall be operated with a wireless controller. The range of the wireless unit shall be sufficient to ensure its function when operated from any location in the bottom of the dry well and any location within the pump station building.
Supply Rails
Wire conductors for the trolley shall be of the enclosed copper conductor type with spring loaded collectors and shall be complete with all necessary insulation, supports and appurtenances.

Safety Features
The hoist shall include the following safety features:
- Auto stop at the top of its hoisting range.
- Auto stop in the event of power failure.
- Electrical overload limit.

Chain and Hook
The chain and hook shall be corrosion-resistant "black" steel. Stainless steel is not suitable for hoists. The length of the chain shall be consistent with the depth of the dry well and the chain bucket shall have sufficient capacity to accommodate this length without tripping the hoist. The throat of the hook shall be wide enough to pick up the lifting bar on the pump without manual intervention. The thickness of the lifting bar shall be confirmed on site. The hook shall swivel through a full 360 degree. A safety spring shall be provided on the bottom hook.

Trolley
Hoists with a Safe Working Load (SWL) of 2 tonnes 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.

Vermin Resistance
Electrical wiring shall be vermin resistant. Subsequent arrangements for maintenance of the hoist shall include replacement of vermin baits as required.

Labelling
The monorail beam shall be clearly labelled with the Safe Working Load (SWL) of the hoist in accordance with the Australian Standard. The hoist shall also be provided with a nameplate showing the SWL that can be clearly read from the floor. Subsequent arrangements for maintenance of the hoist shall include re-labelling of the hoist as required.

Standardisation
Hoists shall be supplied in the following standard sizes:
- SWL 500 kg
- SWL 1000 kg
- SWL 2000 kg
- SWL 5000 kg
AW's preferred equipment is nominated in Section 4 General Material Requirements – Mechanical Installations.

Height
The hoist shall be located at a height that provides a minimum of 150 millimetres of clearance between the floor and the underside of the pump when it is hanging under the hook. Allowance shall be made for any steps, kerbing or any other installation component within the pathway for the pump's removal that may protrude above floor level. The height of the hoist shall be designed to cater for a pump sized for the 2056 Planning Scheme Demand (PSD).

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 300 millimetres 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 300 millimetres beyond the roof line to allow the pump to be lifted by a crane truck.

**Noise**
The hoist shall operate at a noise level not exceeding 45 dB measured at the boundary to an adjacent residential property.

**Maintenance Log Book**
A maintenance log book shall be provided for the hoist and stored on site. The log book shall be stored in a clean dry cabinet within the pump station building. If such a cabinet does not exist then one shall be provided.

**Crane Maintenance Platforms**
The detail, fabrication and erection of the crane maintenance platform and access stairs or ladders of the monorail shall conform with the approved design drawings. The design shall make cognizance of the limited space available and shall ensure that access around screening equipment is not impeded by platform supports. The platform shall strictly comply with AS 1418 and AS 1657. The platform shall be fabricated in accordance with the specification and drawings. All steelwork shall be hot dip galvanized after fabrication.

**Signs**
All signs necessary for complying with the requirements of AS 1418 shall be provided and located by the Contractor. The signs shall include:

- SWL
- Crane classification
- Direction plate under bridge
- Manufacturer
- Type
- Year of Manufacture
- Serial number
- Hoist rope type, size, grade
- Hoist rope minimum breaking load
- Hoist rope length

**Acceptance Requirements**

**Commissioning**
The lifting gear shall be inspected, load tested and commissioned in accordance with AS 1418. The load test shall be performed at 100% of the rated capacity and 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 provided.

Furthermore, the full functionality of the lifting gear shall be tested using a spare pump of equivalent size and weight to that in service. The test pump shall be provided by AW.

For the purpose of carrying out the load tests, the Contractor shall provide sufficient material to form a load 10% in excess of the nominal crane capacity. Should the crane installation not meet the requirements of the above Department and/or should the test fail to perform the work as set out herein, or should any defects show up or develop, whether due to defective design, material or workmanship or to any fault of the Contractor or his agent, such defects shall be made good by the Contractor at his own expense on notification by the Superintendent.
Monorails shall be load tested as specified above. The test load shall be 10% in excess of the 
nominal hoist capacity. 
The monorails shall be permanently and visibly marked with the safe working load in accordance with 
AS 1418 and 8.1.5 herein.

Registration
Where required by the Workplace Health and Safety Regulation 2008 the lifting gear shall be 
registered and the following certificates provided:
- Certificate of Registration of Registrable Plant
- Certificate of Registration of Registrable Plant Design

Certification
The lifting gear shall not be operated until it has been inspected and certified as being safe for use by 
a competent person. A certificate shall be provided generally in accordance with the format given in 
AS 2550 part 3.
Upon certification of the lifting gear a Certification Plate shall be affixed to the monorail beam. The 
Certification Plate shall state the following items:
- Identifying details of the crane.
- That the crane has been inspected and certified in accordance with AS 2550.
- The date the certification occurred.
- The date re-certification is required.
- Details of the certifying organisation.
- The certificate number.

Competent Persons
Competent persons shall be those that comply with the definition provided in AS 2550. As a minimum, 
the competent person shall be a degree qualified engineer, registered as a professional engineer in 
Queensland (RPEQ) and have at least 4 years of experience in the field of crane design, installation, 
inspection, testing and certification.

Technical Documentation
The following documentation shall be provided:
- Drawings
- Supporting Documentation
- Asset Data
- Warranty Details
- Operator's Manual
- Maintenance Manual

Reference shall be made to the relevant sections of AW's Standard Specifications for more details.

Handover Inspection
Prior to the Superintendent granting Practical Completion the works shall be inspected by the 
Superintendent's Representative and AW personnel representing Asset Management and Operations 
& Maintenance for conformance with the requirements detailed in this document. A sample 
Acceptance Checklist is provided below.

Sample Acceptance Checklist

<table>
<thead>
<tr>
<th>PUMP STATION:</th>
<th>ADDRESS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>CONTRACTOR:</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CLAUSE:</th>
<th>PASS</th>
<th>FAIL</th>
<th>CLAUSE:</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alignment</td>
<td></td>
<td></td>
<td>Load Capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Duty</td>
<td></td>
<td></td>
<td>Design Life</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### 4.3.10 Equipment And Plant Access

#### Accessibility
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 walkway shall be provided for access to components requiring frequent adjustments, service or inspection.

#### Performance Requirements for Access

**Floor Openings**
The opening through the floor of the pump station to access the equipment in the dry well shall be covered with panels of aluminium floor grating. The panels 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 pump station building. If such a cabinet does not exist then one shall be provided.

The size of the panels shall be such that they can be removed manually by one person if required. Hinged panels are not acceptable as they obstruct access to the opening. The surrounds to the grating panels shall be fabricated with studs or a similar locating device to prevent the panels from sliding horizontally when an adjacent panel is removed.

The section of grating directly over each pump shall also be slotted to allow the pumps to be lifted and moved longitudinally up to 1 metre to clear blockages without needing to remove the grating. The slot through the grating shall be wide enough to allow the hook to pass through without manual intervention. Support framing shall be provided around the slot to ensure that the floor design loads and deflection limits are complied with.

**Guardrailing**

---

| Hoisting Speed | Control | |
| Safety Features | Chain and Hook | |
| Trolley | Vermin Resistance | |
| Labelling | Standardisation | |
| Height | Extent of Travel | |
| Noise | Maintenance Log Book | |
| Floor Openings | Guardrailing | |
| Stairways | Step Ladders | |
| Platforms | Working Space | |
| Lay-Down Area | Commissioning | |
| Registration | Certification | |
| Competent Persons | Technical Documentation | |

**COMMENTS:**

**INSPECTED BY:**

**SIGNATURE:**

**DATE:**

---

SS10 Sept 2010

Section 3  Page 140
The opening through the pump station floor shall be fenced on all sides with aluminium guardrail complete with kneerail and toeboard in accordance with AS 1657. The fencing at end of the opening nearest the door shall be removable to allow equipment to be removed from the building.

Stairways

Stairways, rather than ladders, must be installed for access to units requiring routine inspection and maintenance, such as aeration tanks, clarifiers, etc. Stairways shall be located so as to provide access for servicing and maintenance in a safe manner and shall be fabricated from aluminium with handrails on both sides.

Access to the pumps and other equipment in the dry well shall be provided by means of a stairway conforming to AS1657. There shall be not more than 18 rises in each flight and adjacent flights shall be connected by a landing of width and length not less than the width of the stairs. There shall be not more than 36 rises without a change in direction. Grating shall be used for all treads and landings. Handrails shall be provided on both sides of the stairway.

The slope of stairways shall not exceed 45 degrees. All rises and goings in the same flight shall be of uniform dimensions within a tolerance of 5 mm. The geometry of the rises and goings shall conform to AS 1657. Treads shall overlap by at least 10 mm. All stairway components shall be aluminium unless noted otherwise.

Step Ladder

In cases 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 AW. The slope of step ladders shall not exceed 65 degrees. The vertical distance between landings shall not exceed 6.0 metres. Where the vertical height of the installation exceeds 6.0 metres, and the installation consists of more than one step ladder, succeeding step ladders shall change direction or, if this is not practicable, be staggered at each landing. Handrails shall be provided on both sides of the step ladder.

Rung ladders are not acceptable.

Platforms

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 safely without having to climb on the equipment.

Where fixed platforms and walkways can not be provided a mobile platform shall be provided. Fixed and mobile platforms and walkways shall be horizontal with guardrailing and stairways conforming to AS 1657. The floor of the platform shall be grating. All platform components shall be aluminium unless noted otherwise.

Working Space around Pumps

Ideally the arrangement of the pump station dry well, pumps and other equipment shall be such that a minimum of 1.2 metres of clear working space is provided around the pumps. 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.

Lay-Down Area

The lay-down area outside the building shall be a level concrete pad flush with the surrounding ground level with a minimum size of 1.5 metres x 1.5 metres. The pad shall be designed to be trafficable and withstand the weight of the pump being placed on it. The pad shall be designed to cater for a pump sized for the 2056 Planning Scheme Demand (PSD).

4.3.11 Mechanical Ventilation

General
The air conditioning and ventilation equipment specified herein is intended to be standard equipment supplied by manufacturers who are fully experienced, reputable and qualified in the manufacture of such equipment. The Contractor shall coordinate the work associated with the installation of the mechanical ventilation equipment with the work of other trades and ensure that conflicts with other services are avoided and provision is made for:

Penetrations and framing through walls, partitions etc. for the passage of ductwork, cables and grilles. Trimming and making good openings to effectively seal the clearance space around penetrations. Underflashing of all external penetrations through the building structure

Power outlets adjacent to single phase fans and air conditioner.

**Pumping Stations Ventilation**

Adequate ventilation shall be provided for all pumping stations. Where the dry well is below the ground surface, mechanical ventilation is required. The wet well shall be independently ventilated if screens or mechanical equipment requiring maintenance or inspection is located in the wet well. Throttling dampers shall not be used on exhaust or fresh air ducts and fine screens or other obstructions in air ducts should be avoided to prevent clogging. Switches for operation of ventilation equipment shall be marked and located conveniently. All intermittently operated ventilating equipment shall be interconnected with the respective wet well or dry well lighting system. Consideration shall be given to automatic controls where intermittent operation is used. The fan wheel shall be fabricated from non-sparking material.

Ventilation may be either continuous or intermittent. Continuous ventilation shall provide at least 12 complete air changes per hour for wet wells and at least six complete air changes per hour for dry wells. Intermittent ventilation shall provide at least 30 complete air changes per hour. Air shall be forced into the wet well rather than exhausted from it. This requirement does not apply to the upper or grade level operating room of a wet well/dry well type pumping station.

**Recommended Laboratory Ventilation**

Laboratories should be separately air-conditioned, with external air supply for 100% make-up volume. In addition, separate exhaust ventilation should be provided. Ventilation outlet locations should be remote from ventilation inlets.

**Ventilation for Screening and Grit Removal Facilities**

For indoor installations, uncontaminated air shall be introduced continuously at a rate of 12 air changes per hour or intermittently at a rate of 30 air changes per hour. Intermittently operated ventilating equipment shall be interconnected with the lighting system. Odour control facilities may also be warranted.

**4.3.12 Air Conditioners, Exhaust Fans, Wall Mounted Fans And Roof Mounted Fans**

The Contractor shall carry out the design, supply, installation, testing and commissioning of mechanical ventilation systems in accordance with the approved drawings, job specification and AS 1668.

Electrical work shall be in accordance with SS10-COMMON ASSEMBLY REQUIREMENTS – ELECTRICAL and the relevant Australian Standards.

Ductwork

The Contractor shall carry out the design, supply, installation, testing and commissioning of air ductwork in accordance with the approved drawings, job specification and AS 4254.

The drawings with sizes of proposed ducting are provided for guidance purposes. It shall be the responsibility of the Contractor to check dimensions on site to ensure that space is available and that lengths, offsets, bends, transitions, branches and other fittings are suitably located to avoid interference with building components.

Specified duct sizes may be amended where necessary, subject to:

a) The amendment does not reduce the air flow capacity or increase the total frictional resistance of the amended section; and

b) The amendment is approved by the Superintendent and noted for incorporation in “As Built” drawings to be supplied by the Contractor at conclusion of the contract.
The standard of ductwork construction covered by this 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 in the drawings.

The Contractor shall provide shop drawings of the proposed ductwork in accordance with SS10 – INTEGRATION REQUIREMENTS prior to fabrication. An adequate number of flanged joints shall be provided to facilitate fabrication and assembly otherwise the ductwork may be in continuous lengths. Ductwork shall be supported by clamp straps or angle rings held by rod or strap hangers attached to the building structure in accordance with table below.

Table: Ductwork Support Requirements

<table>
<thead>
<tr>
<th>Nominal Duct Size</th>
<th>Hanger Size</th>
<th>Clamp or Ring</th>
<th>Spacing (max.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to 450</td>
<td>6</td>
<td>25x1.6 clamp</td>
<td>3000</td>
</tr>
<tr>
<td>475 to 900</td>
<td>10</td>
<td>28x2.5 clamp</td>
<td>3000</td>
</tr>
<tr>
<td>925 to 1800</td>
<td>12 – 2 per ring</td>
<td>32x32x3 angle</td>
<td>2500</td>
</tr>
<tr>
<td>1825 and over</td>
<td>20 – 2 per ring</td>
<td>38x38x3 angle</td>
<td>2500</td>
</tr>
</tbody>
</table>

The ductwork shall incorporate inspection openings for test purposes. Each opening shall be fitted with an airtight cover 200 dia. x 1.6 mm thick held with four M^150 coarse studs and wing nuts and fitted with a 3 mm rubber insertion gasket.

Dampers shall be provided where necessary in ducts and branches to enable correct balancing of the system. Dampers shall be single blade, butterfly type with aluminium blade and stainless steel shaft with a lockable quadrant regulator with Open/Closed indicator and end bearings sealed to prevent air leakage.

All bolts, nuts and washers in flange joints and hangers shall be Grade 316 stainless steel.

Construction (Low Pressure Ductwork)

Sheet metal rectangular and circular ductwork shall be constructed and installed in accordance with AS 4254.

4.3.13 Odour Control

N.B. For major stations or for stand-alone odour control stations, the design of the Odour Control Facility shall meet the requirements set out in SS10 Section 2 for Wastewater Treatment Plant design.

Odour Control Systems

Odour Control Systems shall be constructed in accordance with the approved drawings.

Odour Bed Commissioning

It is impractical to conduct performance type tests prior to installation and commissioning within the odour beds.

Following commissioning of the vacuum station, conduct H2S gas sampling and testing over a period of four (4) weeks to establish the base load H2S levels from the vacuum station or sewerage pumping station wet-well.

Following commissioning of the vacuum odour bed (biofilter) allow a 4 week bio-acclimatisation period before conducting the following tests over a period of at least four (4) weeks:

Repeat H2S gas sampling and testing to verify that the system achieves a 95% H2S reduction and is capable of meeting environmental regulations;

Measure and record the relative humidity in the biofilter at regular intervals throughout the 4 week period to verify that it maintains a relative humidity between 50-90%:

Measure and record the temperature in the biofilter at regular intervals throughout the 4 week period to verify that it maintains an operating temperature in the range 15-45OC; 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 Regulator.

If the biofilter fails to achieve a 95% H2S reduction or operate within specified temperature and relative humidity ranges or meet noise requirements, identify and correct any faults, and make any
necessary adjustments before retesting after a further bio-acclimatisation period of 2-4 weeks. Repeat until the odour control system is capable of meeting all performance requirements.

4.4 SPECIFIC ASSEMBLY REQUIREMENTS –CIVIL & MECHANICAL TREATMENT PLANTS

The Works shall include the design, fabrication, supply, installation, commissioning and testing of all mechanical equipment for the treatment facilities and for any pump stations included in the Works.

4.2.1 General Requirements

System Velocities
Pipelines conveying influent wastewater, partly treated wastewater, fully treated wastewater (recycled water) shall be designed to achieve the flow velocities set out elsewhere in the Contract Document, or as summarised below:

Minimum pipeline velocity = 0.80 m/s;
Maximum pipeline velocity = 2.2 m/s;
Exceptional min velocity = 0.60 m/s; and
Exceptional max velocity = 3.0 m/s.

Items ‘c’ and ‘d’ above may be used only with the written approval of the Superintendent.

Compatibility and Alternative Manufacturers and Equipment
The Contractor shall ensure that all materials, components and items of equipment are suitable for and compatible with the proposed installation, services and infrastructure and with all new and / or existing items of mechanical and electrical plant forming a system or part thereof to be installed as part of the Works.

The Contractors' detailed design shall be based upon the services offered by preferred manufacturers and suppliers. Where items have not been specified the Contractor shall submit the components to the Superintendent for review based upon compliance with this Contract Document.

Electrolytic Action, Dissimilar Materials and Process Compatibility
Due note shall be taken of the possibility of electrolytic action between dissimilar metals and materials. The design and installation of all items included, as part of the Scope of the Works, shall be such as to eliminate or reduce, to a level to be agreed with the Superintendent, the likelihood of electrolytic and / or chemical action occurring.

Where the compatibility of dissimilar materials and / or process fluids associated with items of plant, services and equipment installed is brought into doubt, the Contractor shall provide documentary evidence confirming their suitability and combined use throughout the installation.

The Contractor shall replace, repair and reinstate all new and existing work affected by electrolytic and / or chemical action as a result of the Contractor's design, construction, testing and commissioning activities.

Installation Timing
Equipment shall be installed after completion of concrete placement and finishing. If it is agreed by the Superintendent that any piece of equipment may be installed before completion of concrete placement and finishing, then it shall be completely protected from the potential of concrete splashes or spills and, where necessary to prevent damage, environmental conditions.
Underground Components
All electrically actuated valves, metering and / or monitoring equipment which is located external to buildings and for well founded design reason is located below ground shall be located in concrete pits. Each concrete pit shall be easily accessed. Each concrete pit shall be suitably covered and shall be free draining to a low point such that the pit will not hold water. Should the pits not be free draining through a separate drainage pipework system, then a three phase sump pump shall be provided in an adequately sized sump of dimensions not less than 400 mm square by 450 mm deep.

Safe Equipment Access
Mechanical equipment shall be designed for easy access for operation and maintenance. Specific attention is required to allow maintenance activities to be undertaken using safe working practices. All equipment shall be installed to ensure that safe access is readily available.

4.2.2 Standards
Materials supplied, work carried out and testing performed under this section shall comply with the requirements of the following Standards to the extent that they are relevant and not overridden by these Contract Documents.

Australian Standards

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS1074</td>
<td>Steel Tubes and Tubulars for Ordinary Service</td>
</tr>
<tr>
<td>AS1111</td>
<td>ISO Metric Hexagon Bolts and Screws – Product Grade C</td>
</tr>
<tr>
<td>AS1112</td>
<td>ISO Metric Hexagon Nuts</td>
</tr>
<tr>
<td>AS1237</td>
<td>Flat Metal Washers for General Engineering Purposes (Metric Series)</td>
</tr>
<tr>
<td>AS1254</td>
<td>Unplasticised PVC (uPVC) Pipes and Fittings for Storm and Surface Water Applications</td>
</tr>
<tr>
<td>AS1260</td>
<td>PVC Pipes and Fittings for Drain, Waste and Vent Applications</td>
</tr>
<tr>
<td>AS1281</td>
<td>Cement Mortar Lining of Steel Pipes and Fittings</td>
</tr>
<tr>
<td>AS1319</td>
<td>Safety Signs for the Occupational Environment</td>
</tr>
<tr>
<td>AS1359.30</td>
<td>Rotating Electrical Machines – General Requirements – Preferred Outputs and Frame Sizes</td>
</tr>
<tr>
<td>AS1359.32</td>
<td>Rotating Electrical Machines – General Requirements – Temperature Limits and Measurements of Temperature</td>
</tr>
<tr>
<td>AS1432</td>
<td>Copper Tubes for Plumbing, Gasfitting and Drainage Applications</td>
</tr>
<tr>
<td>AS1444</td>
<td>Wrought Alloy Steels – Standard, Hardenability (H) Series and Hardened and Tempered to Designated Mechanical Properties</td>
</tr>
<tr>
<td>AS1460</td>
<td>Fittings for use with Polyethylene Pipes</td>
</tr>
<tr>
<td>AS1463</td>
<td>Polyethylene Pipe Extrusion Compounds</td>
</tr>
<tr>
<td>AS/NZS1477</td>
<td>PVC Pipes and Fittings for Pressure Applications</td>
</tr>
<tr>
<td>AS/NZS1554</td>
<td>Structural Steel Welding</td>
</tr>
<tr>
<td>AS1565</td>
<td>Copper and Copper Alloys – Ingots and Castings</td>
</tr>
<tr>
<td>AS1572</td>
<td>Copper and Copper Alloys - Seamless Tubes for Engineering Purposes</td>
</tr>
<tr>
<td>AS1579</td>
<td>Arc Welded Steel Pipes and Fittings for Water and Wastewater</td>
</tr>
<tr>
<td>AS1589</td>
<td>Copper and Copper Alloy Waste Fittings</td>
</tr>
<tr>
<td>AS1627</td>
<td>Metal finishing - Preparation and Pretreatment of Surfaces</td>
</tr>
<tr>
<td>AS1628</td>
<td>Water Supply - Metallic Gate Globe and Non-Return Valves</td>
</tr>
<tr>
<td>Standard Reference</td>
<td>Description</td>
</tr>
<tr>
<td>--------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>AS1631</td>
<td>Cast Grey and Ductile Iron Non-pressure Pipes and Fittings</td>
</tr>
<tr>
<td>AS1646</td>
<td>Elastomeric Seals for Waterworks Purposes</td>
</tr>
<tr>
<td>AS1657</td>
<td>Fixed Platforms, Walkways, Stairways and Ladders – Design, Construction and Installation</td>
</tr>
<tr>
<td>AS1718</td>
<td>Water Supply - Copper Alloy Screw-down Pattern Taps - Specified by Dimensions</td>
</tr>
<tr>
<td>AS1722</td>
<td>Pipe Threads Off Whitworth Form</td>
</tr>
<tr>
<td>AS1755</td>
<td>Conveyors – Safety Requirements</td>
</tr>
<tr>
<td>AS1769</td>
<td>Welded Stainless Steel Tubes for Plumbing Applications</td>
</tr>
<tr>
<td>AS1830</td>
<td>Grey Cast Iron</td>
</tr>
<tr>
<td>AS2032</td>
<td>Code of Practice for Installation of uPVC Pipe Systems</td>
</tr>
<tr>
<td>AS2033</td>
<td>Installation of Polyethylene Pipe Systems</td>
</tr>
<tr>
<td>AS/NZS2053</td>
<td>Conduits and Fittings for Electrical Installations</td>
</tr>
<tr>
<td>AS2074</td>
<td>Cast Steels</td>
</tr>
<tr>
<td>AS2129</td>
<td>Flanges for Pipes, Valves and Fittings</td>
</tr>
<tr>
<td>AS/NZS2280</td>
<td>Ductile Iron Pressure Pipes and Fittings</td>
</tr>
<tr>
<td>AS/NZS2312</td>
<td>Guide to the Protection of Iron and Steel Against Exterior Atmospheric Corrosion</td>
</tr>
<tr>
<td>AS2439</td>
<td>Perforated Plastics Drainage and Effluent Pipe Fittings, Parts 1 and 2</td>
</tr>
<tr>
<td>AS2518</td>
<td>Fusion-Bonded Low-Density Polyethylene Coating for Pipes and Fittings</td>
</tr>
<tr>
<td>AS/NZS2544</td>
<td>Grey Iron Pressure Fittings</td>
</tr>
<tr>
<td>AS/NZS2566</td>
<td>Plastics Pipelaying Design</td>
</tr>
<tr>
<td>AS2638</td>
<td>Gate Valves for Waterworks Purposes</td>
</tr>
<tr>
<td>AS2729</td>
<td>Roller Bearings – Dynamic Load Ratings and Rating Life</td>
</tr>
<tr>
<td>AS2837</td>
<td>Wrought Alloy Steels - Stainless Steel Bars and Semi-Finished Products</td>
</tr>
<tr>
<td>AS2887</td>
<td>Plastic Waste Fittings</td>
</tr>
<tr>
<td>AS2977</td>
<td>Unplasticised PVC Pipes for Pressure applications – Compatible with Cast Iron Outside Diameters, Parts 1, 2 and 3s</td>
</tr>
<tr>
<td>AS/NZS3500</td>
<td>National Plumbing and Drainage Code</td>
</tr>
<tr>
<td>AS/NZS3518</td>
<td>Acrylonitrile Butadiene Styrene (ABS) Piping and Fittings for Pressure Applications</td>
</tr>
<tr>
<td>AS3571</td>
<td>Glass Filament Reinforced Thermosetting Plastics (GRP) Pipes - Polyester Based - Water Supply, Sewerage and Drainage Applications</td>
</tr>
<tr>
<td>AS3578</td>
<td>Cast Iron Non-return Valves for General Purposes</td>
</tr>
<tr>
<td>AS3579</td>
<td>Cast Iron Wedge Gate Valves for General Purposes</td>
</tr>
<tr>
<td>AS/NZS3678</td>
<td>Structural Steel - Hot-rolled Plates, Floorplates and Slabs</td>
</tr>
<tr>
<td>AS3680</td>
<td>Polyethylene Sleeving for Ductile Iron Pipelines</td>
</tr>
<tr>
<td>AS3681</td>
<td>Guidelines for the Application of Polyethylene Sleeving to Ductile Iron Pipelines and Fittings</td>
</tr>
<tr>
<td>AS3688</td>
<td>Water Supply - Copper and Copper Alloy Compression and Capillary Fittings and Threaded End Connections</td>
</tr>
</tbody>
</table>
AS3690  Installation of ABS Pipe Systems
AS3691  Solvent Cement and Priming (Cleaning) Fluids for use with ABS Pipes and Fittings
AS3709  Vibration and Shock—Balance Quality of Rotating Rigid Bodies
AS4024  Safety Of Machinery
AS4041  Pressure Piping
AS4087  Metallic Flanges for Waterworks Purposes
AS/NZS4129 Fittings for Polyethylene (PE) Pipes for Pressure Applications
AS/NZS4130 Polyethylene (PE) Pipes for Pressure Applications
AS/NZS4158 Thermal Bonded Polymeric Coatings on Valves and Fittings for Water Industry Purposes
AS4775  Emergency Eyewash and Shower Equipment
AS/NZS4791 Hot-dip Galvanised (Zinc) Coatings on Ferrous Open Sections, Applied by an In-line Process
AS/NZS4792 Hot-dip Galvanised (Zinc) Coatings on Ferrous Hollow Sections, Applied by a Continuous or a Specialised Process
AS60529.8 Degrees of Protection Provided by Enclosures (IP Code)
AS60947.8 Low Voltage Switchgear and Controlgear – Control Units for Built in Thermal Protection (PTC) for Rotating Electrical Machines

Other Standards and Guidelines
The following International Standards apply to the Contract Works:

ISO2858  End Suction Centrifugal Pumps (Rating 16 bar) – Designation, Nonimal Duty Point and Dimensions
ISO8573.1 Compressed Air – Part 1: Contaminants and Purity Classes

4.2.3 General Mechanical Component Requirements
All equipment offered shall have a history of successful use in similar facilities. Reliability shall be such that 40,000 hours of uninterrupted operation are normally obtainable between major services / overhauls.

The following general requirements shall apply to the Works where applicable.

Mechanical Drive Components
Gearboxes
Gearboxes shall be manufactured to AGMA Standards based on 24 hour operation with moderate shocks and a service factor of not less than 1.5.

The casing shall be manufactured in close-grained cast-iron and shall include inspection cover, a breather incorporating a filter suitable for the climatic conditions specified, an oil level gauge and lifting eyes.

Helical, herringbone or worm gears shall be used, manufactured in hardened steel or other accepted material. Gears and bearings may be splash or pressure lubricated. An oil drainage point shall be incorporated in the casing and if this is not readily accessible a suitable drain pipe, with screwed plug, shall be fitted to make it accessible and to easily catch waste oil.
Speed Reduction Gearboxes
Each unit shall be a SEW Drives or of similar manufacture acceptable to the Superintendent.

Speed reduction gearboxes shall be of the appropriate quality, robustly sized for the particular application with a minimum safety factor of 2 against the anticipated solids and hydraulic loadings. The gearbox may be close coupled to the electric motor.

In addition, each gearbox shall be designed to withstand startup torques of up to 250% of the full load running torque to the driving motor. Each gearbox shall be a double or triple reduction unit with helical gears.

The gearbox and/or motor assembly shall be mounted clear of the flow of wastewater. The gearbox and oil-filled bearings shall be mounted so that oil levels can be maintained in accordance with the manufacturer’s recommendations and can be conveniently checked and refilled by the Principal’s staff.

Each gear housing shall be of high grade iron in two piece construction with a top cover for ease of inspection and maintenance. Cast iron shall be minimum grade T250 to AS 1830. Each housing shall have ample internal ribs for rigidity with the direction of rotation of the input and output shaft permanently marked on the housing. Removable gasketed inspection covers shall be provided to permit inspection of the gears without disassembly of the gear reducer. Lifting lugs shall be provided to facilitate safe lifting of the gearbox.

Gears, pinions and shafts shall be made from alloy steels. The gears and pinions shall be through hardened, induction hardened or carburised and shall be designed to have a service factor for both durability and strength of at least 1.5.

Gears shall be manufactured to AGMA (American Gear Manufacturer’s Association) Quality Number 9 or better, as specified in AGMA Gear Classification Manual 390.02.

The gears shall be splash lubricated from a sump. The bearings shall be either splash lubricated or grease lubricated. Where grease lubricated bearings are fitted, seals will be installed to keep the grease in the housing. Grease nipples and a grease pressure relief device shall be fitted to each housing containing grease lubricated bearings.

The gearbox shall be provided with sight glass or indicator to observe oil levels. The oil fill and drain lines shall be of sufficient size to permit efficient functioning and shall be located on the gear unit in a position which is easily accessible from the floor. The Contractor shall supply all oil and drain piping so that a container may be placed under the drain discharge.

Vee Belt and Toothed Belt Drives
Belts shall be standard commercial items readily available and normally kept in stock.

Pulleys and sprockets shall be keyed onto the shafts using a taper type locking hub.

Where the primary drive from the electric motor to the driven unit input shaft is a vee belt drive, the belt drive shall be rated for a minimum of 40% more than the installed motor power and there shall be at least two belts in the drive.

Unless otherwise noted, vee belt drives shall be Fenner Spacesaver wedge belts with matching wedge-belt pulleys and Fenner Taper-Lock bushes as manufactured by Fenner Dodge (Australia) Pty. Ltd., or equal as reviewed by the Superintendent.

Where a toothed belt is provided, it shall comprise a reinforced rubber belt with teeth moulded onto the inside surface. The pitch, belt width and pulley diameters shall be selected to suit the application and service factors specified for vee belts above. Where pulleys can be submerged during normal
operation, the pulleys shall be fabricated from a non metallic material such as nylon, or from stainless steel.

Pulleys and bushes shall be dynamically and statically balanced. Pulleys shall be separately mounted on their bushes by means of three pull-up grub or cap tightening screws. All fasteners in the pulleys shall be Grade 316 stainless steel. Bushes shall be seated to the drive shaft.

Belts shall be selected for no less than 140 % of motor rated output and, where two pulley sizes are specified, shall be capable of operating with either set of pulleys. Belts shall be of the antistatic type where flame proof equipment is specified or required.

Each different type and size of belt-driven unit shall be furnished with a complete set of separate belts. Spare belts shall be properly identified as to design, power rating, speed, length, pulley size and use and shall be packaged for storage. Where two or more belts are involved, matched sets of belts shall be provided.

**Chain Drives**

Unless submitted to and reviewed by the Superintendent, chains shall be standard roller chains comprising steel links and hardened steel pins and rollers. Chains shall comply with ISO 4347 and shall have a minimum pitch of 19 mm.

Unless submitted to and agreed by the Superintendent, sprockets shall be of steel with flame hardened teeth, with hardness not less than 360 Brinell.

Access covers for inspection and lubrication of the chains and sprockets shall be provided in an easily accessible locations.

**Couplings**

Unless otherwise specified, mechanical equipment with a motor rated output greater than 0.5 kW, where the input shaft of a driven unit is directly connected to the output shaft of the driver, shall have the two shafts connected by either a Fenner Dodge Disc type flexible coupling with Taper-Lock bushes or equal as reviewed by the Superintendent or Fenner Dodge “Fenaflex” cast iron flange coupling or equal as reviewed by the Superintendent, but in no case shall the manufacture’s recommended power ratings be exceeded. For motors larger than 75 kW, flexible couplings shall be Fenner Dodge “Fenaflex” cast iron flange coupling or equal as reviewed by the Superintendent.

Coupling sizes shall be as recommended by the manufacturer for the specific application, considering power, speed of rotation, and type of service, and shall be installed as recommended by the manufacturer. The use of couplings as specified herein shall not relieve the Contractor of its responsibility to align precisely all driver/driven units.

Couplings shall be designed for an angular misalignment of 0.1 mm for each 600 mm of coupling diameter, plus a parallel misalignment of 0.2 mm. Runout shall be less than 0.05 mm.

Overload couplings (e.g. slip clutch) shall be provided to protect the equipment drives against mechanical overload. The torque limiting device shall be a totally disengaging overload coupling such as a Mayr EAS torque sensor fitted to the output shaft of the gearbox or gear reducer.

The Contractor shall supply and install a limit switch mounted on a suitable bracket to detect the operation of the overload coupling. The limit switch shall be manufactured from corrosion resistant material, and shall be rated to IP 66 in accordance with AS 1939.

**Roller Bearings**

Unless otherwise specified, all equipment bearings shall be oil or grease lubricated, ball or roller anti-friction type of standard manufacture. Bearings shall be conservatively designed to withstand all
stresses of the service specified. All ball or roller bearings shall be rated in accordance with AS 2729 with factors a1, a2 and a3 equal to one (1) to give a B10 life of 100,000 hours.

All bearings shall be grease lubricated unless specified otherwise in the Contract Documents with greasing fittings located for easy servicing from the outside and shall meet the requirements of Clause 3.2.4 of AS1755. All grease lubricated bearings, except those specified to be factory lubricated-for-life, shall be fitted with easily accessible grease supply, flush, drain and relief fittings. Extension tubes shall be used when necessary to ensure that greasing points are conveniently and easily accessible. Grease tubing shall be Grade 316 stainless steel or heavy duty nylon, 6 mm minimum diameter. Grease supply fittings shall be Tecalmit hydraulic type as manufactured by Tecalmit (Asia) Pty Ltd, or acceptable equal.

All grease lubricated bearings shall be sealed to prevent ingress of dust and water.

Oil lubricated bearings shall be equipped with either a pressure lubricating system or a separate oil reservoir type system. Each oil lubrication system shall be of sufficient size to safely absorb the heat energy normally generated in the bearing under a maximum ambient temperature of 45°C and shall be equipped with a filler pipe and an external level gauge.

Plain bearings shall have stainless steel shafts running in bronze bushes and shall have a loading, based in a projected area, or not more than 300 kPa. Materials other than stainless steel and bronze may be agreed by the Superintendent where full details are submitted by the Contractor.

Vibration Monitoring

Each motor that has a rated output in excess of 55 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 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. The data from the continuous vibration monitoring system shall be input to the Plant PLC/DCS.

Vibration monitoring shall comprise one or two IFM Efector Octavis VE1001 vibration diagnostic units or similar vibration diagnostic units reviewed by the Superintendent attached to the monitored device.

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. The actual speed shall be provided by either a 0 to 20 mA current loop or a pulse input to ensure the correct diagnosis of variable speed applications.

Each vibration diagnostic unit shall be capable of:

Monitoring up to 5 different rolling element bearings or up to 20 individual frequencies which can be divided between 5 objects;
Monitoring fixed and variable speeds in the range 12 to 1500 r/min;
Operating at either 12 or 24 V DC;
Assigning each of the 5 diagnostic different rolling element bearings it's own limit values; and
Assigning selectable peak or g-monitor with speed related limit values for an early warning alarm and a main alarm.

The data from the Plant PLC/DCS 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.

**Machinery Guarding**
The equipment shall be provided with protective guards in accordance with the requirements of AS1755
and AS4024.1 Safety of Machinery.

No removable guard section shall exceed 18 kg in weight. All removable sections shall have suitable
lifting, handling and / or transportation aids.

All valves, local (manual) control stations, panels and any removable and maintainable parts (requiring
annual or more frequent operator or maintainer intervention) shall be located in a position to enable the
safe and unrestricted access for the completion of all necessary operation and maintenance activities to
be carried out without the use of any ladders, scaffolding, etc. The location and arrangement of all
valves, local (manual) control stations, panels and any removable and maintainable parts (requiring
monthly operator or maintainer intervention) shall be subject to the review of the Superintendent.

All valves, local (manual) control stations, panels and any removable and maintainable parts shall be
located so that no physical part, direct or indirect, in any way constitutes a hazard to personnel or
restricts access to other plant and / or equipment. There must be no encroachment on recognised
walkways or areas set aside for maintenance and safe passage.

Guards shall be adequately sealed and, where required, an outlet port provided at a suitable location to
connect to the foul air extraction system. Where provided, the guards and headbox shall be provided
with a positive seal to enable the odorous air extraction system to maintain the enclosed components at
a negative pressure.

**General Electro-mechanical Equipment Requirements**
All mechanical equipment shall be supplied with all electric motors, limit switches, proximity switches,
level switches, transmitters, together with all other instrumentation or monitoring devices, local control
stations and control panels necessary for the safe and effective operation (manual or automatic) of the
mechanical equipment.

The connections for all power, instrumentation, control and automation equipment supplied as part of
the mechanical equipment shall be wired to central marshalling box(s) with all terminations, cable cores
and cables clearly marked with a unique identification numbering system, subject to the acceptance of
the Superintendent. Sufficient separation between control, instrumentation and power terminations
shall be provided and maintained at all times.

As a minimum all electrical plant and equipment shall have an ingress protection rating of IP56 suitable
for a wet corrosive environment. Where such equipment is likely to be submerged or exposed to a
higher degree of water ingress then a suitable rating applicable to the expected conditions shall be
used to the acceptance of the Superintendent.

**Fasteners**
All threaded items, screws, washers, nuts and bolts including fasteners in all fixtures and fittings and
holding down bolts body fasteners in motors, gearboxes, valves, actuators, pumps, etc, shall be Grade
316 stainless steel. Anti-galling paste shall be used on all Grade 316 stainless steel screws, threaded
items, nuts and bolts.

**Pipework and Valves**
Pipes and fittings shall be Grade 316 stainless steel, ductile iron (DI), GRP or HDPE and shall be
nominated on all Contract Drawings.
Pipe threads greater than 50 NB shall not be used. All joints over 50 NB are to be flanged.

All pipe threads shall conform to the requirements of AS1722, Part 1, 1975.

Pipe threads shall have durable and robust seals.

All flanges shall be dimensionally compatible with Class 16 flanges to AS4087.

Flange gaskets shall be 3 mm thick natural rubber insertion sheet, unless this material is unsuitable for long reliable service with the conveyed material.

Shutoff valves, excluding solenoid valves, shall be either: sluice, gate, ball, angle, globe, knife gate, Saunders Type A, KB diaphragm valves or similar and accepted.

All ball valves shall be of the full-bore design.

All shut off valves shall be clearly marked with clearly visible, robust and durable directions for opening and closing.

All screw operated valves used in the Works shall be anti clockwise to close.

All manually operated valves shall have valve handles or hand wheels easily accessible and well clear of any obstructions. The minimum clearance from adjacent obstruction shall be 60 mm measured in any direction.

All valves shall have a minimum pressure rating of no less than 1.5 times the closed valve head of any pumping plant or the maximum design pressure, whichever is the greater.

All pipework shall be subjected to a hydrostatic test of no less than 1.5 times the maximum design pressure of the relevant portion of the pipework after completion.

Motorised valves shall be rated for continuous duty at the differential pressure that the valve is required to hold and not cause excessive surging in the pipeline.

Drains with drain valves shall be provided for each tank and where necessary in the lines to enable any line to be drained for maintenance purposes. All drained liquors shall be returned to the head of the works, via the Scour Pump Station. No liquors shall be drained to the environment.

All actuated valves, gates and diversion flaps shall be electrically operated, as required, for effective process operation, routine operation and / or emergency isolation. Actuators shall be selected suitable for the application, with particular attention given to the speed of response (opening and closing) relative to the process application.

Where practicable, the use of solenoids shall be kept to a minimum with a maximum line size of 40 mm. Details of all actuators and solenoids shall be provided with the tender in Schedule 14.

Access Platforms Guardrails, Guards and Safety Equipment

All access stairways, platforms, guard railing and flooring provided for access to machinery shall conform to the requirements of AS1657, AS4024 and with the Principal’s Standard Specifications.

All walkways and covers in accessible areas shall be designed and installed to be free of trip and bump hazards, have recessed hinges, recessed lifting handles and the like.

To avoid bump hazards on walkways, platforms and the like, guardrailing (handrailing systems) shall not be used as general support systems for miscellaneous equipment such as pipework systems,
electrical controls and instruments and lighting support. All such items shall be provided with their own support system.

Fixed ladders shall be avoided and preference given to stairways, unless the specific instance is reviewed by the Superintendent.

4.2.4 Pipework And Fittings

General Requirements

All pipework systems shall be complete with all pipework, valves, actuators, couplings, appurtenances, controls, supports, anchors, and fixtures and fittings necessary for the operation and maintenance of the system in accordance with the Superintendent reviewed Project Drawings, these Contract Documents and the equipment manufacturer's recommendations.

The Project Drawings shall show the layout and sizes of pipes, materials to be used and the manner in which the pipework is joined and how supported if not buried.

Pipework shall be:

- Designed and installed to enable automatic flushing of pipework and all equipment where required for process purposes;
- Designed and installed to enable manual flushing of pipework and all equipment under all situations;
- 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.

Above ground pipelines in appropriate locations will be considered.

Ductile Iron Pipework

Ductile iron pipes shall be manufactured and tested in accordance with AS/NZ2280 and shall be:

- PN 20 for pipe ≥225 nominal diameter;
- PN 35 for pipe <225 nominal diameter or where pressure requirements so dictate;
- Flange Class pipe (equivalent to old K12) where flanging is required; and
- Either Fusion Bonded Nylon (FBN) or cement mortar lined.

Where pipework is to carry potentially aggressive fluids (such as the influent wastewater pressure mains or Scour Pump Station pipeline to the PTA), FBN lining shall be used.

Buried pipes shall be wrapped in polyethylene sleeve. Flexible joints shall be "Tyton" socket and spigot or equivalent.

Ductile iron fittings shall be manufactured and tested in accordance with AS/NZ2280. Fittings shall be either FBN or cement mortar lined as used for the relevant pipeline.

Flanged joints shall be to AS4087, Class 16 to suit the pressure requirements. All flange nuts, bolts and washers shall be Grade 316 stainless steel and nickel based anti-seize compound shall be applied to threads before assembly.

Pipes shall be coated externally with cold applied bituminous paint except where pipework is exposed to view in which case it shall either be FBN coated or factory painted with a liquid applied epoxy paint recommended by the pipe manufacturer. The epoxy paint colour shall match as closely as possible the colour of fusion bonded nylon fittings.
PVC Pressure Pipework
PVC pressure pipes 100 mm diameter and greater shall be manufactured to AS/NZ1477 Series 2, minimum Class 16. Pipes with diameters less than 100 mm shall be manufactured to AS/NZ1477 Series 1, minimum Class 18. Buried pipes shall be rubber rings jointed except for diameters less than 100 mm where solvent welded joints shall be used. Above ground exposed pipes shall be flanged commensurate with the pressure rating of the pipe and where subject to UV radiation, suitable protection or barrier screening shall be provided.

ABS Pressure Pipework
ABS pressure pipes and fittings shall comply with AS3518, minimum Class 12.

Reinforced Concrete Pipework
Reinforced concrete pipes shall be manufactured and tested to AS4058. All pipes shall be rubber ring jointed, protected against corrosion and installed as per requirements of the Principal's Standard Specification SS5.

Flanges
Flanges shall conform to the requirements of AS4087. Flange pressure rating shall be greater than or equal to the test pressure of the pipes with which they are to be used, and shall be minimum AS4087 Class 16.

Metal backing rings on flanges shall be Grade 316 stainless steel.

Flexible Couplings
Flexible couplings and dismantling joints are compression unions, gibault joints, loose flanged couplings, tied dismantling joints and ‘Adaptor’ flanges. 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 Contractor shall submit all flexible couplings proposed to be used to the Superintendent for review.

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/NZS2544 for underground use. Rubber rings shall comply with AS1646. All gibault joints and reducing gibault joints shall be of the elongated type.

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. All buried flanges and metallic flexible couplings shall be fully wrapped with a complete Denso or similar joint wrapping system.

Fasteners
Fasteners for flanges shall be suitable for the application with metric studs, bolts, nuts and washers in accordance with the requirements of AS2528. The threaded length shall be such that after the joints are made up the bolt shall protrude through the nut by at least two threads, but not by more than 15 mm. Fasteners for other types of joints and couplings shall be as recommended by the manufacturer. Washers shall be used under all nuts and bolt heads.

All threaded rods, bolts, nuts and washers used in the pipework system including in valve and coupling bodies shall be Grade 316 stainless steel. Where necessary galvanic isolation washers shall be used. Nickel based anti-seize compound shall be applied to all threads before assembly.

Pipework Support Systems
Pipework supports, brackets and clamps shall be provided to fully support the pipework, valves and fittings against movement and vibration under all conditions of normal operation. The location and number of supports shall be calculated by the Contractor to provide horizontal and vertical support and to prevent distortion of the pipework.

Pipework supports, brackets and clamps shall be provided in accordance with the manufacturer’s recommendations for pipe deflection and spacing. The maximum spacing of pipework supports shall be 600 mm for small diameter flexible pipework and 1500 mm for large diameter rigid pipework unless otherwise agreed after reviewed by the Superintendent. Additional supports or brackets shall be provided under valves and both sides of dismantling joints and both sides of expansion joints.

Pipework supports and brackets shall be capable of horizontal and vertical adjustment to ensure that the completed installation is fully parallel and truly horizontal and/or vertical as required.

Pipework supports and brackets shall be fabricated from Grade 316 stainless steel where immersed or located above or near water. In other instances, pipework supports and brackets may be fabricated from steel and be hot dip galvanised after fabrication.

Cutting and drilling of sections of full lengths of hot dip galvanised Unistrut to provide shorter supports with patching of the damaged hot dip galvanising does not comply as ‘hot dip galvanised after fabrication’.

Fasteners shall comply with Section S3.6.4.8 above.

Dissimilar metal contact shall not be permitted and adequate insulation shall be provided.

4.2.5 Valves

General
Valves shall be provided with all actuators, positioners and the like as a complete and operable unit. Valves shall be sized to match the nominal pipe size of the pipework to which they are connected.

All valves in the following applications shall be closed by anti-clockwise rotation:

- All sewerage system applications;
- All sewage valves;
- All recycled water system valves;
- All wastewater treatment plant applications (except for potable and fire water pipeline valves); and
- All recycled water treatment applications (except for potable and fire water pipeline valves).

All valve flanges shall be drilled to AS4087, Class 16.

Resilient seating valves must not be used in situations where frequent operation against high unbalanced heads, high velocities or cavitation may be experienced.

All valve bodies shall be suitable for the maximum pressure as specified, which may be applied to the valve either as continuous or transient peak pressure, including test pressures. Valves except butterfly valves shall be tested to twice their maximum working pressure. Only “closed end” tests are required except for scour valves, shut-off valves and discharge valves which are to be “open end” tested. Test pressures and test type (open or closed end) shall be nominated in a Valve Schedule both in the Design Report and on the Project Drawings.

Cast iron components shall be coated externally and internally with a thermally bonded polymeric coating complying with AS4158

All studs, bolts, nuts, washers, or any other fasteners in all valves shall be Grade 316 stainless steel.
Each valve shall be labelled with a Grade 316 stainless steel label permanently engraved in 10 mm high Arial font or similar agreed by the Superintendent with the SAP Descriptor/Code (where the valve fits the Principal's criteria) and any tag number that is allocated by the Contractor. Each 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. The valve handwheel is not an acceptable location.

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.

Sluice valves shall be Class 16 and manufactured to the requirements of AS2638. Valves shall bear the inspection stamp of a recognised testing authority. Valves shall be coated externally and internally with a thermally bonded polymeric coating complying with AS4158. Sluice valves 300 mm diameter and less shall be resilient seated except as noted above in Section S3.6.6.1. Sluice valves greater than 300 mm diameter shall be metal seated.

Valves located above ground shall be provided with hand wheels or electric actuators. Valves located below ground shall be provided with a hot dip galvanised steel extension spindle. It shall be designed, fabricated and installed in accordance with the Principal's standard requirements shown on the Principal's Standard Drawings.

Non Return Valves
Non return valves shall be provided on all pipelines where backflow prevention is required. Isolating valves shall be provided for the purpose of maintaining non return valves. A dismantling joint shall be provided between the isolating valves to allow the non return valve to be removed. Where required, the dismantling joint shall be thrust transmitting. Non return valves shall be sized to achieve a maximum through flow velocity of 2.20 m/s. Valves, where included in below ground pipework, shall be installed in accessible concrete pits with drainage as detailed in Section S3.6.1.3.

Swing check non-return valves shall comply with AS3578 and be suitable for use in horizontal pipelines. Each valve shall be fitted with extended shafts and counterweights suitable for the fitting of flow switches where required. Valves shall be coated internally and externally with a thermal-bonded polymeric coating complying with AS4158.

All studs, bolts, nuts, washers, or any other fasteners in all non return valves shall be Grade 316 stainless steel.

Knife Gate Valves
The Principal has completed a detailed value engineering assessment of major pumping station installations and has resolved not to allow knife gate valves in critical pumping installations.

Use of knife gate valves otherwise shall be subject to review by the Superintendent but shall be generally acceptable where line pressures are less than 100 kPa. Consideration needs to be given as to how the valve can be safely taken offline for gland repacking.

Knife gate valves shall be flanged on either side or lugged and drilled or tapped to suit the mating flange. The body of each valve shall be manufactured from materials complying with the minimum requirements of AS2638 Table 2.1 or 2.2. Steel flanges shall not be accepted. The body, gate, seat, stem, valve superstructure, handwheel and all threaded rods, bolts, nuts, washers and studs shall be Grade 316 stainless steel unless otherwise agreed by the Superintendent. The stem nut(s) shall be gun metal, phosphor bronze or aluminium bronze. The seals shall be synthetic rubber, PTFE or Nylon 6. The seal shall not be located at the bottom of a recess in the valve body but shall be located in the side of the recess.
Each knife gate valve shall be tested open to withstand 30 metres head of water and to withstand and operate against an unbalanced head of 10 metres from the opposite direction. Drip tightness is not required for the unbalanced head test.

Each knife gate valve shall be supplied with a handwheel, extended spindle or electric actuator as appropriate to the Contractor’s design and as reviewed by the Superintendent.

**Eccentric Plug Valves**

Eccentric plug valves shall have a cast iron body, resilient faced plug, a welded nickel seat, stainless steel packing and permanently lubricated radial bearings. Where used in air mains, account shall be taken of the elevated temperatures associated with the compressed air when selecting valve materials. Valves shall be fully flanged.

**Ball Valves**

Ball valves shall be three piece construction with:

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

For certain applications, one piece construction may be acceptable and shall be submitted to the Superintendent for review.

**Butterfly Valves**

Butterfly valves shall not be used on sewage pipelines or pipelines carrying materials likely to rag or block the valve.

Each butterfly valve shall be resilient seated valves with a disc of corrosion resistant bronze or Grade 316 stainless steel and a one piece Grade 316 stainless steel shaft, cast iron body, corrosion resistant bearings and shaft seals. The resilient seal shall be securely held in place by a seat retaining ring or the tailpipe flanges. Flanges shall be drilled to AS4087 Class 16.

The valves shall be wafer face to face configuration (lugged) or flanged. The butterfly valve bodies shall be coated with a tough uniform coating of minimum thickness of 250 microns complying with AWWA Standard C550-81.

Each butterfly valve up to 150 mm diameter shall be manually operated through an quarter turn latching lever handle or an electric actuator. Each latching lever handle actuated butterfly valve shall be provided with a Grade 316 stainless steel quadrant complete with Grade 316 stainless steel fasteners and a cast iron or similar latching lever handle.

Each butterfly valve greater than 150 mm diameter shall be manually operated through an enclosed gearbox or electric actuator. The gearbox shall be of weatherproof construction with cast iron cover, cast iron or forged steel handle with open-shut position indication. All bolts, nuts and screws including those to cover plates and end cap fixings shall be Grade 316 stainless steel.

The cast iron components of each butterfly valve shall be coated externally with a thermally bonded polymeric coating complying with AS4158.

The working and test pressures for butterfly valves shall be as follows:

- Working pressure 1.2 MPa
- Works test pressure on seat 1.2 MPa
- Works test pressure on disc 1.6 MPa
Works test pressure on body 1.95 MPa
The Contractor shall check that there is adequate clearance between the valve disc and the adjacent pipes when the valve is opened and closed. The sealing surfaces of the valves shall bed on the metal face of the pipework flanges. If the valve sealing surface does not bed on the metal face, the Contractor shall provide Grade 316 stainless steel insertion rings and additional insertion joint rings.

**Solenoid Valves**
Solenoid valves shall operate at 240 V, 50 Hz or at 24 VDC and shall have an IP67 enclosure rating. Coils shall have Class H insulation and rated for continuous duty. The solenoid valves shall have Grade 316 stainless steel body with tapered BSP threads or flanges as appropriate.

Solenoid valves shall be suitable for the proposed application, and shall be capable of manual operation or be provided with a manually valved bypass. Solenoid valves shall not be used on pipelines greater than 40 mm nominal diameter.

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

**4.2.6 Pipework Installation**

**General**
All pipes shall be carefully placed and supported to the required levels, lines and grades and, where possible, shall be sloped to permit complete drainage. Pipework runs shall maintain adequate clearances between pipelines and structures, services or other pipelines. Pipelines shall be run parallel or square to the walls or ceilings of structures.

Design and installation of pipework shall include a sufficient number of barrel unions, flanges or Victaulic couplings or other coupling reviewed by the Superintendent for the purpose to allow any section or run of pipe to be disconnected and taken down without taking down adjacent runs of pipework. Barrel unions may be used on pipelines of 50 mm nominal size or less.

The handling and installation of all pipes and fittings shall be in accordance with the manufacturer's recommendations and in such a manner as will not cause damage or excessive deformation or stress to the pipes or fittings.

Wherever a metal pipe, other than steel or cast iron, is connected to a steel or cast iron pipe, insulating dielectric unions shall be installed.

The inside of all pipes, valves and fittings shall be smooth, clean and free from blisters, loose mill scale, sand and dirt when erected.

Where pipework is connected to structures, a watertight seal shall be made with a thrust or weep flange or similar. It is preferred that thrust or weep flanges be factory fitted. Wherever pipe of 25 mm nominal size or larger passes from earth to concrete, two flexible couplings spaced 600 mm apart shall be installed in the earth section of the pipeline. The first coupling shall be within 300 mm of the concrete. Couplings on pressure pipelines shall be restrained.

PVC pipework installation and design shall comply with AS2032.

ABS pipework installation shall comply with AS3690.

Requirement for Buried Pipework and Fittings
Buried pipework leading into structures shall have two flexible joints and a short length of pipe adjacent to the structure (refer also Sub-section S3.6.8.1).
All pipework, other than groundwater drainage pipes, under permanent structures shall be fully encased in concrete of minimum 100 mm thickness.

All buried flanges and tapping bands shall be wrapped with a corrosion protection system, unless an factory applied system reviewed by the Superintendent has been used. Gibault joints shall not be buried where possible. Where buried, they shall be wrapped with Denso system or similar reviewed by the Superintendent.

All corrosion protection system materials and procedures shall be of a recognised manufacturer, such as Denso, and shall be submitted to the Superintendent for review. Only fully trained and experienced personnel shall used for the wrapping of fittings.

All underground DICL pipework shall be installed with polyethylene sleeving. Supply and installation of the polyethylene film shall be in accordance with AS3680 and AS3681. Sleeving colour shall be suitable for the fluid conveyed.

All underground pipework shall be installed with electrically continuous marker tape. The marker tape colour shall be suitable for the fluid conveyed.

Each end of the electrical cable for the marker tape shall be extended to a closed small circular electrical junction box on the side of each Plant structure that the pipework connects. Each electrical junction box shall be labelled as to its contents with a reference to the pipeline marked by the tape. The electrical cable shall be extended around pit and manholes that do not extend above ground level and shall be proved to be continuous from one end to the other by the Contractor.

**Jointing**

Joints of whatever description shall be completed with the greatest of care. All components shall be properly aligned and the joint made strictly in accordance with the pipe and/or joint manufacturer's instructions. All joints shall be watertight under the test conditions.

Flanged joints shall be made with gaskets, reviewed by the Superintendent and suitable for the type and class of pipework being jointed, and the specified fasteners tightened uniformly and tightly.

Joints for PVC pipework above ground shall be solvent welded joints made in accordance with the procedure described in AS2032 and the manufacturer's instructions. Joints for ABS pipework shall be solvent welded joints made in accordance with AS3690 and the manufacturer's instructions.

Where constructed pipework connects to existing or new pipework or fittings constructed by others, the Contractor shall provide all materials, make the connection and make good the pipework or fitting to the satisfaction of the Superintendent using a gibault joint, flange or other coupling reviewed by the Superintendent.

**Thrust Restraint**

Thrust restraints shall be designed and installed by the Contractor to transmit the full thrust at bends, tees and ends, or where necessary, under maximum loading conditions and without deformation or overstressing.

Where an underground pressure pipe bends to move above ground, the bend shall be flanged on one end and socket connector on the other. The flange must face upwards.

**4.2.7 Stop Boards, Slide Gates, Stop Logs And Penstocks**

**Scope**
This Section of the Project Specification applies to all new stop boards, slide gates, stop logs and penstocks provided by the Contractor and shown on the Contractor’s Design Deliverables reviewed by the Superintendent.

The purpose of this Section of the Project Specification is to outline the standard and details of slide gates and penstocks to be fabricated, procured and installed by the Contractor.

Standards and References
Work carried out under this Section of the Project Specification shall comply with the requirements contained herein and elsewhere in this Project Specification.

The Contractor shall submit detailed structural calculations and shop drawings for the proposed penstock design for review by the Superintendent prior to commencement of manufacture.

Stop Boards/Slide Gates and Stop Logs
Stop boards/slide gates shall be “Watergates sp US series” or equivalent reviewed by the Superintendent.

Stop logs shall be “Watergates sp SL series” or equivalent reviewed by the Superintendent.

Performance
Each stop board/slide gate and set of stop logs shall be designed to withstand the maximum on and off-seating heads determined by 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.

Seal Frames
Each seal frame shall be designed to withstand all loads that result from the nominated maximum head acting on the gate and be manufactured from welded Grade 316 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.

All stainless steel components shall be pickled after fabrication and the whole assembly shall be passivated after fabrication. All fasteners shall be Grade 316 stainless steel.

Stop Boards/Slide Gates
Each top 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, two handles shall be provided to accommodate a two man lift operation. Where the resultant lift force exceeds 36 kg, either a manual actuated penstock or segmented stop logs shall be provided.
All stainless steel and aluminium welds shall be pickled and the whole assembly shall be passivated after fabrication. All fasteners shall be Grade 316 stainless steel and shall be fully separated from aluminium components.

Stop Logs
Each stop log shall be manufactured from:

Grade 316 stainless steel; where the normal function of the stop log requires it to be fully or partially immersed; and
Grade 316 stainless steel or marine grade aluminium; where the normal function of the stop log requires it to be housed out of the liquid stream.

Each stop log shall be suitably stiffened so the stop log will not deflect more than 1/500 of the length of the stop log under the design head. Each stop log shall have UHMW polyethylene bearing rubbing strips fixed at each end to help prevent jamming of the stop log in the guide frame. Each stop log shall be fabricated with appropriate lifting points to suit the lifting device.

The bottom of each stop log shall have a resilient seal running the full length of the stop log.

A lifting device shall be provided to suit the stop log width. The lifting device shall be guided into position by the stop log guides and shall be capable of securing and releasing each stop log with the use of a lanyard from the lifting device operating level.

Seals
Each seal frame shall be fitted with sealing faces that form a ‘U’-shape around the aperture. The side sealing faces shall provide a maximum coefficient of friction of 0.15 with the surface of the gate. Under the nominated maximum head acting on the gate, the resultant pressure acting on the seals shall be limited to prevent long-term creep of the material. The seal frame shall be fitted with a resilient flush bottom seal arrangement with a minimum seating width of 20 mm and shall be securely attached to the frame along the invert. Side seals shall be easily replaceable, in situ, from operating level. The invert seal shall also be easily replaceable.

*Manual and Electrically Actuated Penstocks*

Manual and electrically actuated penstocks shall be ‘Watergates sp model 25A-T’ or equivalent reviewed by the Superintendent.

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

*Performance*

Each penstock shall be designed to withstand the maximum on and off-seating heads determined by 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.

*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 manufactured from welded Grade 316 stainless steel sections. 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 as flat back.

All fasteners shall be Grade 316 stainless steel. Stainless steel welds shall be pickled and the whole assembly shall be passivated after fabrication.
Penstock Gates
Penstock gates shall be fabricated from Grade 316 stainless steel in areas subject to:

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

Elsewhere penstock gates can be manufactured from either Grade 316 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).

All fasteners shall be Grade 316 stainless steel. All stainless steel or aluminium welds shall be pickled and the whole assembly shall be passivated after fabrication.

Stems
Stems shall be manufactured from a machinable Grade 316 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 permanent deformation, twice the rated output of the actuator (manual operation rated at 160 N rim pull). Stems shall be supported such that the slenderness ratio for the unsupported portion of the stem shall not exceed 200.

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. Under the nominated maximum head acting on the gate, the resultant pressure acting on the seals shall be limited to prevent long-term creep of the material. The penstock frame shall be fitted with a resilient flush bottom seal arrangement with a minimum seating width of 30 mm and shall be securely attached to the frame along the invert. All seals shall be easily replaced in situ.

Adjustable pressure plates shall be fitted to the frame with Grade 316 stainless steel fasteners to compress the seal against the penstock to achieve optimum sealing. These plates shall be easily adjustable on site.

All stainless steel fasteners, where mating threads are of similar hardness stainless steel, shall be coated with anti seize/anti galling compound prior to fastening.

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 Section S3.6.7 of this Project Specification. The Contractor shall provide safe access complying with AS1657 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 AS4158

**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 Contractor. The size and spacing of the anchor bolts for each penstock headstock shall be nominated by the Contractor.

**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. 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.

### 4.2.8 Penstock And Valve Actuators
The type of actuator for all penstocks and valves shall be submitted to the Superintendent for the review and shall be included in the Design Report.

**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.

Operating handwheels shall be located in a readily accessible position with the centreline of the handwheel between 900 mm and 1200 mm above the floor level. Where handwheels cannot be readily reached a chain wheel type operator shall be provided. The chain shall extend to within 1000 mm of the floor level or operating platform.

**Electric Actuators**
Electric actuators shall be in accordance with SS10 Section 4 Common Electrical Requirements.

Actuators shall be 415 volt AC, on-off electrically controlled with permanent gear override facility, torque travel limit switches and visual position indicator. Weatherproof protection to AS60529 Class IP68 shall be provided. 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 brands considered equivalent by the Superintendent may be submitted to the Superintendent for review. The Contractor shall provide safe access complying with AS1657 to all actuator compartments.
Where practical for sites without a DCS (and with a PLC based control system) and where the application would lead to operational and/or cost benefits, actuators with communications capability allowing for connection to the communications network shall be provided.

**Pneumatic Actuators**

Pneumatic actuators may be proposed subject to review by the Superintendent. Where a significant number of pneumatic actuators are proposed across the Plant or in a particular Plant facility or area, a compressed air reticulation system shall be provided. The system shall be appropriately designed to provide redundant air storage and redundant supply pipelines with suitable system isolation valves.

Each solenoid actuated valve manifold for pneumatic control shall be installed in a fully enclosed powder coated marine grade aluminium or Grade 316 stainless steel cubicle. Each cubicle shall comply with the requirement for external electrical SCAs as defined in SS10 Sections 4 and 5.

The spent air from each solenoid valve shall be discharged to the exterior of the cubicle through a corrosion resistant exhauster/silencer.

### 4.2.9 Pumps

Pumps shall be of a standard and proven design for which spare parts are available readily in Australia. The direction of rotation shall be clearly and permanently marked on the pump body.

The Contractor is to ensure that the Net Positive Suction Head Available (NPSHA) exceeds the Net Positive Suction Head Required (NPSHR) by the pump by at least 1 metre over the full operating range. For conventional centrifugal pumps provide a flooded suction.

Tappings for pressure gauges and transmitters shall be included on both suction and discharge pipework and suitably ranged gauges supplied.

Pumps shall be selected which operate at high efficiency and the specified duty point shall be close to the best efficiency point of the pump. The pumps shall be stable in operation at all heads and under all conditions of single or parallel operation, within the full range of static head from maximum to minimum. Installations with multiple duty pumps shall have maximum efficiency for single pump operation.

Each pump shall be fitted with an engraved Grade 316 stainless steel nameplate fastened to the pump body. Nameplate information shall include as a minimum the manufacturer's name, address (or agent’s address), model number, serial number, capacity, head, motor kW, speed of rotation, and date of manufacture. The nameplates shall be permanently attached to the pump (using Grade 316 stainless steel fixings) and be clearly visible after installation. Duplicate plates shall be located in a logical location above submersible pumps so that they can be readily read without lowering water levels or raising the pump. These labels are separate to the label detailing each pump’s and/or motor’s SAP Asset Number and Plain English Name.

All pumps and appurtenances shall be provided with protective coatings. The proposed paint system shall be subject to the review of the Superintendent and the system shall also be detailed in the Design Report.

**Submersible Pump Units**

Each submersible pump unit shall be selected to:

- Meet the Contractor’s design duty points within the range of 70% to 120% of the pump’s 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 nominal pump operating speed at 50 Hz shall not be greater than 1500 rpm unless stated otherwise ie 2 pole motors are not acceptable. Resonance during operation shall not occur and vibration amplitude shall not exceed 0.046 mm for four pole, 0.065 mm for six pole and 0.081 mm for eight pole motors respectively.

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 90% of the motor rated power output at any point on its curve.

Each pump shall have a Net Positive Suction Head Required (NPSHr) at least 2 m less than 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.

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.

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 provides a water tight seal against the discharge flange of the pump.

All pump, motor and coupling components shall withstand, without damage, the effects of reverse rotation due to reverse flow through the pump up to 120% of normal direction rated speed.

Each pump shall be required to pump fluids with the following inclusions:

- Frangible solids;
- Hard solids, e.g. grit, sand and stones;
- Fibrous solids, e.g. rags, rope and sanitary napkins; and
- Mineral and other oils.

The pump shall be non-clogging and non-ragging.

The Minimum Sphere Passing Capability shall be:

- 25 mm for pumps below 50 mm discharge;
- 40 mm for pumps above 50 mm but below 100 mm discharge; and
- 75 mm for pumps above 100 mm discharge.

The impeller shall:

- Be of an accepted grade of cast iron (AS1830-2002 - Grey cast iron, gradeT250 or superior), and shall be accurately finished to reduce friction and leakage losses to a minimum;
- Have clearing vanes integrally cast into the backs of shrouds;
- Be of the screw centrifugal type or other proven non-clog design; and
- Be dynamically balanced prior to assembly in accordance with AS3709 - Vibration and Shock - Balance quality of rotating rigid bodies, grade G6.3.
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 accepted grade of flake graphite grey cast iron (AS1830 - Grey cast iron, grade T250 or superior) or wear resisting high-chrome iron. Carbon steels are not acceptable. The casing for each pump shall be tested to 1.75 MPa of water pressure. All casing joints shall have machined metal to metal faces and be seated with a Nitrile Rubber O ring. The bolts and nuts joining the various sections of each pump’s housing shall be Grade 316 stainless steel.

All cast iron parts that come in contact with liquid shall be treated externally by abrasive blast cleaning followed by painting with a coating subject to the approval of the Superintendent.

A pump for wet well service shall have the volute shaped so that the discharge nozzle aligns with the centreline of the pump, such that the pump induces a single plane moment only on the discharge support bend.

Renewable sealing rings and wearing rings shall be fitted to pumps with shrouded impellers.

Wearing ring(s) shall:

Be of dissimilar corrosion and erosion resistant materials;
Have a minimum hardness 50 Brinell higher than the impeller sealing ring(s), to prevent galling during operation; and
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.

The impeller shall be shrouded and shall be designed so as to prevent clogging and choking. The impeller shall be attached to the shaft by a single nut.

The shaft shall:

Be machined from solid one piece bar stock of Grade 431 in accordance with AS1444 stainless steel or better;
Have a ground finish over its entire length;
Have sufficient dimensions to transmit the maximum power of the motor; and
Equipped with replaceable shaft sleeves in areas subjected to wear or crevice corrosion.

The shaft shall be designed such that:

The first lateral critical speed is not less that 150% higher than the maximum operating speed of the pump;
The first lateral critical speed shall be calculated for the maximum diameter impeller able to be fitted to the pump, without any support from wearing ring(s) or neck ring(s); and
The maximum lateral deflection of the shaft shall be determined to establish permissible internal clearances, taking into account all lateral hydraulic reactions on the impeller and any external loads.

Sealing of the shaft shall be:

By tandem mechanical seal arrangement or other accepted arrangement such that no external flushing and cooling of the seal arrangement is required;
Of robust construction, designed to withstand the adverse operating conditions; and
Guaranteed for a minimum operating life of 10,000 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 from Grade 316 stainless steel or better.

Between each pump and its motor, an oil chamber shall be provided to lubricate and cool mechanical seal units on each side of the chamber. The lower seal shall prevent sewage, grit and other abrasives from entering the motor.
from entering the oil chamber. The seal faces shall be of tungsten carbide or silicon carbide material. The seal must also be effective for both directions of shaft rotation. The seal units shall be designed to provide reliable and durable sealing performance.

The Oil Chamber shall incorporate:

Oil fill and drain points; and
A leakage detection device, in order that water leakage past the lower mechanical seal is detected and an alarm condition is shown on the MLC and on the relevant Plant DCS/SCADA screen.
Each pump unit shall be supplied with a discharge support bend designed with the following features:

A support foot suitable for bolting to the pump well floor, capable of resisting all static and dynamic loads induced by the pump and discharge pipework;
A de-coupling joint able to be manipulated from the top of the pump well by lifting or lowering the pump, without the need of special devices, and able to maintain a leakage free seal between pump and pipework during all operational conditions. The submerged joint shall involve the use of a rubber or similar gasket. This gasket shall be positively fixed to one of the jointing surfaces;
An anchor point for mounting of two (2) vertical guide rails, located to ensure that the pump can be raised and lowered in the pump well without lateral deviation; and
A flanged discharge port complying with AS4087 Class 16.
The guide rails shall be fabricated from Grade 316 stainless steel. The top bracket for the guide rails shall be manufactured from Grade 316 stainless steel and shall feature a resilient spacer between the bracket and each guide bar.

Each pump unit shall also be supplied complete with:

Grade 316 stainless steel guide rail/s;
A Grade 316 stainless steel top mounting bracket for the guide rail/s; and
Grade 316 stainless steel foundation bolts.
Intermediate mounting brackets for the guide rail/s, suitable for connection to discharge pipework flanges. The brackets shall be sufficient in number to ensure excessive loads are not placed on the guide rails, but not less than required for 5.0 metre centres.
The Grade 316 stainless steel lifting chain shall:

Be a continuous length of suitably rated stainless steel chain with an elongated link every metre;
Include Grade 316 stainless steel shackles, connection(s), clips etc to the pump
Extend from the point of connection at the pump unit up to the top of the guide bars plus an extra 1.5 m.; and
Include break type clips for attachment of the motor cable(s).
A Grade 316 stainless steel chain and cable hook shall be fabricated and installed on the face of the wet well opening between the guide bar brackets.

Each motor shall comply generally with AS1359 and shall be suitable for connection to a three (3) phase, 415 volt, 50 cycle, earthed neutral supply. The motor shall be insulated with a minimum of Class F materials in accordance with AS2768 and shall be designed to operate within Class B limits, as specified and measured by AS1359 Part 32, specially impregnated for moist atmospheric conditions.

The duty rating of the motor, when determined by the method shown in AS1359 Part 30, shall be classified as Duty S1. The output rating of the motor as defined in AS1359 Part 30 shall be such that:

When cooled by the liquid at 27°C it exceeds the power required by the pump over the whole range of discharge from shut-off head to zero head; and
When cooled by air at 40 °C it exceeds the power required by the pump pumping against minimum head and system resistance.
Where electric motors are driven by variable frequency inverters the maximum output rating for the motor shall be increased by 20% 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 AS60947 Part 8.

660 volt cable/s suitable for use under water shall be supplied with each pump unit. All cables entering the motor shall be glanded to a single demountable flange. 10 m of electrical cable shall be supplied with each pump unit. The other end of the cable shall, wherever appropriate, terminate in a plug which shall fit into a socket. The plug and socket shall comply with the requirements of SS10 –Section 4 Common Electrical Requirements.

Cables incorporating cores for power, stator thermal protection and moisture detection shall have the protection and detection cores provided with secondary sheaths.

Motors that are to be driven by variable speed drives shall be provided with screened cables.

Cables shall be multicore flexible neoprene sheathed, suitable for continuous immersion in wastewater. Other sheathing materials are not acceptable.

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

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 mega ohms. The Contractor shall guarantee the insulation resistance of the motor at the end of the defects liability 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.

A tapping shall be made into the vertical riser five (5) pipe diameters above the discharge connection stand flange for each pump unit and a nominal 20 mm diameter acrylonitrile butadiene styrene (ABS) pipe led from each tapping over to the wall and up to the top of the pump well and be fitted with a nominal 20 mm diameter ABS multiport ball valve in L port configuration with plain socketed union ends with the leg orientated vertically. The valve 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 20 mm to 12 mm BSP reducer. This assembly shall be located on the side of the pump unit access opening 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 600 mm.

**Horizontal Centrifugal Pump Units**

Each pump and motor shall be mounted on a common base plate. The pump and motor shall 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. 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.

The rated speed of each pump unit shall not exceed 1500 r/min unless otherwise specified. Resonance during operation shall not occur and vibration amplitude shall not exceed 0.038 mm for four pole motors.
The flanges for each pump shall comply with AS2129 Table C.

All fasteners in each pump shall be Grade 316L stainless steel.

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

The duty rating of the motor, when determined by the method shown in AS1359 Part 30, shall be classified as Duty S1. The output rating of the motor as defined in AS1359 Part 30 shall be such that when cooled by air at 40 °C 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 20 % 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 AS60947 Part 8.

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.

**Horizontal End Suction Pumps**

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. Each pump shall be manufactured to the dimensional requirements of ISO 2858.

The casing for each pump shall be Grade T-220 cast iron to AS1830 and shall be tested to a pressure of 1.6 MPa. 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.

The impeller shall be of phosphor bronze to AS1565/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 AS2074/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 lead bronze face. Spring and backing washers shall be Grade 316L stainless steel to AS1444.

**Horizontal Split Casing Pumps**
Each pump shall be a single stage, horizontally split casing, between bearings, centrifugal pump, long coupled to its motor. 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 AS1830 and shall be tested to a pressure of 1.6 MPa. 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 AS1565/C 90250.

The impeller shall be of phosphor bronze to AS1565/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 AS2074/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 lead bronze face. Spring and backing washers shall be Grade 316L stainless steel to AS1444.

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

The pumping units shall operate satisfactorily between maximum and minimum pipeline characteristics graphed in Section E, Appendix E2 and down to flood minimum head without exceeding a current in any motor cable equivalent to 95% of the motor MCR current under the specified supply conditions.

**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.

Each base plate shall be fabricated from substantial sections. Where black steel is used, it shall be hot dip galvanised after fabrication. 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.

The maximum speed of each pump unit shall be limited to 350 r/min. The actual operating speed shall be as nominated by the Contractor.

Each unit shall be a pedestal mounted, positive displacement helical rotor pump. The pumping element shall consist of a Grade 316 stainless steel rotor to AS2837 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 AS1830 tested to a pressure of 1.2 MPa. The test shall be either quality assured or be witnessed by the inspection and testing organisation and the housing then stamped.

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.

The rotor drive shaft shall be of Grade 431T stainless steel to AS1444 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.
Pumps shall be fitted with a dry run protection device equal to a Trolex temperature probe mounted in the pump stator reviewed by the Superintendent.

Each unit shall be a Mono C Series pump or of similar acceptable manufacture.

The pumps 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 AS1359 Part 30, shall be classified as Duty S1. The output rating of the motor as defined in AS1359 Part 30 shall be such that when cooled by air at 40 °C 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 20 % 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 AS60947 Part 8.

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 a closed discharge valve. 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 set to the by-pass pressure.

Each pressure relief valve shall be a minimum 80 mm nominal diameter Rapid Figure 270 or equivalent acceptable. It shall be tapped into a blank flange on a tee or located in some other acceptable manner. Provision shall be available in each valve to connect a pipe to its discharge should it be necessary to collect the discharge.

4.2.10 Band Screens

Band Screen Mechanical Arrangement

Band screens shall consist of an endless band of screen panels contained within a vertical self-supporting frame. The band screen shall be equipped with inlet plates designed to direct the flow into the centre of the screen. Discharge of the flow shall be perpendicular to the inflow direction through the screening panels.
The band screen frame and headbox shell shall be constructed from Grade 316 stainless steel.

The band screen frame and headbox shell shall be fully pickled and passivated both above and below the water line.

The band screen shall be delivered to site fully assembled and ready to fit into position. All routine maintenance shall be carried out from the finished level of the top of the PTA from the odour collection covers. Other than the band screen segments, there shall be no permanent submerged moving parts.

The configuration and installation of each band screen shall minimise the accumulation of any materials in the screening channels immediately upstream of the unit.

**Band Screen Panels**

Band screen panels shall have a nominal aperture to satisfy the requirements of Table S2.5. The band screen panel design shall eliminate as much as possible the effects of 'blinding' from fibrous and alike matter. The band screen design shall allow for its easy and safe removal of debris with the adopted washing system. Any carryover of 'blinding' material following washing shall not be permitted.

Band screen panels shall incorporate lifting forks or escalators to enable the transport of large solids such as bricks, stones and large rags up the screen. The forks shall have serrations and a landing area which shall enable the lifting of at least half brick sized stones from the bottom of the band screen to the discharge chute. The band screen panels shall be capable of withstanding the repeated impact of such objects.

The serrations on the escalators shall also prevent screenings ‘balling’ within the band screen.

**Band Screen Frame**

The band screen frame shall be self supporting and manufactured from Grade 316 stainless steel. The band screen frame shall be fitted with replaceable roller tracks and locating strips to guide the screening band. The lower section of the frame shall be fitted with a replaceable semi-circular track to guide the screening band around the base of the screen. Additional sprockets and idler rollers located at the bottom of the band screen shall not be permitted.

The frame shall be designed to withstand a total head loss across the band screen in excess of 1.0 m of wastewater.

The band screen frame shall be fully pickled and passivated both above and below the water line.

**Band Screen Drive Chain**

The drive chain shall be wastewater lubricated with rollers of Acetal co-polymer or similar and accepted with seals of neoprene.

The chain shall be sealed against the frame using a neoprene contact seal to prevent bypassing and short circuiting.

**Band Screen Drive Arrangement**

The drive unit shall comprise a single shaft mounted motor and gearbox assembly of the double reduction worm type as manufactured by Flender or similar and reviewed by the Superintendent.

Gearboxes shall be manufactured to AGMA Standards based on 24 hour continuous operation with moderate shocks and a service factor of not less than 1.5.
The casing shall be manufactured in close-grained cast-iron and shall include inspection cover(s), breather incorporating a filter suitable for the climatic and environmental conditions, together with a clearly accessible, visible and robust oil level gauge and lifting eyes.

Helical, herringbone or worm gears shall be used, manufactured in hardened steel or similar and accepted material. Gears and bearings may be splash or pressure lubricated. An oil drainage point shall be incorporated and where this is not easily accessible a suitable drain pipe, complete with screwed plug, shall be fitted to make it accessible and to easily catch waste oil.

The drive shaft shall be located above the maximum wastewater level and shall be manufactured from Grade 420 stainless steel.

Bearings external to the motor and gearbox shall be sealed for life, of the self aligning type and housed in sealed cast stainless steel housings.

All bearings shall have \( L_{10} \) lives of greater than 100,000 hours. As a minimum bearing life shall be determined by the procedures outlined in AS2729.

All bearings shall be sealed to prevent the ingress of water / wastewater and other contaminants. The bearings, gearboxes and casings shall prevent the leakage and / or seepage of lubricating oils.

**Band Screen Odour Collection Cover(s)**

Each band screen shall be fully enclosed and fitted with removable Grade 316 stainless steel or GRP odour collection covers for the safe and uninterrupted access for all necessary service and inspection purposes. Hinged or removable sections shall be incorporated in the covers to allow easy access for maintenance but not compromise operator safety or odour control. Grease lines shall be extended so that lubrication can be carried out with the covers in place. Limit switches, interlocked with the control system (manual and automatic operation) shall be installed to prevent screen rotation when the covers are removed or opened.

If fabricated from Grade 316 stainless steel, the covers shall be fully pickled and passivated.

Covers shall be designed and installed to contain all splashing, sprays and seepage from the operation of the band screen and the cleaning system(s). Such covers shall also provide a positive seal to enable the OCF foul air extraction system to maintain the PTA, including the band screens, at a negative pressure.

**Band Screen Emergency Bypass**

The back (downstream) face of each band screen frame shall incorporate a Grade 316 stainless steel emergency bypass weir capable of being fully height adjustable relative to the Contractor’s hydraulic design.

**Band Screen Upstream Bypass Weir Arrangement**

The screening facility shall be equipped with an upstream over flow system (weir(s)) used in the event that the band screens are unable to pass the inflow due to failure, blinding or when one band screen and its associated channel is taken offline.

This overflow system shall be suitable for passing Maximum Hydraulic Capacity. The emergency bypass weir length referred to above shall not be included in the total length for this overflow weir.

This weir shall be securely fixed and robustly sealed to the screen frame and channel floor / walls and set based on the maximum screening capacity and fabricated from not less than 6.0 mm thickness Grade 316 stainless steel plate suitably reinforced to accommodate a total hydraulic unbalanced 2.0 m head of wastewater without distortion, movement or transfer of load onto the band screen frame.
The weir length shall be such that at no time can the water level upstream of this weir(s) reduce the available freeboard to less than 150 mm.

The final arrangement shall be submitted to the Superintendent for review.

**Band Screen Wash System**

Each band screen shall be equipped with a washing system comprising nozzles and distribution bars to completely wash the screen panels when the preset level differential is sensed across the band screen or upon elapsed run-time.

Normally, Plant service water (the treated wastewater from the Plant) shall be used for this function with suspended solids at less than 10 mg/L and particle size typically less than 100 micron.

All additional screening / filtration of the Plant service water required to achieve the necessary quality of water for all sprays, together with the deluge system to operate without failure, shall be provided by the Contractor. Where necessary, all additional screening / filtration systems(s) shall be of the automatic continuous self cleaning type. Any screening or filtration system requiring operator intervention to perform the cleaning function will not be considered. The downtime through blockage shall be an absolute minimum.

Each washing system shall consist of a Grade 316 stainless steel manifold with removable Grade 316 stainless steel nozzles including dedicated pressure and flow regulation, together with pressure indication and flow monitoring integrated with the control system (manual and automatic operation).

**Band Screen Wash Pumps**

Local screen wash pumps shall not be provided as part of the Contractor’s design, unless localised service water storage and dedicated screen washwater pumps represent a significantly better technical solution and WLC greater than the requirements for the additional capacity for the Service Water Facility.

**Band Screen Screenings Discharge**

Solids and screenings collected on the inside of each band screen shall be discharged into a screenings hopper where they shall continue to be discharged through a sluicing chute into a screenings launder. The discharge and the hopper shall be located above deck level at a height to facilitate the safe and uninterrupted access for all necessary inspection and maintenance activities. Each screenings hopper shall be equipped with a hinged lid to enable the removal of any blockages and large obstructions that will not readily transport through to the discharge chute. All hinged lids shall have Grade 316 stainless steel hinges and quick release latches.

The screenings hopper and sluicing chute shall be located on the upstream side of each band screen such that any overflow is directed to the inlet side of each screen.

The covers for the screenings hopper and sluicing chute, and the connection to the screenings launder, shall be designed and installed to provide a positive seal to enable the odorous air extraction system to maintain the internal air space of the PTA, including the internal air space of each band screen, at a negative pressure.

**Band Screen Fasteners**

All fasteners including nuts and washers in all band screen components including in the body and external surfaces of gearboxes and motors shall be Grade 316 stainless steel with appropriate isolation from dissimilar metals where necessary. The fasteners shall be assembled with a liberal coating of anti-galling paste (nominally nickel based anti-seize paste).
4.2.11 Screenings Handling Equipment

Screenings Sluicing Launder

Each screenings sluicing launder shall be fitted with adequate overflow facilities, at each band screen, sized to overflow the entire washing flow discharged with the screenings. Each launder shall be fitted with odour extraction points to enable connection to the Plant’s odour mitigation system. Level monitoring equipment shall be provided to detect high levels in the launder at the band screen interface points and at the stone trap, independently, with alarm enunciation at the Plant’s PLC/DCS.

The screenings launder trough shall be fabricated from Grade 316 stainless steel ‘U’ sections sized to convey all wet screenings, stones and solid matter. The launders shall be supplied complete with suitable Grade 316 stainless steel supports.

Flanged joints shall be used to connect all sections of the launder trough. The sections shall be joined using Grade 316 stainless steel fasteners. The flanges shall surround the entire launder ‘U’ section to provide adequate stiffening and sealing at each joint. Neoprene gaskets shall be used to form a leak tight joint. Gaskets shall be trimmed to present a flush and neat internal surface free from protrusions into the launder.

The entire launder system shall present a continuous fall from each band screen to the receiving equipment, suitably designed to ensure effective transportation of all captured screenings, to include stones and washing flow.

Where the launder interfaces and/or interconnections with items of plant and equipment all necessary flanged joints, transitions and seals shall be provided to facilitate a complete conveyance system. All necessary bifurcation sections complete with all necessary actuated diverter gates or valves shall be provided to achieve a complete and fully functional system.

Launder Covers

Covers shall be fitted to all launders for the purpose of containing odours and spills. Covers shall be fabricated from Grade 316 stainless steel with a minimum thickness of 3 mm. On straight sections of launder, the covers shall be hinged, with latching support struts, on one side. All covers shall be fitted with lifting handles. The free or unhinged side of each cover shall be fastened with Grade 316 stainless steel quick release toggles to allow unrestricted and safe access without the need for tools. Covers shall be robustly sealed with suitable gasket material to maintain a positive airtight seal throughout its serviceable life. The sides of all covers shall be turned down to provide a positive location on top of the launder and to provide rigidity.

Where hinging of the covers is considered impractical, by way of shape, location or other reason, then all covers shall be positively fastened to the launder with Grade 316 stainless steel quick release fasteners and sealed with resilient seals and provided with sufficient lifting handles. Cover sections shall not exceed 18 kg and shall be fixed to ensure that each section is manageable without risk to the operator’s or maintainer’s health or safety. All removable sections shall have suitable lifting, handling and/or transportation aids.

Odour Ductwork Connection Points

Odour ductwork connection points shall be provided in the launder, without restricting removal of any covers, maintenance activities, repair or replacement of faulty/damaged parts.

Stone Trap

A suitably sized and rated stone trap shall be provided in the screenings launder downstream of the band screen installation.
The stone trap shall capture all stones, whilst allowing the screenings to freely flow onto the screenings handling facility. The stone trap shall be equipped with a minimum of two actuated knife gate valves or a similar arrangement and shall be submitted to the Superintendent for review.

The bore of the open valve shall not present any hindrance to the flow of the stones or associated sluicing water. The chute conveying the stones and sluicing water from the launder stone trap to a suitable distribution conveyor shall be equipped with all necessary drain ports prior to entry into the conveyor. These drain ports shall comprise a tee with a coarse stainless steel or Ultra High Molecular Weight Polyethylene (UHMWPE) mesh to allow drainage of the sluicing water through the drainage branch before the stones enter the conveyor.

The drainage tee shall be constructed from Grade 316 stainless steel. The tee shall be complete with hinged lid(s) and Grade 316 stainless steel quick release toggles as necessary.

**Screw Wash Presses**

Each screw wash press, Kuhn or similar, and submitted to the Superintendent for review shall be free standing and manufactured from Grade 316 stainless steel. Where necessary and as required, each screw wash press shall be supported on a Grade 316 stainless steel frame.

Where a dual screw wash press is required to achieve the duty (screenings loading) each half of the screw wash press shall be of the dual structural frame design and of robust and durable construction. Dual screw wash presses shall consist of dual motor gearboxes and a machine body consisting of an inlet zone, dual washing zone, dual dewatering zone and dual press pipes. Each half of the dual wash press shall be capable of operating independently, i.e. the failure of one half of the press does not render the other half inoperable.

The structural frame design shall have an integrated inner pipe within an outer body frame of 5 mm minimum thickness Grade 316 stainless steel. The inner frame shall have perforated holes to allow for free draining of screenings and the sluicing water. The outer frame shall provide additional strength as well as the drainage conveying section for the sluicing water. A flanged or threaded drain hole of 50 mm minimum size shall be provided on each of the outer frames.

The screw wash press shall be complete with all necessary solenoid valves and inspection and access hatches. In addition to the normal wash zone sprays, additional sprays and service water injection points shall be provided following the wash zone section of the press (i.e. in the compression zone).

These injection points shall allow the use of additional water in the event that the compression from the screw causes excessive heating of the compacted screenings.

The screw wash press shall be capable of handling screenings discharged from a number of screens via a dedicated launder trough.

For enhanced washing and dewatering, each screw wash press shall be capable of being retrofitted with counter pressure system (CPS).

The screw, constructed from high tensile quality grade alloy steel, shall have a diameter of not less than 300 mm and an overall length to suit the design and application and shall have a solid formed screw design. The screw shall rotate within the inner trough between the bearing and a replaceable wear liner. The bearing shall be designed for the applied axial loads.

Screenings shall enter each screw wash press through the inlet hopper from the interconnecting sluicing launder. The screw transports the screenings towards the washing zone where washing takes place by injecting service water and mixing it together with the screenings. The screenings are then transported by the screw to the dewatering zone where dewatering and compaction takes place. The Contractor shall provide all necessary screens/filtration equipment and facilities to ensure that the quality of the service water required by the manufacturer of the equipment is achieved.
Sufficient, suitably positioned and sized service washing water connection ports shall be provided in the wash section of each press. A minimum of four (4) additional washing water connection ports shall be provided in the compression zone.

At the discharge end of each screw wash press, a pipe shall be fitted to each discharge to move the processed screenings into either of two outloading conveyors that shall discharge the screenings into self loading container bins. Each press discharge pipe shall be fabricated from Grade 316 stainless steel. Each press discharge pipe shall be connected to a bifurcated chute which will discharge the screenings directly into either outloading conveyor by the automatic actuation of a diverter gate or valve.

Each processed screenings discharge pipe shall be fitted with a 500 mm long 120 degree bolted on cover plate located immediately above the lower bend on the accessible side to allow jammed screenings to be removed from discharge pipe. The inside face of the cover plate shall be flush with the bore of the discharge pipe. The bolts for the cover plate shall be tapped into the pipe and shall not protrude more than one thread into the bore of the discharge pipe.

Each bifurcated chute shall be fitted with a 450 mm square bolted on cover plate located opposite the discharge from the upper bend/s on the accessible side to allow jammed screenings to be removed from the bifurcated chute. The bolts for the cover plate shall be tapped into the bifurcated chute and shall not protrude more than one thread into the bifurcated chute.

All Grade 316 stainless steel components shall be fully pickled and passivated after fabrication.

4.2.12 Grit Removal And Handling Facilities

Vortex Grit Removal Chambers
Each vortex grit removal chamber shall comprise two cylinders of different diameters connected by a conical cylinder. The upper part of the cylindrical structure shall have a diameter larger than the lower part. There shall be a tangential feed into the upper cylinder, a top overflow for liquid discharge with the inlet and outlet separated by not less than 270° of the chamber periphery. The walls at the transition section from the upper cylinder shall slope to allow grit to settle to the base of the lower cylinder. There shall be a hopper arrangement in the base of the bottom cylinder for the collection of separated grit.

Each vortex grit removal chamber shall be a reinforced concrete structure.

Grit collected within the hopper, with the assistance of a fixed speed mechanical paddle, shall be transferred to the classifier unit prior to discharge into a bin for disposal.

A grit removal paddle consisting of a vertical rotating hollow tube and demountable impeller shall be fitted centrally in each cylindrical chamber. The impeller shall be fitted with blades which shall create an upward flow in the central zone of the upper chamber, whilst leaving the outer annulus of the upper cylindrical chamber quiescent to allow grit settlement. The impeller blades shall be self shedding of fibrous material.

All equipment shall be of weatherproof construction and suitable for continuous operation in an external location. Guardrailing shall be provided around tanks and along the sides of bridges. All stairways, platforms, guardrailing and flooring provided for safe access to machinery shall conform to the requirements of the Contract Documents, AS1657, AS4024.1 Safety of Machinery - Permanent Means of Access to Machinery, and with the Principal's Standard Specifications as appropriate.

**Grit Pumping**
Each grit collection system shall make provision for pumping the grit from the hopper at the base of the lower cylindrical chamber and for classification and discharge to a container for disposal.
Transfer mechanisms shall be designed to remove grit from each hopper. The grit shall be classified by separating out organic material and liquid. Transfer and classification may be combined using a reciprocating rake classifier or screw classifier.

Grit pumps shall be used for the transfer of grit from the collection sump / hopper to the classifier. Where necessary, carrier water shall be provided to re-suspend the grit and facilitate grit removal, with the return liquor discharge back to treatment. The grit pumps shall operate automatically in conjunction with the classifier unit.

Each grit pump shall incorporate abrasion resistant materials and recessed torque flow impellers. Suction and discharge isolation valves and a discharge non-return valve shall be provided.

Grit pumps shall be proprietary items specifically designed for the duty and form part of the grit removal assembly.

**Grit Cyclone Separators**

Each grit cyclone separator shall be constructed from cast iron or Grade 316 stainless steel with renewable, wear resistant plastic liners. Flows from the cyclone shall pass into the inlet hopper of the classifier.

Access platforms and ladders to gain access to the grit cyclone separators shall be provided where the height of the cyclones and top of the classifier is such that safe and unrestricted access to undertake routine maintenance / repair or replacement from the normal walkway is not possible. All stairways, platforms, guardrailing and flooring provided for safe access to machinery shall conform to the requirements of the Contract Documents, AS1657, AS4024.1 Safety of Machinery - Permanent Means of Access to Machinery, and with the Principal’s Standard Specifications as appropriate.

**Grit Classifiers**

The classifier shall comprise:

Inlet hopper to receive the mixture of grit and screened wastewater;
Solid shaft or shaftless helical screw conveyor contained in a Grade 316 stainless steel ‘U’ channel trough;
Replaceable wear liners;
Discharge chute;
Odour collection covers and odour ductwork outlet; and
All necessary supports and brackets.
All components with the exception of the support brackets and framework shall be of integral and unitised design. Access hatches at the bottom of the grit hopper shall be provided to allow entry to relieve blockages and carry out routine inspections / repair or replacement.

Each classifier which shall be designed for maximum retention of solid particles and minimal fine sand carryover. The screw feeder shall convey the grit up the inclined trough for discharge into a distribution conveyor for transport into a common screenings and grit bins.

All wetted parts shall be manufactured from Grade 316 stainless steel and wearing surfaces shall be equipped with renewable UHMWPE or similar wearing sleeves.

The grit shall be washed at the lower end of the conveyor to remove putrescible matter from the grit. The screw conveyor shall be equipped with a flanged or screwed drain connection at the lower end for draining of fluids and organics from the grit to the head of the works, via the Scour Pump Station.

The solid shaft helical screw conveyor shall be manufactured from high tensile alloy steel or better and driven by a shaft mounted helical gear reducing gearbox located at the high end of the conveyor.
overhang between the end of the conveyor and the last discharge port shall be kept to the minimum to reduce the possibility of blocking and locking of the screw conveyor.

The screw conveyor may be inclined up to 25 degrees and that part which protrudes from the inlet hopper shall be covered with a Grade 316 stainless steel removable lid secured into place with Grade 316 stainless steel quick release toggles. The lid shall be sealed against the trough with suitably resilient and environmental resistant gaskets.

The inlet and discharge from the classifier shall be able to be readily disconnected from the conveyor such that in the event of a conveyor breakdown grit can still be discharged from the classifier.

All necessary plant, materials, equipment, fixtures and fittings to achieve a complete and fully functional system shall be provided.

Each grit classifier shall comprise a solid shaft helical screw design, rotating in a fabricated Grade 316 stainless steel trough of 6 mm minimum thickness. The trough shall be inclined to enable the grit to be lifted and discharged into the dewatered screenings and grit conveyor which directs the material to the on-line bin. The screw shall be supported in upper and lower bearings as appropriate.

The lower bearing shall be of the self aligning type, sealed to prevent the ingress of grit and shall be grease lubricated by an electrically driven variable output automatic lubricator. A deflector plate shall be fitted over the bearing to prevent the grit being discharged on to the bearing. The upper bearing shall be grease lubricated sealed bearing of the combined thrust and radial type.

The water and organic material only shall be returned to the main flow via the Scour Pump Station. The dewatered grit shall be discharged at high level from a chute into the on-line bin.

Each classifier’s screw shall be driven by a direct coupled shaft mounted geared motor. The screw shall be guarded by Grade 316 stainless steel covers securely fixed to the top of the trough. The complete classifier unit shall be self supporting and suitable for bolting to prepared foundations.

The Contractor shall determine the grit quantity and loading rates to design the grit collector and grit handling plant accordingly. A peak multiplier of not less than 10 shall be used as a minimum where no specific data is available.

Each grit classifier shall be sized to operate over the full range of flows and all equipment shall be installed in accordance with the manufacturer’s instructions.

Grit classifiers shall be of proprietary design. Each unit shall facilitate removal of organic matter from the removed grit. All extraneous solids and water shall be returned to the head of the Plant for treatment, via the Scour Pump Station.

Drainage of the bin loading area shall be connected to the scour drainage system and returned to the head of the Plant for treatment, via the Scour Pump Station. Wash down facilities using Plant service water shall be provided at the bin loading area.

4.2.13 Dewatered Screenings And Grit Conveyors

Each conveyor shall comprise a geared motor drive, high tensile alloy steel or better shaftless screw, trough with removable lids, renewable wear sleeves of UHMWPE or similar, inlet and outlet ports, actuated slide gates / knife gate valves for flow diversion, and a drain outlet at the lower end to drain water received with the stones from the stone trap. 0.75 m long access hatches spaced along the length of the conveyor at a maximum of 1.5 m to allow inspection of inlet and outlets and access to any internal bearings and the liner shall be provided.

Sufficient flanged off takes, for connection to the odour mitigation system adjacent to the outlets of the screenings bins, shall be provided.
All components in contact with the stones, screenings and grit shall be manufactured/ fabricated from Grade 316 stainless steel. The motor and drive shall be located at the high end of the conveyor. The last discharge port, feeding into an emergency screening bin, shall be located as close to the end of the conveyor as possible to prevent the likelihood of blocking or locking. Access platforms, walkways and stairways to gain access to the screenings, grit and stone transportation equipment shall be provided, as required and shall comply with the Contract Documents.

The grit classifiers shall discharge into each conveyor downstream of the screening discharge to minimise the wear of each conveyor’s liner and to maximise the liner’s life.

The Grade 316 stainless steel conveyor covers shall be removable and secured into place with Grade 316 stainless steel quick release toggles. Each cover shall be sealed against the trough with durable, robust and resilient wastewater resistant gaskets.

The conveyor shall be supplied with all necessary Grade 316 stainless steel support brackets and framework.

As a minimum the inlet ports to screw conveyor shall comprise:

One for connection with the stone trap conveying system;
One for connection with the grit classifier;
Two for connection with the screw wash presses; and
Others as required as part of the Contractor’s design.

As a minimum the outlet ports from the screw-conveyor shall comprise:

One for connection to each self-loading bin;
One for connection to the emergency bin; and
Others as required as part of the Contractor’s design.

Off takes for connection to the odour mitigation system shall be provided.

The conveyor shall be supplied with all necessary chutes to allow discharge of the contents to all necessary bins. Pneumatically operated bellow type flexible couplings shall be provided at the connection of any bin to allow for disconnection of the conveyor from said bins prior to transportation off site.

4.2.14 Self Loading Bins

Each bin shall be equipped with spiral distributor(s) manufactured from high tensile alloy steel or better and a suitable level monitoring device to provide operator feedback on the status of each bin, whilst also controlling the respective inlet valve. A drain valve to facilitate full drainage from the bin shall be provided. The floor of each bin shall have a sufficient fall towards the associated drain valve.

All slide gates shall be equipped with end-of-travel (digital) and valve positional (analogue) feedback.

The bins shall be fully seal welded both inside and outside to ensure a water and odour tight construction and to suit hot dip galvanising. The walls and top shall be manufactured from not less than 3 mm thick black steel plate and the floor not less than 6 mm thick black steel plate. All drainage liquors shall be returned to the head of the Plant, via the Scour Pump Station. Grade 316 stainless steel ‘kamlock’ coupling and isolation valve on the drainage point shall be provided. The bins shall be fully covered to contain odours during filling and transportation.

Each bin shall be provided with one inlet port, having a manually actuated slide gate for sealing during transportation.

Each bin shall be provided with an odour extraction port connected to the odour mitigation system.
Each of the inlets, outlets shall be designed and arranged for the safe and unrestricted connection, disconnection and isolation following delivery and removal of the bins.

All bins to be provided shall be a minimum of 10 m³ and accepted by the Superintendent and compatible with the Principal's current haulage Contractor’s vehicles for ‘ride up’ delivery and removal.

The bins shall be equipped with one water and odour tight axial discharge door.

The screw conveyor shall be driven by a motor driven gearbox. All bearings shall be grease lubricated with greasing points led to a readily accessible position.

Each bin shall be provided with a Rotable Asset Descriptor in the SAP Asset Management System whist each bin location will be given a specific Asset Descriptor in the SAP Asset Management System.

The self loading bins shall be provided with locating guides fastened to the concrete slab. The locating guides shall be hot dip galvanised after fabrication.

4.2.15 Emergency Bin
Each bin shall be a conventional static bin fully covered and equipped with a drain valve to facilitate full drainage from the bin. The floor of each bin shall have a sufficient fall towards the associated drain valve(s).

Each bin shall be fully seal welded to ensure a water and odour tight construction. The walls and top shall be manufactured from not less than 3 mm thick black steel plate and the floor not less than 6 mm thick black steel plate. A ‘kamlock’ coupling and isolation valve shall be provided on each drainage point. The bins shall be fully covered with hinged and latched down black steel covers to contain odours during filling and transportation.

Each emergency discharge bin shall be manufactured from black steel as detailed above. Each bin shall be hot dip galvanised after fabrication.

4.2.16 Air Blowers And Compressors
Each air compressor system shall provide oil free compressed air. These requirements apply to plant air supplies, not to aeration blowers.

Air Compressors
Each air compressor shall be manufactured by Atlas Copco or a similar manufacturer acceptable to the Superintendent.

Each air compressor shall:

Be of the oil-less screw type capable of a minimum working pressure of 850 kPa;
Be direct or belt driven by a 415V three phase 50 Hertz electric motor;
Be installed complete with a flexible connector pipework, non return valve, pressure relief valve and an isolating valve;
Be sized for a 50% duty cycle; and
Be provided with an acoustic enclosure where noise generation is above 80 dBA.
The drive and flywheel shall be fitted with metal guards, easily removable for vee belt adjustment and so that belt inspection can be made without having to remove the guards.

Each compressor shall be fitted with inlet air filtration as specified below. It shall be approved by the manufacturer to limit wear and ensure long life.
Each compressor shall be fitted with inlet air and/or purge silencers where necessary to reduce noise to acceptable levels.

Each compressor shall be provided with automated PLC or DCS based pressure set point control including the following controls:

Duty with selection of MANUAL-OFF-AUTO;
Compressor start (typically 600 kPa);
Compressor stop (typically 700 kPa);
Air E-Stop & local operating display including an indication of running, stopped, faulted, loaded, unloaded and the air pressure reading.

Air Receivers
Each air receiver shall be designed and constructed to meet all relevant Australian Standards and shall be supplied with test and compliance certification. The Contractor shall arrange for registration of all pressure vessels with the relevant Statutory Authority and shall provide all necessary Statutory Authority approvals.

Each air receiver shall be sized to limit the connected compressors to six (6) starts per hour during all operational sequences.

Each receiver shall be of all welded steel construction designed to AS 1210 and shall have a design rating of 1,000 kPa. The receiver shall be hot-dip galvanized inside and out to AS/NZS4792.

Each receiver shall:

Be fitted with an inspection opening large enough to allow access to the entire inside area of the tank for cleaning purposes;
Have a flanged air inlet connection;
Have a flanged air outlet connection;
Have a safety pressure relief valve;
Have a 100 mm diameter all stainless steel glycerine oil filled pressure gauge calibrated from 0 kPa to 1,000 kPa with a red line indicating normal operating pressure. The gauge shall be fitted with a gauge snubber;
Have a drainage outlet with an isolating valve and an automatic condensate drain;
Have two differential pressure switches (pressure control & monitoring to be provided using a pressure transmitter with separate switches as required for high / low pressure alarms) for the pressure control system; and
Have a pressure controller for unloading the compressor (if required).

Air Filters and Water Separators
There shall be two compressed air filters on the outlet of each air receiver upstream of its filter/dryer unit, one removing particles down to 0.1 microns and the other removing particles of 0.01 microns.

An automated filter/dryer unit shall be supplied to provide a compressed air quality of 1:2:1 to ISO 8573.1 with the following configuration:

Location in a common pipeline either before or after the two air receivers;
One coalescing pre-filter with zero-loss drain trap;
Duplex dryers;
One particulate after-filter with zero-loss drain trap; and
Capacity of a single filter/dryer train sized to handle 100% of the design air flow.
The compressed air quality after the air dryers and filters to ISO 8573.1 1:2:1 shall be:

Solid Particles, Class 1 100 solid particles 0.1 to 0.5 micron/m³; 1 solid particle 0.5 to 1 micron/m³; and 0 solid Particles 1 to 5 micron/m³.
Water, Class 2 Pressure dew point < - 20 °C; and
Oil, Class 1  < 0.01 mg/m^3 including vapour.

**Air Dryers**

The operation of each air dryer shall be continuous, and the air dryer shall be designed and constructed accordingly. The drainage from each air dryer shall be by means of automatic compressed air zero-loss drain traps with inlet Y-strainers and bypasses.

The design of the air dryer system shall comply with the following requirements:

- Each air dryer shall be of the heatless or externally-heated desiccant-filled type;
- Each air dryer shall be a twin tower design and shall be fully automated for in-service regeneration;
- It shall use a duty/standby arrangement. If regeneration is required or if failure occurs, then automatic changeover shall occur between the duty and standby air dryers; and
- The drainage of condensate from the air dryers shall be automated.
- Each air dryer shall be automatically controlled to produce a set-point controlled pressure dew point from no load to full load.

**Compressed Air Pipework**

The main distribution compressed air pipework shall be a minimum of 25 mm nominal diameter air quality ‘Dark Blue’ high density PE100 polyethylene pipe with welded and flanged fittings. Duplicate main distribution compressed air pipework shall be provided.

Individual connections from the main distribution pipe to controls or valves shall be made using smaller diameter air quality ‘Dark Blue’ high density PE100 polyethylene pipe joined with compression fittings. Flexible Grade 316 stainless steel metal hoses shall be used to connect to each piece of equipment. All compression fittings for the polyethylene pipe shall be Grade 316 steel “Swagelok” fittings or equivalent. All compression fittings for the flexible Grade 316 stainless steel metal hoses shall be Grade 316 steel “Swagelok” fittings or equivalent.

Isolating valves shall be installed throughout the compressed air pipework system so that equipment can be repaired without draining the whole of one leg of the compressed air distribution system.

The main distribution pipework shall have a falling grade of no less than 1 in 100 in the direction of flow. Automatic drain traps shall be installed at any low point and at the end of each run. All drains shall be to the process drainage system and shall not run across access walkways.

**4.2.17 Electric Motors**

**Design**

Electric motors shall be of the totally enclosed fan cooled type, fitted with ball or roller bearings designed for a nominal life corresponding to 40,000 hours when calculated in accordance with AS2729 at full load operation when the motor is direct coupled to the driven machine. Electric motors shall have ready access for lubrication and provision for excess grease relief.

Electric motors shall be totally enclosed fan-cooled and have an enclosure designation of at least IP 56 (for non-submerged applications) and IP68 (for submerged applications).

Electric motors shall be, insulated with a minimum of Class F materials in accordance with IEC 60034-18 and shall be designed to operate within Class B limits, as specified and measured by AS 60034.1., specially impregnated for moist atmospheric conditions. Electric motors for submerged application shall have Class E insulation.

For submerged motors a 660 V 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 cable gland and be encapsulated in an appropriate sealant. The other end of the cable shall
terminate in a hose-proof plug which shall fit into a hose-proof socket. All submerged motors shall incorporate suitable integral seal failure functionality.

The duty rating of each motor when determined by the method shown in AS 1359.30 shall be classified as Duty S1. The output rating of each motor as defined in AS 1359.30 shall be such that when cooled by air at 40°C it develops the maximum power required by the driven equipment when running under any condition of operation which may be encountered in normal use. This shall include zero head and closed valve conditions for centrifugal pumps or blowers and jamming by foreign matter for mechanical handling equipment. For positive displacement blowers, this shall include the maximum capacity of the blower against the worst condition of pressure expected plus 10%. This requirement is in addition to the requirements of the following paragraph.

Where electric motors are driven by variable frequency inverters, the maximum output rating for the motor shall be increased by 10% above the requirements of the above paragraph and all electric motors regardless of size shall be fitted with thermistors as detailed below.

**Duty**

All motors greater than 0.2 kW shall be 4 pole configuration and shall operate on a 415 V, 3 phase, 50 Hz supply. Smaller rated motors may, with the specific approval of the Superintendent, be single phase suitable for 240 V operation. Motors shall be capable of operating continuously at any frequency between 48 Hz and 52 Hz at a voltage which may vary within + 10% of the nominal value.

The motor shall be suitable for up to at least twelve (12) starts per hour or more frequent as applicable to the specific operational requirements of the motor, except where the Contractor can demonstrate that such a frequency of operation is unwarranted or impractical for the motor in question and the Endorsement process agrees this.

**Performance**

The motors shall be manufactured in accordance with AS 60034.1 with an electrical performance which complies with the relevant sections of AS1359 and AS 60034. The locked rotor current will not exceed 650% full load current.

Unless otherwise reviewed and agreed by the Superintendent, the maximum continuous rated shaft output of the motor shall be at least 10% greater than the design duty-point, or equal to the most severe operating point power of the driven machine, whichever is greater.

Where motors are mated to variable speed drives, the motor should be capable of continuous operation at 110% of its rated speed.

The motor shall comply with the requirements of AS 60034.9. and AS1359.114 with respect to noise and vibration.

**Frame Features**

All bearing housings shall be sealed to prevent moisture and dust from entering through the shaft opening.

Where motors are required to be located outdoors, or exposed to weather or sprays, they shall be constructed from cast iron or steel properly finished and painted and will have cast iron or steel fans, suitable for rotation in either direction, protected by a cast iron fan housing.

Each motor shall be provided with a brass or stainless steel plate fixed with two stainless steel screws or drive pins on which the motor identification number has been engraved.

**Terminal Boxes**
Terminal boxes shall be totally enclosed, of ample size for the connecting cables, sealed against air from the motor carcass and shall have flanged joints fitted with neoprene rubber gaskets and sufficient bolts or studs to ensure proper sealing.

Terminal boxes shall be capable of being mounted in any one of four positions and will generally be on the left hand side of the motor when facing the non-drive end and shall be bottom or side entry only.

**Thermistors**

Unless specified otherwise, for example submersible pumps and motors with variable speed drives, electric motors larger than 11 kW shall be installed with thermistor protection. In addition, all motors with variable voltage variable frequency drives or Intelligent Motor Protection Relays (IMPRs) shall incorporate thermistor protection. Thermistors shall be of the PTC resistor type connected in series, one per phase, integral with the stator windings and clearly marked in the terminal box. The thermistors, their fittings in the motor, reference temperature and testing of the motor shall be in accordance with AS 60947.8. All instruments shall be suitable for continuous unattended operation and shall maintain their rated accuracy with a minimum of maintenance or need for adjustment and re-calibration.

**Motor Heaters**

Motor heaters shall be provided to all motors which can be idle for extended periods (standby plant) with MCR greater than 11 kW. Heaters shall be suitable for connection to a single phase, 240 V 50 Hz supply.

**Fasteners**

All external fasteners in each motor including the terminal boxes shall be Grade 316 stainless steel.

4.2.18 **Safety Showers And Eyewash Stations**

Safety Showers and Eyewash Stations shall be located in close proximity to loading and storage areas containing storage and loading of chemicals, additionally where there is a risk of contamination from hazardous or corrosive chemicals.

A new safety shower and eye bath station shall be provided at the existing lime handling, storage and dosing system.

The safety shower should be potable water fed for continuity of supply for up to 15 minutes.

A header tank with a minimum volume of 1200 litres shall be provided which guarantees 15 minutes uninterrupted supply at 76 L/min.

Each header tank shall be provided with 2 No ballcocks with sufficiently sized inlet pipe to ensure replenishment of the tank within 30 minutes during no discharge.

Design standards of safety showers and eye wash units to be in accordance with AS4775.

Signs shall be clearly displayed in colours associated with this equipment to AS1319 to clearly identify this safety equipment.

All costs associated with the provision of safety showers and eye bath stations are the responsibility of the Contractor and shall be generally included in the Contract Sum.

Safety showers shall be hand and treadle operated and shall continue to operate until the valve is manually closed.

Trace tape and / or an immersion heater shall be used to heat the water.
The water temperature shall not exceed 20°C under normal ambient conditions and shall not drop below 15 deg C during the 15 minute showering duration.

The shower head shall deliver a conical deluge of water.

Shower frame pipework shall be of stainless steel encased in a PVC-U jacket and insulated with polyurethane and / or polystyrene encased in Green GRP panelling.

An eyebath shall be mounted adjacent to or on the rear of the standpipe.

Where required a light shall be mounted on the shower controlled by a timer and / or photocell to illuminate the shower when dark.

Signs and operating instructions shall be prominently displayed in the vicinity of the shower.

Drench showers shall have spray heads with overhead shower arms and bodywash facilities.

Showers and eyebaths shall deliver the following minimum flow rates:

Shower/Body wash 76 L/min;
Facewash 12 L/min; and
Hand Held Eyebath 4.5 L/min.

A means of draining each header tank for testing and maintenance shall be provided.

All units shall be manufactured with corrosion resistant materials with shower heads being anodised cast aluminium and facewash bowls being manufactured from stainless steel.

All units shall be designed for ‘hands free’ operation during emergency conditions.

Drainage shall be provided from all units.

4.2.19 Lifting Equipment
The Contractor shall be responsible for the provision and operation of all lifting equipment required for the execution of the Works.

All lifting equipment shall be certified and tested in accordance with the statutory requirements of the Workplace Health and Safety Plan and all regulations made there under.

Any lifting equipment provided by the Contractor under the Contract may be used for erection purposes, provided it has been tested and certified before it is used, and that it is restored to its original state and re tested prior to Practical Completion.

The use of lifting equipment belonging to the Superintendent, that may be available on Site, shall exclude the use of the slings, shackles and similar items.

The Contractor shall make his own assessment, by calculation or approved load testing equipment, of the weight of main components to be lifted and, prior to lifting, shall ensure the safe working loads (SWL) of any cranes and other lifting facilities are not exceeded.

All items of plant shall be designed to be removable. The Contractor shall provide lifting beams, hoists, eyes, davits, jibs, gantries, trolleys etc., to allow large / heavy plant items to be removed from any building, or containment areas, i.e. from the point of installation to the point of exit of any building / containment area. Alternative means of lifting, e.g. mobile crane shall be with the agreement of the Superintendent. Shipping routes from point of installation to point of exit shall be free from obstructions. Lifting equipment shall be designed to minimise manual handling.
Prior to any lifting operations taking place on-site, the Contractor shall prepare and submit a detailed Lifting Plan, as part of the Work Place Health and Safety Plan, covering all lifts of plant and equipment to demonstrate that a workable and safe process shall be adopted prior to such lifts.

### 4.2.20 Corrosion Protection Treatment Plants

#### General

All equipment, pipework systems, steel structures and concrete structures shall be supplied with or given corrosion protective coatings, except the following surfaces, unless specified otherwise elsewhere:

- Concrete structures exposed to aerobic mixed liquor which are not enclosed (i.e., not covered by odour collection covers) or exposed to secondary treated wastewater or Class D or better recycled water;
- Pipes in trenches;
- Stainless steel and non ferrous metals, e.g., aluminium and copper;
- Machine finished surfaces which will normally be lubricated;
- Chains and sprockets;
- Polyethylene and polycarbonate surfaces;
- ABS, PVC FRP and GRP surfaces not exposed to sunlight;
- Brickwork; and
- Colorbond products.

All coatings shall be confirmed by the manufacturer to be appropriate for the environment in which they are to be placed.

Pipework systems, including ABS, PVC and GRP, which are mounted externally or exposed to sunlight shall be coated with a coating appropriate to the pipe material and the duty environment unless the pipework is completely ultra-violet light stabilised.

Bitumen paint shall not be accepted by the Superintendent as an adequate corrosion protection on exposed cast iron or ductile iron pipes and fittings, either exposed in part or in full. Partly or fully exposed cast iron or ductile iron pipes and fittings shall be epoxy coated.

Surface preparation for and application of the coating treatments shall be in accordance with the manufacturer’s recommendations. The Contractor shall ensure that the coating thickness applied to all items is in accordance with this Contract Document and/or the manufacturers’ recommendations and is consistent with achieving the required design life of the asset stated in the Contract Documents.

All equipment items, valves and painted pipework shall have the final finish colour as per AS2700. A manufacturer’s standard equipment colour is acceptable for proprietary equipment items provided that the manufacturer’s coating system is consistent with achieving the required design life of the asset stated in the Contract Documents.

Typically concrete surfaces of enclosed structures will be provided with either an epoxy coating where the service conditions are not severe or where the conditions are severe and the structure can readily be bypassed for corrective maintenance or recoating, or a FRP/GRP liner where the conditions are severe and the structure cannot be readily bypassed for corrective maintenance or recoating.

Examples of locations where the conditions are not severe are the walls of a chlorine contact tank or a treated wastewater storage tank. Examples of locations where the conditions are severe but where the structure may be provided with a bypass are (i) under the covers for a Preliminary Treatment Area or (ii) a screened and degritted wastewater balance tank. In each case, if the structure was capable being bypassed, then this would allow the coating to be replaced when required. Typically a proven epoxy coating would be accepted in these locations.
An example of a location where the conditions are severe and where the structure cannot be provided with a bypass is under the covers for a flow distribution chamber downstream of a Preliminary Treatment Area. In order to maintain adequate flow distribution, the structure could not typically be bypassed to allow the coating to be replaced when required, thus requiring an extra long life GRP/FRP lining.

Alternate coatings to epoxy coatings such as a polyurea or a polyurethane coating may be considered by the Superintendent but only if the Contractor can provide evidence of the application of the product in a similar environment with excellent performance over a minimum period of five (5) years. The implications of coating failure are high and the Superintendent will seek to inspect the reference locations first hand to establish that the material is suitable.

Standards
The following Australian Standards are referenced within, and shall be read in conjunction with this specification:

- AS1192 Electroplated coatings, nickel and chromium
- AS1214 Hot-dip galvanised coatings on threaded fasteners (ISO metric coarse thread series)
- AS1318 SAA Industrial Safety Colour Code
- AS1319 Safety Signs for the Occupational Environment
- AS1345 Identification of the contents of piping, conduits and ducts.
- AS1627 Metal finishing – Preparation and pretreatment of surfaces
- Part 1: Cleaning using liquid and alkaline solutions
- Part 2: Hand and Power tool cleaning
- Part 4: Abrasive blast cleaning
- Part 9: (ISO 8501-1) Pictorial surface preparation standards for painting steel surfaces
- AS1789 Electroplated zinc (electrogalvanized) coatings on ferrous articles (batch process)
- AS1897 Electroplated coatings on threaded components (metric coarse series).
- AS2310 Glossary of paint and painting terms
- AS/NZS2312 Guide to the protection of structural steelwork by the application of corrosion-resistant coatings
- AS2700 Colour standards for general purposes
- AS894 Site testing of protective coatings
- Method 1: Non-conductive coatings – Continuity testing – High voltage ('brush') method
- Method 2: Non-conductive coatings – Continuity testing – Wet sponge method
- Method 3: Determination of dry film thickness
- Method 5: Determination of surface profile
- Part 10: Inspection report – Daily
- Part 11: Equipment report
- Part 12: Inspection report - Coating
- AS/NZS4020 Products for use in contact with drinking water
- AS4312 Atmospheric corrosivity zones in Australia
- AS/NZS4680 Hot-dipped galvanised (zinc) coatings on fabricated ferrous articles.
- AS4848.1 Application specifications for coating systems, Part 1: Single coat inorganic zinc silicate

The following document is also referenced within, and shall be read in conjunction with this Contract Document:

APAS Australian Paint Approvals Scheme – Specification List www.apas.gov.au

General Corrosion Protection Requirements
All coating materials used shall be of the type and quality described herein and shall have Australian Paint Approval Scheme (APAS) endorsement for the relevant application.

Colours for top coats shall be as specified in the design delivery documents. Where colours are indicated they shall match Australian Standard AS2700S.
All work shall be carried out to accepted standards of good practice as described in AS/NZS2312 by competent tradesmen and to the review by the Superintendent.

A schedule of data sheets for alternative manufacturers equivalent and compatible products of the protective coating systems proposed to be used on the surfaces of all main parts of the equipment, structures and fittings shall be submitted for review by the Superintendent. If requested, sample panels of any proposed coating system shall also be supplied.

**Health and Safety (Corrosion Products)**
Statutory health and safety requirements shall be followed at all times and environmental regulations observed. Site safety, health and work procedures shall be followed for any work which is carried out on the site or for any off-site coating work.

Attention shall be paid to all Material Safety Data Sheets and warning labels attached to the coating and related product containers and the relevant technical literature. Safe Work Method Statements shall be in place to comply fully with these directions.

Scaffolding and other equipment shall be erected and maintained by qualified persons.

Eye, hearing and face protection shall be worn by all operators to comply with the all relevant associated legislation, the Contractor’s Site Safety Management Plan required by SS10 Section 2 and all of the Contractor’s subservient Safe Work Method Statements and the like.

In the least:

First aid equipment including eye wash bottles shall be located adjacent to the material pump;
Adequate ventilation shall be provided at all times to remove solvent vapours from the area;
Spark proof equipment and tools shall be used;
Spray and blast cleaning equipment shall be earthed to eliminate any electrostatic charge; and
“No Smoking” and “Flammable Liquid” signs shall be displayed and suitable fire fighting equipment shall be readily available at the work place.
This Project Specification does not purport to address all health and safety problems associated with surface preparation and use of protective coatings. The Contractor shall ensure that the users and operators establish appropriate health and safety practices, follow appropriate Safe Work Method Statements and determine the applicability of regulatory limitations prior to proceeding with work of this type.

**Concrete Surfaces - Epoxy Resin Coating**
Various surfaces of the structures shall be coated with Peerless Emulsion "Epigen 1311" or an alternative reviewed by the Superintendent. The extent of the coating shall be as shown on the Project Drawings or specified in the relevant clause of SS10 Sections 4&5. This Section of the Contract document shall apply to all references for epoxy coating of concrete surfaces unless specific requirements are provided otherwise.

The epoxy resin coating shall not be applied until at least 28 days have elapsed from the time of placing the concrete. The receiving surfaces shall then be well cleaned of all loose material by light ‘whip’ sandblasting in strict compliance with the manufacturer's recommendations.

A sample of the finished coating on a piece of fibre cement sheet, or similar, shall be supplied by the Contractor to the Superintendent for review together with details of the repairs outlined below and the method of application to any surfaces being coated.

All air holes and other defects shall be rectified by bagging with a sand filled epoxy mortar or microsphere filled epoxy filler and grinding as appropriate to ensure a smooth surface for the coating application. Cementitious based materials shall not be used for the surface repair. Following filling, the
The coating shall generally be reddish brown in colour and shall have a smooth surface free from any irregularities or undulations. Specialist sub-contractors endorsed by the manufacturer shall apply the epoxy resin coating to the manufacturer’s recommendation. Two coats shall be applied to give a minimum dry film thickness of 600 microns.

The coating shall show no noticeable deterioration at the end of the Defects Rectification Period. Should deterioration be evident the coating shall be made good in accordance with the recommended procedures of the manufacturer.

Concrete Surfaces – FRP/GRP Linings
Where an epoxy coating is not expected to provide sufficient service life, the Contractor shall provide a GRP/FRP lining to achieve the required design life or the functionality.

The materials of construction for the liner shall conform to the following:

The materials selected shall be inherently corrosion resistant under the conditions that might reasonably be assumed to exist in a enclosed raw wastewater situation with high levels of dissolved hydrogen sulphide and turbulence;
The materials selected shall be easy to repair/modify by FRP/GRP specialists using readily available materials and processes; and
The physical design life of the liner shall be 25 years. All components shall provide a physical life of 25 years with no maintenance.
The liner shall not be applied until at least 28 days have elapsed from the time of placing the concrete. The receiving surfaces shall then be well cleaned of all loose material by light ‘whip’ sandblasting in strict compliance with the manufacturer’s recommendations.

All air holes and other defects shall be rectified by bagging with a sand filled epoxy mortar or microsphere filled epoxy filler and grinding as appropriate to ensure a smooth surface for the liner application. Cementitious based materials shall not be used for the surface repair. Following filling, the whole area to be coated shall be etched using an acid solution in strict compliance with the manufacturer’s directions.

The applied FRP/GRP liner shall conform to the following requirements:

The minimum liner thickness shall be 8 mm overall with a 2 mm minimum thickness of resin on the exposed surfaces;
All internal corners for wrapped or strapped joints between components shall be coved using a suitable filler to ensure that the jointing layers are properly adhered to all surfaces;
All external corners for wrapped or strapped joints between components shall be rounded with a suitable radius to ensure that the jointing layers are properly adhered to all surfaces;
The mating parts of any sections with flanged joints shall be fabricated using a female mould onto which the required section thickness shall be laid up;
All holes shall be drilled a minimum of 4 mm oversize. The hole edges shall be sealed with a 2 mm minimum thickness of resin to provide a mechanically robust cover to the glass fibres to prevent moisture entry;
All exposed edges not wrapped or strapped shall be sealed with a 2 mm minimum thickness of resin to provide a mechanically robust cover to the glass fibres to prevent moisture entry;
All exposed surfaces of the liner shall be provided with a 2 mm minimum thickness of resin to provide a mechanically robust cover to the glass fibres to prevent moisture entry; and
Following inspection by the Superintendent, all surfaces shall be spark tested to identify any holidays in the liner.
Cathodic Protection
Where acid sulfate soils, currents from earthing systems and the like, overhead power lines or similar circumstances exist, the use of cathodic protection shall be investigated and costed and submitted for approval to the Superintendent for steel pipelines, diecast flowmeter bodies, etc.

Where cathodic protection is installed, accurate drawings of the location of anode beds and connections shall be produced.

4.2.21 Building Specification

Building Work Requirements

Purpose
The purpose of this section of the Project Specification is to provide the requirements for the building work including quality of materials and workmanship in order to achieve strength, durability, performance and quality of finish.

The building design shall specifically comply with the Development Application and any requirements of the Contract Documents.

Scope
This section of the Project Specification applies to the provision of all plant, labour and materials and shall include all necessary site earthworks, excavation and backfilling, concrete work, brickwork, blockwork, joinery, plumbing, roofing, floor and wall finishes and any other work necessary to complete the building work.

The building work shall be undertaken in accordance with:
- The Project Specification;
- The relevant Australian Standards;
- The Building Code of Australia;
- Our Living City – Gold Coast Planning Scheme;
- Energex’s requirements;
- The Fire Safety Act; and
- All other statutory requirements.

The Contractor shall obtain all approvals required under the Building Codes of Australia and relevant Acts and standards.

The work shall be performed in the tradesmanlike manner to a very high standard, fully in accordance with all applicable standards and to the written instructions of the various suppliers/manufacturers.

Where the Superintendent deems that the building work does not comply with the required standard, the Contractor shall demolish and remove the rejected work and replace it with complying work acceptable to the Superintendent.

The following areas shall be enclosed or covered:

- All equipment areas that contain equipment rated less that IP56;
- Noisy equipment;
- Main switchboards, motor load centres and motor control centres; and
- Electrical controls and instrumentation installations.

The requirement for a building at any location shall be confirmed by case by case analysis and shall be subject to review by the Superintendent.

Standards
Building design shall comply with all Building Code of Australia requirements for Queensland.
Equipment, materials and work shall be to Australian Standards or endorsed International Standards where suitable Australian Standards are not applicable or appropriate.

The following shall apply to materials:

Aluminium
AS/NZS1866 Aluminium and aluminium alloys – Extruded rod, bar, solid and hollow shapes
**Aluminium Windows**

- AS1231: Aluminium and alloys - Anodic oxidation coatings
- AS2047: Windows in Buildings – Selection and installation

**Bricks and Concrete Masonry**

- AS/NZS4455: Masonry units and segmental pavers
- AS1316: Masonry cement (metric units)
- AS2699: Built-in components for masonry construction – Wall ties
- AS/NZS4455: Masonry units and segmental pavers

**Bolts**

- AS1111: ISO Metric Hexagon, Bolts and Screws – Product Grade C
- AS1112: ISO Metric Hexagon Nuts
- AS1237: Plain washers for metric bolts, screws and nuts for general purposes
- AS1252: High Strength Steel Bolts with Associated Nuts and Washers for Structural Engineering

**Concrete Constituents**

- AS2758: Aggregates and Rock for Engineering Purposes
  - Part 1 – Concrete Aggregates
- AS3972: Portland and Blended Cements

**Doors**

- AS1905.2: Components for the protection of openings in fire-resistant walls – Fire resistant roller shutters

**Glazing**

- AS2208: Safety glazing materials for use in buildings (human impact considerations)
- BS952: Glass for glazing
  - Part 1 – Classification
  - Part 2 - Terminology for work on glass
- BS4255: Rubber used in gaskets performed for weather exclusion from buildings
  - Part 1 - Non cellular gaskets
  - Part 2 - Cellular gaskets TTS-001543A sealing compound, silicone rubber base (US Federal Interim Specification Standard)

**Plastering and Tiling**

- AS1672: Limes and limestones – Limes for buildings
- BS1014: Specification for pigments for Portland cement and Portland cement products

**Sheet Metal Roofing and Accessories**

- AS1397: Steel sheet and strip-hot-dipped zinc-coated or aluminium/zinc coated
- AS2179: Specifications for rainwater goods, accessories and fasteners – Metal shape or sheet rainwater goods, and metal accessories and fasteners
- AS2728: Prepainted and organic film/metal laminate products – Performance requirements for interior/exterior applications in building
- AS3566: Screws – self drilling for the building and construction industries

**Steel**

- AS1163: Structural Steel Hollow Sections
- AS1554: Structural Steel Welding

**PVC**

- AS1260: PVC Pipes and Fittings for drains, waste and vent application
- AS1273: Unplasticized PVC (uPVC) Downpipe and Fittings for Rainwater

**Vinyl Floor Coverings**

- AS2055.1: PVC sheet floor covering unbacked flexible
The following shall apply to workmanship and design:

Fire Testing
- **AS1530** Methods for fire tests on building materials components & structures
  - Part 3 - Simultaneous determination of ignitability, flame propagation, heat release and smoke release
  - Part 4 - Fire resistance tests of elements of building construction

Glazing
- **AS1288** Glass in buildings – Selection and installation
- **AS2047.1** Windows in Buildings - Selection and installation
- **AS2047.2** Windows in buildings – Construction, installation and maintenance

Identification
- **AS1319** Safety Signs for the Occupational Environment

Loads
- **AS1170** Structural design actions
  - Part 2 - Wind actions

Masonry
- **AS3700** Masonry structures

Miscellaneous
- **AS/NZS4201.3** Pliable building membranes and underlays – Methods of test – Shrinkage
- **AS/NZS4200.2** Pliable building membranes and underlays – Installation requirements
- **AS/NZS4200.1** Pliable building membranes and underlays - Materials

Plastering and Tiling
- **BS 8481** Design, preparation and application of internal gypsum, cement and lime plastering systems- Specification
- **PD CEN/TR15123** Design, preparation and application of internal polymer plastering systems.
- **BS EN13914.2** Design, preparation and application of external rendering and internal plastering. Design consideration and essential principles for internal plastering.
- **BS EN13914.1** Design, preparation and application of external rendering and internal plastering. External rendering.

Roof Plumbing
- **AS1562** Design and installation of sheet roof and wall cladding - Metal
- **AS3500.3** National plumbing and drainage – Stormwater drainage
  - Part 1 – Performance requirements
  - Part 2 – Acceptable solutions

Steelwork
- **AS/NZS4600** Cold-formed steel structures
- **AS4100** Steel Structures

Termites
- **AS3660.1** Termite Management – New Building Work

The following Australian Standards shall apply to equipment:

Fire Fighting Equipment
- **AS1221** Fire Hose Reels
- **AS2441** Installation of Fire Hose Reels

In addition to the above, other relevant Australian Standards, or in their absence, other recognised standards shall apply.

Definitions
The Contractor shall refer to definitions contained in this Project Specification and the standards and references.
Building Work Requirements
Extent of Work
The work include the supply, installation and construction including all necessary finishing of all building structural and other work as required by this Project Specification and as shown on the Contractor’s Design Deliverables reviewed by the Superintendent.
The work shall be complete with all necessary items for sound structural performance, efficient operation and high standard of finish.
Site Earthworks
The Contractor shall undertake site earthworks as specified in this Project Specification and as shown on the Contractor’s Design Deliverables reviewed by the Superintendent.
Excavation and Backfilling
All excavation for each building’s foundations, ducts, trenches and floor slab/s shall be made to the lines, levels and forms shown on the Contractor’s Design Deliverables reviewed by the Superintendent and to the standards described in this Project Specification.
All backfilling around each building shall be completed to the lines, levels and forms shown on the Contractor’s Design Deliverables reviewed by the Superintendent and to the standards described in this Project Specification.
Termite Protection
The earth beneath concrete floor slabs shall be treated for termite protection in accordance with AS3660.

Concrete
Concrete work shall conform to the requirements Project Specification.
The Contractor shall take care to ensure that exposed off-form concrete surfaces are the smoothest finish with a homogeneous appearance and comply with any specific requirements of the Project Specification. Form-tie holes shall be plugged in a manner consistent with the required finish.

Masonry
Materials
All masonry units shall be of an reviewed brand. Concrete masonry units shall be of the thickness indicated on the Contractor’s Design Deliverables reviewed by the Superintendent, either hollow or solid as specified and complete with all special blocks where required, such as corners, halves, lintels, sills, jambs and column blocks.
All concrete masonry units shall have a minimum characteristic unconfined compressive strength (f’uc) of 15.0 MPa. All clay masonry units shall have a minimum characteristic compressive strength of 7.0 MPa.
All hollow concrete units which are specified to have concrete filling shall have clean open cavity through the full depth of the unit. Blocks with partly obstructed cavities shall be rejected. Clean-out blocks shall have one fully open vertical face.
Broken or damaged units shall not be used in unrendered walls. Units damaged after laying shall be replaced.
Samples of units shall be submitted to the Superintendent and reviewed before use or delivery. Units which do not conform to the reviewed standard shall be rejected.
The mortar shall be mixed in a reviewed mixing machine for not less than three minutes. Handmixing shall not be employed unless specifically reviewed by the Superintendent.
The dry ingredients shall be thoroughly mixed prior to addition of water which shall then be worked thoroughly through the mixture.
Mortar which has become excessively stiff so as to make placement difficult shall be rejected.
Retempering of mortar will be permitted for up to one (1) hour after initial mixing.
Cement shall be Type “GP” general purpose Portland cement of an reviewed brand and shall comply with AS3972 – Portland and Blended Cements.
Sand shall be clean, sharp, pit or fresh water sand, free from loam, saline, or vegetable matter or other impurities and shall not contain soft or weathered particles and if agreed shall be washed when used with cement. Sand shall conform to the grading and properties shown in Table S3.4.

Table S3.4 Sand Grading and Properties
Sieve Aperture & Percent Passing

<table>
<thead>
<tr>
<th>Sieve Aperture</th>
<th>Percent Passing</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.76 mm</td>
<td>95 – 100</td>
</tr>
<tr>
<td>2.36 mm</td>
<td>95 – 100</td>
</tr>
<tr>
<td>1.18 mm</td>
<td>60 – 100</td>
</tr>
<tr>
<td>600 µm</td>
<td>30 – 100</td>
</tr>
<tr>
<td>300 µm</td>
<td>10 – 50</td>
</tr>
<tr>
<td>150 µm</td>
<td>0 – 10</td>
</tr>
<tr>
<td>75 µm</td>
<td>0 – 4</td>
</tr>
<tr>
<td>Fineness Modules</td>
<td>1.5 – 2.8</td>
</tr>
</tbody>
</table>

Mortar
The mortar shall comply with the requirements of Section 10 of AS3700 for a mortar of M3 classification. Compressive and flexural strength of the masonry shall be determined in accordance with Appendix A of AS3700. Such testing shall be conducted on samples of materials to be incorporated in the work, prior to any brickwork or blockwork commencing on site. The specimens shall be prepared by the same tradesmen to be employed on the work and shall be prepared in the presence of the Superintendent. The Superintendent will arrange for testing of the specimens and the Contractor shall deliver the specimens to the testing place nominated by the Superintendent.

Additional strength testing shall be conducted during construction in accordance with Sections 7 and 8 of AS3700.
The average strengths of the specimens tested prior to construction commencing shall not be less than the following:
- Compressive strength $f'm = 8.8$ MPa
- Flexural tensile strength $f'mt = 0.34$ MPa
  For testing during construction, strength values shall comply with AS3700. The characteristics strengths shall be taken as:
- Compressive strength $f'm = 6.3$ MPa
- Flexural tensile strength $f'mt = 0.2$ MPa
All masonry construction represented by a sample deemed not to comply in accordance with Clause 8.6 of AS3700 shall be demolished and removed entirely from the Site.

Workmanship
Masonry units shall be laid to straight and vertical lines and to the layout shown on the Contractor’s Design Deliverables reviewed by the Superintendent, in accordance with manufacturer’s instructions and with AS3700 and SAA Masonry Code.
All concrete masonry units shall be laid dry and blocks stockpiled on the job shall be well protected from weather. The tops of all walls shall be covered upon stoppage of work to prevent moisture penetration. Prior to being used in the work, clay masonry units shall be thoroughly wetted and the top of all brickwork left overnight shall be thoroughly wetted before recommencement of work. Except where reinforced concrete filling is required, all cavities which extend below external ground level shall be filled with fine waterproof concrete.
Unless otherwise shown on the Contractor’s Design Deliverables reviewed by the Superintendent or in the Project Specification, junctions of frames and other metalwork with blockwork shall be raked back 15 mm to receive mastic pointing specified in the clause on Tiling.
Where concrete masonry walls are built up to the underside of beams, stairs or slabs, unless shown otherwise on the Contractor’s Design Deliverables reviewed by the Superintendent, the walls shall finish with 100 mm high blocks, or cut solid blocks, whichever are required to close the opening. All fixings into blocks shall be with reviewed brand plugs of the required sizes. Cutting of masonry units shall be avoided wherever possible.
Masonry shall be laid in stretcher bond. Brickwork shall be laid in even courses with 7 courses to each 600 mm height of wall. Intersecting masonry walls and partition walls shall be bonded as shown on the Contractor’s Design Deliverables reviewed by the Superintendent or by Grade 316 stainless steel ties at 400 mm centres in the vertical direction. Medium duty Grade 316 stainless steel wall ties shall be provided in cavity walls in accordance with Section 3 of AS3700 unless otherwise specified or shown on the Contractor’s Design Deliverables reviewed by the Superintendent.
Masonry units shall be bedded in even courses properly levelled and plumbed and bonded and laid with uniform close joints, not exceeding 10 mm thick and not less than 6 mm thick. Vertical joints shall be laid with a sufficiency of mortar to extend across the full face of the masonry. The joints shall be tooled flush with the face of the masonry.

Concrete blockwork shall be reinforced as shown on the Contractor’s Design Deliverables reviewed by the Superintendent.

All joints shall be properly filled with mortar and shall be struck or grooved as specified. Unless otherwise specified, agreed, or to match existing masonry, concrete masonry joints shall be grooved and brickwork joints shall be fully raked.

Internal work shall, where required, have joints left rough ready for rendering, tiling and similar finishes. When agreed by the Superintendent samples of joints shall be prepared by the Contractor and reviewed before work proceeds.

Concrete masonry bond beams to the exterior of the building shall be constructed of 200 mm high knock-out bond beam blocks filled with fine aggregate Class S32 concrete as shown on the Contractor’s Design Deliverables reviewed by the Superintendent, or specified in the Project Specification. Reinforcement shall not be less than two 12 mm diameter bars cross tied at 300 mm intervals with No. 8 gauge Grade 316 stainless steel wire stirrups. Bond beams shall not be continuous across control joints.

Lintels in 200 mm concrete masonry walls shall be constructed of 400 mm deep lintel blocks and shall be concrete filled and reinforced as shown on the Contractor’s Design Deliverables reviewed by the Superintendent.

Vertical control joints shall be constructed at the following maximum spacings in concrete masonry walls:

Where no joint reinforcement – 8 m;
Where 600 mm vertical spacing of joint reinforcement – 10 m; and
Where 400 mm vertical spacing of joint reinforcement – 12 m.

Vertical control joints shall be constructed at a maximum spacing of 18 m, or where shown on the Contractor’s Design Deliverables reviewed by the Superintendent, in clay masonry walls.

When required the joints shall be located:
At major changes in wall height;
At changes in wall thickness other than for piers and buttresses;
At control joints in footings, in roof and in floors;
At chases and recesses for piping, columns, fixtures, etc;
At one or both sides of wall openings;
Near wall intersection; and
Near return angles in L, T and V shaped structures.

No power-driven type fixings shall be permitted for any fixings where the member is under tensile stress or in 110 mm work.

Hot dip galvanised steel arch bars or angles shall be provided above window and door openings as shown on the Contractor’s Design Deliverables reviewed by the Superintendent or specified in the Project Specification.

All workmanship shall be in accordance with Section 11 of AS3700.

Face Work
The Contractor shall set out face work to avoid cutting of blocks. Units in single leaf walls with face work both sides shall be specially selected.
The Contractor shall keep perpends in alternate courses in vertical alignment.

Wall Ties
Unless specified otherwise in the Project Specification, wall ties shall be as set out below.
Ties to concrete shall be provided at every fourth bed joint in brickwork or 90 mm high blockwork, and at every second bed joint in 190 mm high blockwork, as follows:
Tie masonry walls abutting concrete walls or columns with 38 x 1.6 x 300 mm Grade 316 stainless steel straps. Bend and cast straps into concrete, or if permitted by the Superintendent, fix to face of concrete with Grade 316 stainless steel power fixings or masonry anchors, and provide at least 75 mm embedment in mortar joint; and
Tie block linings faces of concrete elements with 4 mm diameter Grade 316 stainless steel wire ties cast into concrete, carry across cavities if any, and build into blockwork at not more than 600 mm centres horizontally and stagger vertically.

Ties for tying masonry walls to steel columns shall be 3.15 mm diameter Grade 316 stainless steel. The Contractor shall loop ties around rods welded to columns as shown on structural steelwork drawings and building into masonry every:

- Fourth bed joint in brickwork or 90 mm high blockwork; and
- Second bed joint in 190 mm high blockwork.

**Masonry Walls**

All concrete masonry blocks shall be manufactured in accordance with AS/NZS4455. All blocks shall have a minimum characteristic compressive strength of 15 MPa.

The mortar shall comply with the requirements of AS3700 for a mortar of M3 classification. Mortar joints shall be stuck flush with the blockwork where plaster is to be applied or grooved with a round tool where a blockwork finish is required.

All reinforced cores of the blockwork walls shall be concrete filled using Class S20 fine aggregate concrete.

Horizontal reinforcing bars in bond beams shall be held in position by the use of purpose made chairs. All workmanship shall be in accordance with the requirements of Section 11 of AS3700.

Clean-out openings shall be provided at the base of all walls and columns at each lift. All cores shall be cleaned of all mortar protrusions by rodding from the top of the wall. All mortar droppings and foreign matter shall be removed at the clean-out openings. The vertical reinforcement shall be fixed in position by tying to the bars protruding from the floor slab or previous wall section. Formwork shall be fixed in place to seal all openings.

Core-filling concrete shall be placed in 2.0 metre maximum height lifts. At horizontal bond beams the blockwork shall be constructed to the underside of the bond beam and cores filled. The blockwork shall then be constructed to the top of the bond beam, reinforcement installed and the bond beam filled with concrete. Blockwork shall not be constructed above the bond beam until concrete is placed in the bond beam.

Core-filling concrete shall be compacted by rodding or the use of small immersion vibrators. Rodding of cores using core reinforcement is strictly prohibited. Placement of concrete shall be carried out in one continuous operation. The top surface of core concrete in walls or columns shall be prepared as a construction joint in accordance with Section 12.

At the completion of construction all masonry walls shall be cleaned down, as reviewed by the Superintendent, to remove stains. Acid cleaning is not permitted.

**Services Installation**

Wherever possible, service pipes and conduits shall be built into walls and walls shall not be chased after construction. Particular care shall be taken in setting out conduit and other services so that no pipes are exposed or chased into face of walls which are finished as face blockwork.

Where chases are required in unfinished work, these shall be made by cuts with an abrasive saw to the required depth, the remainder being chiselled out. No chases shall be made without the prior review of the Superintendent.

The Contractor shall:

- Form all chases necessary for other trades and form any necessary coring, corbelling, oversailing or set-back courses, splays or rebates as required;
- Provide and build-in all reviewed patent plugs where practicable and grounds for securing joinery as required;
- Build-in all bolts, plugs, straps and similar items as work proceeds; also door and window frames, angle guards and flashings as specified;
- Building-in all items, including pipes and sleeves, set in position or supplied by subAlliance as required;
- Form holes for rainwater and other pipes and communications cables and similar items as required and make good after other trades; and
- Form holes through walls for mechanical equipment.

**Sills**

The Contractor shall lay full height centre block sills where shown on the Contractor’s Design Deliverables reviewed by the Superintendent. Sills shall match the colour of face blocks.
Sill blocks shall be set out symmetrically so that no block is less than three quarters of full length.

Cappings
At positions shown on the Contractor’s Design Deliverables reviewed by the Superintendent, and where otherwise required, the Contractor shall provide a 40 mm thick capping block to top of external concrete masonry bond beam walls.

Cleaning Down
Face blockwork shall be protected during erection from damage and staining and all face work shall be kept clean as work proceeds. Finished work shall be cleaned down after the mortar has hardened by rubbing down with a piece of block, carborundum stone or wire brushing. Only clean water may be used, acid cleaning is not permitted. The Contractor shall follow dry cleaning with hosing down.

Vanadium (green) stain shall be wetted and treated with 10% soda in water. The Contractor shall hose down and repeat as necessary.

Timber stain shall be wetted and treated with 10% oxalic acid using rag swab on a stick or similar used in accordance with the manufacturer’s recommendations. Finally, the work shall be hosed down well. The whole of the masonry shall finish clean and free from all defects and stains.

Damp-proof Courses and Flashings
Flashings shall be provided at all places necessary to ensure the weather-tightness of the building. Flashings and damp-proof courses shall be heavy aluminium core and be UP Building Products “Aluminium Flashing” and Dimet Construction Products “Alcor DPC” or similar reviewed products respectively.

Flashings and damp-proof courses shall be lapped 300 mm at changes of direction only. Joints shall be double folded and sealed with bitumastic adhesive. The Contractor shall step flashings where necessary. Where stepped, flashing shall be turned up in cavity at inner end and dressed down at outer end so that water cannot run back into cavity.

Doors
General
Doors shall be 40 mm thick, ply lined with a solid core flush panel of the dimensions detailed and scheduled. Doors shall be obtained from a reviewed manufacturer. Framing timbers shall be kiln dried stress free reviewed softwood, and non-susceptible or treated for immunity to Lyctus Borer, or of species specified.

The core shall be formed from kiln dried, stress-free reviewed softwood core members assembled, butt jointed and treated with a reviewed preservative.

Both stiles of each flush door leaf shall be edged with timber edge strips of 12.5 mm (finished) thickness, extending full thickness of door and finishing flush with face.

The strips shall be of a reviewed timber species and where a decorative veneer is specified or scheduled, of a similar species.

Fire doors shall resist fire for a minimum of 2 hours.

Any door exposed to the elements shall be weatherproof quality and all adhesives used shall be warranted waterproof.

Materials and Workmanship
Door handles, catches, locks, etc. shall be set at heights as agreed by the Superintendent.

Hardware unless otherwise described shall have a satin chrome plate finish. Exposed screws shall be Grade 316 stainless steel. All other screws shall be brass or Grade 316 stainless steel.

Where trade names and reference numbers are used, fittings of different manufacture but of equivalent performance and quality may be reviewed by the Superintendent.

All hinges shall be Grade 316 stainless steel butt hinges unless extended hinges are shown on the Contractor’s Design Deliverables reviewed by the Superintendent or specified in the Project Specification. Extended hinges shall also be Grade 316 stainless steel.

Electric Door Strikes and Card Readers
Electric door strikes and associated card readers on all exterior doors and for interior doors between sections of the building with different uses/classifications under the Building Code of Australia shall form part of the security work required by Section S3.7.10 of the Project Specification and provided by the Contractor.

Keying
Master key systems and locks shall match the existing the Principal's master key system and locks used for AW assets. The keys and locks shall be obtained from API Security.
Plastic tags shall be fitted to all keys, which shall be labelled appropriately and handed over before Practical Completion to the Superintendent.

All lock combinations shall be master keyed as to match the existing GCCC standards. The Contractor shall supply two duplicates of each master key and stamp each lock cylinder and key with letter and number references. Keys shall be nickel alloy, not brass.

Responsibility for Performance
The Contractor shall be responsible for ensuring the proper fixing and operation of all hardware. All hardware shall be removed and refixed as required for painting of doors.

Door Schedule
The Contractor shall submit a Door Schedule with the building design for the Superintendent’s review. The Door Schedule shall tabulate the following:

- Door Number
- Room Name
- Door Type, Size, Finish, Kick plate, Glass Panel, Grille
- Frame Material, Type, Threshold Material, Hinges, Height, Highlight Panel; Finish, Handing
- Furniture Lock Type, Push Plate, Pull Handle, Closer, Knob, Bolt, Doorstop, Floor Spring, Finish, Electric Door Strike, Keying

Roofing and Ceilings
General
The Contractor shall provide the whole of the buildings where specified to have metal roofing with a fully watertight and birdproof roofing system of the type specified, complete with all necessary accessories, trim and roof plumbing including capping, flashings, gutters, outlets and overflows. The roof system shall include an insulation blanket supported on wire mesh to the satisfaction of the Superintendent.

The roof shall be left clean and free from debris on completion. The Contractor shall ensure that no debris is allowed to be deposited on the roofing and that no debris enters the drainage system. Unless otherwise specified all roofing materials shall be “Colorbond” finished matching the existing Colorbond roofing.

Roofing shall be installed by tradesmen skilled and experienced in the types specified and in accordance with manufacturer’s instructions.

The Contractor shall carry out all necessary operations for the satisfactory performance of the roof, including cutting at junctions, trimming around penetrations and flashings. Before roofing work commences all work above roof level shall be complete or if not the Contractor shall be responsible for protecting the roof fabric from damage. The Contractor shall avoid construction loads on roof.

Materials and Workmanship
Roof sheeting shall be of the profile shown on the Contractor’s Design Deliverables reviewed by the Superintendent or as specified in the Project Specification and unless otherwise specified shall be “Colorbond” finished as manufactured by Lysaght Brownbuilt Industries or an alternate reviewed manufacturer. Normally roof sheets shall be in single lengths to suit each section and to fall from the high point to the gutter with no intermediate joints. The Superintendent’s review shall be obtained to use more than a single sheet in each run for roof section. Manufacturer’s accessories shall be used unless shown or specified otherwise.

Roof sheeting shall have a 0.48 mm base metal thickness, Colorbond finish.

50 mm thick “Bradford Anticon” roofing blanket installed in accordance with the manufacturer’s instructions shall be provided under all roof sheeting.

Fascia and wall sheeting shall be submitted to the Superintendent for review and unless otherwise specified shall be “Colorbond” finished. Sheets shall be in single lengths to suit each section and to be fixed to supports with reviewed clips or fasteners in accordance with the manufacturer’s recommendations.

Flashings, trims, rib and stops and all sundries unless otherwise specified shall be “Colorbond” finished steel to match adjacent material.

Joint sealants shall be butyl sealing tapes and silicone caulking compounds.
All jointing materials, wedges, holdfasts, tacks, collars and connections as required and necessary shall be of a material compatible with the basic materials used. All rivets and roof and wall screws shall be Grade 316 stainless steel and suitably protected against galvanic corrosion.

**Roof Sheeting**

Roof sheeting shall be laid strictly in accordance with manufacturer’s printed directions to falls indicated on the Contractor’s Design Deliverables reviewed by the Superintendent. Roof sheeting shall be laid in single lengths to roof slope with uniform falls at right angles to the purlins. Should it be necessary to use more than one sheet to provide full length coverage, the Contractor shall commence sheet laying at the gutter line and lay subsequent sheets over this sheet to the ridge or fascia, allowing a minimum end lap of 150 mm. End laps in roofs of less than five degrees pitch (approximately 1 in 12) shall be sealed with a reviewed sealant. The minimum end lap for vertical wall cladding shall be 100 mm.

The Contractor shall turn sheet ends up approximately eighty degrees at the high end of the roof that is at ridges or fascia, and turn downwards approximately fifteen degrees at gutters, with the appropriate turn-up/-down tool.

Sheeting shall be fixed to the purlins and girts in strict accordance with the manufacturer’s printed recommendations.

The Contractor shall provide all trims, accessories, etc., required where roof surface is penetrated by pipes, services, etc.

The Contractor shall provide all flashings to parapets, upstands, holes and other penetrations and trims required to ensure that the roof is entirely watertight.

**Metal Ceiling**

Metal ceiling sheeting shall be submitted to the Superintendent for review and unless otherwise specified shall be “Colorbond” finished. Sheets shall be in single lengths to suit each section and to be fixed to supports with reviewed clips or fasteners in accordance with the manufacturer’s recommendations.

**Insulation and Sisalation**

Roofing blanket shall be placed under sheeting before fixing. Insulation projecting past the gutter purlins into the box gutter shall be trimmed off. Roofing blanket shall be supported on wire mesh to the satisfaction of the Superintendent. Bulk insulation shall be installed so as not to reduce ‘loft’ thickness required to achieve nominated R. value.

Unless specified to the contrary in the Project Specification heavy duty sisalation shall be provided on all sheeted surfaces. The sheeting shall be laid over the purlins or girts before the roof sheets are laid. Unless agreed otherwise by the Superintendent, sisalation shall be Bradford Thermofoil 753.

**Bulk Insulation**

Bulk insulation shall be two layers of R2.0 fibreglass insulation, one layer fixed over the purlins beneath roof sheeting and one layer laid over metal ceiling sheeting or fascia sheeting.

**Sealed Joints**

Where sealed joints are required, the Contractor shall use a sealant in conjunction with mechanical fasteners. Sealants acceptable to the Superintendent include GE Silpruf silicone rubber sealant, Dow Corning (Sellesys) 780, Silicoflex, Silicoseal N-1 or 2, Persemprere W234, Expandite Silicone 98, Norton Bear-4, Zincoseal, Ramset RZ805, Zbond V-4 or 60, Poly-Flexiseal and Borden Metal to Metal. Zincalume shall not be soldered. Sealant to gutter joints shall be compressed between the lap rather than an overlay of sealant at the joint face.

**Dissimilar Metals**

The Contractor shall follow Table 2 of AS1562 as a guide to compatibility of metals and ensure that direct contact between incompatible metals does not occur. Where in contact with each other, aluminium and steel surfaces shall be coated with two (2) coats of alkali-resistant bituminous paint or with a reviewed adhesive tape.

**Box Gutters**

The Contractor shall provide box gutters to roofs in accordance with the reviewed Contractor’s Design Deliverables reviewed by the Superintendent, fabricated from 0.8 mm thick Grade 316 stainless steel sheet, to sizes as shown. The minimum fall shall be 50 mm to each 5 m length. The gutter shall be folded as shown on the Contractor’s Design Deliverables reviewed by the Superintendent, with stop ends at parapet abutments and expansion joints at high points. Sumps at outlets shall be minimum 100 mm deep tapered with falls to outlets.
Top edges of gutters shall be gauged to underside of roof sheeting and separated, turned back 25 mm wide at 45 degrees. Similarly, edges shall be turned back at stop ends and capped at expansion joints. Box gutters shall be laid loosely and held down at edges. Upstand “saddle” joint shall be used at expansion joints. Joints shall be riveted and sealed and bottoms dressed into outlet sumps at downpipes. The Contractor shall provide 0.8 mm Grade 316 stainless steel sheet outlets to rainwater heads in the positions shown on the Contractor’s Design Deliverables reviewed by the Superintendent. At each end of gutters, the Contractor shall provide 100 mm diameter stainless steel overflows set to project 25 mm past external face of wall.

Fascia Gutters
Fascia gutters shall only be provided where specifically reviewed by the Superintendent. Fascia gutters shall be prefabricated selected profile “Colorbond” steel or treated aluminium fascia gutter as appropriate fixed with similar colour treated fascia brackets at 900 mm centres or reviewed proprietary fixings.

Downpipes
Downpipes shall be full length from gutter or outlet to drain and shall be built flush against the structure in positions shown on the Contractor’s Design Deliverables reviewed by the Superintendent. Stack drops shall be vertical at entry of drains.

Unless shown otherwise on the reviewed Contractor’s Design Deliverables reviewed by the Superintendent external downpipes shall not be allowed. If they are accepted, then they shall be 100 x 100 mm “Colorbond” treated aluminium or Grade 316 stainless steel downpipes.

Downpipes shall discharge into stormwater drains via neatly formed concrete encased bends.

The Contractor shall securely fix downpipes to the structure using “Unistrut” pipe guides or reviewed straps of the same material to the downpipe.

Flashings and Trims
Flashings and trims, including over-flashings, shall be installed at verges, abutments, junctions, etc. and at pipes passing through roofs and wherever necessary, to make the whole installation birdproof and watertight. The material shall be the same as the roof.

Cappings shall be carried over the top of parapet walls and turned down maximum 150 mm on the internal face of external parapet walls. On the external face the capping shall be turned down as detailed on the Contractor’s Design Deliverables reviewed by the Superintendent.

Flashings shall be in long lengths with joints lapped 100 mm in direction of prevailing weather. Joints shall be riveted and sealed.

Flashings shall be notched over roof sheeting ribs and dressed down to trays where angled to ribs and to extend over a minimum number of two ribs.

Flashings shall be pop riveted to ribs and set in caulkling compound. Expansion joints shall be provided in long flashings, at 6 m maximum centres in reviewed locations. All expansion joints shall be separated a minimum of 6 mm and be turned back 35 mm and an expansion cap fitted, turned into the folds. The cap shall follow the profile of the flashing. Joints which are flashed shall have minimum cover of 100 mm vertically and 150 mm horizontally.

Pipe flashings to roof shall be counter flashed, pop-riveted and set in caulkling compound. All roof penetrations shall be counter flashed.

Rainwater Heads
If reviewed by the Superintendent, rainwater heads shall be provided in positions shown on the Contractor’s Design Deliverables reviewed by the Superintendent and shall be fabricated from 1.0 mm Grade 316 stainless steel sheet. Heads shall be approximately 350 x 350 x 150 mm wide and shall be complete with tapered outlet to suit 100 x 100 mm downpipe and with overflow splitter.

Open-top rainwater heads shall be provided with hail guards fabricated from 0.8 mm stainless steel wire mesh supported along its perimeter by 6 mm diameter aluminium rods, welded at corners.

Membrane Roofing
Membrane roofing shall be Sealex ‘Challenger’ 44IP system, two layer membrane, insulated with concrete paver protection all constructed and installed in strict accordance with the manufacturer’s recommendations.

Expansion and Contraction
The Contractor shall refer to AS1562, Design and Installation of Metal Roof, regarding deleterious expansion and make adequate provision for thermal movement in the installation of roof assemblies.
The Contractor shall pay special attention to joints and fastenings, particularly in sheet metal and thin section.

The Contractor shall prevent all detrimental effects including tearing, buckling, opening of joints, undue stress and fatigue. Any leaks in the roofing and displacement of roofing where due to faulty workmanship or materials shall be rectified by the Contractor.

Samples
Where agreed by the Superintendent, a strip of roofing, sufficient to indicate laying, dressing around vents, flashings and general quality of workmanship shall be laid for review prior to final erection.

Testing
The Contractor shall, after installation, test gutters, sumps and overflows to a running overflow condition for one hour.

Where faults are apparent, the Contractor shall remedy all defects and re-apply the test. The Contractor shall provide all necessary test equipment.

Aluminium Building Joinery

Aluminium Material and Standards
All aluminium windows, doors and louvres shall be fabricated from alloy 6063 T5 heavy duty extruded framing conforming to AS1866, Aluminium and Aluminium Alloys – Extruded Rod Bar, Solid and Hollow Shapes. The finish of the framing shall be as shown in this Project Specification.

Other Materials and Workmanship

General
The Contractor shall supply and install aluminium louvre units complete with louvre blades, and all fittings including handles, catches, locks and latches.

The Alliance shall protect louvres from damage of any kind and provide strippable plastic protective film before delivery to site.

Any damaged units shall be made good and all broken, scratched or cracked glass shall be replaced by the Contractor.

The Contractor shall supply and build in window, door and louvre units strictly in accordance with the manufacturer’s instructions.

Where the sizes are not standard, window, door and louvre units shall be specially fabricated to suit. All sizes shall be checked on site before manufacture.

Where shown on the Contractor’s Design Deliverables reviewed by the Superintendent or specified all aluminium shall be anodised to 10 microns thickness to comply with first quality standards.

All doors, frames, louvres and glazing shall comply with the wind loadings shown on the Contractor’s Design Deliverables reviewed by the Superintendent and the requirements and intentions of the Contractor’s Design Deliverables reviewed by the Superintendent and Project Specification to achieve waterproof conditions at all times.

Fixed louvred units shall be provided with a reviewed birdproofing.

Louvres
Cameron and Jason type V35 aluminium louvre (57 mm pitch), with 100 mm x 50 mm aluminium head, jambs and self draining sill section or reviewed similar.

Birdproofing
Birdproofing mesh shall be fitted to all external grilles and louvres and be aluminium in an aluminium frame matching existing or as reviewed by the Superintendent.
Fixings
All fixings shall be by Grade 316 stainless steel threaded fasteners in accordance with the required standards of first quality workmanship to achieve strength for wind loadings and weatherproofing and to ensure that all stress, weights, dynamic loads, shock loads etc. are transmitted into the structure through such fixings. Fixings shall include nuts, washers and any required isolation of dissimilar metals. Stainless steel fasteners shall have anti seize paste applied to threads before assembly.

Tolerances
All necessary allowances shall be made for thermal movement in the design and detail of the fixings. Frames shall be designed and installed to fit and operate without buckling, opening of joints or undue stress on hinges, fasteners, tracks or guides.

Dissimilar Materials
Aluminium shall be prevented from contacting dissimilar materials by the use of suitable gaskets, washers, sleeves or tapes

Rejections
All aluminium components, units, assemblies, fixings, completed units etc., which do not, in the opinion of the Superintendent, meet the requirements of this Project Specification, shall be liable to rejection. In which case they shall be removed from the job and replaced with complying items.

Fabrication
Fabrication drawings of all windows, doors, frames and louvres shall be prepared by the Contractor and supplied to the Superintendent for review, before fabrication commences. Frames shall be so designed so as to support the weight of the proposed doors without distortion or deflection.

Certificate
The Contractor shall provide, concurrently with supply of the fabrication drawings, a certificate, from a reviewed Testing Authority for each window, door and louvre type, certifying compliance with AS2047, Aluminium Windows for Buildings, for the relevant design wind pressure.

Fire Stopping
The Contractor shall supply and install fire stopping for all services which pass through fire barriers and / or firewalls, particularly fire ceilings. The fire stopping shall be consistent with the fire rating of the building element that the service is passing through.

The material to be used shall be compatible with that in use throughout similar installations or of an reviewed equivalent, which complies with the relevant Australian Standards.

Services
All new building work shall be provided with power and lighting services, telephony, computer communications, security, fire detection, potable water supply and sanitary drainage, and service water as appropriate to the building’s proposed needs and use. The Contractor shall make full provision for all Plant equipment power, control, instrumentation and PLC/DCS communications cabling.

Services to buildings shall include:
Power;
Potable water;
Communications;
Fire Detection;
Security; and
Internal and external lighting.

Building Finishes
Paint Systems and colours shall be generally as listed in the Schedule of Finishes prepared as part of the Contractor’s design. The Contractor shall submit proposed colours and colour panels to the Superintendent for review prior to ordering finish materials.

Materials
All paints shall be ready mixed, of premium quality complying with all relevant Standards and Codes. All materials shall comply with Government regulations regarding the use of non-poisonous paints. Paint shall be brought on the job in its original sealed containers. The use of bulk materials other than the appropriate quality shall not be permitted.

Thinners, stainers, primers and undercoats shall be of the type supplied by the manufacturers for use with the various types of paint.

Putty shall be first grade linseed oil – whiting putty stained as necessary to match adjoining work.
Plaster based patching powder compound shall be used for porous and fibrous cement surfaces.

Sample Panels
Sample boards for each colour, 450 mm square shall be prepared, made up on material appropriate to the purpose for which the paint is to be used. Boards shall be coated with primers, undercoats and finishing coats to the same Project Specification as required for the particular finish.

The Superintendent’s review shall be obtained before proceeding with the Work. Samples shall be held available for reference on the job until completion of the Work.

Workmanship
All painting shall be carried out by competent tradesmen in a first class manner. All paints shall be thoroughly mixed and stirred before use. All mixing shall be done on the job but not on the floor of the building.

Primed or undercoated work shall not be left in an exposed unsuitable situation for an undue period of time before applying subsequent coats.

An adhesive tape test shall be applied to plastered walls before painting commences. Painting shall not commence until surfaces are in a reviewed finished condition to receive paint.

Preparatory Work
Metal
All metal surfaces shall be clean, smooth and dry, free from mill scale, grease, rust, tar, oil and other foreign matter. Surfaces shall be properly sanded and brushed down.

Metal work shall be degreased with mineral turpentine prior to applications of priming coat, etch primer, or red oxide primer as appropriate. All galvanised surfaces shall be etch primed. Shop primed metalwork shall be spot primed on site with matching primer.

Masonry Surfaces
All nibs shall be removed and all minor cracks and imperfections filled and sanded down.

Where acrylic paint is specified, the Contractor shall dampen masonry surfaces as recommended by the manufacturer, prior to application of paint.

Where satin and flat enamel finishes are specified, masonry surfaces shall age for at least 6 weeks and gypsum plaster and fibrous cement surfaces for at least 30 days, before painting.

Rubbing Down
All timber and joinery work shall be lightly rubbed down between coats with fine sandpaper and brushed clean.

Application
All materials shall be used strictly in accordance with manufacturer’s written instructions. Paint shall not be spread beyond its covering capacity.

All coats of paint shall be evenly and smoothly applied with full cover to all parts, finished free from blotches, brush marks, runs, sags, and other defects to obtain a first class finish.

Each coat of paint shall be allowed to harden in accordance with the manufacturer’s instructions before the next is applied.

Painting shall not be carried out in adverse weather conditions. No clear finishes shall be applied in wet or foggy weather.

Painting shall be left till such time in the work program to ensure that other trades have completed work in painted areas thereby minimising damage and patchwork to the finished surface.

The Contractor shall comply with all necessary safety precautions as recommended by the manufacturer and any relevant authority when handling and applying paint coatings. This shall include the use of protective clothing, skin creams and breathing masks as appropriate. Adequate ventilation and lighting shall be maintained at all times during the application and drying of paints.

The Contractor shall finish one colour against another to a true straight line and cut in against glass, metal frames and other junctions similarly.

The Contractor shall adequately protect all floors, fittings and other surfaces during painting, with drop sheets and masking as necessary.

All door hardware, switch plates and similar items shall be removed before adjoining surfaces are painted and replaced accurately on completion.

Schedule of Exterior and Interior Finishes
All finishes for new work in existing structures and buildings shall compliment the existing finishes.
For new structures and buildings, all exterior finishes shall match existing structures and buildings on the WWPS and local environment shall be part of the Contractor’s Design Deliverables and shall be reviewed by the Superintendent. All interior finishes shall be included with the submission of proposed colours and colour panels to the Superintendent for review required by this Project Specification.

Suspended Flooring

Suspended flooring shall be provided as shown on the Contractor’s Design Deliverables reviewed by the Superintendent.

The flooring shall be installed in a manner that allows it to be easily removed and replaced without damage to the flooring, supports or local environment. Panel sizes shall be limited to a weight less than 16 kg.

Clean Up

All paint spots shall be removed from floors, tiles, light fittings, switch plates, hardware, stainless steel, aluminium, chrome plate, glass and all similar surfaces.

Glass and metalwork shall be cleaned and polished and the work of this trade shall be left in first class condition.

After completion of painting work, the job shall be thoroughly cleaned and tidied. The Contractor shall be fully responsible for any damage by its staff, suppliers and sub-contractors and shall make all repairs as deemed necessary by the Superintendent.

4.4 COMMON ASSEMBLY - ELECTRICAL REQUIREMENTS

4.4.1 General Requirements

This specification covers the general requirements for Electrical Installations within Water (including recycled) and Wastewater Pump Stations and Treatment Plants.

Design Responsibility

The Contractor shall prepare drawings as required in the Specification and shall be responsible for the complete design of the Switchboard / Motor Control Centre, including supporting frames and all other details necessary to obtain proper performance of the Switchboard / Motor Control Centre and Control Panel.

All equipment shall be located and installed so that it will be readily accessible for operation and maintenance. The Superintendent reserves the right to require minor changes in location of equipment prior to roughing-in, without incurring any additional costs or charges.

Switchboard design is to be in accordance with the Standard Specification Drawings.

Site Conditions

The Contractor shall familiarise himself with site conditions, including any requirements for access to plant and equipment.

Safety

Adequate provision must be made to effectively protect the operator and visitors from hazards. The following must be provided:

- Enclosure of the plant with a fence and signs designed to prohibit the entrance of unauthorized persons and animals;
- Hand rails and guards around tanks, trenches, pits, stairwells, and other hazardous structures complying with AS1657;
- Gratings over appropriate areas of treatment units where access for maintenance is required complying with AS1657;
- First aid equipment;
- "No Smoking" signs in hazardous areas;
- Protective clothing and equipment, such as self-contained breathing apparatus, gas detection equipment, goggles, gloves, hard hats, safety harnesses, etc.;
- Portable blower and sufficient hose;
- Appropriately-placed warning signs for slippery areas, non-potable water fixtures, low head clearance areas, open service manholes, hazardous chemical storage areas, flammable fuel storage areas, etc.;
• Provisions for confined space entry in accordance with WorkCover requirements.

4.4.2 Electrical Supply
In general, the electrical supply to the switchboard/motor control centre will be a 400 volt 3 phase 50 Hz AC M.E.N. system.

For larger projects, HV supply may be specified.

Extension of Power supply
The Contractor shall:
• Make application to the Supply Authority for alteration of electricity supply as required
• Arrange additional metering and pay all fees and charges on behalf of and in the name of AW
• Provide new consumer mains and new supply authority metering panel.

4.4.3 New Connection And Tariff
The tariff shall be confirmed with the Superintendent prior to installation. Preference is for T22 (SR22) for general supply. All applications for power supply to water and sewage pump stations shall include a community ambulance cover Exemption Form 2. The contractor/project manager shall provide to Service Delivery Branch of City of Gold Coast the ORIGIN ENERGY “New Connection Tri Application Form- June 08” with the appropriate sections complete for forwarding to Origin Energy. The Contractor/Project Manager will then send an ENERGEX Form 2 with the same details to ENERGEX to arrange connection.

4.4.4 Drawings
Complete manufacturing drawings shall be submitted to the Contract Superintendent for approval prior to manufacture of switchboards, motor control centres, distribution boards and the like. The drawings shall include a complete equipment schedule such as brand, supplier, quantities, equipment labelling, catalogue number, model number, power rating (kW), type and size. The drawings shall be in accordance with the Clause “Drawings” elsewhere in this specification.

4.4.5 Prior Delivery Inspections and Tests
Inspections and tests shall be carried out in accordance with the Clause “Inspections, Checking and Testing” in Section 5 unless specified elsewhere.

4.4.6 Electrical Standards
All plant, equipment and installation works shall be supplied and set into operation in accordance with the latest edition of the following standards. In addition to this specification work shall comply with AS/NZS 3000 ELECTRICAL INSTALLATIONS (Wiring Rules -current edition), Supply Authority Regulations 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 Superintendent’s decision upon which standard takes precedence, shall be final and binding.

All Standards referred to in the body of the Specification shall be complied with. The version that applies shall be the version current at date of contract and if the standard has been superseded, then by the standard that supersedes it.

<table>
<thead>
<tr>
<th>Standard</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS/NZS 1125</td>
<td>Conductors in insulated electric cables and flexible cords</td>
</tr>
<tr>
<td>AS/NZS 1574</td>
<td>Copper and copper alloys – wire for electrical purposes</td>
</tr>
<tr>
<td>AS 1627</td>
<td>Metal finishing – Preparation and pre-treatment of surfaces</td>
</tr>
<tr>
<td>AS 1660.1</td>
<td>Test methods for electrical cables cords and conductors</td>
</tr>
<tr>
<td>AS/NZS 1680.0</td>
<td>Interior lighting – Safe movement</td>
</tr>
<tr>
<td>AS 1746</td>
<td>Conductors – Bare Overhead – Hard-Drawn copper</td>
</tr>
<tr>
<td>AS 60529</td>
<td>Degree of protection provided by enclosures for electrical equipment (IP Code)</td>
</tr>
<tr>
<td>AS/NZS 2053</td>
<td>Conduit and fittings for electrical installations – Complete Series</td>
</tr>
</tbody>
</table>
4.4.7 Switchboard Specifications (Water and sewage Pump Stations)

NB: Treatment Plants switchboard specifications are covered in “Specific Assembly Requirements – Electrical Wastewater Treatment Plants”

**Fault Capacity**

The board shall comply with the requirements of AS/NZS 3000 with particular attention to Clause – Devices for Protection Against Overcurrent. For fault levels up to 10kA and less than 800 Amps per phase Form-1 shall be used and for fault levels greater than 10 kA Form-3b shall be used. Segregation shall be in accordance with standard drawings.

**Construction of Pump Stations Switchboards (where outdoor location is specified)**

The switchboard shall be a totally enclosed self-supporting metal structure housing the isolators/fuse switch units/circuit breakers, control equipment, busways and cable connection chambers. The
The switchboard shall be prefabricated from minimum 2 mm thick 316 Grade stainless steel or 3mm 5251 or 5083 Alloy Aluminium with adequate supports to withstand the mechanical stresses which may occur during operation, fault conditions, transport and erection. All edges and corners are to be accurately and neatly folded. The switchboard shall be ventilated, vermin and dust-proof with degree of protection IP56 with the exception of the cubicle vents which are to be IP 54 and shall be as shown on standard drawings and should be suitable for outdoor use. Sun shades shall be fitted on the switchboard roof, the sunshade should be 300 mm wider than the panel top surface and be sloped so that water falls away from where operators stand and directs water away from vents or cable entries. The switchboard shall contain the main switch, all circuit breakers, contactors, starters, indicating lights, meters, push buttons, selector switches, relays, PLC–RTUs, pump controllers, surge protection and other equipment required, specified or shown on the drawings, for the complete operation of the pumping units. The equipment shall be grouped in accordance with the Standard Specification Drawings.

Internal cable cover panels and general access panels may be of a lesser thickness depending on size and supports required. A minimum of 1.6mm thickness shall be used for stainless steel construction and 2mm minimum for aluminium construction. Removable equipment chassis may be constructed from minimum 2.0mm mild steel.

All electrical equipment in the cabinet shall be mounted either on the equipment chassis or on the escutcheon. Equipment mounted on the cabinet floor, ceiling or sidewalls is not acceptable. On no account is equipment to be located in the cable duct. 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 the equipment chassis.

For wastewater, the switchboard shall be effectively sealed to prevent the ingress of gases from the well. This shall be achieved by ensuring the base plate of the section above the breezeway is sealed by an approved gasket or welded. The cables shall enter the switchboard via approved sealed glands. The base plate shall be sealed except for the motor and control cable gland holes. Space should be available to add cables or increase the size of existing cables. All unused holes must be sealed mechanically.

For wastewater pump stations, the switchboard shall incorporate a breezeway in the lower 200mm section. The breezeway sections are to be on the sides of the switchboard that have no vents to prevent gas being drawn directly into the switchboard. The breezeway section shall have mesh on the back section secured internally. The front section shall have a lockable access door or lockable removable panels.

The switchboard shall be bolted to a channel plinth. The plinth shall be approximately the full size of the switchboard cubicle base, with fully welded corners and channel cross members where required. A mild steel plinth shall be hot dipped galvanised after fabrication and an aluminium plinth shall be painted as per switchboard paint specifications. The switchboard plinth shall be of 100x50x6mm mild steel channel iron or 100 x 50 x 6t x 8t mm 6061 Alloy Aluminium channel and is to be bolted to the switchboard with a minimum of four M10 bolts.

The switchboard shall be secured to the concrete floor with at least four approved masonry fasteners of not less than 13mm diameter. Chemset fasteners are suitable for this application. Corner gussets are preferred to enable masonry anchors holes to be drilled vertically during installation. Stainless steel hinged panel door stiffeners and mullions are to be a minimum thickness of 1.6mm. Aluminium hinged panels; door stiffeners and mullions are to be minimum thickness of 2mm. All metalwork is to be welded at joints. All external joints are to be fully (continuous) welded and stiffened where necessary to form a ridged weatherproof plinth mounted enclosure to IP56 with the exception of the switchboard vents, which are to be IP54.

The switchboard shall be fitted with a minimum of two 316 stainless steel plates or 5251 or 5083 Alloy Aluminium plate lifting lugs welded to the top of the cubicle. Eyebolts are not acceptable. Unless shown otherwise, all fixing hardware used in the construction of the switchboard and the mounting support of equipment is to be minimum 304 Grade stainless steel.

All bolts, metal threads and screws are to be used with hexagon-machined nuts or tapped holes having a minimum thickness equal to or greater than three times the thread pitch. Self-drilling / tapping screws and the like are not to be used under any circumstances.
The bottom of the drawing holder is to have two 20x20mm cut-outs to allow foreign objects to fall through.
The switchboard shall be fitted with sufficient vents and vent fans to meet the cooling requirements of equipment selected. The switchboard vent cowls are to be fully welded to the walls of the switchboard and the bottom edge of each cowl is to cover the bottom of the vent cut-out by a minimum of 30mm. Each vent is to be fitted with a removable stainless steel gauze frame. A second frame is to clamp a filter mat over the gauze frame and is to be secured with wing nuts or other approved means for easy removal.
The front removable equipment chassis is to be retained by a minimum of six studs. The rear removable equipment chassis is to be retained by a minimum of four studs. Welded Aluminium studs (in lieu of 304 Grade stainless steel bolts) may be used in an Aluminium switchboard to support the removable equipment chassis.
MCCs shall be arranged so that all live parts of equipment immediately accessible when the switchboard doors are opened are insulated. All connections to busbars or equipment shall be either sheathed with PVC to approval or shall be made behind a removable cover plate. All equipment shall be mounted at a minimum height of 300mm above the floor level. Any door shrouding shall be fitted with a removable clear PVC cover and shall be installed so that it slides between two rails and is fixed by minimum of hardware. (See also clause 20.1 Equipment general).
Fit stainless steel catch stays to all doors to hold the doors open at a minimum 100 degrees (external) and 90 degrees (internal).
The kWh meter viewing panels shall be Lexan. All viewing panels shall have a hinged metal cover. This cover will be secured using a standard coin lock.
Weld door switch brackets to switchboard body so that limit switches may be operated by the door operation.
All equipment mounted on chassis must be capable of being removed whilst standing in front of the respective chassis without having to disassemble or remove items not forming an integral part of that individual piece of equipment.
Door seals are to be black neoprene.
Where external telemetry boxes are used, all cables to the telemetry units are to be multicore or coax and are to be separately ganged into the bottom of the telemetry enclosure. Analogue signals are to be cabled with screened twisted pair cable.
Areas designated as “space” are to be fitted with DIN rail. DIN rail is to be aluminium. All unused holes are to be sealed with removable gas tight blanking plugs.
One cable only per each cable gland is to be fitted and is to be sized to suit the cable so that a cable gland rating of IP67 is maintained.
The cable to the telemetry is to be circular.

Construction of Pump Station Switchboards (where indoor location is specified)
The switchboard shall be constructed to the same specification as the outdoor switchboard with the exception of the following:
The switchboard is to be constructed from 5251 or 5083 Alloy Aluminium and powder coated (as per Painting clause elsewhere in this specification).
The switchboard is to be single sided and sized to fit into the building. Sun shades are not necessary on indoor switchboards.
The telemetry panel is to be located at one end of the switchboard mounted in a separate section of the switchboard. Space is to be allowed (if required) for flow transmitter equipment. The meter panel for this arrangement is to be flush mounted outside the building to supply authority specifications; the panel is to be secured with a standard ENERGEX padlock. The main switch is to be mounted on the switchboard. Isolating requirements for ENERGEX metering shall be met.
The switchboard is to allow for a three phase vent fan connection, (with auto manual operation in the control circuit and a change over switch on the panel door, with run indication), lighting circuit, a three phase outdoor supply (20 Amp).
The switchboard shall be secured to the floor with a minimum four approved masonry fasteners of not less than 13mm diameter.

Common Switchboard Construction Requirements
Door hinges shall be fitted with lift off type chrome plated solid brass body (80mm minimum length) with stainless steel hinge pins.

Exterior doors (if required) shall have 3-point locking system (locking bars to be fitted with rollers) and profile locking swing handles capable of exerting sufficient pressure to ensure proper contact of the sealing medium all around the door. Handles shall be flush mounted with the doors. Doors providing access to the breezeway shall be one point stainless steel quarter turn locks.

Locks in handles on the exterior doors shall use the standard G.C.C.C. spring loaded quarter turn lock, keyed to 92268 with the “push to lock” insert barrel type option.

All internal electrical equipment compartment doors are to have a separate locking system, preferably a 3-point locking system with the lock in the middle using quarter turn locks and shall use the standard G.C.C.C. Lenlock 604 key.

Panel hinges are to be stainless steel full-length piano hinges or must use a minimum of 3 standard hinges.

Supply Authority compartments shall have locks according to the Authorities requirements. Padlocks shall be supplied by the Contractor.

All equipment positioned on doors or removable panels shall to be protected by insulated panels to prevent any accidental contact with live equipment when maintenance and servicing takes place. The insulated panel shall be easily removable for servicing and is to be transparent for easy viewing.

Equipment offered shall possess 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 Engineer.

The maximum mounting height for equipment shall be 1800 mm.

**Busbars**

Busbars are to be phase colour coded at regular intervals.

Busbars shall be completely insulated (except at joints) where not in a dedicated busway.

Main busbar and connections shall be of high conductivity hard-drawn copper sized to carry the installations ultimate load without exceeding 40 degrees Celsius temperature rise. All busbar connections shall be securely bolted.

**Arrangement**

Equipment shall be neatly arranged at all times. There shall be a minimum of 5mm clearance between relays, contactors and timers. Equipment shall be arranged such that removal of access panels and opening of compartment doors does not affect the operation of other equipment.

**Maintainability**

The electric switchboards and equipment shall be designed to permit inspection and maintenance of individual items without causing an overflow, surcharge, bypass or violation of statutory requirements. Provisions 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.

**Emergency Generator Connections**

A 5-pole weatherproof IP66 socket shall be provided in the breezeway for outdoor pump station switchboards connected to the busbar via a lockable circuit breaker as follows:-

For pump motors up to 15kW, a 90 Amp socket is required so 1 pump can be started/run
For pump motors up to 30kW, a 250 Amp socket is required so 1 pump can be started/run
For pump motors above 30kW, single phase plug and sockets shall be used or a connection box arrangement with suitably sized connection studs with washers and nuts shall be submitted to the Superintendent for approval prior to construction of switchboard. A risk analysis, arranged by the Superintendent, will determine if 1 or both pumps will be required to run under emergency generator connections and may change requirements.

**4.4.8 Painting General**

**INDOOR UNITS**
Shall be painted as follows: -

Switchboard: - Powdercoat external panels of the switchboard in electrical orange (Colour X15 of AS 2700). The interior surfaces are to be powder-coated colour No N14 (white) as of AS 2700.

Aluminium hinged panels: - Grind smooth all external welds and powder coat to colour N14 (white) of AS 2700.

Note: Pre-treatment of the complete switchboard prior to Powdercoating shall be applied in accordance with AS 3715. The atmospheric environment is classification 5, severe (coastal marine) of AS 3715.

**OUTDOOR UNITS**

Stainless steel switchboard and hinged panel: - Grind smooth all external welds and sand blast (with clean sand, not contaminated with ferrous metals) ensuring that sand blasting does not deform panels.

Removable equipment chassis: - Grind smooth all external welds and Powdercoat to colour N14 (white) of AS 2700.

Removable mild steel plinth: - Grind smooth all external welds, de-scale and hot dip galvanise.

Aluminium Switchboard: - Powdercoat in colour No. G54 of AS2700 (Mist green), inside and outside. Solar resistant and anti-graffiti formulations are to be used or an outer anti-graffiti coating to be applied. The Aluminium hinged panel is to be the same as the switchboard except that the Powdercoat is to be colour N14 (white) as of AS 2700.

Removable Aluminium plinth: - Grind smooth all external welds and Powdercoat to colour G54 (Mist green) of AS 2700. Powdercoat shall be applied in accordance with AS 3715. Pre-treatment of the switchboard prior to coating to be in accordance with AS 3715 and the atmospheric environment is classification severe (coastal marine) of AS 3715.

### 4.4.9 Earthing And Neutral Connections

The Contractor shall be responsible for the earth system installation and reticulation, which shall comply with the relevant requirements of AS/NZS 3000 and requirements of supply authority.

The earth bar shall be provided within the switchboard, with minimum 20 per cent spare (unused) connections.

The earth busbar shall have bands of green or green/yellow insulation at regular intervals to identify it as the main earth.

The neutral busbar shall have bands of black insulation at regular intervals to identify it as the neutral. The neutral bar shall be provided with minimum 20 per cent spare (unused) connections and shall be fully labelled at each termination.

A M.E.N. link sized to AS/NZS 3000 shall be provided and labelled as such. Neutral and earth busbars shall be completely isolated from each other, except for the M.E.N. link.

All metal cases of instruments, selector switches and other equipment either mounted on hinged doors or front covers, shall be connected by an electrically continuous PVC covered flexible earth wire or flat braided wire.

In the case of fuse switches connected to the main busbar system, the earthing cable shall be to the supply authority’s requirements.

### 4.4.10 Shrouding Of Live Terminals

All exposed live terminals are to be shrouded. This applies when the switches are by-passed during fault finding. Busbars not installed in a specific bus area shall be completely shrouded.

Hinged panels shall have one shroud to cover all exposed live terminals. This shroud is to 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 approved prior to installation.

### 4.4.11 Lightning & 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 should not affect the operation of equipment under normal operating conditions.
All surge protection systems shall be installed in accordance with the manufacturer's recommendations. Large pump stations and treatment plants shall utilise an equipotential bonding scheme to ensure no hazardous touch potentials arise under normal and fault conditions. All hazardous areas requiring electrical instrumentation shall utilise intrinsic safety rated equipment and all other equipment shall have the appropriate hazardous rating.

4.4.12 Switchboard 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 shall be connected to a local earth electrode. Shunt surge diverters shall be supplied and installed on the main 3-phase bus of the switchboard before the Main Switch or immediately after the supply changeover switch if fitted. They are to 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 mains and the surge diverters where the consumer’s mains are protected by fuses rated at more than 100 amps. Where a site consists of a main switchboard and a number of sub-switchboards, which are located separately in other buildings or via sub main cables in excess of 20m, the above surge diverters shall be installed on each switchboard.

A surge reduction filter rated at 10A shall be provided in each switchboard. 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 or the same building only. Remote equipment in a separate building or switchboard 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.

4.4.13 Surge Diverter Specification

Metal oxide shunt diverters specifically designed for multipulse lightning events on powerlines shall be installed immediately on the load side of the main incoming switchgear between each phase and the neutral bar by the shortest most direct route using straight copper bar or braid of minimum cross sectional area 35 mm\(^2\).

The diverters shall be rated at 275 V RMS, 80 kA on a single shot 8/20 usec impulse with an energy absorption capability exceeding 2800 Joules. Each device shall comprise five MOV segments whose status is continuously monitored and displayed on a five segment LED bar panel. The device shall be encapsulated in shock absorbent material, and be fitted with integral 250 VAC 2 A changeover isolated alarm contacts. Reduction in surge handling capacity to below 80% shall activate the contacts. Peak let through voltage as defined in AS1768 Cat C 20 kA pulse conditions shall not exceed 900 V. The device shall have a design capability of withstanding and diverting at least 1000 20kA Cat C pulses.

The diverters shall be mounted in the SCA so that the LED indicators are clearly visible at all times without the need to open doors.

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 volts. 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 signals 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.

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 earth bar. The surge protector shall be securely bonded to ground via an earth cable to the earth bar or quality tested local earth electrode.

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 volts.
All field communications Profibus-DP and Profibus-PA devices shall incorporate Fieldbus (Profibus) surge protection.

Instrumentation Power
Supply Cables:– The supply cable for 230v powered instruments located external to buildings shall be surge protected.
The surge suppression units are to be located both in the field adjacent to the instrument/device and in the motor control centre instrument 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 50kA (8/20 micro seconds). The use of dual surge units is to be avoided unless extreme space restrictions exist.
The surge suppression units are to be series type filter devices. They should be multi-stage devices with a primary protection rating of 10kA (8/20 micro seconds). Unless special requirements exist, the units should be designed for a working voltage of 230V and current of 3A
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 Vrms, 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 10A. The maximum let-through voltage of the device shall be 500V. A surge diversion failure indicator shall be provided which shall be clearly visible on the switchboard front panel without the need to open 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.

UPS Protection
The supply cable to the UPS shall be provided with surge protection. The UPS surge protection device will be rated at 50kA (8/20 micro seconds). It should be positioned local to the UPS.

4.4.14 Electrical Equipment for Hazardous Areas
Ensure equipment located in hazardous areas comply with safety standards relevant to the classification zone i.e refer the Standards to AS/NZS 2381.1 and AS/NZS 60079.14.

4.4.15 Power Supply To Motors, Mains And Sub-Mains
The Contractor shall supply, install and terminate all motor 400 volt and 230-volt power supply cabling, mains and sub-mains. All cabling shall be circular PVC/PVC or XLPE multicore copper, unless other types are approved in writing by the Superintendent.

Cables shall comply with Current Carry Capacity, Voltage Drop, Let-Through Energy (I²t), and Earth Fault Loop Impedance requirements in accordance with AS/NZS 3000 and AS/NZS 3008.1.1.
The cables shall be installed in areas such as the underside of walkway overhangs and inside channels. The Installer shall take installation aesthetics into consideration. The Superintendent may reject any installation that is considered to detract from the overall appearance of the plant.

All mains and sub-mains shall be a minimum of 16mm² sized cable.

All non-VSD (variable speed drive) motor cabling shall be PVC/PVC or XLPE/PVC, 0.6/1 kV multi-stranded copper multicore, V-90 thermal rating sized in accordance with AS 3008.1.1 for volt drop or full load motor current plus 10 per cent, whichever is the more severe duty.

Motor cabling for VSD motors is detailed in clause “Variable Speed Drives”.

Areas classified as hazardous areas shall comply with AS/NZS 3000 “Hazardous Areas”, plus relevant Australian Standards.

It shall be 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 duct shall be provided.

Where cables are exposed to U.V., the cable shall be protected by covers or ducting.

### 4.4.16 Control Cabling

The Contractor shall supply, install and terminate all control cabling as part of the field equipment installation.

Field Control cable shall be PVC/PVC 0.6/1 kV grade, multi-stranded copper multicore, V-75 thermal rating of minimum size 1.5mm².

In all cases where multicore control cables are used the Contractor shall include at least two (2) spare cores (e.g. if 3 cores of a control cable are required a 5 core cable shall be installed).

#### Wiring

Wires are to be neatly run in insulated ducts with clip-on covers within the cubicle. All wiring shall be carried out in multi-strand and 0.6/1 kV grade V75 PVC insulated wire to AS/NZS 5000.

Power circuits shall be wired in phase coloured wire to AS/NZS 5000.1, minimum size 2.5mm²

Control circuits shall be wired in minimum 1.0mm² stranded (32/0.20) within the switchboard and 1.5mm² minimum for field wiring.

PLC control wiring may be PVC 0.6/1 kV grade, multi-stranded copper multicore, V-75 thermal rating of minimum size 0.5mm² (16/0.20).

Instrumentation wiring and cables to carry analogue signals to PLC or process instrumentation shall be PVC covered, aluminium screened twisted cables minimum 0.5mm2 (7/0.30). Each screen of all instrumentation cables shall be earthed at only one point

Single strand (solid) cable shall not be used.

Wire colours shall be in accordance with the following table: -

<table>
<thead>
<tr>
<th>Wiring Type</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase wiring</td>
<td>red, white &amp; blue</td>
</tr>
<tr>
<td>240 v controls</td>
<td>orange</td>
</tr>
<tr>
<td>240 v Neutrals</td>
<td>black</td>
</tr>
<tr>
<td>24 V AC Active</td>
<td>grey</td>
</tr>
<tr>
<td>24 V AC Neutral</td>
<td>black/ white trace</td>
</tr>
<tr>
<td>Telemetry</td>
<td>purple / violet (from signal source to AI or DI)</td>
</tr>
<tr>
<td>Telemetry (Terminal strip to RTU analogue I/O connections)</td>
<td>Dekoron or Instrolex numbered black and white pairs</td>
</tr>
<tr>
<td>24 V DC controls +ve</td>
<td>pink</td>
</tr>
<tr>
<td>24 V DC –ve</td>
<td>brown</td>
</tr>
<tr>
<td>Thermistor circuit</td>
<td>white (twisted pr.)</td>
</tr>
<tr>
<td>12 V DC + (pos)</td>
<td>Red</td>
</tr>
<tr>
<td>12 V DC – (Neg)</td>
<td>Red with Black Stripe</td>
</tr>
</tbody>
</table>
4.4.17 Submersible Pump Cables
Submersible pumps cable shall be manufactured to the requirements of AS/NZS 5000 and meet the test criteria as described in AS/NZS 1660.
A certificate of compliance shall be submitted prior to installation.
The cable shall be suitable for use in wastewater applications.

4.4.18 Termination Of Wiring
Control and power wiring shall be identified at each termination with an approved full sleeve marker ferrule. Ferrules shall be selected to neatly fit wiring insulation. Wiring shall be identified in accordance with this Specification.
Cables shall be firmly anchored to prevent movement.
Incoming and outgoing power and control wiring shall be terminated at low level or other approved location in approved numbered terminal strips with insulated pin type connector lugs. The units shall be pre-wired in the manufacturer’s works. Terminal strips shall not be mounted lower than 250 mm above the base of the motor control centre. The terminal strips are to be mounted in such a manner as to provide easy access to the terminal screws and wires.
“Clip-on” rail terminals (clamp type) shall be supplied and installed at a low level in the main pump control panel. An allowance of 10 per cent spare capacity is to be made on the rails. Termination of cables to the control panel shall be made using crimp-on compression type pin connectors.
Oversize terminal spacers shall be installed between different voltages and phases.
Motor terminals inside switchboard shall be minimum 4mm².
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 will be used in this situation.

4.4.19 Cable Installation

General
Cable installation methods shall comply with the Supply Authority regulations and the AS/NZS 3000 Electrical Installations and as follows: -

- Voltage Drop, \( I^2t \), Earth Fault Loop Impedance and Maximum Demand calculations shall be submitted prior to installation.
- Power and instrument cables are to be separated by a minimum of 300mm
- The Contractor shall supply and install final sub-circuit cables to the respective equipment.
- Cables shall be installed to minimise the effects of Electro Magnetic Interference and Harmonic interference.
- Cables shall leave their respective starters via terminals located at low level within the switchboard or other approved locations. The cables shall exit via the bottom of the cubicle and shall run via cable trays and or conduits to their respective equipment.
- Outgoing cables shall be 0.6/1 kV grade XLPE/PVC or PVC/PVC cables glanded through gland plates provided or through the base of the switchboard. All cables entering or leaving the motor control centre shall be firmly anchored to prevent cable movement. Where cable gland plates are not provided, cables are to be glanded and fixed to the panel as required.
- Cable to motors shall be terminated via brass 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 shall be run on cable trays or in conduit to the requirements of the clauses entitled “Conduits” and “Cable Trays” below. Exposed cables will not be accepted.
- Splices in wiring will not be permitted.
- Cables not installed on cable trays shall be laid in continuous conduit runs unless prior approval is given in writing from the Engineer to do otherwise.
- Cables, other than mains and submersible pump cables shall be PVC/PVC, 0.6/1 kV, multi-strand copper, V-90 thermal rating and sized, to take into consideration the supply authority’s requirements for voltage drop and in any case a minimum size 1.0 mm² to AS/NZS 5000. (Except signal cables .5mm2)
- Final sub-circuits to motors shall be sized, for full load motor current plus 10 per cent.

### 4.4.20 Underground Cabling

Before proceeding with excavation work, the details of all existing underground services and those to be installed in the area shall be ascertained.

Cables laid under roadways shall be laid in approved ducts. The ducts shall project 0.5 metres beyond the back of the kerb. They shall be category “A” PVC underground conduit and shall be supplied and installed unless otherwise stated.

Cables in conduit shall be laid at a minimum depth in accordance with AS/NZS 3000 in a clean bed of sand, minimum cover 100 mm. A warning tape shall be laid over the entire length at a depth of 300 mm. Care shall be taken when laying the tape around curves and bends. The trench is to be backfilled and consolidated to finished ground level.

**NOTE.**

Reinstatement of turf shall be necessary when trenching is completed in “sensitive areas” e.g. outside domestic property or through parkland.

### 4.4.21 Cabling In Cable Trays

Cabling installed on cable trays shall comply with AS/NZS 3000. Cables shall be securely tied to the trays with UV protected cable ties at maximum one-metre centres. No cable crossovers, excepting where cables enter or leave the trays, will be permitted.

### 4.4.22 Cable Termination

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.

### 4.4.23 Conduits

**General**

Conduit used throughout the electrical installation shall comply with AS/NZS 2053 whether it is PVC rigid, PVC flexible, or steel.

Conduits shall be concealed unless otherwise agreed to by Superintenden. Where it is necessary to use exposed conduit a neat installation will be insisted upon.

Conduit exposed on painted structures shall be painted to the same colour as the structures.

Conduit shall be not less than 20 mm in diameter.

Draw rope shall be installed in all conduits including conduits containing cables. Draw rope shall be braided orange polyethylene, or prior approved equivalent.

Power and instrument conduits shall be separated by a minimum of 300mm.

**Cable Trunking**

General. Cables shall be installed in 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 trunking shall be such as will permit installation of the cables without damage. Cable trunking is to be sized to allow for the installation and termination of all internal and external wiring.

A minimum of 10% spare capacity is to be allowed in the sizing of the trunking after all internal and external wiring has been installed.

**Conduit Fittings**

Conduits shall be installed to avoid all mechanical duct systems and other pipe services. The conduit shall be laid as far as possible in straight lines with easy sets or bends. Where conduit is to be bent, it must be bent without altering its section.

Jointing of PVC conduit and fittings shall be carried out strictly in accordance with manufacturer’s recommended jointing method.
Expansion joints shall be installed in all PVC runs, at intervals not exceeding the manufacturer's recommendations.

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. In addition, conduit shall be fixed not less than 150 mm from each surface box, switch or elbow. The conduit is in no part to 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 metres. Conduits shall not touch any other pipes and shall in all cases, be at least 450 mm from heating or gas pipes.

Conduit fittings shall be approved rigid PVC accessories. Fittings used with PVC conduit shall be PVC. For metallic conduit, screwed metallic fittings shall be used. Galvanising shall be carried out after the fittings are threaded.

Pull boxes shall be supplied with neoprene gaskets and stainless steel screws. Where pull boxes are located in exposed locations or in floors, they shall be fully sealed against the entry of moisture. Draw rope shall be installed in all conduits including conduits containing cables. Draw rope shall be braided orange polyethylene, or prior approved equivalent.

**Saddles and Supports**

Conduits where run on the surface of walls and ceilings shall be fixed by means of double-sided saddles. Such fixings shall be at intervals not exceeding 1000 mm. Conduits shall be fixed with stainless steel saddles and stainless steel screws (2 stainless steel screws per saddle). Explosive or hammer-in type fasteners will not be accepted for fixing. Support brackets, where necessary, shall be stainless steel 316 grade or marine grade aluminium. Cables and/or conduits shall be grouped as far as possible and all supports, clips, saddles and brackets spaced to prevent appreciable sag.

**Conduit at Wastewater Pump Stations**

Conduit between the switchboard and well shall be as follows:
- One conduit for each pump cable being a minimum of 100mm in diameter or three times the outside diameter of the installed cable, whichever the greater.
- One conduit for instrument cables being a minimum of 80mm in diameter.

**Sealing**

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 switch rooms and cable pits, with a re-enterable sealant or by other means approved by The Superintendent.

Ensure all spare conduits and ducts are effectively plugged and sealed. Seals shall be painted to the same colour as the surrounding structures. For switchboards with a breezeway, conduits will be sealed with a conduit cap and a compression type cable gland. For all other switchboards, conduits shall be sealed at the switchboard end with an approved waterproof re-enterable sealant.

**4.4.24 Cable Trays and Ladders**

Cable trays, brackets and ladders shall be fabricated from stainless steel or marine grade aluminium and shall be adequately supported and fixed in position. Cable trays and ladders shall support a load of 75 kg per linear metre. Maximum span shall be 3 metres unless otherwise approved by The Superintendent. Cable ties shall securely tie cables to the trays and ladders. Cable trays shall be of the expanded metal type of 2mm thickness with edges trimmed in a continuous metal envelope. Standard tees, crosses and bends shall be used with the cable tray.
Where necessary for separation of different type cables, full depth barriers shall be supplied and securely fitted.

Edges and openings in cable trays shall be protected to prevent cable damage. The method of protection shall be subject to approval.

Tray fasteners shall not be explosive driven types without written approval.

Tray supports shall be fitted with a minimum of two fasteners.

Cable tray covers shall be installed where U.V exposure to the cables is possible.

Cable tray entry into buildings shall be sealed to prevent rodent access.

4.4.25 Mechanical Protection

Supply and install approved mechanical protection on all electrical equipment under the following conditions:

- When mounted within 1.5 metres above a floor or access platform.
- Where subject to damage during normal plant operation and maintenance.
- Areas on which scaffolding and / or planks may be placed, or which may be used as means of access for abnormal plant maintenance.

Conduits and / or cables (other than single core cables) requiring mechanical protection shall be installed in galvanised steel water pipe or other prior approved means.

Sheet metal covers installed to provide mechanical protection of electrical equipment shall be constructed to withstand the shock loading likely to occur in the area. Covers shall be constructed of a minimum 3mm marine grade aluminium material or other approved metal.

Sheet metal covers 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. Any device 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.

Covers shall be easily removed to facilitate maintenance and repair. Explosive or hammer-in type fasteners will not be accepted as fixing for covers.

4.4.26 Equipment Positioning And Mounting

Where necessary, supports, brackets and plates for the mounting and positioning of electrical equipment such as power outlets, light fittings, switches, control stations, isolating switches, conduits, cables and the like shall be supplied and installed.

Packers, shims and grouting to ensure correct levelling and alignment of equipment shall be supplied and installed.

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 and shall be suitably protected, i.e. painted or galvanised.

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 prior approved structure for the mounting of such equipment.

Mounting supports, brackets, plates and the like shall have space allowance, where required, for equipment identification.

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 correct 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 metres 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 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.

4.4.27 Identification And Labelling

The Contractor shall supply and install labels to identify all switchboards, modules and electrical components mounted on or within the respective switchboards, in accordance with the equipment identification detailed on the drawings. In the operator section of the board, the label shall be the plain English designation. In all other sections, the equipment designator shall be used. Where no such identification is given the Contractor shall seek the Superintendent's direction as to the identification to be used.

Switches, motors and other electrical equipment shall be identified with labels. Power connections shall be identified at each termination with the appropriate phase colour. All other wiring shall be colour coded in accordance with the supply authority's requirements. Each cable core termination shall be prefixed with the applicable drive equipment number. Such identification shall be carried out at the time of making off.

Cables shall be identified at each termination by means of approved tags or strips numbered in accordance with the wiring diagram wire numbers. Each cable shall be identified adjacent to the cable gland.

Cable cores including neutrals shall be identified at each termination with approved interlocking full sleeve marker ferrules, numbered in accordance with the respective wiring diagrams. 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.

All labels and nameplates for indoor use shall be manufactured from Traffolyte material, with black lettering on white background, unless specifically stated otherwise. Labels shall be glued and fixed with at least two 304 Grade stainless steel screws per 120 mm label length. Self-adhesive labels will not be accepted. Screw holes shall be slightly enlarged when necessary to prevent buckling of the label.

NOTE: In switchboards the labels are to be fixed as close as possible to the identified item, yet not on the cable duct cover. i.e. on the gear 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 Stainless Steel screws or 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. Under no circumstances shall the colour green or green-yellow be used for other than earth connections.

4.4.28 Inspections Checking And Testing

Inspection and Tests –See Section 2 “Integration” for requirements.

PROJECT INFORMATION & DRAWINGS

General

This section to be read in conjunction with SS10 Section 2 Integration.

At the completion of the project, City of Gold Coastwill become the Copyright holder for all documentation, PLC code and SCADA configuration produced specifically for the project.

Site Record Drawings

A neatly marked set of site record drawings, detailing interconnections shall be maintained. Drawings shall be kept current with the work as it progresses and shall be subject to inspection at any time.

"AS CONSTRUCTED" Drawings and Information

General
Two (2) paper copies of electrical “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.

The drawings should be fully legible at A3 size.

For Water and sewage Pump Stations only - One (1) copy of the drawings will be supplied full size & laminated (suitable for day to day engineering use), 2 paper copies are to be supplied A3 size.

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

One CD copy of electrical “As Constructed” drawings is required. They should be issued on completion of each minor & major milestone and updated and reissued on project completion. They should be supplied in a format compatible with City of Gold Coast requirements. The CDs are to be given to the project’s nominated custodian.

Circuit Diagrams with all details:
- wire numbers and cross-referencing
- telemetry connections

**Computer Aided Drafting**

One complete set of “As Constructed” drawings on a CD R shall be supplied. The drawings shall be compatible with the AutoCAD 2004 version and supplied in DXF format.

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

**Major Project Drawings**

For designated major projects, the following drawings are to be supplied in draft form for inspection and endorsement prior to the commencement of site works. They will be updated and re-supplied on project completion:
- Process and Instrumentation Diagrams (P & ID)
- Single Line Diagrams
- Electrical Schematic Drawings
- Fault Calculations And Cascading/Discrimination Tables
- Switchboard General Arrangement Drawings
- Local Control Station (LCS) General Arrangement Drawings
- Electrical Equipment Schedules
- Cable Schedules
- Electrical Equipment Layout Drawings
- Embedded Conduit Arrangement Drawings
- Cable Block Diagrams
- Earthing arrangement diagrams
- Power, Lighting And Communications Plans
- Load Listing and Maximum Demand (MD) Calculations For All Main Switchboards, DC/UPS Power Supplies, And Other Emergency Power Supplies.
- Cable Route Drawings
- Instrument Schedules
- Instrument Loop Diagrams
- PLC I/O Module Connection/Wiring Diagrams
- I/O Allocation Tables.
- Termination Diagrams
- Functional Specifications
- Control System Logic Diagrams
- Control System Tag Databases
- Inspection And Test Procedures
- Completed Inspection And Test Checklists
4.4.29 SCADA And PLC Handover Documentation

**PLC Configuration**

Two CD copies of PLC Configuration Code are required. They should be issued on completion of each minor & major milestone and updated and reissued on project completion. They should be fully labelled and dated and supplied in similarly labelled cases. The CDs are to be given to the project’s nominated custodian.

**Scada Configuration**

Two CD back up copies of SCADA Configuration Code are required. They should be issued on completion of each minor & major milestone and updated and reissued on project completion. They should be fully labelled and dated and supplied in similarly labelled cases. They should be complete with all required files and drivers to allow the reinstallation of the SCADA system on a new PC loaded only with MS Windows operating system. The CDs are to be given to the project’s nominated custodian.

4.4.30 Project Specific Documentation

Two copies of Project Specific Documentation are to be supplied on paper in draft form (for evaluation and approval) before the start of site works. The information is to be updated and re-issued on CD on completion of each major milestone and updated and reissued on paper (and CD) 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
  - Trends where the tag is used

- **PLC List**, featuring for each PLC:
  - PLC Number
  - Location/Plant Area
  - Source of supply
  - Module Part List
  - Module Individual I/O list
  - Associated Drawing Numbers

- **Equipments List**, featuring for each new piece of equipment:
  - Equipment Number
  - Equipment Description
  - Equipment Location
  - Source of supply MCC/Circuit
4.4.31 Operation And Maintenance Manuals

General
This clause to be read in conjunction with Section 2 Integration.
Submission and Acceptance of Manuals
Submission of draft manuals may be required for designated major projects.
PLC and HMI Specific Instruction Manuals
Two copies of fully updated project PLC and HMI instruction manuals are to be supplied on project completion.
The project instruction manuals are to include paper copies of technical information on all supplied equipment and software copies are also to be supplied. The information CDs are to be fully labelled, securely located and protected at the front or rear of the main instruction manual, alternately they could be supplied independent of the main manual but still attached together, fully labelled, securely located and protected.
The instruction manuals are to 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 or VSDs.
- Full operating/maintenance instructions for all other supplied equipment.

PC/PLC based operating procedures
The instruction manuals are to contain detailed step-by-step methods for all PC based operational and maintenance procedures.
The methods are to include but not be limited to:
PC Based methods
- The installation of a back up 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 back up copy of the SCADA configuration code on to a PC loaded only with the appropriate “Windows based” operating system & the SCADA operating system.
- The making of a “back up” copy of the SCADA configuration code.
- The making of a “back up” copy of the PLC configuration code.
- The installation of the PLC engineering software on to a PC loaded only with the appropriate “Windows based” operating system.
- The installation of a back up copy of the PLC configuration code on to a PC loaded only with the appropriate “Windows based” operating system & the PLC engineering software. The upload & download of PLC configuration to a remote PLC via the site communications network.
- The archiving of trend data.
- The restoration from archive of trend data.
- The creation of daily/weekly/monthly reports including the addition or removal of individual process tags.

PLC Based methods
- The making of a “back up” copy of the PLC configuration code (from the PLC) to a local engineering laptop.
- Installation of a backup copy of the PLC configuration onto a PLC from a local engineering laptop.

PLC and SCADA Software
Licensed copies of all programming and configuration software (complete with all license keys) are to be supplied on project completion. The CDs are to be given to the project’s nominated custodian (name to be announced). The CDs are to cover all essential aspects of the project including:

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

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

4.4.32 Equipment

All equipment positioned on doors or removable panels shall to be protected by insulated panels to prevent any accidental contact with live equipment when maintenance and servicing takes place. The insulated panel shall be easily removable for servicing and is to be transparent for easy viewing. Equipment offered shall possess 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 Engineer.

Arrangement

Equipment shall be neatly arranged at all times. There shall be a minimum of 5mm clearance between relays, contactors and timers. Equipment shall be arranged such that removal of access panels and opening of compartment doors does not affect the operation of other equipment.

4.4.33 Motor Selector Switch

Each Switchboard/MCC shall have a selector switch that will control the mode of operation of the drive, e.g. Man-off- Auto or Field-Off-PLC. The “Manual-Field position will operate the drive from the stop/start buttons on the door of each module or from “Local Control Stations” LCS’s at Treatment Plants and the auto position will allow the motor to be controlled automatically by the control system. The switches are to be mounted with the auto position to the right. For Pump Stations, a selector switch shall be installed as above or alternatively, a Run-Off-Auto switch can be used where the Run position- starts the drive motor on selection, Off position- stops the drive and Auto position- allows the control system to operate the drive.

4.4.34 Motors

General

Motors shall be as follows:

- 400 volt 3 Phase, 50Hz - Squirrel Cage Rotor
- Speed shall not exceed 1500 rpm. Two pole motors are not acceptable.
- Rating shall be continuous
- Bearings shall be roller and/or ball
- Protection shall be IP56
- Thermistors shall be embedded during manufacture
- Insulation shall be Class F
- Minimum 12 starts per hour
- Non-submersible motors shall be T.E.F.C (Totally Enclosed Fan Cooled)

Technical Details

Each motor supplied 30kW and above shall have the following data supplied in a dedicated booklet format (2 copies):

- 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.
• Type of enclosure.
• Maximum temperature rise at specified load.
• Ambient temperature.
• kVA code letter.
• 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.
• Starts per lifetime.
• Time - current and thermal limit curves i.e. Acceleration time versus current, running overload and acceleration versus time.

**Motor Control**

Each motor shall be controlled and protected by equipment providing:

**General**

• 3-phase thermal overload
• PTC Thermistor protection (>5kW)
• Loss of Phase, Phase Reversal and Undervoltage protection
• Motor on-load isolator (padlockable)
• Selector switch - Manual or Run /Off/Auto (auto position to right)
• Stop & Start Button i.e. if “Manual” selector switch position used
• Electromagnetic thermal overload remote reset facility if discrete component used ie a separate relay not inbuilt in Motor Protection Unit or Soft Starter.
• Control circuit breaker
• Three phase motor circuit breaker
• Ammeter or red adjustable indicator to show full load motor current

**Water Pump Station**

In addition to the general requirements:

Fault lights (where required) to Indicate:

• Low flow
• High pressure
• Low pressure.

**Wastewater Pump Station**

In addition to the general requirements:

• “Water in Oil” relay and indication light

**Motor Isolating Switches**

Every motor shall be provided with an isolating switch complying with AS/NZS 3000. 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. Isolating switches mounted behind equipment panels will not be accepted.
Motor control Centre isolation switches shall be provided with one set (NO & NC) 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 to provide remote indication of motor isolation. Circuit breakers may be used as both motor circuit breaker and isolator where the above still applies.

4.4.35 Switches And Isolators

Main Switches
The main switches shall be suitable for fault making/load breaking duties to AS/NZS 3947.3. Suitable main switches are auto circuit breakers, fused FCU's (see below) or fault make/load break switches. Non-auto circuit breakers or FCU's with solid links are not acceptable unless they have been tested for fault make/load break duties to AS/NZS 3947.3. Unless noted otherwise, the following duties shall apply:

<table>
<thead>
<tr>
<th>Type of switching</th>
<th>&quot;Independent Manual Operation&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated Duty</td>
<td>&quot;Uninterrupted Type&quot; for non-vented enclosure.</td>
</tr>
<tr>
<td>Fault Capacity</td>
<td>&quot;Rated Short Time Withstand Current&quot;</td>
</tr>
<tr>
<td>Utilisation Category</td>
<td>AC-21 Minimum</td>
</tr>
<tr>
<td></td>
<td>AC-23 for Motor Loads</td>
</tr>
</tbody>
</table>

The FCU type switch shall be interlocked to prevent the door being opened with the switch closed, or the switch being closed with the door open. However provision shall be made for authorised personnel to defeat the interlocks for test purposes.

In the case of pump stations and if applicable, a label shall be fixed adjacent to the main switch identifying the electrical pillar box to which the pump station is connected.

Each Main Switch shall be labelled as a 'Main Switch'

Motor Control Centre Compartment Isolators
C.F.S. units for M.C.C. compartments shall have handles that are pad-lockable and units shall be complete with fuse covers and terminal shrouds.

4.4.36 Fuse Combination Unit

Fuse combination units shall be of the totally enclosed type and shall comply with AS/NZS 3947.3.

The FCU's shall have the following details unless noted otherwise:

<table>
<thead>
<tr>
<th>Type of Switching</th>
<th>&quot;Independent Manual Operation&quot;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duty Rating</td>
<td>&quot;Uninterrupted Type&quot;</td>
</tr>
<tr>
<td>Utilisation Category</td>
<td>AC-21 Minimum</td>
</tr>
<tr>
<td></td>
<td>AC-23 for Motor Circuits</td>
</tr>
</tbody>
</table>

Indicated fault capacity refers to the "Rated Fuses Short Circuit Current". Padlocking facility in the "Off" position. This facility must be able to accommodate a minimum of 2 standard "Lockwood" padlocks.

A primary indication of FCU "On - Off" status by the operating handle. A secondary indication of FCU "On - Off" status shown on the FCU body internal to the switchboard (i.e., behind escutcheon or door). Alternatively this indication can be obtained through a transparent window.

Where fuses are mounted on a withdrawable carriage which ensures isolation from the supply before access to the fuses is possible, this secondary indication can be omitted.

All "On-Off" Status indications must be clearly marked on the FCU so that they can be seen under poor lighting conditions.

4.4.37 Fuse Fittings And Cartridges

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 manufacturer 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.

4.4.38 Circuit Breakers

The contractor shall ensure that all circuit breakers are correctly sized to protect the downstream equipment against overload and fault conditions.

Circuit breakers shall be capable of horizontal or vertical mounting and interchangeable 3 single poles for 1 triple pole. Multi-pole breakers shall interrupt all phases via a common tripping mechanism for a single-phase fault. Circuit breakers shall comply with AS 3111.

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 breaker shall not be more than the level which the 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 breaker on the load side can withstand thermally.
- The rated breaking current of the 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 breaker.

Circuit breakers shall be selected in accordance with the manufacturers recommended cascade co-ordination chart, Category II only.

The circuit breaker 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.

Horizontally mounted circuit breakers shall have been fully tested as being capable of successfully operating under full load and short circuit conditions in the horizontal position.

Circuit breakers shall incorporate the following features:

- Arc interrupting device
- Toggle action quick break
- Inverse time limit characteristics
- Trip-free handle
- Contacts to 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
- Double pole circuit breakers shall be used on 24 V dc circuits.

4.4.39 Contactors

AC Contactors shall comply with AS 60947.4.1.

Unless otherwise indicated, the following details shall apply:

- Block style, electromagnetic, air break type.
- Rated duty shall be "uninterrupted type" for non-ventilated enclosure.
- AC utilisation category shall be "AC-2" minimum ("AC-3" or "AC-4" for motor loads).
DC utilisation category shall be "DC-2" minimum ("DC-3" to "DC-5" for motor loads).
Series or parallel contacts shall not be used to achieve the required ratings.

**4.4.40 Current Transformers**
Current transformers shall be resin encapsulated window type and shall comply with AS 60044.1. Unless otherwise indicated, the following details 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.
- Secondary windings of protection current transformers shall be rated at 5A and shall be suitable for the burden.

**4.4.41 Motor Starters**
Every motor supplied from a switchboard or motor control centre shall be provided with an automatic motor starter. The preferred type of starter is Direct On Line (DOL) subject to Supply Authority starting current limitations.

Where there are starting limitations or variable speed requirements electronic soft starters or VSDs shall be used.

Electronic starters include soft starters and variable frequency drives. Electronic starters shall be mounted in accordance with manufactures instructions. The recommended free space shall be provided around the 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. Fan ventilated enclosures shall operate under positive pressure. High quality replaceable filters shall be provided to dust proof the air intakes.

The starter shall be mounted within the relevant switchboard/motor control centre. Care shall be taken to segregate power, control and motor cables. Motor cables for VSDs 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 AS/NZS CISPR 11.

Starters shall be designed for utilisation category AC3 and an intermittent duty of up to 12 starts per hour.

**DOL Starters**
Main contactors shall be rated for motor starting requirements and have a minimum of two 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.

The motor starters shall be equipped with overload and under voltage protection. They shall comply with the following codes and requirements:

- AS/NZS 60947 AND SHALL BE CLASSIFIED AS FOLLOWS: -
- Duty - uninterrupted and intermittent - Class 12
- Utilisation Category - AC 3, and
- Minimum no load operating cycles 3.0 million
- DOL starters shall incorporate an electronic protection relay and provide the option for communications modules to be added. Communication protocols shall include Profibus-DP or Modbus.

**Soft Starters**
Each fixed speed motor 5 kW (does not apply to Treatment Plants) and above in size is to be controlled by a reduced voltage “soft starter”. They shall have a microprocessor based IGCT or SCR control circuit for the control of induction motors operating on a 3 phase 400V 50 Hz supply. They shall have a continuous rating of not less than maximum input rating of the pump after allowing for motor efficiency.
Each starter shall comply with the following requirements:

- Adjustable acceleration ramp with adjustable start volts, current or torque for periods of up to 60 seconds.
- Adjustable deceleration ramp with adjustable volts, current or torque for periods of up to 60 seconds. Control settings for deceleration shall be independent to those for acceleration.
- Transient protection.
- Starters and starting duties are to 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 a F = 50% and S= 10 operating cycles per hour. The 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.
- All starters shall have output contacts to control the line and bypass contactors. Relays are to be rated at no less than 230V AC at 1.8 Amps. The drive shall also incorporate load terminals for the bypass contactor.
- Phase failure, phase reversal, under-voltage protection.
- Starter over-temperature protection.
- Display indication on starter of each of these faults.
- Operating voltage 400 V ± 20% 50 Hz.
- Three (3) wire operation for start and stop control.
- Temperature range -10 degrees Celsius to + 50 degrees Celsius - ambient when used in conjunction with a bypass contactor.
- Easy maintenance through component interchangeability and access to all control cards.
- Twelve months or the manufacturers full warranty.
- 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 internal controls allowing external control signals to control starter ie “force to local control mode”.
- A fieldbus (Profibus) connectivity option
- All solid-state starters shall comply with the Australian C-tick EMC requirements as defined in the following standards AS/NZS 4251.1, AS/NZS 4251.2 and AS/NZS 61000.6.1. 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.
- The solid state units should offer 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 protection
  - Starter thermal protection
  - Excessive acceleration time
  - Current overload
  - Adjustable time between restarts

Soft starters 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.
- To be remotely mounted where necessary.

- One copy of the PC software in disk or CD format to interface with the controlling PLC or RTU shall be provided per site.

Variable Speed Drives
General
Variable frequency drives shall operate on the vector control principal. They shall be sized for a constant torque load that is greater than the full load current of the driven motor. The VSD shall provide motor protection as detailed in clause “Motors” above.
The 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.
The drive shall be suitable for continuous operation at full load in ambient temperature of 50ºC. Care shall be taken during installation to ensure that the drive is protected from direct sunlight and weather. The drive shall be manufactured to quality assurance and manufacturing standards according to AS/NZS ISO 9001.
A motor fed from a VSD shall have a shielded and appropriately earthed cable suitable for VSD operation. Length of 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.

VSD Enclosures
When VSDs are to be located inside a switchboard supplied by others, in IP rating of IP21 for VSDs up to 22kW. IP00 for VSDs 30kW and above is adequate. This is to ensure adequate air ventilation is provided to the VSD inside the cubicle.
When the VSD is to be located outside of a switchboard in a switchroom an IP54 or IP55 enclosure is required.
The metal enclosure must be earthed with a low impedance connection to the main earthing system. The VSD shall include a door-mounted interface for status indication and programming. It shall be possible to control the VSD from this local interface and from remote inputs.

Performance
The output waveform design shall ensure maximum total efficiency is obtained from the drive and motor at all speeds and loads.
The drive shall automatically correct the output voltage during mains supply variations of +/- 10% to prevent loss of torque and speed variations occurring during motor operation.
The drive 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.

Electromagnetic Compatibility
ALL VSDs shall comply with the Australian C-tick EMC requirements defined in the following standards AS/NZS 4251.1, AS/NZS 4251.2 and AS/NZS 61000.6.1.
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.

Harmonics
The drive shall comply with AS/NZS 61000.3 for Harmonic Distortion levels when installed on site. Prior to installation approval, the Contractor/Developer shall provide a harmonic spectrum of the anticipated harmonic currents and voltages based on the following system data at the 400 volt AC busbars: -
The Contractor/Developer shall obtain the system data at the point of common coupling, from the Supply Authority.
The existing background levels shall be obtained by the contractor/developer in order to determine compliance with AS/NZS 610003.3
If the harmonic voltages exceed the limits specified in AS/NZS 61000.3 alternative formats of VSD can be offered as an option to reduce harmonics to acceptable levels. The use of DC line reactors or AC series reactors within the VSD’s 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 must include phase shifting transformers.
Upon completion of commissioning the Contractor/Developer shall provide a written independent test report of the actual harmonics generated when the VSD’s are operating at maximum output.
In order to eliminate any system resonance occurring within the motors operating frequency range, the controller shall be provided with a minimum of 2 by-pass frequency adjustments (dead band).

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 drives that have galvanic or opto isolation as an integral part of the drive will be accepted.

The drive 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.

The drive shall respond to speed commands from: 0 - 10Vdc and or 0/4 - 20mA control signals, and be capable of manual speed adjustment locally from the controller.

The drive shall 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 i.e. a fieldbus connectivity option.

The drive shall have an alphanumeric display and shall provide comprehensive information on the drive and the motor’s condition. The following are considered as minimum requirements:

- Frequency Hz
- Current A
- Output voltage V

Preference shall be given to drives offering the additional information following:

- Reference % of control signal
- Motor thermal reserve %
- Inverter thermal reserve %
- D.C. voltage V
- Power kW
- Energy kWh
- Hours run

The display shall be mounted on the front panel of the switchboard. 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. Minimum of two relays shall be provided for remote indication of the drive.

Preferably one relay output shall be reserved for an “alarm signal”. The other relay output 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 250Vac, 2A.

Preference shall be given to drives 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 disk or CD format shall be provided per site to set up drives.

Protection and Monitoring
The drive 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 considered as minimum requirements:

- Overvoltage
- Undervoltage
- Phase loss
- Overcurrent
- Undercurrent
- Earth fault
- Over temperature
- I²t thermal
- External fault signal

The drive shall include electronic motor thermal overload protection where the trip time is based on the motors 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.

The drive shall provide for both automatic and manual reset operation. The restart time after a trip in automatic mode shall be adjustable.

The drive shall 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.

Training
A training and familiarisation session shall be arranged to demonstrate the operation of keypads and external software programs that are used via serial port connections.

4.4.42 Motor Overload And Thermistor Protection
Motor (>5kW) overload and thermistor protection will be incorporated in the motor drive or starter, as detailed in this specification.

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 the 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.

Thermistor 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. PTC Thermistor sensors shall be supplied and installed by the motor manufacturer. Thermostatps are not acceptable.

The whole temperature protection system shall not latch-out in case of power failure, i.e. shall not prevent the starter from restarting the motor when the power is restored from failure.

4.4.43 Emergency Stop Pushbutton Stations
Where required, a red mushroom-head type emergency stop pushbutton is to be wired into the control circuit of the drive and will immediately stop or where necessary due to load, decelerate the motor safely and isolate the motor when it is activated.

The pushbuttons shall incorporate a mechanical latching facility such that the button latches out when the button is depressed and cannot be reset until the locking ring is released.

Pushbuttons shall be pad-lockable in the ‘off’ position.

4.4.44 Timers
All timers shall be of the electronic type, DIN rail mount base, and plug in type.

4.4.45 Selector Switches
All non-illuminated selector switches shall be of the flush mounting, rotary action type.

4.4.46 Hours Run Meters
For all pump contactors “hours” run meters shall be panel mounted with capacity to record to 9999.9 hours.

Note: The hour meter digits are not to be red on black. Hour meters where possible are to be mounted at eye level.

4.4.47 Lighting Installation

General
Fittings shall be installed using a minimum of two screws. Nail in type fixings will not be accepted.

Internal Lights
Fittings shall be 2 x 36 Watt fluorescent fitted with impact resistant polycarbonate diffusers. Fittings shall be constructed of reinforced polycarbonate, with I.P. 65 rating and stainless steel clips. Internal lights are to be mounted preferably on walls rather than ceilings to allow easy access.

External Lights
Lamps shall be supplied for all fittings and shall be of the size specified for the fitting. Fittings for fluorescent and discharge type lamps shall be fitted with ballasts for 240 volt A.C. supply. Fittings shall have a power factor correction to not less than 0.85. Ballasts shall comply with AS/NZS 61347.2.8 and with AS/NZS 60921 and AS/NZS 60925.

Fixtures 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 the fixtures. Fixtures shall be cleaned when the job is complete. 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.

Emergency Lighting

Emergency lighting shall be installed as per the appropriate Australian Standard.

Note:
Consideration is to be given to the positioning of the emergency lights for maintenance purposes. Confirmation of lighting positions is to be obtained prior to installation.

4.4.48 General Purpose And Three Phase Power Outlets

All 3-phase outlets shall have the same phase rotation, which the Engineer may witness check at his discretion.

All single and three-phase outlets rated 20A or less are to be protected by RCDs. A 30mA device shall be used.

All general purpose and three phase outlets shall be marked with the originating circuit breaker.

4.4.49 Level Transducers

General

The transducers shall be a hydrostatic pressure type and a multi-sensored level probe. Other types may be offered but subject to approval by The Superintendent.

Hydrostatic Pressure Transducers

A hydrostatic pressure transducer shall be a loop powered 4-20mA continuous level device utilising a pressure cell to measure the hydrostatic pressure of the liquid being measured.

The following characteristics shall be met:-

- Operate on a 24v DC supply
- Accuracy -0.20% of range
- Linearity -0.15% of range @25-C
- Operating Temperature -20-C to 80-C
- Adjustable range with a turn down ratio 5:1 typical
- Surge protected
- Body 316 stainless steel
- Diaphragm –ceramic with gold plating or equivalent.
- Overpressure protected to 200% of rating
- Rated for 1 bar (103.43kPa) or 2 bar (206.85kPa) ranges for most applications or as specified for special applications.

Digital Display And Adjustment/Ranging Transmitter Panel Enclosure

- Pre-calibrated
- Easy to set up
- Units to be displayed are metres or percentage
- Standard cable length 15m

Ultrasonic Level Transducers

An 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.

The following characteristics shall be met: -

- Operate on a 24v DC supply
- Accuracy -0.25% of range
• Temperature compensated
• Transducer Operating Temperature -20-C to 80-C
• Adjustable span range with wind down ratio 38:1 typical
• Resolution 1 mm
• Blanking distance 3% of range
• Sealing IP68 Transducer
• Cable glands IP68
• False echo mapping function to eliminate false echoes from fixtures
• Automatic gain adjustment
• Digital display and remote adjustment/ranging transmitter panel enclosure
• Pre-calibrated
• Easy to set up
• Units to be displayed are metres or % of set range
• The ultrasonic frequency shall be suitable for the application.

Multi-Sensor Probe
The probe shall be constructed from PVC tubing with moulded sensor units at regular intervals along the probe. Probes shall be designed
• To prevent the ingress of moisture
• Promote self cleaning
• 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 .75mm flexible cable. The cable will be numbered (number and text) along the entirety of the cable and at intervals not greater than 200mm for identification.
The flexible cables shall be capable of supporting the weight of the probe and cable, without the need for additional support.
The cable shall be secured to the top of the probe by a synthetic rubber compression fitting.
Probe length shall be a minimum of 1.0 meter.
Probe cable length shall be sized to allow position adjustment within the well entirety.
The probe will be mounted in a turbulent area of the wet well, suspended on its own cable and connected to a 6mm stainless steel hook which will be hooked to a 30mm stainless steel angle containing 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 30mm hole and slot, enabling the probe to be pulled through and cleaned.
This probe shall be installed in accordance with the manufacturer’s installation instructions.

Equipment Failure
Instrumentation whose failure could result in an overflow, surcharge, bypass or a violation of statutory requirements shall be provided with an installed backup sensor and readout. The backup equipment may be of a different type and located at a different point, provided that the same function is performed. No single failure shall result in disabling both sets of parallel instrumentation.

4.4.50 Actuators
General
The actuators shall be Rotork IQ or approved equivalent and shall be suitable for use on a nominal 400 volt 3 phase 50 Hz power supply and are to 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.

Diagnostics and Testing
The 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.

**Actuator Sizing**

The actuator shall be sized to guarantee valve closure at the specified differential pressure. The safety margin of motor power available for seating and unseating the valve shall be sufficient to ensure torque switch trip at maximum valve torque with the supply voltage 10% below nominal.

**Ambient Temperature**

The actuator shall be capable of functioning in an ambient temperature ranging from -30°C to +70°C.

**Motors**

Electric motors for isolating (on/off) and inching valve actuators shall be Class F insulated and shall be suitable for 60 starts per hour, rated for a minimum S2 (15 min).

**Motor Protection**

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.

**Gearing**

The actuator gearing shall be totally enclosed in an oil-filled gearbox suitable for operation at any angle.

**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 should be pad-lockable in both hand and auto positions. It should 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 must 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 unless otherwise stated in the job specification.

**Remote Valve Position / Actuator Status Indication**

Four sets of relay contacts rated at 5A, 230V AC, 30V 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)
- 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 4-20mA analogue output or fieldbus signal corresponding to valve position.

**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 position shall be included on the actuator. The digital display shall be maintained without any external supply being connected.

**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.

**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 (20V to 230V 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 1.1kV. 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)

Actuators requiring analogue 4-20 mA control shall include a Folomatic Position Controller Unit or equivalent. Adjustments shall be provided for zero, span, deadband, and motion inhibit timer. Infrared adjustments are preferred.

**Enclosure**

Actuators shall be “O” ring sealed, watertight to IP68 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 should be of stainless steel.

**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 AS1565 Copper and copper alloys, ingots and castings, driven by a ground steel worm.

Modulating actuators shall be controlled from an analogue 4-20mA or fieldbus signal and adjustments shall be provided for zero, span, deadband, and motion inhibit timer. Infrared adjustments are preferred.

An internally powered 4-20mA contactless transmitter or fieldbus interface shall be provided for remote indication of valve position.

**Secondary Gearboxes**

The supplier of the secondary gearbox shall be the same as that of the actuator.

A complete set of any special tools required shall be supplied with the actuator

**4.4.51 Programmable Logic Controllers**

**General**

Where PLCs are specified they shall comply with the following specifications.

**Programming**
A copy of the completed FAT document is to be submitted to the Engineer for approval prior to downloading the program. Downloading of the program is to be undertaken in the presence of the Engineer using a personal computer programmer. Two “as constructed” copies of the program are to be submitted. Should any additional programming or alterations to programs be made consultation is required and amended PLC code is to be issued at practical completion.

Two copies of the final PLC program are to be submitted in CD format. All parts of PLC programs shall have a written description of each line of program in plain English terminology. All components are to be labelled.

Following practical completion the PLC Program copyright shall become and remain the property of City of Gold Coast. Installations not giving City of Gold Coast complete ownership and copyright will not be accepted.

The PLC shall have a minimum of 20 per cent spare capacity on both input and output connections. All input and outputs shall be via approved knife switch type terminal strips.

All terminal strips are to be labelled.

Each PLC input module shall be separately protected against short circuit and overcurrent.

All PLC voltages shall be capable of 24 V AC, DC or 240 v AC operation.

The programmable controller shall comply with the information detailed below.

General Communication Protocol

Communication between PLC’s and HMI software shall utilise the latest Profibus protocol or industrial Ethernet or an approved open and generally available equivalent protocol.

System Capability

The PLC system must be modular and offer modules for digital and analogue I/O. Analogue to be available in input ranges of:

- 0-5V
- 0-10V
- 0-20mA
- 4-20mA

Units offering arithmetic closed-loop control, pulse output to step controller functions are required.

The PLC shall be complete with the manufacturers dedicated power supply.

Manuals for system set-up, programming, fault finding and diagnostic interpretation must be of the highest standard and must embrace all items of equipment supplied. Manuals shall be supplied incorporated with the operation and maintenance manuals as documented elsewhere in this specification.

**PLC Software**

A copy of the proprietary PLC programming software (licensed to City of Gold Coast) is to be supplied for each and every project as well as programming software for display panels and the like. This software may be utilised by the installer during design and construction stages however the software is to be handed over at Practical Completion.

NOTE.

This provision is to be verified in writing before the design stage of the project.

If the PLC software is NOT required, advice is to be obtained in writing from the City of Gold Coast.
4.5 SPECIFIC ASSEMBLY REQUIREMENTS – ELECTRICAL WASTEWATER TREATMENT PLANTS

4.5.1 Scope
Scope of the Works includes the provision of all design, material, labour, equipment, services, and any other things necessary to design, procure, fabricate, install, test, commission and handover electrical systems.

The scope includes, but is not limited to:

- Energy Efficiency Measures;
- Mains Power Supply;
- Standby Power Generation;
- SCAs/ Switchboards/ Motor Load Centres/ Motor Control Centres;
- Field Equipment including;
- Local Control Stations;
- Filed Wiring;
- Lighting;
- Instrumentation;
- Programmable Logic Controllers/ Distributed Control Systems;
- Building Security Systems; and
- Building Fire Detection Systems.

4.5.2 Standards
The installation as a whole shall comply with:

- Rules and regulations of the relevant local Electricity Supply Authority;
- Any other Authority having jurisdiction over the installation;
- Supporting Documents (SS10 – Section 4 Common Electrical Requirements); and
- The relevant Australian Standards.

The relevant Australian Standards shall include the following:

- AS 60947.4.1 Low Voltage Contactors
- AS/NZS 2381.1. Code of Practice for Selection, Installation and Maintenance of Electrical Apparatus and Associated Equipment for Use in Explosive Atmospheres (Other than Mining Applications) - Installation and Maintenance Requirements for Instrumentation
- AS/NZS1125 Conductors in Insulated Electric Cables and Flexible Cords
- AS1627 Metal Finishing - Preparation and Pretreatment of Surfaces
- AS1670 Fire detection, warning, control and intercom systems - System design, installation and commissioning
  - Part 1 Fire
  - Part 4 Sound systems and intercom systems for emergency purposes
- AS 1768 Lightning Protection
- AS 60269.1. Low Voltage Fuses - Fuses with Enclosed Fuse Links
- AS/NZS CISPR 11 Limits and Methods of Measurement of Electromagnetic Disturbance characteristics of Industrial, Scientific and Medical (ISM) Radio Frequency Equipment.
- AS 60947.2. Low Voltage Switchgear and Controlgear - Moulded Case Circuit Breakers for Rated Voltages up to and Including 600 V ac and 250 V dc
- AS2467 Maintenance of Electrical Switchgear
- AS2700 Colour Standards for General Purposes
- AS 2832.1 Guide to the Cathodic Protection of Metals Part 1 - Pipes, Cables and Ducts
- AS/NZS3000 SAA Wiring Rules
The Principal has a preferred list of components SS10 Section 5. Components identified on this list shall be used unless the component does not meet the specified performance standards as set out elsewhere in these Contract Documents. Any change shall be subject to review by the Superintendent. In proposing any relaxation of the requirement to use the preferred components, the Contractor shall give consideration to the specified performance standards nominated and to operational and maintenance matters.

4.5.3 Energy Efficiency Measures

The Principal requires the Contractor when designing and building new assets, renovating, maintaining and / or modifying existing assets to adopt the following approach:

1) Where energy input is required, all reasonable design options and sources of energy shall be considered, with the lowest WLC options being selected, unless quality standards or health, safety and/or security standards preclude this;
2) The starting point for any new assets shall be zero or minimal energy consumption. For example, maximum use shall be made of gravity sources for the displacement of fluids before consideration is given to pumping, and use of passive ventilation and daylight for building services;
3) The starting point for any extended, modified or renovated assets shall be no net increase in energy / chemical consumption;
4) Where potential exists to generate 100 kW(e) or greater, renewable and / or self generation opportunities that are integral to the process shall be considered, fully evaluated and employed (where technically and economically feasible) in preference to imported energy;
5) Where opportunities under (1), (2), (3) and (4) have been considered and discounted, energy consumption that is deemed necessary shall be treated from a minimum requirement standpoint, with the lowest energy cost and energy efficient systems, plant, and / or products being specified; and
6) All energy-consuming items of plant over 50 kW or with actual or expected energy flows >175 MWh/a shall be metered and/or sub-metered for the purposes of management information and shall provide the following outputs; kWh, kVA, and kVAr. The following calculation shall be applied for determining whether or not electricity sub-metering shall be installed:

Equ. 1: \( X \text{ MWh/annum} = Y \text{ [kW]} \times Z \text{ [load factor]} \times 8760 \)

If \( X > 175 \text{ MWh/a} \), sub-metering shall be installed by the Contractor.

All new Plant areas, together with all renovated Plant areas shall have load schedules and maximum demand schedules created at design stage in a format that is to the satisfaction of the Superintendent. Any expected resultant change to the load and / or maximum demand shall be communicated to the Superintendent. Any changes shall be included in the Contractor’s design, as part of the Contract Works. During commissioning, actual load and demand profiles shall be recorded by the Contractor’s commissioning personnel based on actual operational data recorded, for a minimum period of 1 month. This shall be extrapolated, by the Contractor, to give a derived 12 month demand profile, which shall then have the appropriate tariffs applied to give a 12 month cost model. Consolidated profiles shall be provided by the Contractor upon completion for all new and modified Plant areas.

Control solutions shall integrate the four technical areas of Infrastructure, Process Control, Optimisation and Scheduling and Performance Management in order to achieve the most cost effective and efficient solutions with regard to the use of utilities (e.g. water, power, etc.) and chemicals.

Definitions
Infrastructure – includes sensors, instrumentation, actuators, valves, drives, PLC, SCADA and DCS; Process Control – controls designed to achieve stable regulatory operating conditions; Optimisation and Scheduling – process improvements to achieve optimal performance and designed to reduce the cost of operation; and Performance Management – assimilation of process data and information to facilitate simulation, data mining, statistical process control, trend analysis and early warning of potential regulatory non-compliance(s).

Therefore control system design principles shall include:

1. Selecting control solutions that shall provide optimal energy efficient solutions which do not compromise process control, compliance with regulatory requirements or increase the requirement for manpower; and
2. Scheduling features and load management in any control regime where there is an opportunity to reduce the cost or consumption of energy / chemicals. Where possible, batch processes and / or non-critical load shall be scheduled to operate outside of peak tariff periods.

Mains Power Supply
If required to accommodate the combined maximum demand of the existing Plant and the new Works, the Contractor shall:

- Make application to the Supply Authority for supply of electricity as required;
- Work with the Supply Authority to achieve timely extension of the power supply system to the Site;
- Where supply is taken at high voltage, supply and install all necessary transformers and switchgear;
- Arrange additional metering and pay all fees and charges on behalf of and in the name of the Principal; and
- Provide new consumer mains and new supply authority metering panel.

The supply and installation of new consumer mains and each new supply authority metering panel shall comply with the requirements for Field Equipment in 10 Section 4.

4.5.4 Standby Power Generation

General
This section defines the requirements for the performance, design, inspection and testing of a diesel engine powered low-voltage power generator, hereafter referenced as the power generator set.

Refer to Contract Specification for specific details as to whether the power generator set is intended for:

Standby operation; or
Standby operation with ‘bumpless' transfer; or
‘Islanding'/peak lopping operation.

The operating environment of the power generator set (including details of EMC requirements, etc) is coastal. Refer to Contract Specification for specific details as to:

Whether the power generator set is installed inside a building in a suitably configured generator room or externally in a container or other sound proof enclosure;
What the EMC environment for the power generator is (either light industrial or industrial);
Whether the ambient air temperature for the power generator set lies outside of the range of -10°C to +40°C; and
Whether the relative humidity for the power generator set is in excess of 80%.

**Electrical Supply and Load Characteristics**

Supply Characteristics

The power generator set shall be suitably designed / rated for the proposed / existing electrical supply. The supply characteristics shall be 415 Vac, 50 Hz, three phase – 4 wire. The tolerances on supply shall be +/- 10 % for voltage and +/- 2 % for frequency.

Load Characteristics

The Generator shall be suitable for the applied loads as defined in part by the Contractor’s design, as defined below and in the Contract Specification.

**Performance Specification**

General

The generator set asset life shall be as defined in SS10 Section 2.

Electrical Performance

The power rating of the generator set (excluding the electrical power absorbed by the essential independent auxiliaries) shall be as defined below and selected as part of the Contractor’s design in accordance with the Contract Specifications.

This shall be sufficient to supply the specified electrical load.

The power rating classification of the generator set shall be defined below.

The performance class of the generator set shall be as defined below.

This shall be appropriate to the specified electrical load.

The minimum power output that the generator set is capable of producing for extended periods of time without adversely affecting the reliability of the engine shall be as stated by the Contractor.

Noise and Vibration

Noise
Unless otherwise specified, the maximum noise levels at a distance of 1 m from the generator set enclosure shall be 80 dB(A) (based on the generator set being mounted in free field conditions). Noise levels shall be measured in accordance with BS7698-10. 2.

Any further noise attenuation requirements (e.g. maximum noise levels at the site boundary) shall be as defined in the Contract Specification.

Vibration

The Contractor shall select anti-vibration mountings to reduce the transfer of mechanical vibration from the alternator / engine to the structural supports.

The maximum vibration values for the generator set shall comply with BS7698-9.

Whole Life Costs

Fuel Consumption

The fuel consumption of the engine at the specified duty points shall be as guaranteed by the Contractor in the Technical Schedules.

Service Lives and Costs of Components

The guaranteed and expected service lives of the major power generator set components shall be as guaranteed by the Contractor in the Technical Schedules.

The replacement costs and approximate times required to replace each of the components specified shall be as guaranteed by the Contractor in the Technical Schedules.

Details of the maintenance tasks required to achieve the specified power generator set asset life (refer to S3.7.5.2.1 above) and if appropriate, the guaranteed and expected service lives of the components detailed below shall be provided by the Contractor.

This information shall be presented as separate lists of tasks that must be performed on a daily, weekly, monthly, yearly and less frequently than yearly basis and shall include the approximate times and number and discipline of personnel required to perform each task.

Availability

The minimum availability of the generator set shall be defined in Contract Specifications.

Design Specification

General

The Contractor shall supply the following information which shall be consistent with the Technical Guarantees:

a) A general arrangement drawing/s of the power generator set (including the fuel storage / supply system, exhaust system, etc.) indicating the overall dimensions / footprint and typical layout of key components / systems;

b) Technical specifications for the engine and alternator;

c) A lubrication schedule detailing all components / systems requiring lubrication, the method and frequency of lubrication and the type and manufacturer of the lubricants;

d) All calculations and assumptions used for sizing the power generator set;

e) A schedule of spares required for an operating time equivalent to 2 major service intervals or 500 h, whichever is the greater (plus associated costs and lead times);

f) A typical control philosophy; and

g) A typical commissioning plan (including timescales for completion).
With respect to a), the drawings shall indicate, where appropriate, the minimum clearance distance required for the removal of components (for refurbishment or replacement) with the power generator set in situ and details of interfaces with other equipment.

All components / systems (tanks, pumps, valves, pipes, accessories, etc.) shall be adequately labelled to ensure ease of identification, correct operation and compliance with relevant standards and regulations.

Labelling/identification of components / systems shall comply with SS10 Section 3.

Engine
General

The generator set shall incorporate a multi-cylinder, direct injection, 4 stroke, water cooled, compression ignition engine, rated in accordance with the specified power rating classification (refer to Contract Specification).

The engine shall be designed to run on summer / winter grade diesel fuel oil as appropriate to the location and application.

The engine shall be able to cold start, without any preheat, with a minimum ambient air temperature (outside the engine room/enclosure) of 0 °C.

Engine exhaust emissions shall comply with all relevant Australian Emission Regulations / Specifications.

The engine shall be provided with a replaceable, dry element air cleaner with restriction indicator.

Engine Speed (Governing)

The engine shall be fitted with a constant speed, electronic governor, complying with BS 5514-4 (Class A1).

The engine speed shall not exceed 1500 rpm.

Power Factor Correction

The power generator set shall operation with a bulk Power Factor Correction system attached to on the busbars on the Plant's Main Switchboard.

Weights and Lifting Arrangements

The weight of the complete power generator set and the heaviest individual maintenance and erection lifts shall be as defined by the Contractor in the Technical Schedules. The weights of the engine and alternator (if above 25 kg) shall be indicated on information plates, permanently fixed to the engine and alternator. The plates and their fixings shall be manufactured from corrosion resistant, non-degradable materials.

Components weighing over 25 kg, that are likely to be removed for maintenance, shall be provided with clearly identified, permanent lifting points located to give a safe, balanced, lift. If lifting points are not designed for lifting the whole component, they shall be clearly marked accordingly.

Corrosion Protection for Generators

All fabricated metal components (e.g. the baseframe, enclosure, etc.) shall be designed to prevent the collection of water and debris and facilitate the application of paint systems and protective coatings.
All power generator set components shall be designed and assembled to avoid galvanic corrosion.

All machinery shall be guarded in accordance with AS4024. Guarding of machinery shall be independent of any acoustic enclosure. Generator set components and associated pipework that present a burns hazard shall be insulated / guarded.

**Maintainability**

Components that require regular inspection, cleaning or maintenance shall be readily and safely accessible and where appropriate, easily replaceable.

Equipment shall be designed to avoid the need for the use of special tools for maintenance. If special tools are required, they shall be provided.

All drain points for lubricant and coolant shall be extended for easy access and positioned so that drainage may be carried out easily into a container with a minimum height of 200 mm.

Any special access/lifting facilities, required / provided for the removal of major components / systems for maintenance shall be defined by the Contractor.

**Operational and Maintenance Manuals**

Information for the Operational and Maintenance Manuals shall be provided in accordance with the requirements of SS10 Section 3.

**Baseframe**

The generator set shall be mounted on a black steel, fabricated baseframe at the supplier’s Works and delivered to site as a fully-assembled package. The baseframe shall be sufficiently rigid to maintain correct alignment between the generator set components under all operating conditions.

If necessary, to prevent excessive levels of vibration being transmitted to the surrounding building or plinth, the baseframe shall be provided with anti-vibration mountings. The energy absorbing elements of the anti-vibration mountings shall be resistant to all fuels, lubricants and coolant additives used with the generator set.

The baseframe shall incorporate an integral bund tray. The capacity of the bund tray shall be a minimum of 110 % of the combined capacities of the engine lubrication and coolant systems. If the fuel service / day tank is an integral part of the baseframe, the capacity of bund tray shall be a minimum of 110 % of the combined capacities of the fuel service/day tank and engine lubrication and coolant systems. The bund tray shall be provided with a level switch to cut-off the fuel supply to the generator set, shut down all automatic lubricant and coolant top-up systems and generate a 'bund filling' alarm. The level switch shall operate when the bund is approximately 25 % full.

**Engine Lubrication System**

The engine shall incorporate a pressurised oil lubrication system. The oil consumption of the engine at the rated power output shall be as defined by the Contractor.

The lubrication system shall be provided with the following items, as a minimum:

- An appropriate number of full-flow oil filters;
- Readily accessible oil drain and fill points. The drain point shall be provided with a lockable gate valve and 'blanked' with a threaded stop-end;
- A dipstick and dip point; and
- An oil pressure sensor.

The Contractor shall provide the first fill of all lubricants.
The lubrication system shall be designed to prevent engine damage in the event of oil filter blockage as defined by the Contractor.

Bulk Lubricating Oil System (If Required/Provided)

Where a bulk lubricating oil system is required as part of the Contractor’s design, the system shall comprise the following items, as a minimum:

A bulk lubricating oil storage tank. The tank details shall be as specified, by the Contractor, below:
- A fill point;
- A valved outlet connection and associated pipework to the engine filling point;
- A vent connection and associated pipework, fitted with a condensate trap;
- A valved drain connection and associated pipework;
- A dipstick and dip point;
- An analogue contents gauge, graduated in litres and marked with the tank ‘high high’ level;
- A level switch to generate a ‘low low oil level’ alarm; and
- An engine oil level switch and make up control valve.

With respect to the first bullet point, the tank shall be mounted in a steel bund to form a composite unit. The bund capacity shall be a minimum of 110% of the tank capacity.

All pipework between the tank and the engine shall be bunded or run in ducts that drain to a bund.

Engine Cooling System

The engine shall be provided with a pressurised, closed-circuit cooling system. The system shall be capable of continuous effective operation at the rated generator set output, with a maximum ambient air temperature outside the engine room / enclosure as specified in Contract Specification.

The cooling system shall comprise the following items, as a minimum:

- An engine driven water pump;
- A thermostat;
- A warm up by-pass;
- A fan-assisted radiator fixed to the generator set baseframe, unless otherwise specified below;
- Readily accessible coolant fill and drain points. If the fill point is not readily and safely accessible from ground level, a hand pump filling system shall be provided. The drain point shall be provided with a lockable gate valve and ‘blanked’ with a threaded stop-end;
- A sampling point for coolant analysis, if required as part of the Contractor’s design or as defined below;
- Visual indication of coolant level and a level switch to generate a ‘low coolant level alarm’, and
- A coolant temperature sensor.

The cooling system shall be filled with a non-alcohol based, antifreeze mixture containing corrosion inhibitors and shall be rated for a minimum ambient air temperature inside the engine room / enclosure of 0 °C.

The Contractor shall provide the first fill of coolant.

The waste heat from the radiator shall not impinge directly onto any surface or object. Suitable warning notices shall be fixed where pedestrian access within 2 m of the radiator grille is possible.

Cooling fans shall be guarded in accordance with BS EN 292 and BS EN 953.

Where required the engine shall incorporate a thermostatically controlled, coolant heater to maintain it at a suitable temperature to ensure fast start-up and load acceptance. The heater shall be capable of maintaining the engine block at a temperature of at least 10 °C with a minimum ambient air temperature inside the engine room/enclosure of 0 °C.
The heater shall operate from a 240 v, 1 phase, 50 Hz supply, from a maintained source external to the generator set control panel (GCP).

The heater shall be automatically turned off when the engine is running.

The coolant heater shall be provided with isolating valves so that it can be replaced without draining the coolant system.

**Engine Fuel System**

The following items shall be provided in the fuel delivery pipework, adjacent to the engine:

A safety isolating valve;
A moisture separator; and
A full-flow fuel filter with replaceable spin-on canister element.

The engine shall be provided with the following items:

a) An engine driven, mechanical, positive displacement fuel pump; and
b) A fuel solenoid valve (energised to run).

The final connections to the engine shall be by lengths of flexible, fuel-grade tubing / hose. They shall be provided with braided, stainless steel oversheaths.

**Fuel Storage System**

**General**

The type of fuel storage system required / provided shall be as defined below and in the AW Contract and Standard Specifications.

The options are as follows:

Option A – bulk storage tank and service / day tank – pumped transfer; or
Option B – bulk storage tank and service / day tank – gravity transfer; or
Option C – service / day tank (may be integral with baseframe) and no bulk storage tank; or
Option D – bulk storage tank and no service / day tank – gravity feed to engine.

The design and construction of all fuel tanks shall comply with BS 799-5.

Tank / pipework heating and insulation requirements/provisions shall be as defined below.

Heaters shall operate from a 240 v, 1 phase, 50 Hz supply, from a maintained source external to the GCP.

Tanks and pipework installed outdoors or in buildings with no heating shall be suitably protected against corrosion. The interior of tanks shall be coated with oil at the Supplier’s factory to prevent corrosion occurring before service.

Pipework shall not be directly buried underground.

Where necessary, pipework shall be protected against mechanical damage.

Galvanised steel shall not be used for any part of the fuel system.

Level switches shall be fully rated for their switching duty (both make and break) and be suitable for a minimum of 30,000 operations without contact-burn or contact-weld.

The Contractor shall provide the first fill of fuel in the tank(s), after all testing / commissioning activities have been completed.

The fuel storage system shall comply with all related Statutory Regulations and the requirements and recommendations of the Local Authority, Environmental Regulator and Fire Service as applicable.
Filling Point
Tanks accepting bulk deliveries of fuel by road tanker shall be provided with a secure filling point. The location of the filling point shall comply with the requirements of the fuel supplier.

If the filling point is located outdoors, it shall be housed in a corrosion resistant, weatherproof cabinet.

The dimensions and arrangement of the filling point shall comply with BS 799-5.4. All relevant tank ‘high high level’ and ‘bund filling’ alarms shall be indicated at the filling point.

Where specified below, tank contents shall also be indicated at the filling point.

The filling point shall be provided with a bund. The bund shall be sized to contain the contents of the filling pipe or drain to the storage tank bund (if provided).

Bulk Storage Tank (If Required/Provided)
The bulk storage tank shall be installed above or below ground level as defined below and in the AW Contract and Standard Specifications.

The bulk storage tank capacity and type of construction and bunding shall be as defined below and in the SS10 Section 4 and 5. The tank shall be designed so that there is a minimum of 10% spare capacity between the ‘high high’ and ‘overflow’ levels. Double skinned tanks shall be provided with a method of detecting leakage of fuel through the inner skin.

The bulk storage tank shall be provided with the following connections and associated pipework:

- A valved inlet connection and associated pipework from the filling point;
- An inlet connection and associated pipework from the service/day tank return/vent (Options A and B) or engine (fuel return line) (Option D);
- A valved outlet connection and associated pipework to the fuel transfer pump(s) (Option A), service/day tank (Option B) or engine (Option D);
- An overflow/vent connection and associated pipework to the bulk storage tank bund;
- If specified below, a valved drain connection and associated pipework; and
- A connection and associated pipework for drawing off water/sludge. The connection shall extend from the top of the tank to a point approximately 50 mm from the base of the tank.

The bulk storage tank shall be provided with one or more fuel level indicators as defined below and in SS10 Section 4&5. All level indicators shall be graduated in litres and marked with the tank ‘high high’ level. Level switches shall be provided to generate ‘high high fuel level’, ‘low fuel level’ and ‘low low fuel level’ alarms.

The bulk storage tank shall be provided with personnel access and inspection openings in accordance with BS 799-5. The minimum dimensions for personnel access shall be 750 mm in any direction to facilitate access with breathing apparatus. Any further requirements shall be as specified below.

If the bulk storage tank is provided with a bund the following shall apply:

- The bund capacity shall be a minimum of 110% of the tank capacity;
- The bund rainwater collection allowance shall be as defined below;
- Penetrations for pipework, etc. shall not be routed through the bund walls or base without approval; and
- The bund shall be provided with a level switch to generate a ‘bund filling’ alarm. The level switch shall operate when the bund is approximately 25% full.

If specified below, to facilitate removal of rainwater/fuel from the bund, the floor of the bund shall slope towards one corner and shall be provided with a sump. A method of removing rainwater/fuel from the bund sump shall be provided as specified/stated below.
Fuel Transfer
Pumps shall be suitable for the duty.

If the bulk storage tank is installed below ground level, pumps shall be provided with priming facilities.

Pumps shall be positioned to allow maintenance or replacement without removing other items of equipment.

Pumps shall be located within a bund or ducts that drain to a bund. All pump components/systems that are unsuitable for immersion in rainwater/fuel shall be positioned above the top liquid level in the bund.

The pipework material(s) and type of construction shall be as defined below and in SS10 Section 4 and 5. All pipework routed between bunded areas shall be double skinned. Double skinned pipework shall be provided with a method of detecting leakage of fuel through the inner pipe.

The type of valve required / provided at the inlet to the service / day tank (Options A and B) shall be as defined below and in SS10 Section 4 and 5.

A dead-weight fire valve shall be installed inside the engine room/enclosure where the fuel pipework enters, with a Fire Push located adjacent to each door entry to the engine room/enclosure. The fire valve shall be operated by fusible links positioned over the alternator and engine. All necessary pulleys and tensioning springs to interface with the fire valve shall be supplied and installed. The number of pulleys shall be kept to an absolute minimum.

Service/ Day Tank (If Required/Provided)
The service/ day tank shall be standalone or form an integral part of the baseframe as defined below.

The service/ day tank capacity and type of construction and bunding shall be as defined below. The tank shall be designed so that there is a minimum of 10 % spare capacity between the ‘high high’ and ‘overflow’ levels. Double skinned tanks shall be provided with a method of detecting leakage of fuel through the inner skin.

The service/ day tank shall be provided with the following connections and associated pipework:
A valved inlet connection and associated pipework from the fuel transfer pump(s) (Option A) or bulk storage tank (Option B);
An inlet connection and associated pipework from the engine (fuel return line);
A valved outlet connection and associated pipework to the engine (fuel delivery line); and
A return/vent connection and associated pipework to the bulk storage tank (Options A and B).
The service/ day tank shall be provided with one or more fuel level indicators as defined below. All level indicators shall be graduated in litres and marked with the tank ‘high high’ level. Level switches shall be provided to generate ‘high high fuel level’, ‘low fuel level’ and ‘low low fuel level’ alarms.

The service/ day tank shall be provided with a capped inspection facility, with a minimum diameter of 50 mm, to facilitate manual dipping and visual fuel level checking.

If the service / day tank is provided with a bund the following shall apply:

The bund capacity shall be a minimum of 110 % of the tank capacity (plus the coolant/ lubrication system capacities if a common coolant/ lubrication system bund is required/ provided);
Penetrations for pipework, etc. shall not be routed through the bund walls or base without approval; and
The bund shall be provided with a level switch to generate a ‘bund filling’ alarm. The level switch shall operate when the bund is approximately 25 % full.
If specified below, to facilitate removal of fuel from the bund, the floor of the bund shall slope towards one corner and/or be provided with a sump. A method of removing fuel from the bund/bund sump shall be provided as defined below.

**Air Supply**

The Generator Room/enclosure shall be provided with a louvred air inlet and air outlet to ensure efficient engine operation and cooling. The louvred air inlet and air outlet shall be sized to match the airflow requirements of the engine when it is operating at the maximum generator set power output under all weather conditions.

Louvres shall be vandal and weather proof and incorporate an open mesh grill to prevent entry of birds or vermin.

The method(s) of air inlet and outlet louvre opening and closing required/provided shall be as defined below. The moving parts of the louvres shall be resistant to atmospheric corrosion and require no maintenance.

The radiator shall be connected to the air outlet by a fire retardant, flexible connection.

The air inlet and outlet shall be positioned to prevent the re-circulation of waste heat and/or exhaust fumes and the entry of gases into the engine room/enclosure that could cause an explosion hazard or depleted oxygen levels.

If, as stated below, noise attenuators are mounted on the louvres to comply with Section S3.7.2.3 above, these shall not excessively restrict airflow into/out of the engine room/enclosure, such that engine performance is adversely affected.

**Exhaust System**

The engine shall be provided with an exhaust system (including silencer) suitably rated and installed for the specified duty. If more than one generator set is required/provided, each set shall be provided with its own dedicated exhaust system.

The exhaust manifold and turbocharger shall be connected to the exhaust system by a flexible connection.

The exhaust system shall be designed and installed to minimise back-pressure on the engine.

Exhaust pipework shall be designed and installed to prevent the creation of a fire/burns hazard to surrounding material/personnel. The following measures shall be taken:

- Pipework that can be touched during normal operation shall be guarded or insulated;
- Uninsulated pipework shall be installed a minimum of 250 mm from combustible material; and
- Metal thimble guards shall be installed where pipework passes through a wall or roof.

With respect to the first bullet point, insulation around flexible connections (e.g. between long pipework runs) shall accommodate all necessary movements due to pipework expansion/contraction.

Exhaust pipework shall be designed and installed to prevent condensate entering the engine or silencer. Drain points shall be provided at appropriate positions in the pipework to allow removal of accumulated condensate.

Horizontal exhaust outlet pipework shall be cut off at an angle of 30 to 45° to prevent rain entering the system. Vertical outlet pipework shall incorporate an exhaust pressure actuated rainflap. All outlet pipework shall be provided with an open mesh grill to prevent entry of birds or vermin.
The exhaust outlet shall be positioned so that exhaust fumes and deposits do not present a hazard or nuisance to personnel or any building or structure.

**Starting System**

**Battery**

The battery type shall be as defined below.

The minimum battery design life (during which the capacity should not drop below 80% of the rated capacity) shall be as defined below. If specified / stated below, the battery shall comply with the relevant parts of BS 6290 and BS EN 60896.

The battery voltage and capacity shall be as stated below.

The battery shall be rated to start the engine within a maximum of 6 consecutive cranking operations of 10 s duration; each separated by a rest of 10 s. This performance shall be achievable from a charge state of 80% of full capacity and a battery temperature of 0 °C (the engine having stood for a period of 24 hrs at 0 °C with the engine heater switched off). Batteries shall be rated to supply all relevant control equipment during cranking operations.

The battery shall be mounted on / in an accessible, corrosion resistant, drip-proof tray/housing. The battery position shall be as defined below. Vented lead-acid batteries (if required / provided) shall be positioned so that electrolyte levels can be easily checked and if necessary, topped-up, with the battery in situ.

Batteries shall be provided with terminal shrouds to prevent short-circuits. All battery connections and links (e.g. between batteries) shall be insulated to prevent short circuits.

If specified below, the battery shall be provided with an online condition monitoring system that complies with IEC 62060 (applicable to lead acid batteries only). The parameters capable of being monitored shall be as specified/stated below.

An isolator shall be fitted on the main battery feed to the starter.

**Battery Charger**

The engine starting system shall incorporate a suitably rated, constant voltage, current limiting type battery charger.

The charger shall operate from a 240 v, 1 phase, 50 Hz supply, from a maintained source external to the GCP. The charger shall be automatically isolated from the 240 v supply during engine starting and running.

The charger shall be capable of recharging the battery from its fully discharged condition to 100% of its fully charged condition within 10 hrs, taking temperature correction into account.

If specified below, the charger shall be capable of varying the charging voltage with ambient temperature to optimise battery life. If specified below, the charger shall be capable of varying the charging voltage with the state of charge of the battery to optimise battery life.

The charger shall comply with the battery manufacturers’ recommendations. The level of AC ripple on the charger output shall not exceed the maximum value specified by the battery manufacturer.

The charger shall incorporate float and boost charging facilities, selected by a ‘Boost / Float / Off’ selector switch on the GCP or charger enclosure. Selection of boost charging shall energise a timer that shall automatically switch the charger back to float charging after a pre-set time period. The boost charging time cycle shall not re-start after a mains failure.
The charger location shall be as defined below. If the charger is not mounted within the GCP, the enclosure shall be of robust, sheet steel construction with a minimum degree of protection of IP 41 and shall be accessible from the front via hinged lockable doors.

The charger compartment/enclosure shall be provided with a door mounted isolator.

**Alternator**

**General**

The alternator shall be of the synchronous, brushless, self-exciting type. The type of excitation system shall be AREP (Auxiliary windings, Regulator, Excitation Principle).

The performance, design and construction of the alternator shall comply with the relevant parts of AS 60034.1. and BS5000-3. The basic continuous rating of the alternator (based on duty type S1 in accordance with BS EN 60034-1) shall be 400 V, 3 phase, 50 Hz, 4 wire, clockwise (RYB) phase rotation.

Unless otherwise specified below, the alternator shall provide a 400 V, 3 phase, 50 Hz, 4 wire electrical output with clockwise (RWB) phase rotation.

The insulation class of the windings shall be Class H, in accordance with IEC 60085. The temperature rise limit shall be Class H. The temperature rise shall be measured.

The final connection to the terminal box shall be via a flexible cable(s) i.e. armoured cables shall not be terminated directly to the terminal box. Flexible cables shall be suitably rated for the load duty and be resistant to all fuels, lubricants and coolant additives used with the power generator set.

Terminal markings shall be in accordance with AS 60034.8 and a diagram plate shall be permanently attached inside the terminal box cover showing the connections for the specified direction of rotation.

The cable termination arrangements shall not adversely affect the IP rating of the alternator.

Terminal mountings shall be arranged such that all cables can be disconnected without disturbing internal connections.

Terminals for thermistors, anti-condensation heaters and alternator windings may be housed within the same terminal box, provided there is sufficient room for ease of connection and appropriate segregation is provided. Alternatively, separate boxes with non-interchangeable covers shall be used for the heaters and thermistor connections, which shall be clearly marked.

The terminal box shall be easily accessible without the need to remove other components. It shall be designed to facilitate the installation / removal of cables without excessive cable distortion or cramping.

Terminals shall be suitable for connection of pressure crimped or soldered lugs and shall give full-face contact with the cable lugs.

The main, auxiliary and earth terminals shall be adequately sized for the current to be carried and be rated to withstand the prospective short-circuit current and shall be properly and securely mounted and protected. Means shall be provided for preventing terminals from working loose after connections have been made.

**Anti-Condensation Heaters**

Anti-condensation heaters (ACHs) shall be provided. ACHs shall operate from a 240 v, 1 phase 50 Hz supply, from a maintained source external to the GCP.

The ACHs shall be terminated in an enclosure, clearly marked ‘DANGER 240 v AC HEATER SUPPLY - ISOLATE BEFORE REMOVING COVER’. If the ACHs are terminated within the main
alternator output connection enclosure, the ACH terminals shall be shrouded and bear the label ‘DANGER 240 v AC HEATER SUPPLY - ISOLATE ELSEWHERE’.

The ACHs shall be isolated when the alternator is in use. If the alternator has a separate shaft mounted exciter, this shall also have an ACH, which shall only operate when alternator is not in use.

**Earthing**

A suitably labelled earth terminal shall be fitted on the alternator frame external to the terminal box for bonding to the generator set earth bar.

The terminal box and gland plate (where provided) shall be bonded to the alternator frame.

**Rating Plate**

The rating plate shall be made of a corrosion resistant metal and shall be indelibly stamped or engraved with the information specified in the relevant part of AS 60034.1.

**Output Voltage**

The alternator output voltage shall be controlled by a semi-conductor based, automatic voltage regulator (AVR) system controlling the alternator exciter field.

Voltage regulation shall comply with AS 60034.1, grade VR 2.31.

This level of performance shall be achievable at any load power factor from 0.8 to unity at all steady state load conditions between zero load and full load (including hot and cold variations). The AVR shall incorporate a method of manually adjusting the output voltage to any value between +/- 10 % of the rated value.

**Generator Set Control Panel (GCP)**

**General**

The power generator set shall be provided with a generator control panel (GCP) incorporating all necessary components / systems for the control and protection of the power generator set.

Unless otherwise specified / stated below, the GCP and its associated electrical installation shall comply with the SS10 Sections 4 and 5.

All electrical components incorporated within the GCP shall comply with SS10 Sections 4 and 5. PLCs shall be of an approved type, preferably Siemens. PLC ladder logic shall be supplied in disk form and annotated hard copy.

If the GCP is mounted on the baseframe, it shall be mounted on anti-vibration mountings. The GCP shall be positioned so as not to impede the airflow into the power generator set.

**Operator Controls, Monitoring Instruments and Alarms and Indicators**

**Operator Controls**

Comprehensive operator controls shall be provided on the GCP.

**Monitoring Instruments**

Comprehensive monitoring instruments shall be provided on the GCP. Monitoring instruments shall be provided as separate meters or integrated within a HMI.

Frequency meters shall not be the ‘vibrating reed’ type.

**Alarms and Indicators**
Comprehensive alarms and indicators shall be provided on the GCP. Alarms and indicators shall be provided as separate lamps or integrated within a HMI.

**Output Circuit Breaker**

The GCP shall incorporate a suitably rated output circuit breaker housed within a dedicated compartment.

The output circuit breaker shall trip in the event of any of the following:

- Overload;
- Short-circuit;
- Earth-fault (restricted protection); and/or
- Earth leakage fault (restricted protection).

The type of circuit breaker required / provided shall comply with SS10 Sections 4 and 5.

The operating handle of the circuit breaker shall be mounted on the exterior of the compartment and shall be mechanically interlocked with the compartment door, such that the compartment door can only be opened or closed when the device is unlocked and in the ‘off’ or ‘test’ positions. The circuit breaker shall be padlockable in the ‘off’ position.

The circuit breaker shall incorporate adjustable earth fault and earth leakage fault current and time delay settings, as defined in SS10 Sections 4 and 5.

The circuit breaker shall be fitted with a certified bus bar system on the input and output to the breaker. The bus bar system shall have provision for current transformers (CTs) on both sides of the breaker. An electrical earth bus bar shall be fitted to the outside of the circuit breaker enclosure. Provision shall be made for the fitting of a REF CT.

The circuit breaker shall incorporate a volt-free, change-over contact for remote monitoring. If specified below, the circuit breaker shall also incorporate facilities for remote control.

**Remote Monitoring (Plant PLC/DCS)**

The states and alarm conditions specified below shall be wired to a terminal strip for input to the Plant PLC/DCS. The specified states and alarm conditions shall be output individually.

The terminal strip shall be of the blade type to facilitate testing.

**Earthing**

**General**

The generator set earthing system shall comprise the following items, as a minimum:

A suitably rated and labelled generator set earth bar made of high conductivity solid copper with a minimum size of 300 x 25 x 6 mm;
- An earth electrode system, comprising earth rods or plates;
- Circuit protective conductors (CPCs), connecting the generator set earth bar to the earth electrode system, alternator star point and GCP; and
- Bonding conductors, connecting the metallic pipes of all incoming services, exposed conductive parts and any extraneous conductive parts to the generator set earth bar.

The generator set shall be connected to the earth electrode system provided for the Motor Load Centre (MLC).

Reinforcing bars or steelwork of concrete structures shall not be used as an earth electrode system, but shall be bonded to the generator set earth bar where there is any protrusion from the concrete structure.
The CPC connecting the star point of the alternator to the generator set earth bar shall incorporate an accessible, bolted test link.

All metal parts of the generator set (including the frames of the engine, alternator, baseframe and GCP), except those forming part of an electric circuit, shall be bonded to the generator set earth bar. Metalwork may be used for this purpose provided that earth continuity conductors are fitted at all joints and other discontinuities and which connections to metalwork are made using welded or bolted terminals or screws.

If the electrical system is supplied by an Energy Provider (e.g. Energex) at LV from the Energy Provider owned HV to LV transformer and the generator set is not capable of parallel operation, the value of the resistance to earth shall be in accordance with AS/NZS 3000.

Neutral Earthing
The method of earthing the alternator winding star point shall be as recommended by the alternator supplier.

Neutral conductors shall be fully rated and adequately identified by location. For convenience, CTs may be installed before the star connection of the three phases and carry the same currents as those installed on the outgoing phase conductors.

Parallel Operation
Earthing shall comply with the requirements of AS 3010 Electrical Installations—Generating Sets amended by any specific requirements of the Energy Provider (ie Energex) for parallel operation (with their supply) with export.

The Energy Provider may have specific requirements to prevent circulating neutral currents during parallel operation with their supply possibly involving export. The Contractor shall contact the Energy Provider to source any specific requirements and provide copies of their advice/s to the Superintendent to forward to the Principal.

A winding pitch factor shall minimise circulating neutral currents i.e. WPF=0.66

If a neutral earthing contactor is required, it shall be designed to fail-safe.

Automatic Mains Failure / Generator Set Changeover Panel (If Required)
An automatic mains failure/generator set changeover panel shall be provided.

Enclosure
General
The type of enclosure required / provided shall be as defined below.

The degree of ingress protection and corrosion resistance of the enclosure shall be appropriate to the operating environment. If the generator set is located outdoors, the enclosure shall also be vandal and vermin proof.

The dimensions and external colour of the enclosure shall be as agreed with the Superintendent.

A minimum clear distance of 800 mm shall be provided on three sides of the generator set and in front of the GCP door.

Lockable, hinged doors shall be fitted in the walls of the enclosure (ISO style containers and kiosks) to provide access for maintenance. Doors shall open outwards and be provided with panic bars and self-latching stays. All door fittings shall be made of stainless steel. Door locking arrangements shall be as specified below. All locks shall be fitted before delivery of the enclosure to site.

The enclosure shall be provided with a louvred air inlet and air outlet.
If specified below, the following equipment shall be provided within the enclosure (ISO style containers and kiosks):

Fluorescent lighting to provide a minimum level of illumination of 300 lux;
Heating controlled by tamper proof froststats. The operator shall be able to override the controlling froststat via a pushbutton. After a pre-set timed period of 30 minutes the override shall automatically reset returning the control of the heaters to the froststat. Adjacent to the override push button an engraved label shall be provided. The wording shall be as follows: ‘30 minute heating boost override’. The controlling froststat shall be positioned in the most practical cool spot. The heating shall be sized to give adequate frost protection and on the boost setting, to maintain a comfortable working environment within a reasonable time from initiation;
Two 13 amp, 2 gang, switched socket outlets, each protected with 30 mA RCD; and
Emergency battery backed lighting (for safe egress only).
All electrical services within the enclosure (ISO style containers and kiosks) shall be installed in heavy-duty, high impact resistance plastic conduit or cable trunking. All fittings shall be metal clad pattern. The final position of all equipment shall be reviewed by the Superintendent before supply.

A warning notice shall be prominently displayed on the inside and outside of the enclosure, as appropriate, to warn personnel that the power generator set is likely to start without warning.

ISO Style Container (If Required / Provided)
The container shall be of suitably rigid construction.

The container shall be made from non-combustible materials.

The container shall have a bunded floor. The capacity of the bund shall be a minimum of 110 % of the combined capacities of the engine lubrication and coolant systems. If, as specified / stated below, the fuel service tank is within the container, the bund capacity shall be a minimum of 110 % of the combined capacities of the fuel service tank and engine lubrication and coolant systems. The bund shall be provided with a level switch to cut-off the fuel supply to the generator set, shut down all automatic lubricant and coolant top-up systems and generate a ‘bund filling’ alarm. The level switch shall operate when the bund is approximately 25 % full.

The container shall have two separate crash button emergency exits.

The exhaust silencer shall be inside the container, unless otherwise approved.

‘Walk-In’ Kiosk
The kiosk shall be of suitably rigid construction.

The kiosk material shall be as defined below. All panels shall be joined using stainless steel fixings and all joints shall be sealed with a non-biodegradable mastic sealant.

If equipment is to be mounted on the kiosk walls, either:

The walls of the kiosk shall be stiffened by encapsulated steel sections; or
Suitably sized, 18 mm thick, varnished, marine quality, plywood boards shall be fitted to the walls of the kiosk.
If the kiosk is made from glass fibre reinforced plastic (GRP), the quality of construction shall ensure the following:

The thermal transmittance of the kiosk shall not exceed 1.5 W/m2K; and
The fire resistance (retention of stability, integrity and insulation) of the kiosk shall be Class 2 in accordance with BS 476-7, when tested in accordance with BS476-(20-23) for a period of over half an hour.
The kiosk shall have an open base and the walls shall have returned bottom flanges, suitable for bolting down to a 50 mm wide rebate in a concrete base slab. The rebate shall be filled with concrete on completion of the kiosk installation. The bolt-holes shall be spaced at suitable intervals to prevent flange distortion.

Fixing bolts shall be of the stainless steel, expanding type, complete with large washers to prevent damage to the flanges (chemical anchor bolts shall not be used).

The interface between the bottom flanges of the kiosk and the plinth shall be sealed with a non-biodegradable mastic sealant, which shall be applied before the kiosk is lowered into position and before the flange fixing bolts are positioned and tightened.

The kiosk shall be designed so that the generator set can be removed with the kiosk in position.

Close-Fitting Covers (If Required / Provided)
The enclosure shall incorporate hinged doors or lift-off panels to provide safe access to all components / systems requiring inspection, cleaning or maintenance. Doors shall be restrained against wind loads when open and doors / lift-off panels shall be securely held in place when closed. Lift-off panels shall be easily removed and manipulated by one person (e.g. fitted with suitable handles) and have a maximum weight of 25 kg. Locking arrangements shall be as defined in SS10 Sections 4 and 5. All locks shall be fitted before delivery of the enclosure to site.

All monitoring instruments (oil temperature/pressure gauges, filter pressure drop indicators etc.) shall be visible without the need to remove panels or enter the enclosure.

Control Philosophy

General (All Applications)
The power generator set shall be designed to be fail-safe, such that failure of any essential components / systems shall generate an alarm and, if necessary, shut down the power generator set.

Standby components/systems shall start automatically if duty components / systems fail. Failure of duty components/systems shall signal an alarm on the GCP and to the Plant PLC/DCS. Failure of both duty and standby components/systems shall similarly signal an alarm on the GCP and to the Plant PLC/DCS.

When the power generator set is stopped, apart from during a fault condition, it shall automatically reset in readiness for the next starting sequence.

No alarm or shutdown shall isolate the control panel display.

Alarms shall continue to be displayed until manually reset.

Engine Starting
The control system shall allow a maximum of 3 attempts to start the engine with the specified cranking and dwell regime. If the engine fails to start after the third attempt, it shall lock-out.

Engine Stopping
The engine shall continue to run off-load after any on-load run for a pre-set period (cooling run), adjustable between 0 and 20 minutes. The factory setting shall be as stated below.

If the control system is in ‘Manual’ mode, pressing the engine ‘STOP’ pushbutton shall override the cooling run timer and stop the engine immediately.

Shutdown Modes
The power generator set shall automatically shut-down (or starting shall be inhibited) under the fault / alarm conditions specified / stated below. Re-starting of the power generator set shall not be possible unless the fault / alarm is manually reset at the GCP.

Alarms such as low oil pressure and engine under-speed / alternator under-frequency shall be inhibited during the engine start-up sequence.

Emergency Stop
Operation of an emergency stop pushbutton (on the GCP or elsewhere) shall cause the power generator set output breaker and the incoming power generator set circuit breaker on the MLC / changeover panel to open and the power generator set and all auxiliary plant to stop immediately, in all operational modes. A latching ‘Emergency Stop Operated’ alarm shall be indicated on the GCP and to the Plant PLC/DCS.

Resetting the emergency stop pushbutton shall not cause the power generator set to re-start. Only when the ‘Emergency Stop Operated’ alarm has been physically reset on the GCP, may the power generator set be re-started.

Load Control – “Island Operation”

Upon total loss of supply to main switchboards for over 1 minute, “Island Mode” shall be initiated by the control system:-
Main Energex supply circuit breakers shall be opened and confirmed open.
Any other safety interlocks shall be initiated.
Motor drives shut down by deloading sequence.
Standby Generator started and closed onto switchboard bus.
Loading sequence started to load plant up to rating of standby generator.
Upon restoration of supply for 1 minute, deload plant as per 3 above.
Shutdown generator and open GCB –generator circuit breaker.
Restore Energex supply and restart plant.

Load Control When Synchronized -PLC and SCADA System/DCS Automatic Control

At times of high power demand or at times of mains power supply restriction the Plant will be required to reduce the load on the Plant’s 11kV supply. This shall be accomplished by running one (or more than one if installed) power generating set in parallel with the supply so that the total power imported into the Plant is reduced to an acceptable level.

Each power generating set shall operate in an automatic arrangement in one of two Operator selectable modes:
Under fully automatic control, the automatic Synchronisation and connection of the set shall be initiated and terminated using operator setpoints for power import into the Plant; and
Under manually initiated control, the Operator shall manually initiate and terminate the Synchronisation of the generating sets

Under PLC and SCADA System/DCS Automatic Control, each power generating set shall be started, synchronized to the supply, connected to the main switchboard bus and start accepting electrical load from the Plant. PLC and SCADA System/DCS Automatic Control shall be disabled under any of the following circumstances:
If the selected power generating set/s are required to run under blackout conditions; or
If the selected power generating set/s is/are not available for use.
PLC and SCADA System/DCS Automatic Control shall allow the Operator to select the duty load shedding power generating set. If the selected power generating set is unavailable, the other power generating set (if installed) shall automatically be selected as duty.

Fully Automatic Control –Synchronised Mode
In this mode, each power generating set shall automatically be paralleled to the Supply Authority power supply when the following criteria are met. PLC and SCADA System/DCS Automatic Control shall allow the Operator to enter the Maximum Allowed Power Import Setpoint [kW]. When the power being imported to the site exceeds the Maximum Allowed Power Import Setpoint for two (2) minutes, PLC and SCADA System/DCS Automatic Control shall initiate the Power Generating Synchronisation Sequence. The generator shall increase load kW to within 100kW of plant load or to full load provided 100kW or greater is imported via Energex supply. If Energex load import is below 20kW for 3 seconds, generator is to trip off.

PLC and SCADA System/DCS Automatic Control shall allow the Operator to enter the "Power Generator Set Shutdown Power Import Setpoint [kW]" being the sum of generator load and Energex import load (kW) and the Power Generator Set Shutdown Delay Time Setpoint [minutes] as engineering variables for use in the sequence. When the plant load power site is below the Power Generator Set Shutdown Power Import Setpoint, the Power Generating Synchronisation Sequence shall start a delay timer. Once the delay timer has reached the Power Generating Set Shutdown Delay Time Setpoint AND the power generator has been running for a time greater than the Power Generator Set Minimum Runtime Setpoint, PLC and SCADA System/DCS Automatic Control shall terminate the Power Generating Synchronisation Sequence. If at any time the plant load power exceeds the Power Generator Set Shutdown Power Import Setpoint, then the delay timer shall be halted. If the power imported to site is once again below the Power Generator Set Shutdown Power Import Setpoint, then the delay timer shall be re-started from zero.

Manually Initiated Control –Synchronised Mode

In this mode the Operator manually initiates the Power Generating Synchronisation Sequence. This mode is required so that the load on the Supply Authority power feeder can be reduced at the request of the Supply Authority operations section or to test run a power generator set. The PLC and SCADA/DCS System provides the Operator with Power Generator Set Synchronisation Start and power Generator Set Synchronisation Stop controls for the synchronisation sequence. These controls shall be disabled if any of the following conditions are true:

- If Manually Initiated Control mode is not selected; or
- If the selected power generator set is not available; or
- If the power generator set is currently performing a start-up or shutdown sequence; or
- If the power generator set is already running due to a site power outage.

When the Power Generator Set Synchronisation Start control is selected, the PLC and SCADA System/DCS shall immediately initiate the Power Generating Set Synchronisation Sequence. The generator shall increase load kW to within 100kW of plant load or to full load provided 100kW or greater is imported via Energex supply. If Energex load import is below 20kW for 3 seconds, generator is to trip off.

When the Power Generator Set Synchronisation Stop control is selected, the PLC and SCADA/DCS System shall start a delay timer. Once the delay timer has reached the Power Generator Set Shutdown Delay Time Setpoint, the PLC and SCADA System/DCS shall terminate the Power Generating Synchronisation Sequence.

An priority 2 alarm shall be raised every hour when in “Manually Initiated Control Mode” to alert the operator to stop the generator at the appropriate time.

Alarms
The alarms for the power generating system are given in the Table below. The alarm wording and priority is given in the ‘Actions’ column. In some cases, a generic wording is given, however when raising the alarm, the PLC and SCADA System/DCS shall identify cause as detailed in the ‘Cause’ column.

<table>
<thead>
<tr>
<th>Cause</th>
<th>Actions</th>
</tr>
</thead>
</table>

Key Alarm Conditions for the Generating System
### Cause Actions

<table>
<thead>
<tr>
<th>Cause</th>
<th>Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mains failure of any one incoming supply.</td>
<td>Raise Priority 2 alarm: Mains Supply failure &lt;Identify Supply&gt;</td>
</tr>
<tr>
<td>General fault for any power generator set when in standby mode. Failure of power generator set circuit breaker to close when the power generator set is running.</td>
<td>Raise Priority 2 alarm: Standby Power Generator Set failure &lt;Identify Power Generator Set&gt;</td>
</tr>
<tr>
<td>Mains failure of all supplies to one main switchboard.</td>
<td>Raise Priority 1 alarm: Mains Supply Failure &lt;Identify Switchboard&gt;</td>
</tr>
<tr>
<td>Failure of the power generator set when it is required to run. This alarm will occur whether the power generator set is required to power only one switchboard bus or two. Failure of the GCB to close when the power generator set is required.</td>
<td>Raise Priority 1 alarm: Standby Power Generator Set Failure &lt;Identify Power Generator Set&gt;</td>
</tr>
<tr>
<td>Low fuel&lt;br&gt;Alternator fault&lt;br&gt;Fail to start&lt;br&gt;Engine fault&lt;br&gt;Low coolant&lt;br&gt;Low oil&lt;br&gt;Temperature high&lt;br&gt;Overload</td>
<td>Raise Priority 2 alarm: Standby Generating Set Fault &lt;Identify Power Generator Set and cause&gt;</td>
</tr>
</tbody>
</table>

### Interlocks

**Safety Interlocks**<br>All safety interlocking shall be performed by each power generator set’s control unit.<br><br>**Equipment Interlocks**<br>All equipment interlocking shall be performed by the power generating set’s control unit.<br><br>**Process Interlocks**<br>All process interlocking shall be performed by each power generator set’s control unit.

### PLC and SCADA System/DCS Indication

#### Control Setpoints

The power generating system control setpoints for the power generating system are given in Table below.

**Power Generating System Control Setpoints**

<table>
<thead>
<tr>
<th>Control Setpoint</th>
<th>Setpoint Specification</th>
<th>Security</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duty –“Load Shedding Power Generator Set” if more than one.</td>
<td>Gen 1, Gen 2, Gen 3</td>
<td>3 (HMI)</td>
</tr>
<tr>
<td>Maximum Allowed Power Import Setpoint</td>
<td>xxxx kW</td>
<td>3 (HMI)</td>
</tr>
<tr>
<td>Power Generator Set Shutdown Power Import Setpoint (= local plant load)</td>
<td>yyyy kW</td>
<td>3 (HMI)</td>
</tr>
<tr>
<td>Power Generator Set Shutdown Delay Time Setpoint</td>
<td>2 (1 - 30) minutes</td>
<td>3 (HMI)</td>
</tr>
<tr>
<td>Power Generator Set Minimum Runtime Setpoint</td>
<td>30 (10 - 60) minutes</td>
<td>3 (HMI)</td>
</tr>
</tbody>
</table>
Trends, Displays and Reports

The PLC and SCADA System/DCS shall include the following at the HMI display, trends and reports. The items listed here for displays, trends and reports are in addition to the standard list for each power generator set.

SCADA Displays, Trends and Reports for the Generating Sets

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Displays</td>
<td>Graphic display; Operating status of all generating sets;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Open / Closed status of all motorised circuit breakers;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Mains power import for each main switchboard;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Power export for each generating set;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>All phase voltages for each generating set;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Temperature of each generating set;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Total mains power import for the plant</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Plant load</td>
<td></td>
</tr>
<tr>
<td></td>
<td>All setpoints and controls.</td>
<td></td>
</tr>
<tr>
<td>Trends</td>
<td>Power output for each generating set;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Phase voltages for each generating set;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Temperature of each generating set;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Fuel Remaining (Hours @ full load)</td>
<td></td>
</tr>
<tr>
<td>Reports – daily</td>
<td>Total running time of generating sets [hrs].</td>
<td></td>
</tr>
<tr>
<td>Reports – monthly</td>
<td>Total running time of generating sets [hrs].</td>
<td></td>
</tr>
</tbody>
</table>

Additional Power Generator Set Protection

The Contractor shall supply and install additional duplicate power generator set protection for the safe parallel operation of each power generator set complete with independent dc supplies. The additional duplicate power generator set protection shall include:

Three phase set of protection class current transformers;
Power generator set protection relay which shall include:
  Three phase instantaneous and time delayed and neutral overcurrent for earth and phase faults;
  Under/over voltage;
  Under/over frequency;
  Low forward or reverse power;
  Negative current sequence;
  Loss of excitation;
  Over excitation; and
  Circuit breaker failure;
Anti-islanding relay which shall include:
  Three phase instantaneous and time delayed phase overcurrent;
  Three phase instantaneous and time delayed earth fault;
  Rate of change of frequency (ROCOF df/dt);
  Vector shift; and
  Circuit breaker failure;
Primary and backup auxiliary tripping relays; and
Duplicated dc battery backed power supplies.

Power Generator Synchronising Controls
The Contractor shall supply and install the following additional controls to allow for parallel operation:

- Automatic synchroniser;
- Three phase metering current transformers;
- Three phase power generator set voltage sensing inputs;
- Single phase bus voltage sensing inputs;
- Remote control/monitoring communications interface; and
- Digital automatic voltage regulator (AVR) compatible with the whole of the power generator set and synchronizer controls.

The synchroniser may be co-located along with the duplicate power generator set protection devices and dc power supplies in the GCP for each power generator set.

**4.5.5 SCAs, Switchboards / Motor Control Centres (Wastewater Treatment Plants)**

**NOTE.**
The manufacturer of the switchboard / motor control centre must have a current type test certificate. A current copy of the certificate is to be forwarded to the Superintendent before construction of the SCA is commenced.

**Form of Construction and Separation**

**Switchboards**
Where the dominant loading on a switchgear and controlgear assembly (SCA) [or switchboard] is power distribution, it shall be designated as a Main Switchboard or Switchboard.

The Switchboard shall be metal clad, front connected cubicle type AS3439.1 and shall comply with AS3000, AS3439.1, other applicable standards and the Supply Authority requirements. For maximum demand loads up to 100A Form 1 separation shall be provided and for greater maximum demand loads Form 3b shall be provided.

All equipment shall have front connection and removable cover plates shall be provided to permit ready access for this purpose.

Each Form 3b Separation Main Switchboard or Switchboard shall be constructed to withstand a short circuit current of 40 kA or to the predicted short circuit current. Each Form 1 Separation Main Switchboard or Switchboard shall be constructed to withstand a short circuit current of 10 kA.

Each Main Switchboard or Switchboard shall be constructed suitable for plinth mounting with bottom and top cable entry as appropriate for the SCA’s location.

Each Main Switchboard or Switchboard shall be arranged so that all live parts of equipment immediately accessible when the switchboard doors are opened are insulated. All connections to busbars or equipment shall be either sheathed with PVC to approval or shall be made behind a removable cover plate. All equipment shall be mounted at a minimum height of 300 mm above the floor level.

**Motor Control Centres**
Where the dominant loading on an SCA is motor drives, it shall be designated as a Motor Load Centre and shall be in accordance with the requirements of Standard Specification SS10 Section 4 for MLCs or MCCs (either under Common Electrical Requirements or Asset Class -Specific Electrical Requirements).
Each MLC or MCC (hereafter referred to as an MLC) shall be metal clad, front connected cubicle type AS3439.1 and shall comply with AS3000, AS3439.1, other applicable standards and the Supply Authority requirements.

All equipment shall have front connection and removable cover plates shall be provided to permit ready access for this purpose.

Each MLC shall be constructed to withstand a short circuit current of 40 kA. Each MLC shall be type tested in accordance with AS3439.1. Segregated functional unit (e.g. drive starter, contactor, control relay, switch, button, isolator, circuit breaker, communications converter and fuses associated with the drive) compartments shall be Form 3b of AS3439.

Each MLC shall be constructed suitable for plinth mounting with bottom and top cable entry as appropriate for the SCA’s location.

Each MLC shall be arranged so that all live parts of equipment immediately accessible when the switchboard doors are opened are insulated. All connections to busbars or equipment shall be either sheathed with PVC to approval or shall be made behind a removable cover plate. All equipment shall be mounted at a minimum height of 300 mm above the floor level.

**Arrangement**

The motor control centre shall be provided with a minimum of 10 percent spare module space with a minimum of one spare module of each installed size over and above all allowances for known future equipment. All spare compartments shall be provided with hinged door complete with the appropriate locking hardware. Bolted on doors will not be accepted and Each hinged door which contains only a motor isolator or distribution isolator shall be earthed to the remainder of the SCA. Modules for “future” equipment and “spare” modules shall be constructed as part of the motor control centres and shall be fitted with bus connections, terminal strips, doors and fuse carriers ready for fitting of future equipment.

Busbars for all future and spare modules shall be provided in the motor control centre. The upper section shall house horizontal busbars, which shall feed a three-phase vertical busbar system for the vertical stacks of motor control modules.

All equipment shall be neatly arranged in separate modules or cubicles. There shall be a minimum of 5mm clearance between relays, contactors and timers. Equipment shall be arranged such that removal of access panels and opening of compartment doors does not affect the operation of other equipment.

Door openings shall allow easy access to the equipment.

All electrical equipment in the cabinet shall be mounted either on the equipment chassis or on the module door. Equipment mounted on the module floor, ceiling or sidewalls is not acceptable. On no account is equipment to be located in the cable duct. 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 the equipment chassis.

Door mounted equipment shall have suitable insulated barriers fitted to prevent contact of personnel against live equipment with the doors in the open position. The barriers shall also prevent mechanical damage to door mounted equipment.

All equipment shall be mounted at a minimum of 300mm above the floor level.

**Construction**

The motor control centre shall be of the totally enclosed dust-proof and vermin-proof type, comprising folded sheet steel cubicles, or 5251/5058 Alloy Aluminium and modules securely bolted together to form a neat composite assembly having a flush appearance. Horizontal and vertical busbar zones shall be enclosed in separate compartments completely separated from each other by means of metal or insulated barriers. Busbar sections shall be arranged for future extension and shall be pre-drilled as required.
Construction shall be of 2.0mm minimum thickness for steel construction or 3mm for aluminium construction. All sections shall be adequately rigid to enable site installation by lifting from above and to permit the use of rollers for final location.

The modules or compartment units shall be arranged in vertical stacks or tiers, each module being self-contained i.e a complete functional unit and fitted with a lockable on-load isolator (capable of being by-passed by an authorised person) fitted with interlocks complying with AS 3439.1 2002. A functional unit includes drive starter, contactors, control relays, switches, control buttons, isolators, circuit breakers, communication converters and fuses associated with the drive.

The isolator shall include a fourth (and where required, a fifth) pole, as applicable, to prevent alarm initiation when a motor is isolated at the motor control centre. These extra poles shall be early make / late break and shall open when main poles close.

All equipment within the unit shall be arranged to be fully accessible for inspection and maintenance without the need to remove other components.

No live metal shall be exposed. Shrouds shall be provided on all equipment including terminals. Installed components shall utilize the manufacturers shrouding where available.

The motor control centres shall include full-length removable plates (several removable sections may be used), mounted at low level, preferably at the interface of the motor control centre and the sub-frame.

Hinged doors shall be fully sealed with neoprene gaskets. Hinges shall be concealed. Gaskets shall be firmly held in place by continuous metal retainers in addition to the adhesive.

All screws and bolts used on the face of the motor control centre shall be Stainless Steel and the number used should be kept to a minimum.

Welds shall be ground smooth prior to painting.

All electrical equipment compartment doors are to have a separate locking system, preferably a 3-point locking system using quarter turn locks. The standard GCCC Lenlock 604 key shall be used if switchboard is not in a locked purpose built switchroom.

Escutcheon plates shall be neatly cut to fit around equipment so as to conceal wiring ducts, cables, busbars and the like.

Escutcheon plates shall be not less than 1.6 mm Grade 316 stainless steel. Escutcheon plate fixing screws shall be Grade 316 stainless steel of the mushroom head type. Escutcheon plates shall be provided with handles to facilitate ease and safety in removal from the switchboard. The handles shall consist of at least two 100 mm long "D" type metal handles lock-nutted to the escutcheon plate.

Provision shall be made at the top and bottom for conduit and cable gland entries. 6 mm thick brass or aluminium gland plates are to be provided as required. All glands passing through a gland plate shall be fitted with nylon gland seals, reviewed by the Superintendent to prevent ingress of corrosive fumes and vermin.

**MCC Busbars**

Busbars shall be rounded-edge hard drawn high conductivity (HDHC) copper and shall comply with AS 3439.1 where applicable.

The main busbars shall have a minimum continuous rating equal to the incoming circuit breaker or isolator.

All droppers or tee-off busbars to circuit breakers or controlling devices shall have the same rating and that rating shall be equal to the maximum possible load on any one set of droppers.

The earth busbar shall be rated to suit the prospective fault level and shall be a minimum cross section area of 100 sq mm.

All joints, take off points and other connections on the busbars shall be adequately prepared to avoid high contact resistance for the life of the board. This preparation shall include as a minimum requirement, abrading with fine grade emery paper or draw filing then coating with a non-corrosive rust inhibiting compound or preferably silver plated.

Busbar clamps, for clamping two sections of busbar or droppers from busbars, shall have a minimum of two bolts complete with locking devices. These bolts shall not be used to support the busbar.

Busbar supports shall be non-hygroscopic, have adequate mechanical strength and be spaced for the full fault capacity of the board.

Where not in a dedicated busway, the main busbars shall be coated with extruded PVC or heat shrink insulation in the following colours:
Busbars are to be phase colour coded at regular intervals.
The earth busbar shall be identified with a 50mm long coating, of green or green/yellow extruded PVC or heat shrink insulation at each section of the switchboard.
The main busbars in the Main Switchboard shall be completely enclosed and except for power take-offs, shall be segregated from all other equipment and wiring. Provide inspection covers in each busbar enclosure.
Neutral and earth busbars shall be completely isolated from each other, apart from the interconnecting link, which shall be made within the main switchboard. The link shall be readily accessible from the front of the board. The termination points for connection to the main earthing system shall also be located in this position.
The earth bar shall be tapped at regular spacings to provide at least four tapped holes per motor starter. Aluminium to copper interfaces shall be treated to prevent corrosion without increasing electrical resistance at such joints.

**MCC General**
Compartmenting is required for all motor control equipment. Where common equipment is provided for groups of motors, a separate module shall be provided for this common equipment.
Under no circumstances shall any control equipment associated with a particular motor be subject to a second source of supply that exceeds 32 volts when the particular motor is isolated by means of the motor isolating switch or C.F.S. unit.

**Arc Containment**
If the fault level is 10kA or greater, then the switchboards supplied under this contract shall be of the arc fault containment type in accordance with this clause. Acceptable protection for operators shall be provided for operators in the event of an internal arcing fault occurring on the line side of a protective device in any switchboard compartment. A recognized testing authority in accordance with the standard test procedures detailed in AS/NZS 3439.1 shall have tested the design being offered. Acceptable protection shall be as defined in the Annex to AS/NZS 3439.1. The construction methods and protective devices or approved equivalent used in the tested switchboard shall be the same as in the switchboard being supplied under this contract.

**Lightning And Surge Protection**
Please refer to section 3

**MCC Location**
Motor control centres shall be protected from sprays or moisture from liquid processing equipment and from breaks in liquid handling piping, where practicable, the electric equipment shall be located in a separate room from the liquid processing equipment. Liquid handling piping shall not be run through this room.

**Power-Actuated Bypasses**
The design of the wastewater treatment system requires provisions for bypassing around some unit operation. The actuation of all bypasses shall require manual action by operating personnel. All power-actuated bypasses shall be designed to permit manual operation in the event of power failure and shall be designed so that the valve will fail as is, upon failure of the power operator.

**Over-Current Relays**
Motors rated up to 15 kW shall be protected against over-current by thermal protection relays which comply with AS 1023.2 and incorporate the following features:
- be ambient temperature compensated.
- a manual reset button, and selection of auto or manual reset.
- single phasing detection which will operate at 60% of motor full load rating under single phasing conditions.
- one N/O and one N/C electrically separate auxiliary contact.
- be directly connected to the contactor by proprietary links.
Motors rated at 15 kW and up to 55 kW shall be protected against over-current by electronic protection relays (if not incorporated as standard functions in the electronic starter) incorporating integral current transformers featuring simulated motor thermal image based on phase currents, integral thermistor protection, phase failure and asymmetry protection.

Motors rated at 55 kW and above shall be protected by electronic protection relays featuring individual heating and cooling time constants for the motor thermal image, single phasing protection, ground fault protection, stall protection, incorrect phase sequence protection and adjustable underload protection. The relay shall be front panel flush mounted. Settings shall not be adjustable without the use of tools.

**Phase Failure Relay**
The relay shall be suitable for 400 V 50 Hz.
The relay shall be normally energised and drops out on voltage or phase unbalance, loss of single phase, under-voltage or reverse of phase sequence.
The phase difference sensitivity shall be adjustable between 5 and 15% of rated.
The under-voltage shall operate at 80% of rated.
A minimum time delay of 100 ms shall occur before the relay drops out.
The minimum electrical and mechanical life shall be one million operations.

**Thermistor**
Thermistor over-temperature units shall comply with AS 60947.8.
The following features shall be incorporated:
An integral Manual reset push-button.
Automatic reset after power failure.
One N/O and one N/C auxiliary contact.
A green LED to indicate normal condition.
Provision for remote reset.

**Motor Starters**
AC motor starters shall:
comply with AS 60947.4.1.
be electromagnetically operated
be rated for intermittent duty 0.1 minimum (and also uninterrupted duty)
have minimum utilisation category AC-3
be rated for enclosed operation
include a triple pole thermal over-current relay
include a thermistor over-temperature unit where
(i) motor rating is 11 kW or above; or
(ii) thermistors are installed in the motor
include control switching devices where indicated or required
be rated for ten million no-load operating cycles
be rated for one million on-load operating cycles
have a rated operational current (i.e.) of auxiliary circuit AC-11, 6A 230V ac
be rated for the greatest of
(i) actual motor rating
(ii) indicated starter rating
(iii) 15 A
Any contractor shall use those soft starters and those components nominated in AW's SS10 Preferred Equipment Schedule in Material Requirement Sections.
Motors 15 kW and larger shall be started by means of electronic soft starters. Auto transformer starters and star/delta starters are not acceptable.

**Relays**
All relays shall be plug-in type as determined in the Standard Specification SS10 General Material Requirements -Preferred Equipment.
Fit relays with clear plastic dustproof covers which enclose the complete relay.
Coils, contacts and insulation shall comply with the manufacturer's recommendations particularly with regard to a.c. or d.c. voltage and current to be applied.
Use contactors for switching current in excess of 6 A. Contactors used as relays shall have clear plastic dustproof covers which enclose the complete assembly.
Provide twin contact spring sets for relays used for light duty switching (under 1 A).
Use the constant resistance contact type, eg. gold contact or reed relays for switching electronic circuits.
Where relay contacts are to be used for mixed voltages, each contactor shall be separately isolated from each other by means of a clear plastic cover or similar to approval, to prevent accidental short circuiting.
Clearly mark voltage type on each contactor, eg. 24 V d.c., 240 V a.c.
Minimum mechanical life shall be 10 million operations.
A minimum of 2 spare contacts shall be provided, one N/O and one N/C within each relay.
Time Delay Relays
Each time delay shall be of the plug-in type.
For electronic time delays, power failures of less than 20 milliseconds duration shall not effect timer operation.
Provide visual indication of "power on" and "time up" condition on each timer.
Each time delay relay shall be adjustable over a timer range to suit the particular application.
Minimum mechanical life shall be 10 million operations.
Timers
The timers shall be suitable for industrial use.
The timers shall be panel mounted with a minimum front of 72 mm square.
The timers shall be suitable for operation of 240 V 50 Hz. The timers shall have a maximum setting error of ±2% and a maximum repeat error of ±0.5%.
Minimum mechanical life shall be one million operations.
Each timer shall be adjustable over a time range to suit the particular application.
24 Hour Timers
The timers shall be suitable for industrial use.
The timers shall be panel mounted.
The timers shall have a minimum of 4 "on - off" adjustable switch points with a minimum "on" period of not more than 15 minutes.
The timers shall be suitable for operation of 240 V 50 Hz.

Switches
Rotary switches shall be cam-operated. Unless otherwise indicated, switch positions shall be arranged with a displacement of 60°. If "OFF" position required, it shall be in a vertical plane. The escutcheon plate shall be a minimum of 60 square and shall be reverse engraved to clearly indicate switch functions.

Indicating Lights
Indicating lamps shall be Light Emitting Diode (LED) type (high intensity). Colours of indicating lights shall comply with "Colours of indicating lights and their meaning" AS 60947.5.1.

Metering
Unless otherwise indicated, the following details shall apply:
- Flush mounting.
- Square bezel 90 degrees quadrant scale.
- All meters on the one switchboard shall be of the same style and size.
- Accuracy class 1.5 (minimum).
- Meter movements shall be suitable for a high degree of vibration. They shall be jewel and pivot or taut band with oil damping.
- Impact resistant anti-glare glass.
- The scale shall be suitable for the motor full load current with five times over-scale and shall be marked in red at the motor nameplate current.


- Hours run meters shall be flush mounting cyclometer dial type to 9999.9 hours suitable for 240 v 50 Hz.

**Electronic Power Meter**

Electronic power meters shall comply with AS1284.1 meeting minimum class 1 accuracy requirement. Meter shall record kWh, kW, kVar, Current, Volts as a minimum requirement. Communication via modbus or Profibus DP shall be provided to interface with SCADA systems.

**Terminals**

Terminals shall be designed for the connected cables and also be suitable for cables at least two sizes larger. All terminals suitable for up to 70 mm² cable shall be of the same manufacture and type and shall be suitable for mounting on standard 32 rail DIN 46277, and manufactured from polyamide. For cables up to and including 6 mm², two-screw tunnel terminals, with M4 (minimum) brass or plated steel screws, shall be provided. Screw diameter shall not be less than 70% of tunnel diameter. Spring washers shall not be used for bolted electrical connections.

For cables greater than 6 mm², any one of the following links is acceptable.

M8 (minimum) brass or plated steel screws sweated into a 6 mm thick (minimum) brass or copper bar. A full nut and flat washer shall be fitted to each screw.

M8 (minimum) hexagon head, plated steel or brass set screw tapped into a 6 mm thick (minimum) brass bar. A flat washer shall be provided for each set screw.

Terminals for cables above 70 mm² shall be stud connecting and screw mounted to the switchboard. They shall not be rail mounted.

Terminal blocks shall be mounted horizontally, not more than 200 mm from the top of the switchboard. Rail lengths shall be such as to provide capacity for future terminals. Such capacity for each rail shall be minimum 20% or 3 terminals, whichever is the greater.

Terminals of thermistor circuits shall have an engraved label so that access to the terminals is prevented without removing the label. The label shall read "Thermistor terminals - do not test above 2.5 V".

**Labelling**

Each SCA shall be labelled with its ‘Plain English Name’ followed by it Asset Number (SAP descriptor).

All SCA Tiers shall be labelled. Each device that is allocated a SAP Descriptor shall be labelled with its Plain English Name followed by its SAP Descriptor.

All Neutral Bars and Earth bars shall be labelled.

All fuses and circuit breakers shall be numbered and described using engraved laminated plastic labels. Where double or triple pole circuit breakers are used, numbering shall allow for all poles and neutral terminals to be provided on the neutral bar so as to allow for future replacement with single pole breakers. All zones shall be clearly marked and labelled.

All switches, circuit breakers, contactors, relays and the like shall be labelled with the circuit function as detailed in the Alliance Contractor’s design.

All labels shall be black lettering on white background. Engraving on labels shall be of minimum height 6 mm unless otherwise agreed by the Superintendent.

All labels shall be mechanically fixed with round head metal thread screws, nutted or tapped. A card index identifying labels and numbers with connected circuit functions printed or typed shall be inserted in the card holder on the inside of the door. Hand written details are not acceptable. The card index shall also indicate cable size(s) for associated mains and/or sub-mains to and from the panel. The card shall also include the neutral terminal for each circuit.

**Nameplate**

For MCCs specified to comply with AS 3439.1, provide and install on the MCC one or more nameplates with essential marking as required by Clause 5.1 of AS 3439.1.
Terminations
Blank removable gland plates shall be provided at all cable entry points. The gland plates shall have a thickness of 6 mm, and shall be of sufficient size to have at least 20% extra capacity over and above the allowance for future equipment.

All external cabling shall enter through stainless steel glands and non-ferrous gland plates and terminate on terminal strips inside the switchboard or panel. Exceptions to this are the motor power cables 10 sq mm and larger and mains cabling which may terminate directly onto their respective devices.

Cabling shall be adequately tied, run neatly and enclosed in a cable duct. Duct shall have perforated sides for cable access to individual terminals and shall be fitted with a lid. Ducts shall have a minimum spare capacity of 25% over and above the allowance for future equipment.

Cable serving or inner sheath shall be left on the cable wherever possible i.e. from the gland to approximately the first termination.

The terminal blocks shall be mounted on a horizontal steel rail and shall be placed so that connections can be easily, safely and reliably made and viewed.

Terminals should be logically grouped and terminals of different voltages shall be separated by means of a barrier endorsed by the Superintendent.

There shall be sufficient room and clearance in the termination areas to permit the future disconnection and reconnection of cabling without creating a hazard or requiring a shutdown of other circuits.

All power circuitry and terminations shall be segregated from control and other circuits, and shall be shrouded and provided with a cautionary label in the vicinity to prevent unintentional contact with potentially lethal voltages.

Where access can be gained to uncovered energised conductors, a cautionary label shall be located to provide effective warning. The label shall bear the words "Alive - Isolate Elsewhere".

Circuit groups having operating voltages in excess of 100 volts shall be protected by means of an insulating cover, endorsed by the Superintendent bearing the legend "Warning..... Volts".

All terminals shall be numbered sequentially and labelled accordingly.

Terminals shall be sized and arranged so that one wire only is terminated in either side of each terminal block. Extra terminals with bridging connector links shall be provided where multi-terminations occur.

Each wire shall be terminated with the correctly sized and insulated crimp lug endorsed by the APMT and fitted in accordance with the manufacturer's recommendations. The lug shall be of the type and size most suited to the device terminal e.g. ring tongue for stud terminals and lip blade for tunnel type terminals.

Only one wire shall be crimped in each terminal lug, except in looping earth connections where it is necessary to maintain earth continuity under all conditions.

Each cable core shall be marked at each termination with neat fitting sleeve type ferrules and the marking shall comprise of the cross reference number from the relevant schematics and prefixed by the drive reference number. Neutrals shall be identified with the motor reference number.

Incoming cable cores shall be terminated sequentially (by core number) along the terminal strip with no cross over of cores.

Wiring
All wiring shall be carried out in a neat and workmanlike manner, and shall be enclosed within wiring ducts endorsed by the APMT. Wiring ducts shall have perforated sides and positive continuous clipping (or clamping) edges on both the wiring channel and cover.

Internal wiring shall be insulated (0.6/1kV grade) with V75 PVC insulation.

The control and instrumentation wiring shall be of adequate size, a minimum of 1.0 mm² (32/0.20) rating, multi-stranded flexible copper conductors, PVC V75 Grade. The minimum size for power cables shall be 2.5 mm². Each control wire shall be tinned and terminated with a pin crimp.

Wires shall be colour coded as follows:

<table>
<thead>
<tr>
<th>Phase wiring (A, B and C)</th>
<th>red, white and blue</th>
</tr>
</thead>
<tbody>
<tr>
<td>230V controls</td>
<td>orange</td>
</tr>
<tr>
<td>230V neutrals</td>
<td>black</td>
</tr>
</tbody>
</table>
### Power Factor Correction

If required, sufficient power correction equipment shall be installed to correct the Plant’s power factor to a minimum of 0.95 lagging.

### Active Harmonic Filtering

The Distribution System shall be designed to limit the total harmonic distortion of the supply voltage (THDv) at the Point of Common Coupling (PCC) to 5% (refer AS 61000.3.6 and HB 264). The PCC shall be the HV terminals of the substation transformers. In the case of variable speed drives and other harmonic producing equipment, appropriate input filtering (e.g., active front end) equipment shall be provided to achieve the required limits.

### 4.5.6 Field Equipment

#### General

Unless specified elsewhere, all electrical field equipment shall be housed in stainless steel enclosures with a minimum protection rating of IP 65 for all areas.

All fixings shall be corrosion resistant. All fasteners shall be captive to the enclosure body or lid.

#### Motor Isolators

All motor isolators shall be rated to AC-3 Duty in accordance with AS/NZS 3947.3 and shall be lockable in the OFF position only. Each motor shall have an isolator provided at the switchboard. Motor isolators shall be incorporated into Local Control Stations along with the stop/start/emergency stop devices. The Local Control Stations shall be within view of the motor drive they are isolating and labelled as ‘Motor isolator’.

#### Local Control Stations

The term local control station (LCS) shall be taken to include all associated works including mounts/ foundations, base, stands, sun hoods, equipment and enclosures. Local Control Stations shall include the start button, stop button, emergency stop button (maintained lockable when depressed), and motor isolator.

LCS shall be constructed of 3 mm marine grade aluminium or 2 mm grade 316 stainless steel with sun hood and supported on a marine grade aluminium channel post and base with cover plates. The LCS equipment enclosure shall be sufficiently deep for at least two contact blocks to be used or have available a replaceable lid which will enable the use of two contact blocks per operator. Provide terminal strip for all cabling other than motor sub-circuits. Provide safety strap, to support open front cover if not supported by hinges.

LCS shall not be used for the looping or marshalling of cables. Each LCS shall be labelled using a stainless steel label with the Plain English Name followed by the SAP Descriptor of the controlled device permanently engraved in 10 mm high Arial font or similar agreed by the Superintendent.

### Junction Boxes
Junction boxes shall be used for the marshalling and looping of all field cabling and shall be constructed of 3 mm marine grade aluminium or 2 mm grade 316 stainless steel. Separate junction boxes shall be provided for each different drive or equipment system and for sections of different systems which are not isolatable at one location.

Provide terminal strip. Junction boxes shall have provision for 25% spare cabling in addition to that provided for initial requirements.

Where a cable is junctioned at a junction box it shall be deemed to be a separate cable either side of the junction box and hence will have a separate cable number. The junction box shall be labelled with an appropriate identifying number linked to the electrical schematics.

**Field Cables, Wiring and Accessories**

**General**

All cabling and wiring shall be supplied and installed in accordance with the applicable standards noted elsewhere in this Specification, in particular AS/NZS 3000 and AS/NZS 3008.1.1 Wiring shall be of the size required by the wiring rules for the actual circuit loading, or as specified.

Minimum size shall be:

- **Lighting**: 1.5 sq mm
- **Control**: 1.0 sq mm
- **Power**: 2.5 sq mm

Where motors are subject to vibration, care shall be taken to prevent vibration damage to supply cables.

All cables are to be terminated in pre-insulated crimped lugs or pin terminations similar to "Utilux". Final connections to instruments and similar equipment which is withdrawable from its mounting shall be made with flex entries in PVC double insulated flex not less than 32/0.2 mm. Sufficient flex, neatly strapped, shall be provided to permit easy withdrawal of equipment.

All conductors shall be copper.

Firmly fix all flex connections at each end by a plastic locking grommet endorsed by the Superintendent.

All cables and wiring shall be identified at each end where they are connected to apparatus or terminal strips using ferrules similar to hellerman, hellagrip or hellaclip. The identification used shall correspond to that shown on the drawings.

Cable/core distinguishing colours shall comply with the following:

<table>
<thead>
<tr>
<th>(i)</th>
<th>Single Phase:</th>
<th>Red - Active</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Black - Neutral</td>
</tr>
<tr>
<td>(ii)</td>
<td>Three Phase:</td>
<td>Red - &quot;A&quot; Phase</td>
</tr>
<tr>
<td></td>
<td></td>
<td>White - &quot;B&quot; Phase</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blue - &quot;C&quot; Phase</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Black - &quot;N&quot; Neutral</td>
</tr>
<tr>
<td>(iii)</td>
<td>Earth - Green / Yellow</td>
<td></td>
</tr>
<tr>
<td>(iv)</td>
<td>Control Wiring - Grey</td>
<td></td>
</tr>
<tr>
<td>(v)</td>
<td>Wiring which may be energised when cubicle is isolated - Orange</td>
<td></td>
</tr>
</tbody>
</table>

Wire to and connect all outlets, equipment and the like. Wiring shall not be run through fittings. Wiring shall enter and leave at the one point.

**Wiring shall be as follows:**

- **TPS cables in false ceiling areas and partition walls.**
- **TPS or TPI cables protected by conduit where:**
  - Exposed to damage
  - In poured concrete slabs, columns and the like
  - Within brick and blockwork cavities
  - Where embedded in plaster or the like
  - Wiring shall not be installed between roof sheeting and insulating material when insulation is directly beneath roof sheeting.
Surface conduits are not acceptable. Conduits shall be generally light duty rigid or corrugated PVC except where exposed to mechanical damage, where heavy duty rigid or corrugated PVC conduit is to be used. Corrugated conduit only to be used in difficult areas to a maximum length per run of 3 m between draw in points. All PVC conduit in poured concrete to be heavy duty with a minimum outside diameter of 25 mm. Screwed galvanised steel conduit shall be used where required by AS 3000, e.g. lift and fire protection circuits, and in locations of likely severe mechanical damage. Provide cable trays/ladders or formed ducting where required. Cable trays, ladders and ducting shall be aluminium except where contact with lime or lime solution is possible where 316 stainless steel shall be used.

**TPI and TPS Cable**
TPI and TPS cables shall be 0.6/1 kV grade as applicable in accordance with AS/NZS 5000.1. Insulation shall be V75 grade. All cables shall have multi-stranded copper conductors.

**Instrument Cables**
Instrument cables shall be cable that is specifically designed for instrumentation. This includes correct screening and current rating. A typical example of the appropriate instrument cable is “Dekoron”.

**Aluminium Cables**
Where aluminium conductors are specified joints and/or terminations shall comply with ruling “enquiry C259/76 on rule 3.21.4 of AS 3000, Part 1. Joints and/or terminations shall be carried out by crimping. Lugs for aluminium cable shall be of the bi-metal type with copper palm.

**PVC Armoured Cables**
PVC armoured cables shall be 0.6/1kV grade comprising stranded copper conductors PVC insulated and bedded, galvanised steel wire armoured and PVC sheathed overall. PVC armoured cables shall comply with AS/NZS 5000.1.
PVC armoured cables shall be terminated in heavy compression type glands having wedge type armour clamps for steel wire armouring.

**MV Terminations**
Where screened signal wires are specified, screening shall be continuous from the signal source to the receiver. Earthing of the screen shall be at the substation end only and shall be achieved by connection to the instrument earth busbar.

**Cable Glands**
Cable glands shall be of a weatherproof type, agreed to by the APMT and similar in style and quality to Alco WG series. Cable glands shall be sealed. PVC weatherproof shrouds shall be provided and fitted for glands mounted outdoors or in readable visible areas. The shrouds shall be Alco ‘SG’ type or an equivalent agreed by the APMT. All gland plates shall be drilled to the sizes required by the cable gland. The gland sizes shall conform, for each cable size, to the manufacturer's recommendations. Brass glands shall not be used in aluminium alloy boxes as fittings. Where it is required that PVC cables be connected to equipment that is too small to accommodate the gland, or if permanent wiring is provided with equipment (e.g. solenoid valves), then cables shall be terminated in a conveniently located two-way junction box. The connection to the equipment from the junction box shall be made using flexible PVC coated metal conduit and fittings endorsed by the APMT. The enclosure rating of the junction box and fittings shall be appropriate for the area of installation.

**Cable Terminals**
All cable terminations shall be made using pre-insulated crimp lugs. Crimp lugs shall be crimped with a suitable crimp tool. Where hand operated crimping tools are used, the tools shall be of the type which will not release until full compression is applied. Hexagonal crimping dies shall be used on all cables of 70 sq mm or mm$^2$ cross section and above.

Suitable full sized bolts shall be used for the connection of lugs onto equipment terminals. Where lug holes are not big enough for the size of bolt being used, copper flags shall be provided and fitted.

Wire stripping shall be performed using a wire stripper. The wire shall be stripped to an extent that prevents the covering entering the terminal connection or crimping lug but does not allow the protrusion of bare wire from the terminal block or lug.

No more than one wire shall be connected to one side of any terminal.

The correct size and type of screwdriver shall be used for making terminal block connections.

Terminal strips shall be provided within enclosures and equipment for control cable terminations. Terminal strips shall be provided with the number of terminals required on the drawings plus 25% spare rail capacity.

The terminal blocks shall be coloured as follows:
- 240 volt: white
- 24 volt: grey
- analogue: yellow
- intrinsically safe: blue
- earth: green/yellow

Where control cables and power cables (above 50 V D.C.) are connected to terminal strips in the same enclosure protective covers and warning labels endorsed by the IPT shall be installed over power connections.

Terminals shall be Sprecher and Schuh type VR2-2.5 or an equivalent endorsed by the Superintendent. Each terminal shall be identified with a number in accordance with the drawings using permanent clip-on non-flammable terminal markers with black characters on a white background.

**Cable Ferrules**

The cores of all cables shall be continuity checked, and numbered with white engraved ferrules with black numbers to correspond to the relevant termination diagrams and equipment drawings. Wrap around adhesive markers will not be acceptable. The Contractor shall ensure that the component numbers of the identifier are aligned and that the identifier is clearly visible.

Ferrules shall be of a sleeve type, which will not slip off the ends of the cables. The overall cable shall also be labelled with tags agreed by the Superintendent and identifying references.

**Lighting**

**Design Criteria**

Structures shall be lit at night, including walkways, stairways, ladders, at the structures and pathways between the structures, to ensure staff safety and to enable normal operation of the proposed works.

Lighting shall be in accordance with AS1158.1 to Category C2 within a 10 m radius of all items of equipment.

The mounting height of all lighting shall be as low as possible and a design which incorporates a larger number of low mounted lower power luminaries is preferred. The security lighting shall utilize the lowest possible light level consistent with safe movement of personnel in and around the assets.

Two levels of external lighting shall be provided:

- A low intensity system providing security and workplace safety lighting; and
- Higher intensity work lights which are individually switched for each work area.

Similarly two levels of lighting within each building shall be provided:

- A low intensity system providing workplace safety lighting; and
Higher intensity work lights which are individually switched for each work area.
The lighting system will include emergency lighting provisions in each building to cater for power failure. Exit signs shall illuminate under power failure conditions.

**Luminaries**

Corrosion resistant polycarbonate bodied high pressure sodium luminaries shall be used.

All other external light fittings shall be vandal proof and corrosion resistant.

**Equipotential Earth Bonding**

A continuous equipotential earth bonding system shall be provided to achieve the following objectives:

- Achieve the same earth potential value to the Plant’s PLC/DCS regardless of geographical location;
- Provide the same earth reference point to the DCS/SCADA and instrumentation system; and
- Ensure that step and touch electrical potentials are limited to permissible levels.

The equipotential earth bonding system shall include the high voltage and low voltage systems. Equipotential earth bonding system shall comply with AS/NZS3000 and other appropriate standards, together with the following reference standards and other appropriate regulations and guidelines:

- LV transformer local earth rings shall be connected with 120 mm² copper green/yellow backbone earth cable, installed parallel with the low voltage distribution cables but in separate conduit with properly marked and labelled standard earth inspection pits at each change of direction and field joint.
- The equipotential earthing system shall provide a 0.1 ohm earth resistance value as required by the Principal’s Standard Specification SS10 Section 4 Common Electrical Requirements.
- Earth bonds shall be provided for all metal pipes, tanks, equipment structures, reinforced structures, cable ladder, cable tray, trunking, metallic conduit, MCC main earth bars, filling points and the like.
- The reinforcing steel in concrete footings and slabs, buildings and ancillary structures shall be connected to the earthing system to provide equipotential bonding and to enhance the integrity of the earth connection.
- All buried joints in earthing conductors shall be by exothermically welded connections (CADWELD).
- The separation between earth electrode or earthing cable and buried metallic services and telecommunication and DCS/PLC and SCADA services shall be not less than 0.5 m in order to reduce possible electrolytic action adversely affecting the electrode or service.
- Where conductors are looped between bonded equipment they shall be secured into a common lug to ensure continuity of the whole system should an individual piece of equipment be disconnected.
- New earth electrodes shall be Grade 316 stainless steel of minimum diameter 12 mm. Earth cables shall be fixed to electrodes with a CADWELD process.
- Earth connections shall be provided at MLC main earth bars.
• Transient earth clamps shall be provided between the Plant’s earthing system and communications and the DCS/PLC and SCADA earthing services to achieve equal potential.
• Lightning Protection System
• The Plant shall be provided with appropriate lightning protection as detailed in the Principal’s Standard Specification SS10 Section 4 Common Electrical Requirements.
• In addition, all new telephony land lines connected to the Plant’s external alarming and security devices shall each be provided with three (3) surge diverter connected in series.

### 4.5.7 Electronic Building Security System

#### General Requirements

The Contractor shall provide:

A new electronic security system for the Principal’s Plant to reduce the risk of unauthorised and undetected access to the Plant where no security system is currently installed; or
An expansion of an existing electronic security system for any new buildings at the Principal’s Plant to reduce the risk of unauthorised and undetected access to the Plant where a security system is currently installed.

All buildings in the Plant housing PLC/DCS Components, personal computers, HACCP instruments, compliance monitoring instruments, Class 3 and other hazardous materials and tools shall be provided with an intruder alarm system which has connected to it the electric door strike and card reader/s for each ‘secure’ door. Access data shall be captured, logged and transmitted to the Principal’s 24 hours security monitoring service.

The Contractor shall provide electric door strikes and associated card readers for all exterior doors and for interior doors between sections of each building with different uses/classifications under the Building Code of Australia. Each electric door strike shall be wired to an Intruder Alarm System Panel (IASP) location in each building agreed by the Superintendent. Each of the doors fitted with an electric door strike shall be provided with a card reader/s wired to the IASP.

The system architecture at each Plant comprises/will comprise:

- An Intruder Alarm System Panel;
- Data Gathering Panels;
- Access Readers;
- Locking Devices;
- Break Glass Emergency Door Release Switch;
- Request to Exit Button; and
- Intercom System.

#### Monitoring Equipment

Intruder Alarm System Panels
Each Intruder Alarm System Panel (IASP) shall be a Tecom Challenger Version 8.

The Contractor shall connect to and where necessary expand the IASPs already existing at the Plant. Where possible, the Contractor shall enclose all of the new and existing equipment inside a common enclosure.

Where the panel is installed other than in a secure room, the Contractor shall connect the tamper switch on the cabinet door to a separate alarm input and program it for a entry and exit delay.
Each IASP shall be connected to the Principal’s security monitoring service using a digital dialler. The Superintendent will provide contact details for the Principal’s preferred monitoring service on request from the Contractor.

Data Gathering Panels
Where required, the Contractor shall:

- Provide Data Gathering Panels (DGPs) for the remote extension of the IASP capability;
- Provide DGPs to provide expanded functionality of the system; and
- Obtain from the Superintendent the agreed location of each new DGP before commencing work.

The Contractor shall use 2 pair shielded cable (Belden 8723 or equivalent) or optical fibre where it is provided for other security services for the data connection between the IASP and each DGP.

The Contractor shall provide 240 VAC power connections for each IASP and DGP.

Access Readers
Where shown on the Project Drawings, the Contractor shall provide a ‘Tecom TS087H’ heavy-duty smart card reader connected to the Tecom Challenger LAN.

The Contractor shall configure reader LED options to provide separate annunciation of:

- Area Secure; and
- Card badged (including beeper).

The Contractor shall configure card reader operation to enable accessing and securing of the respective site.

The areas accessed/secured will depend upon the access level and will be advised by the Superintendent upon request by the Contractor.

Locking Devices
The Contractor shall supply Padde, monitored 12 volt ES2000 door strikes or EML series magnetic locks dependent upon application or equivalent reviewed by the Superintendent.

The Contractor shall install these locks in fail-safe mode for designated fire exits and fail secure for other external perimeter doors. The operation of the fail-safe or fail secure mode shall be as required by the specific location and depend on internal application in accordance with the Building Code of Australia.

Shear locks will not be permitted.

Break Glass Emergency Door Release Switch
The Contractor shall supply and install CQR Security Components Ltd White plastic box unit, labelled Emergency Door Release fitted with two individual contacts where shown on the Project Drawings.

Each break glass emergency door release switch shall be fitted inside areas secured with a swipe exit. Operation shall override and release the door, irrespective of lock security status. ‘Break Glass’ shall be monitored on the electronic security system. A key shall be required to reset the break glass.

Request to Exit Button
The Contractor shall provide a Ademco Request to Exit Buttons Model No SW60 where shown on the Project Drawings.

Intercom System
The Contractor shall provide a video intercom system with stations located as shown on the Project Drawings.

The intercom system shall be the Jacques JDDI –1 or JDDI-4 unit or equivalent.
It is intended that the existing telephone backbone cabling at existing Plants be used for the intercom link. If this arrangement is not suitable, then the Contractor shall allow for an alternate arrangement and provide details of alternative solution to the Superintendent for review.

Detection Equipment

General
Unless specified otherwise, detectors shall be those with current endorsement by the Security Construction and Equipment Committee (SCEC) for use in Intruder Resistant Area applications as defined in the latest issue of the Catalogue of Security Equipment.

Tamper contacts on all equipment shall be monitored at all times.

Detection devices shall be installed in accordance with manufacturer’s requirements.

Detection devices installed indoors shall have the cable entry opening sealed with a sealant after cables have been installed.

Detection devices installed outdoors shall have flexible metal conduit connection directly to the device housing using correctly sized glands or conduit adaptors.

Where detection devices are fixed within ladder cages, ladder shrouds, or near ladders, they shall be kept outside the minimum clearances for rung type ladders as required by AS 1657.

The Contractor shall fabricate customised detection device mounting brackets from machine guillotined and folded minimum 2 mm thick Grade 316 stainless steel of a thickness sufficient to prevent movement of the detector. The Contractor shall pre-drill and tap all fixing holes as necessary to suit the device.

The Contractor shall ensure brackets do not protrude from behind the detector and finish flush with the detector edges wherever possible.

Nuisance or False Alarms
Position all detectors so as to minimise nuisance alarms and false alarms.

During the Contract period including the Defects Liability Period, the Contractor shall attend on site within eight working hours after being notified of a nuisance or false alarm.

The Contractor shall carry out any testing necessary to determine conclusively the cause of any nuisance or false alarms, and provide a written report to the Superintendent of the cause.

Within three working days, the Contractor shall notify the Superintendent in writing of the circumstances surrounding the false or nuisance alarm and any action necessary to prevent a similar occurrence.

The Contractor shall bear the costs of all work associated with the attendance of the nuisance or false alarm and the cost of all alterations necessary to eliminate any false alarm problems.

The Contractor shall be responsible for any alterations to the intruder alarm system necessary to eliminate nuisance or false alarms due to technical faults, or due to pre-existing conditions.

Sector Schedule
The Contractor shall provide a sector schedule to the Superintendent that shows the required sectors including tamper contacts and additional sectors required to meet the overall system functionality.

The Contractor shall provide all sectors as necessary to connect detection devices, tamper contacts, and to provide the functionality specified and as shown on drawings.
Separate sectors shall be allocated for the connection of each detection device so that the Principal can identify individual detectors in alarm.

Naming conventions for points, point types and sites will apply to IASP programming. The Superintendent will provide nomenclature for naming conventions which shall be:

- Programmed into the IASPs;
- Programmed into the Titan database;
- Programmed into the Video Recording System;
- Included in as-constructed documentation and software; and
- Provided to the Contract Superintendent in the form of the complete Titan database.

Schedule of Information
The Contractor shall provide the following information containing all details necessary for annunciation of the detection systems to be configured to the Cosec Security Monitoring Centre:

- Site Name;
- Security Alarm Panel PSTN telephone number;
- Network Address;
- Computer Address;
- Site Codes;
- For each centrally reporting alarm sector input:
  - Input number;
  - Panel/DGP number;
  - Sector description;
  - Device type;
- Site plan in electronic format (suitable for conversion to 640 x 480 pixel .bmp) showing:
  - Site boundaries;
  - Major site infrastructure outlines;
  - Detector locations;
  - Camera locations; and
  - Identification of all items.

Infrared Beam Detectors
Detectors shall be Pulnix PB-Series or equivalent reviewed by the Superintendent. The Contractor shall select a detector model appropriate for the distance of each zone requiring protection. Each detector shall not be spaced closer than the minimum spacing recommended by the manufacturer for reliable operation of all beams.

Balanced Magnetic Reed Switches
General

All magnetic reed switches at all sites shall be Sentrol series 1078, 2200 or 2500 or equivalent reviewed by the Superintendent. All reed switch types shall be reviewed by the Superintendent before installation.

Doors

The Contractor shall mount each magnetic reed switch at the top of the door on the leading edge. The Contractor shall mount the reed switch on the inside of the door.

The Contractor shall mount the reed switch on the doorframe or on a mounting bracket. The Contractor shall mount the magnet on the door.

The Contractor shall provide an end of line device.

For double doors, The Contractor shall provide two reed switches, one on each door leaf.

Passive Infra Red (PIR) Detectors
General
PIR detectors shall be provided where shown on the Project Drawings.

The primary function of the PIR detector is to provide movement detection at the curved perimeters of large rectangular structures where infrared beam detectors are not practical.

PIR detectors shall be wide beam short range outdoojector detector, equal to Rokonet RK815DTQ 15 m QUAD PIR/MW and meeting the following requirements:

- Microwave & Quad PIR technologies;
- Anti-Cloak™ Technology;
- Coverage 15m (50 ft);
- Trouble indication;
- Creep zone;
- Microwave range adjustment;
- Flexible installation height up to 3.3m (10'10”);
- Low current consumption;
- 40V/M RF immunity;
- Anti-fluorescent interference signal processing.

**Installation of PIR Detectors**

The Contractor shall install PIR detectors at locations shown on the Project Drawings.

The Contractor shall use proprietary mounting brackets as recommended by the manufacturer.

The Contractor shall set the aiming position and sensitivity to suit the area where the detector is located.

**Wireless Detectors**

Wireless detectors shall be Inovonics 900 MHz range of equipment or equivalent utilising the FA 210 universal transmitter and the FA 400 receiver.

**Other Components**

**Cabinets**

Outdoor cabinets shall be fully welded Grade 316 stainless steel or marine grade aluminium to IP66 rating polyester powder coated after fabrication to Mist Green.

Indoor cabinets shall be fully welded sheet steel to IP5X rating polyester powder coated after fabrication to Mist Green.

Each cabinet shall have tamper alarmed lockable doors. All alarm panels, DGPs, video panels and associated electrical equipment shall be installed within the cabinet unless specified otherwise.

All cabinet cam locks shall be keyed alike for all sites and shall be to the Principal's master keying system.

**Terminations and Connections**

Alarm Sector cabling shall be terminated using cable lugs or tunnel type terminals to separate terminal strips within the panel or in an adjacent tamper alarmed termination cabinet within the panel.

**Logbook**

The Contractor shall provide one pre-printed, lined maintenance logbook in a pocket in the door at each IASP.

**Specific Installation Requirements**

Scope of Work
The installation of the security system shall be undertaken using the material and relevant workmanship requirements of SS10 Sections 4 and 5 for ‘Field Wiring’.

The Contractor’s work on each Tecom Challenger and each DGP shall include, without limitation, the following:

Supply and install conductors between components of the type, shielding and earthing to manufacturer’s recommendation;
Supply and install panel earth to electrical switchboard earth;
Supply and install LAN device ground and termination links to the manufacturer’s recommendations;
Supply and install TS0882 1M memory expansion;
Supply and install TS0091 Computer/printer interface if required;
Supply and install 12 V maintenance free battery marked with date of installation;
Extend the circuit to cover outer MSC in series with N/C door tamper switch;
Address each DGP to allow for full 32 input expansion of each unit where needed (i.e. Multiple DGPs on each Plant to be numbered 1, 3, 5, 7 etc.);
Program unused input numbers as Type 0;
Fit resistors to unused siren outputs to the manufacturer’s instruction;
Enable mains fail monitoring at each panel; and
Configure for PSTN connection via and internal dialler.
Following installation and configuration, the Contractor shall change the default master PIN code to a number provided by the Superintendent.

Transient Protection and Isolation
The Contractor shall provide earthed surge protection on the 240 VAC input to each IASP and DGP.

Surge protection devices shall be single phase three mode surge diverters with 40 kA metal oxide varistor elements and high energy gas filled arrestors in metal enclosure with DIN43880 compliant dimensions. The surge rating shall be 40 kA, 8/20 microsecond pulse response.

End-Of-Line Resistors
The Contractor shall install dual End-of-line (EOL) resistors for each sector within each detector housing and configured as recommended by the manufacturer to provide open and short circuit monitoring of external wiring.

Battery Charger and Batteries
Each panel shall be supplied from standby power batteries in the event of failure of the mains or battery charger. Battery capacity shall be sufficient to operate the entire intruder alarm system including detectors in each location for 8 hours.

Any video system is for alarm verification only and does not require any battery backup.

Each battery chargers shall be located in a panel, and shall be capable of restoring the battery from a fully discharged state, to a fully charged state, within a period of 48 hours after restoration of supply, and at the same time maintain the installation in a fully operational state. The Contractor shall supply and install a separate power supply if the panel supply is insufficient to accommodate the above requirements.

Reference Documentation
The Contractor shall comply with the requirements following documents (or any subsequent updates) produced for the IASP and associated equipment:
Access Cards
The Contractor shall provide sufficient cards to test and commission the system. Site codes and other access control parameters shall be consistent with the Principal’s existing electronic access control coding schemes.

4.5.8 Building Fire Monitoring and Reporting System

General Building Fire Monitoring and Reporting System Requirements
The Contractor shall supply and install a fire monitoring and reporting system in all new Buildings in accordance with AS1670 Fire detection, warning, control and intercom systems - System design, installation and commissioning, Part 1 Fire and Part 4 Sound systems and intercom systems for emergency purposes.

The fire monitoring and reporting system shall be based on a conventional fire monitoring and reporting system using smoke and heat detector suitable for the proposed location and the associated Plant activities.

The Contractor shall detail:
- The types and numbers of detectors in each building;
- The location of manual call points in each building;
- The location of the Main Fire Indicator Panel (typically located in the entry or foyer of the Control Building); and
- The alarm enunciation requirements for each building. Each building shall be assumed to be manned and therefore annunciation shall be provided.

Inter building communications for the fire monitoring and reporting system shall be redundant fibre optic to match the other new communications arrangements at the Plant. The fibre optic cable shall be installed in a ring arrangement following the same route as the plant control system ring to provide increased surety of avoiding communications loss due to cables being accidently dug up or otherwise severed or damaged.

The fibre optic ring arrangement shall provide:
- Improved protection of the fire monitoring and reporting panels against the risk of damage from lightning by have fibre optic communications between the Control Building and the other site buildings. The use of fibre optic cable avoids the induction of high voltages from very close lightning strikes into inter building cabling which often occurs with inground copper cables; and
- Improved surety of communications for the fire monitoring and reporting system by having a fibre optic ring rather than a ‘backbone’ with branches. This approach mirrors the arrangement required for the PLC/DCS communication system.

In addition, the likely future installation of a multi-point aspirated smoke detection system (MASDS) required that the Data Gathering Point/s in each building be configured to suit networking over the fibre optic communications ring mains provided for the security system.

The Contractor shall protect hot dip galvanised components that come in contact with the soil or are embedded in concrete with either a Denso wrapping system or two heavy coats of an alkali and acid resistant bituminous paint.
The Contractor shall supply and install the Main Fire Indicator Panel in the foyer of the Control Building or where agreed with the Superintendent and the Queensland Fire and Rescue Service (QFRS).

The Contractor shall, on behalf of the Principal, make all arrangements with, lodge all necessary applications with and pay all fees and charges to the QFRS for the connection of the Building Fire Monitoring and Reporting System to the QFRS fire alarm monitoring service (FireNET). The communications mode shall be the current system supported by QFRS.

**Specific Building Fire Detection System Requirements**

Each Data Gathering Point shall be supplied with the necessary printed circuit cards to allow for at least 3 levels of alarming with the MASDS.

The installation of the fire detection and monitoring system shall be undertaken using the material and requirements of SS10 Sections 4 and 5 for 'Field Wiring'.

### 4.5.9 Treatment Plant Control and Operational Data Requirements

**Objective of These Requirements**

The objective is to provide a comprehensive standard for configuration teams (including third party configuration teams as may be required for Lump Sum Turnkey (LSTK) plants) to achieve the following objectives:

- Common look and feel for operation and maintenance personnel.
- Simple, hierarchical structure of operating displays
- Ease of commissioning, troubleshooting and fault identification.
- Standard approved modularly structured logic and associated displays.
- Incorporation of alarm management and alarm minimisation.
- Modular configuration/programming
- Incorporation of plant wide approved standards (for example approved standard for colours, tag numbers and other display elements).
- That the system will be subject to a HAZOP study of all control system states.

**General Description of Control System**

All processes are to be controlled by a master-slave PLC system that interface with a central HMI system that allows supervisory control of the overall process and data acquisition (SCADA). Communication between PLC's and HMI is preferred to be via fibre optic connection. Other cabling systems or wireless systems will be considered provided technical advantages and cost advantages are provided. Critical process points shall have redundancy provided either through a redundant processor being available or system redundancy through allowing another PLC to assume control via the local IO network and a duplicate fibre optic communications rings at both the process level ie Profibus PA/DP (or approved equivalent) and the Supervisory level ie Ethernet between PLC's, servers and operator/engineering workstations. A physical separation of 2m is to be maintained between redundant communication rings, where this is not possible mechanical protection shall be provided.

The following requirements are particularly noted:

Programming and configuration shall be designed to fail to a safe condition. This means that the system or the plant shall remain in a safe state after occurrence of process or plant faults or on failure of electric power or instrument air and system. The plant shall remain in a safe state after the fault or failure returns to normal. This includes the plant or equipment not automatically starting or operating on return to normal unless specifically required to do so.

Initialisation logic shall be configured to set all flags, values and devices to required values. The configuration shall provide for the retention of values required to be maintained during power failures and downloads. Equipment shall always restart in a normal, operational and predictable manner after a processor reset or interruption to power supply.
An optical communication system, with full redundancy shall be installed, connecting either all PLCs to each PC server, the PC clients and the engineering workstation or the DCS components together; The optical communication system shall be provided and connected to all new Plant facilities and areas;
Two (2) communications loops, complete with all required hardware (termination boards, optical link modules, optical switch modules and patch leads) shall be supplied, installed and terminated as part of the Works;
The two independent communications loops, each in separate conduit runs, shall each be made up of toughened externally sheathed, rodent proof, six (6) core optical fibre. The optical fibre shall be single mode or multi mode as best suits the project. All six (6) cores shall be terminated and patch leads provided to the optical link modules. The method of joining shall be fusion splice.

A reticulation system of pits and conduits shall be provided for the separate routing of the redundant communications networks. The fibre optic cables shall be run in defined corridors with spare conduit capacity to allow future augmentation and to suit Plant master planning. The networks are to be arranged such that the redundant loops do not share conduits and preferably remain separated from each other by more than 2 m. The pits and conduits shall be sealed and shall be rodent-proof.

**PROGRAMMABLE LOGIC CONTROLLERS - Treatment Plants**

**PLC - General Requirements**
See Common Assembly Requirements Clause “PROGRAMMABLE LOGIC CONTROLLERS” for basic specifications.
The following requirements shall apply to treatment plants:

PLCs which are compatible with fibre optic cabling and the requirements of the control system shall be installed in all areas;
A Profibus cabling system shall be installed around the Plant. The network shall be designed for redundancy should any leg of the cabling be destroyed;
The design shall incorporate redundant cabling to minimise disruptions in the event of a Profibus cable failure; and
Servers and client PCs shall be compatible with the communication and data networks selected.

**Treatment Plant I/O Card Requirements**

AI Analogue input cards, should be selected with the highest degree of internal surge protection & galvanic separation between individual input channels and between the input channels and the PLC’s back plane. It is preferable to limit each card to 8 input channels.
AO Analogue output cards, galvanic separation between channels is required and the ability to drive the cards output into the required load. The minimum load capability must be 500 ohms or better.
DO Digital Output cards should be relay based rather than transistor gate based. Approval may be obtained to use transistor-based cards where IO rack space, switching speed or mechanical wear concerns can be demonstrated.
DI Digital Input cards should be selected with the highest degree of internal surge protection & opto isolation between individual input channels and the PLC’s back plane.

**Treatment Plant Processor Redundancy**

Where a treatment plant is being significantly upgraded or extended then typically a new control node will be created.
The control node will be self-contained so that in the event of plant communication system failure local plant operation will still be possible.
Depending on operational requirement the control node will be provided with a HMI panel or SCADA client.
Where a PLC in a treatment plant is controlling and or monitoring significant core equipment or processes then that device shall be supplied with redundant processors.
The processors shall be of a type specifically designed for (and tried and tested in) hot redundant operation.
The processors shall be mounted on separate racks but linked optically for hot redundant operation.
The event of a PLC processor (auto) changeover should be alarmed and clearly detailed on the plant SCADA log.

The individual PLC racks should be complete with all required power supplies and communications modules.

The term “hot redundant” shall mean that each PLC processor in a pair is fully updated with the current plant operational status and capable of immediately assuming plant control with no interruption to plant operation, sequences, or external equipment status.

The PLCs supplied for treatment plant control shall be from a manufacturer with an equipment range specifically designed for “hot redundant” operation.

Treatment Plant I/O Hardware Quality Requirements

Where there is a requirement for a node but the I/O numbers are small then all processor, power supply, communication and I/O cards can be mounted on a single rack.

Where it is cost effective and suitable equipment exists then plant I/O can be connected to separate I/O racks made up of a lower cost I/O hardware (providing the lesser I/O cards shall be fully compatible with the all aspects of the plants control requirements and the processing and communications cards on the main racks).

The I/O racks will require separate communication cards for each processor module they are attached to.

Treatment Plant PLC Cabinets, I/O Spare Capacity, Terminal Requirements & I/O Surge Suppression.

The PLC cabinets will be generously sized and supplied with conveniently located large capacity cable ducts. The ducts will be sized such that on project completion a minimum of 25% spare capacity exists in all ducts.

The cabinets shall be supplied with two thermostatically controlled vent fans. The fans will be positioned low in the cabinet and their inlets filtered. Warm air will discharge via side mounted insect screened vents located near the cabinet top (above all critical equipment). In the event of the failure of a vent fan an alarm will be triggered.

Cable entry will be via the base of the cabinet will be come ready drilled with holes for all required cables plus 50% spare capacity. The spare holes will be in various sizes to approximately match the ratios of existing hole sizes. Unused holes will be plugged.

The PLC field wiring terminals will be DIN rail mounted. The DIN rails will be arranged vertically. There shall be a minimum of 25% spare DIN rail capacity on project completion.

In addition to the I/O count required for each PLC a further 25% spare I/O capacity shall be supplied at each PLC. The spare I/O will be supplied in the same ratios as the determined process requirement. All spare I/O must be wired to field wiring terminals in the same manner as the other installed I/O cards.

All I/O cards will be supplied with numbered pre-formed wiring looms that are to be connected to approved knife switch terminals. All I/O cards and terminal strips are to be clearly and permanently labelled to show their association.

Each PLC input module shall be separately fused to protect the module.

All analogue circuits that terminate external to the PLC building should be supplied with suitably rated surge suppression units (see section 3).

Instrumentation & Control Distribution Board (ICDB) Protection

Where instrumentation and control distribution boards are required, they shall supply power to all PLC, control, instrumentation, SCADA monitoring, SCADA communication devices, and telemetry equipment located within the switchboard building and its associated area. Each circuit requires an individual circuit breaker. All breakers are to be clearly and permanently labelled.

The distribution boards are most commonly single phase but for boards with large load requirements three-phase boards should be considered. In this case, the associated UPSs will also have to be a 3-phase type. The distribution board source/sources of supply and phase details should be clearly labelled.

To give the highest level of power redundancy it is preferable that the ICDB should have two sources of supply that are fed from different switchboards. The sources of supply should be on the same phase for single-phase boards, or the same phase rotation for 3 phase boards. Both supplies must be powered in the event of the site running on generator power. Should this dual arrangement not be
possible the UPS maintenance bypass switch (detailed above) is essential. The normal source of supply will be from the UPS. The distribution board busses should be protected with surge diversion as per section 3. This surge protection is to give protection to ICDB load circuits should the UPS supply not be available and also protect against surges entering via the field load circuits. If two sources of supply are available, a make before break switch is required on the ICDB inlet to allow mains supply change over without removing power from ICDB circuits. The normal warning signage is required for “two sources of supply” and for “UPS Bypass Mode Selection Is Required before Switch Operation”. This last sign is required to avoid damage to the UPS. Where a distribution board is not UPS powered, the distribution board busses shall be surge protected as per clause 7.1.

**PLC Cabinet/Control Distribution Board UPS**

The UPS selected for supplying the Instrumentation and Control Distribution Board (ICDB) should be correctly sized for a minimum of two hours back up time at the expected load. This period has been selected to allow time for plant generator start up or for safe plant shut down. The MCC will require a supply breaker for the UPS. The supply cable to the UPS will require surge protection as per clause 7.4. The UPS should be single or three phase to match the associated ICDB. The UPS will be connected using plugs at the inlet and the outlet to allow its easy removal for maintenance reasons. Should this requirement not be possible then the external isolation/bypass switches should be provided to allow the unit to be removed without affecting ICDB supply. If the unit supplied features an external battery bank then an external battery isolation switch should be provided. Where a UPS is the sole supply for an ICDB (i.e. no back up supply is available) it is essential that the UPS device be supplied with an external maintenance bypass switch such that the control board circuits will remain energised when the UPS is not available. Large and detailed labels should be provided outlining safe procedures for the operation of the external maintenance bypass switch.

**Surge Protection of Coaxial Antenna & Digital Signal Cables & Field Instrumentation**

See Clause “Lightning & Surge Protection and Intrinsic Safety”

**Communication Networks**

Where major plant extension or upgrade works are taking place redundant optical fibre communication networks are to be supplied. In order to minimise the possibility of simultaneous damage to both communications networks, the communications loop cables should be run in separate conduits, and where possible they should be separated by greater than 2m. The communication conduits and associated pit system shall be clearly and permanently labelled and vermin proof. The optical fibre used in the communications loops will contain a minimum of two spare cores. The fibre offered is to be of a type generously rated for the segment length and network communication speed and loading. The optical fibre cable is to include an external sheath (to protect the inner sheath from damage) it is to be of a type with a known high level of protection from insect, termite and rodent damage. The two communications networks should be in “redundant ring” format and set up such that if a section of the “ring” is damaged all communication would be automatically be conveyed through the undamaged portion of the “ring”. The communication systems should be self-checking and in the event of the failure of a portion of either communication ring an alarm or SCADA system message is to be generated (preferably) identifying the failed section of the ring. To isolate surge damage typically where an I/O rack communicates with a processor rack then that communication will be via optical cable. Ensure all communications Profibus–DP and Profibus-PA (RS485) cabling is segregated within switchboards in accordance with manual “Profibus Installation Guideline for Cabling and Assembly” published by the Profibus and Profinet International (PI) suitable for use in an industrial environment. Active terminators are to be utilised on all Profibus-DP networks. The use of the last device is not acceptable.
Splitter boxes shall be arranged allowing for spare ports for future device connection. Profibus-PA (RS485) devices shall utilise splitter boxes for connection. Splitters Boxes shall be housed inside suitable weatherproof enclosures.

**Treatment Plant Communication**
For communication between nodes within a treatment plant the preferred communication protocol shall be “Industrial Ethernet”. Where a PLC I/O rack communicates with a PLC processing rack or a HMI panel the latest Profibus protocol shall be utilised (or an approved open and generally available equivalent protocol). Wherever possible, optical fibre cables shall be used for all communication connections.

**Programming and Programming Units**
Ease of programming is of a high priority, units featuring a structured programming format in accordance with IEC 61131-3 programming languages will be considered to be advantageous. P.L.C Programming shall be with Windows based programming software and be completely compatible with the manufacturers software package.
Interfacing to the PLC should utilise industry standard fibre optic or standard RS232 cabling. Packages that do not require Hardware or Software protection are desirable. All PLC’s in the range must be capable of being programmed by the one programming unit. Suppliers offering systems capable of being programmed by a P.C based programming unit will be favoured.
Program storage off-line, in the form of a back-up copy, is required.

**Operating Criteria**
- PLC must have self-diagnostics for ease of fault detection by maintenance personnel.
- Forcing of I/O on-line is required.
- On-line programming of PLC is required.
- I/O modules should have:
  - Logic indication
  - Easily removable field wiring terminal blocks.
  - Easily removable modules.
Redundant system configurations should be provided to cater for the failure of one PLC within a group of PLC’s.

**Manuals**
Manuals for system set up, programming, fault finding and diagnostic interpretation must be of the highest standard and must embrace all items of equipment supplied. Manuals shall be supplied incorporated with the operation and maintenance manuals as documented elsewhere in this specification.

**PLC Software**
A copy of the proprietary PLC programming software (licensed to City of Gold Coast) is to be supplied for each and every project as well as programming software for display panels and the like. This software may be utilised by the installer during design and construction stages however the software is to be handed over at Practical Completion.

*NOTE.*
This provision is to be verified in writing before the design stage of the project.
If the PLC software is NOT required, advice is to be obtained in writing from the City of Gold Coast.

**PLC-HMI & RTU-HMI SCADA SPECIFIC REQUIREMENTS**
**Architecture**
**General**
The software must be scalable such that the user can start with a small system, and expand the database to any size by upgrading the license. The SCADA and Engineering licenses must provide for at least 25% spare capacity to allow ongoing upgrades to the plant. This requirement must be fulfilled without adding any complexity to the HMI system simply for the purpose of reducing the size of the license required for the operation of the plant.
The SCADA system must consist of Interface Subsystem(s) and I/O Device Subsystem(s). The Interface Subsystem(s) must access all discrete or analogue field signals via the I/O Device Subsystem. The I/O Device Subsystem must perform all control functions regardless of the state of the Interface Subsystem. The Interface Subsystem must consist of a major brand SCADA software package, personal computers and industry standard hardware. It must be possible to perform any operator function in the SCADA software from any node on the network.

The SCADA software must be configurable as a single global configuration database regardless of the number of nodes in the system. It must be possible to make configuration changes to the global configuration database in a manner that is completely transparent to the user. Each SCADA node must automatically maintain a copy of the global configuration database locally and under normal conditions would use the local copy in order to reduce network traffic.

All server tasks should be treated as critical, such that each task has a primary and a secondary computer for processing. Further, the software should support intelligent redundancy such that the secondary equipment contributes to processing of the load. It should be true redundancy and not just duplication to ensure that there is continued operation in the event of any single hardware or software failure in the Interface Subsystem.

The software must be capable of supporting at least 100 workstations (nodes) simultaneously running the same project database as a single integrated system. Expansion of the system must be possible with the addition of non-proprietary hardware.

Software Licensing should be based on the number of users logged on to the network, not the number of nodes on the network.

The software should support NetBIOS compatible networks such as Netware, Windows Networking and TCP/IP.

The SCADA software must be capable of operating on a network with multiple protocol stacks. A file server must not be required; however the SCADA software must be capable of storing and managing its database on a redundant file server.

The software must be supplied as a complete package. Further, all option modules should be listed. The software must be menu-driven. It must be easy to configure, and context sensitive on line help must be available throughout the system. The software must be configured using either nested or pop-up menus, and fill-in-the-blank forms. The software must provide configuration tools to simplify and significantly reduce the initial configuration by minimising data entry. The database editor must provide facility for find and replace across the database. Fields for tag names, loop names and equipment names must accommodate at least 32 characters. Configuration databases must be in an open format, to allow editing and manipulation by other editing packages. Database management must be configurable by engineers but transparent to the operators. Importing of Tag definitions from I/O device configuration/programming packages must be included as a standard feature such that upon change of a definition in the I/O device tag names, addresses and ranges will automatically be imported into the SCADA software database. In addition to automatic tag definition importing it must be possible to manually initiate the import of tag definitions at any time. It must not be necessary to define tag definitions both in the SCADA software and in the I/O device configuration. Exporting of Tag definitions must be possible to generic interfaces such and CSV files and OPC.

Internet Access to Displays

The SCADA software must include all the necessary software including the Internet server to provide full operator display functionality via the Internet without any loss of functionality. Changes made to the SCADA software database will be automatically provided to the users via the Internet without the need for any action on the part of the user or the person making the changes. Changes will be automatically uploaded to the Internet user’s PC only when the user accesses a display that has been modified so as to conserve bandwidth and optimise performance. Addition of new displays must be treated as a change to the database and must be seamlessly provided to the Internet user.

The SCADA software will operate in conjunction with firewalls and provide robust security to reduce the possibility of unauthorized access. It must be possible to limited access to view only or provide full read write access and functionality identical to a workstation on the LAN.
Assuming reasonable ISP performance, users accessing via the Internet using a 56K modem access must consistently obtain display update times of 10 seconds.

Development
The SCADA software must include an integrated development package utilising menu driven fill in the forms style configuration to develop the runtime system. Comprehensive on-line help must be available for all development functions. The on-line help must contain all information provided in the hard copy manuals. The on-line help must have hot spots that explain meanings for all technical terms, in everyday language. The on-line help must have the facility to search by word or logical expression, including all words in the entire help system.

A utility must be included to back-up or restore an entire database including all graphic displays, configuration data and source code, via a simple point and click method. The backup/restore utility must prompt the user prior to over writing any existing files. The backup/restore facility must employ automatic file compression/decompression and must be capable of operating with either floppy disk or any drive on the network. If the database requires more than one disk, the utility must automatically prompt the user to insert the next disk of the set, and must have in built checking to ensure correct loading of disks.

Performance
Tenderers must supply details of performance guarantees that will be supplied. All conditions and constraints must be nominated. Tenderers should specify the guaranteed responses times in a dedicated environment utilising the basic hardware configuration and transaction volumes for standard types of transactions both on line and batch. Detailed performance criteria will be established and performance guarantees sought prior to entering into any contractual arrangements. Tenderers must also supply a method by which the response time criteria can be measured. Reference sites showing actual performance of nominated response times should be provided.

Process Data Interface
The software shall employ an I/O (Input/Output) Server to read and write variables in the I/O Device Subsystem(s). The I/O Servers must manage the reading and writing of data from the I/O Device Subsystem and must provide the data on request to any client on the Network. The I/O Servers must only read/write data when they are requested to, so as to reduce the traffic on the Network and the I/O Device Subsystem. The I/O Server must maintain a cache of data for a configurable time, such that requests from multiple clients do not generate unnecessary requests to the I/O Device.

Preference will be given to software packages that support drivers for many hardware types without the purchase of additional licenses. The software must support Primary and Standby I/O Servers to provide automatic redundancy in the event of a Primary I/O Server failure. In addition, the I/O Servers must support redundant I/O Device hardware and communication paths and provide automatic changeover in the event of a failure. A Diagnostic Alarm must be posted if the Primary or Standby devices fail at any time. ie; The software must periodically check standby devices. There must be no limit to the number of variables that are read or written from I/O Devices. It must be possible to define time or periodic scheduling for reading & writing of variables from I/O Devices. The system should have persistent cache such that on restart, last known good values are immediately displayed without the need to wait for a re-read.

Runtime System
The SCADA software must provide read-write access to all real-time and historical data to third party software and other computer systems. As a minimum, the SCADA software must support OPC and SQL compliant interfaces. The vendor should list all SQL databases that are supported natively. It must be possible to Read & Write to all Tags in the system via a High Level language API running on any node. Preference will be given to systems supporting C Language. The software must be capable of printing any display to colour and monochrome printers. To aid commissioning, a tag debug function should be included, which will allow for any tag to be read or written to without defining a point or graphic screen for that tag.

Historical Archiving
The SCADA software must be capable of storing long-term archives of trend and alarm history. The length of time for which the data is stored must be solely dependant on the size of disk storage available and not limited by the SCADA system configuration. All archived data must be accessible
via ODBC, OPC or directly using Microsoft SQL server. Preference will be given to systems that store data using Microsoft SQL Server as the archive storage database.

Administration Procedures

File back up/security

The objective is to maintain current backups of configuration and system files in a secure manner, protecting against power surges, theft and fire and enabling the rapid recovery from any loss of data due to corruption or hardware failure. Initial hardware selection should include wherever feasible RAID controlled hard drive arrays. Backups should be created using drive ghosting software that allows the recovery of entire drives or alternatively allows individual file recovery. Backups should be made to a suitable media with the backup media preferably being stored in a safe or locked cabinet in a separate part of the facility.

In the case where the connectivity is required with the City of Gold Coast WAN or even through to the internet, a hardware firewall will be required separating the SCADA from external networks that is capable of blocking ports, state full packet inspections and IP filtering. High security restrictions should be placed on the Network to ensure only the required external access is permitted.

Procedures

A written administrative and procedural system for backing up the configuration files and control system files shall be defined and shall include any procedural variation required as the project moves through its various phases.

Comprehensive written procedures shall describe the necessary steps required to back up and restore the configuration files for the project.

The File Backup/Security system shall address issues relating to security of the back up copies, such as storage location, number of copies, backup frequency and the life of the back up media.

Copies of the backed up configuration and system files shall also be preserved at various milestones as defined in the Contract Schedules.

Logbooks

The status of all backup copies of the configuration shall be maintained in a logbook.

Documentation

The procedures document shall be revised as required to include considerations specific to the selected process.

Control Documentation and Configuration

Process control descriptions

Process Control Descriptions for control logic to be configured shall be generated for each plant area. Such descriptions may take a number of different forms and styles depending on the plant or plant area being described and will not necessarily take into account the particular Process Control System being used to perform the required logic.

Configuration specification

The Configuration Specification shall be written to incorporate the specific detail required for configuration implementation in the particular Control System being used to perform the logic. The logic described in the document shall be based upon the approved Functional Specifications for each plant area.

If any control requirements of the new plant differ from the requirements stated in this standard, then these differences are to be clearly outlined in the Configuration Specification.

The Configuration Specification shall be submitted for review prior to configuration work being carried out.

The objectives of the Configuration Specification shall be that:

- It is a document suitable for use by operation and maintenance personnel. It is not however intended to be an operating manual.
- It provides a plant wide common 'look and feel' for the functional description for each plant area.
- It incorporates the specific implementation features of the installed equipment.
- It includes the principles and standards set by the approved version of this document.

Documentation

The software must provide extensive documentation on configuration and system development in a hard copy format. This documentation must also be available on line. Technical manuals must include an Introduction and Setup manual, User’s Guide, and High Level language guide.

Hardware capability:
Hardware selection should exceed system software requirements by 50% in terms of processor speed requirements and RAM requirements. Storage should be adequate for an expected 5 year lifetime with 30% additional space available. It is expected that the lifespan of the hard drives will not exceed 5 years and obsolescence will lead to the requirement to upgrade within this time.

Signal Scaling
Scale high and scale low parameters will generally be set to the equivalent process values as measured by the field measuring device. Preferred scales shall be used, the intention being that full-scale value and the associated values at fractional scale markings are sensible numbers. Ranges shall be in commonly accepted standard SI (metric) units or derivatives. Preferred units of measurement have been defined for this project.

Variable Addresses
Tag Database Development
Variables shall be allocated to a physical hardware address only where this is required for the control system selected. In general, hardware addresses may be required for:
- Physical input and output addresses
- Communication buffers
- Bulk alarm handling

Variable Scope
The standard allows the declaration of variables that have either global scope (accessible to the whole program) or local scope (accessible only to one program file). The following rules shall be used:
- Inputs and outputs shall have global scope and variable names based on the equipment tag (see below).
- Communication buffer files should have global scope (unless all buffer packing and unpacking is handled inside one program file) and depending on the system selected, may need to be assigned a hardware address to permit remote communications.
- Depending on the system selected and its alarm processing mechanism, alarm matrix buffer files may require global scope so that all alarms can be consolidated into one array for matrix processing.
- Internal variables (both boolean and numeric) that are use for passing data between different program files, or which provide data of potential use to many program files (such as a computed value corresponding to a real process condition) should have global scope.
- Everything else should have local scope. This includes all temporary variables, intermediate calculation results, flags, latches, timers, counters, one-shots, PID blocks. There should be no need to assign hardware addresses to any of these.
- A ready method of distinguishing between local and global variables shall be established. This may be an inherent feature of the system selected or may need to be defined. For example a possible method may involve using all upper case for variable names with global scope and using mixed case or lower case for variables with local scope.

Variable Names
All variable names used within the PLC code should comply with the SAP Asset Register ID. This will apply to all devices that are interfaced with the PLC such as instrumentation, drives and valves. The control system shall support a minimum of 16 characters for I/O tag numbers (more are preferred if supported by the Process Control System.)

Inputs and outputs
The tag number shall be identical to that assigned to the wiring connected to the input or output. Signal tags for wiring, I/O and other signals shall incorporate the instrument or equipment tags as defined in the asset register, plus a suffix describing the purpose of the I/O. The suffix may be as long as the programming software allows up to a limit of five characters. The suffix must be standard across the project. A list of standard suffixes is included in Appendix D. Wherever possible, the contractor must use suffixes from this appendix.

Naming Conventions
Naming conventions shall be established for descriptors, file names, folders and equipment as applicable to the system being configured. Wherever possible, these conventions shall comply with the tags as defined in the asset register.

Variable Descriptors
Comments (descriptors) shall be entered for all variables including all I/O and internal variables. Descriptors for hardware modules shall include reference to physical location (room/cabinet/rack/slot). Variable descriptors shall be shown wherever a variable is referenced in a control program. If the control system does not provide this facility automatically, or the automatic facility provides inappropriately placed or inappropriately sized descriptor text, then text descriptors shall be provided as comments adjacent to where the variables are referenced.

Commenting

All programming and configuration shall be commented liberally and appropriately to make clear the intent of the logic. Identifiable sections of logic shall be commented with details of the function of the section. Program modules shall have a header comment describing the operation of the module. For example, drive logic shall include a title that includes the plant area, drive description and drive number. Other program modules may require more extensive commenting. Sections of logic may require commenting such as ‘Remote-Local logic’ or similar. Function blocks shall be commented to clearly depict the duty being performed. For example a PID block shall be commented with:

The tag number that will call up the associated faceplate
The descriptor associated with the control loop or PID block as appropriate.

Where the selected system supports embedded fields on the function block diagram referencing the above tag and descriptor (and engineering units if applicable) of a function block, then this method of commenting shall be used preferentially to provide this information. This does not mean that any additional commenting is not required.

If program modules do not inherently list the global variables used or set by the module these shall be listed as a comment. Real inputs and outputs of the program module shall be commented on the function block diagrams or program modules if this is not inherently displayed on the diagram or module. This means that it shall not be necessary to ‘drill down’ to obtain this detail.

All commenting that appears on the logic during programming/configuration shall also appear on any logic monitoring displays and on any hard copy printout or self-documentation of the same logic. All hard copy printouts or self-documentation of the logic shall include comprehensive identification of the location of that logic and descriptive comments/titles that clearly identify the associated plant equipment and the purpose of the logic.

The interconnection and interaction of analogue and digital logic blocks on the function block diagrams shall be clearly depicted. If referencing within a function block is not apparent at diagram level, then the connections shall be illustrated by commenting or another suitable method. The object is to improve the readability of the logic.

Calculations shall be commented to ensure ease of understanding. Particular care should be taken to identify constants used. For example, a constant 101.32 may be labelled Reference_Pressure_kPa. If a constant is the result of a combination of factors, then how the constant is arrived at shall be commented to facilitate readability and future modification of the constant if one of the factors needs to be changed.

User defined function blocks shall be liberally commented, with particular attention to commenting of input and output parameters.

Programming Language

General

High Level Language

The software should provide an integrated high-level language. Preference will be given to languages that are inherently multi-tasking, multi-threading and pre-emptive. The language must provide access to all field tags, alarms, graphics displays, database and ASCII files. Access to real-time or historical data must be with functions, not memory pointers. The language must support user written functions and function libraries supported by the computer’s operating system. Preference will be given to languages that have the capability to export or import data directly from other applications.

Any functions must be capable of running forever without restricting other SCADA functions from running correctly.

The language must permit users to create their own functions and integrate them in the language. Functions must be reusable without the need to copy and paste. It must be possible to call the same function multiple times from different locations, with different parameters simultaneously.
The SCADA software must have the ability to test and debug the high level language on line. The debug tool must display the source code as it executes with a pointer identifying the current line of code being executed, the value of local and global variables and any output as the user single steps through the code. Facility to set break points, single step, step over sub functions, step out of sub functions and continue execution should be included.

On-Line, context sensitive help must be provided for all functions when any text is selected in the language editor/debugger.

Unless otherwise approved, only the following types of programming languages shall be used. All programming languages used shall comply with the specifications listed in Clause 0 of this specification.

**Sequential Logic**
A structured high-level control programming language such as Sequential Flow Charts (SFCs) shall be used and shall provide the necessary facilities for real-time control of sequential processes. Simultaneous execution of multiple sequences will be required. As part of SFCs (for some elements of SFCs), other complying programming languages may be used.

**Drive/Interlocking Logic**
A structured high-level control programming language such as Function Block Diagramming shall be used and shall provide the necessary facilities for real-time interlocking of drives, on/off valves and process equipment. Generally, SFCs shall not be used for interlocking.

**Regulatory Logic**
A structured high-level control programming language such as Function Block Diagramming shall be used and shall provide the necessary facilities for real-time regulatory control and monitoring of the process.

**Calculations**
Either Function Blocks (FB) or a high-level control programming language such as Structured Text (ST) shall be used for calculations, whichever is more appropriate. Simple calculations are easily expressed using Function Blocks. Calculations involving detailed formulae, array references or iterative processes are more efficiently expressed using Structured Text.

**Program Structure**
The detailed specification of common requirements for configuration of the Process Control System shall address the following issues:

**Logic Structure**
A hierarchical structure that links higher level modules (such as sequence logic modules) to lower level logic modules (such as those controlling individual drives) shall be defined. This structure will group logic modules for the various plant areas and subsystems in a manner that simplifies the navigation through the configuration logic.

**Logic Modules**
Software shall be designed as simple, self contained, formally structured logic modules, each carrying out clearly defined tasks. Examples of a logic module are the control and interlocking logic for a drive or a PID control loop. A general rule of thumb shall be that any logic module shall contain only one coherent plant system from a commissioning perspective.

Wherever possible, all regulatory and sequence control for a specific system should be grouped together.

Readability of the logic has priority over compactness of coding. An over emphasis on minimisation can result in configuration which is poorly structured and unreadable, and hence difficult to modify. This does not mean that the limits of the configurable resources available should not be considered. Each module shall minimise the interlocks or signals required from other modules.

For applications that are repeated throughout the project, modules shall be designed to be standard repeatable implementations that have been proven by testing.

Within modules, standard repeatable subsections of code that has been proven by testing shall be utilised wherever possible.

Only one logic module or function block shall write to a particular output field such as a flag, output or other item.

**Logic Location**
Logic shall be configured and executed in the controller where the I/O for the logic is configured. Peer to peer controller communications shall be minimised.
Where peer to peer communications are used, then logic shall detect that the communicated values are valid and current and shall perform appropriate interlocking, tripping and alarming functions.

Order Of Execution
Logic components shall be arranged into an execution order minimising the number of logic scans for a change in the system to propagate through the logic.

Order Of Appearance
Whenever program logic modules are listed (such as in a hierarchical tree display) they shall be listed in a sensible order, grouped first by plant area and then in alphanumeric order.

Grouping Of Modules In Folders
Where the programming system allows modules to be grouped into folders for programmer convenience, modules shall be grouped into folders by plant area. Folders shall be named by area, followed by a descriptive name.

Segregation Of Elements
A system of reserving various programming elements, flags and memory blocks based on a functional grouping criteria shall be defined in the revised specification for the selected process control system. For example, flags used for a particular drive or purpose may be grouped together. The objective is to provide structure by setting guidelines if the structure does not inherently exist.

Signal Monitoring
Whenever possible, signal monitoring functions for alarming and or tripping shall be implemented by any built-in signal monitoring capabilities of the function blocks that also used for monitoring and controlling.

Critical safety interlocks shall not share functionality with process control functions.

Communications
Refer to telemetry clauses in Section 39 Wastewater System, in Section 40 for Water System and Section 40 for Treatment Plant Control.

Power Failure Logic
If it is known that a power failure has occurred, a power outage alarm shall be raised. All alarms for individual items of equipment will be suppressed if these alarms have been caused by the power outage.

Following the restoration of power all equipment in the plant shall restart in a sequenced manner. Callouts to operators will only occur if equipment fails to operate upon restart of the plant.

Standard Drive Logic
For each type of drive, standard drive logic for repeat use throughout the project shall be developed. The use of standardised logic embedded into standard user defined function blocks is preferred, providing this is supported by the selected control system.

Drive Modes
Each drive shall have two modes of operation. These are LOCAL and REMOTE.

The drive can be stopped from the local stop button, the MCC stop button or the operator workstation in all modes.

<table>
<thead>
<tr>
<th>MODE</th>
<th>FUNCTIONALITY</th>
<th>MNEMONIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOCAL (FIELD)</td>
<td>Drive cannot be started from the control system. The drive can only be started from either the local start pushbutton or the MLC start button, depending on the position of the selector switch located on the MLC. All safety interlocks are enabled (and other interlocks that have been considered on a case by case basis as necessary in this mode)</td>
<td>LOC</td>
</tr>
<tr>
<td>REMOTE (CONTROL SYSTEM)</td>
<td>Drive can be started/stopped by the control system. The drive cannot be started from the MLC or the local start button. All safety interlocks are enabled (and other interlocks that have been considered on a case by case basis as necessary in this mode).</td>
<td>REM</td>
</tr>
</tbody>
</table>

Table -1 Drive Modes of Operation
A consistent method of display and changing of the drive mode (Manual/Auto) on the custom plant graphics shall be implemented.

Drive Alarm Management
General Drive Alarm Logic
Unless otherwise stated, the occurrence of any drive alarms will cause the control system to remove the run signal to the drive.

Drive first out alarm trapping
When a drive is started any previous ‘first out’ alarm for that drive is automatically reset. All drive interlocks are monitored and when a drive interlock causes that drive to trip, the cause of the trip is latched for display to the operator. Simultaneously a drive trip alarm is generated for that drive to alert the operator. The trip cause is logged but does not cause a separate alarm.

Drive Status Indication
For each drive, at least the following states shall be provided for operator display purposes and for other logic:
- Auto Selected
- Manual Selected
- Drive Running
- Seal Failure (NB. for treatment plant pumps only)
- Stopped, Not Ready to Start
- Interlocked
- Stopped, Ready to Start.

For each drive, at least the following states shall be also be displayed on the custom plant graphics.

<table>
<thead>
<tr>
<th>STATUS</th>
<th>FUNCTIONALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tripped</td>
<td>Latched on by drive in the run state being tripped by a safety or equipment interlock. Reset by a restart of the drive</td>
</tr>
<tr>
<td>Interlocked</td>
<td>Indicated when drive is prevented from running in Remote mode by a process interlock.</td>
</tr>
</tbody>
</table>

Table -2 Drive Faults

Drive Interlocking
Drive interlocks
Drive interlock logic shall reflect the specific tripping requirements of the particular drive as well as a ‘failed to run’ trip.

Drive interlocks shall not cause an alarm to be generated if the drive was not running or starting.

There are three types of drive interlocks and each shall have different functionality as described in the following table.

<table>
<thead>
<tr>
<th>INTERLOCK TYPE</th>
<th>EXAMPLES</th>
<th>FUNCTIONALITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Safety</td>
<td>Stop Button, Thermal Overload, Pull Wire</td>
<td>Hard wired, cannot be over-ridden. Inputs to control system configured for monitoring, alarming, tripping of drive logic.</td>
</tr>
<tr>
<td>Equipment</td>
<td>Seal Failure, Belt Drift, Blocked Chute, Failed to Run, Trip.</td>
<td>Inputs to control system configured for monitoring, alarming, tripping of drive logic. Able to be bypassed by configured logic.</td>
</tr>
<tr>
<td>Process</td>
<td>Downstream equipment status, Process levels, flows and pressures.</td>
<td>Inputs to control system configured for monitoring, alarming, tripping of drive logic. Able to be bypassed by configured logic. Bypassed in 'MAINTENANCE' Mode. No alarm for drive, only for the process interlock.</td>
</tr>
</tbody>
</table>

Table 4-3 Drive Interlocks

Process interlocks
A process interlock will cause a drive to stop but will not generate a drive trip alarm for that drive. This is because the stopping of the drive is a consequence of another event that is subject to the alarming defined for that event.

For example, if drive A is interlocked to stop when drive B is stopped then:
- If drive A is running and drive B stops then no drive trip alarm is generated for drive A.
- If the cause of drive B stopping is a trip then a drive trip alarm is generated for drive B only.
If the cause of drive B stopping is that the operator stopped it from the drive faceplate, then no alarms are generated for drive A or for drive B.
If the cause of drive B stopping is an interlock from another drive then a drive trip alarm is generated for that other drive only.

Drive Run Time Indication
Drive run indication shall be provided for each drive. The duration of run time logged before rollover shall be a minimum of 10 years. The run time shall accumulate with a resolution of one minute or better.
Resolution of one second is preferred.
If time accumulators with the above characteristics are not supplied as a standard part of the control system, then a standard function block with a retentive timer and one or more counters shall be implemented.

Standard Valve Logic
For each type of valve controlled by the Programmable Control Equipment, standard valve logic for repeat use throughout the project shall be developed.
Typically, standard valve control logic types shall include On-Off valves (with various forms of feedback) and motorised valves.

Valve Common Requirements
Logic execution speed shall be appropriately selected for the service.

Valve Mode Selection
Consistent methods of display and changing of control mode shall be developed for all types of valves to be used within a project.

Valve Alarm Management
General Valve Alarm Logic
Unless otherwise stated, the control system will try to maintain the desired position of the valve regardless of the occurrence of any alarms generated by that valve.
Valves with open/closed limit switches
Valves with limit switches shall generate an alarm if they do not achieve their target state within a pre-set individually adjustable time. When a ‘failed to open’ or ‘failed to close’ alarm is generated, the target will be maintained unless altered by operator action or other logic that has been specified.
Valves with limit switches shall generate a discrepancy alarm if the limit switches indicate a mutually exclusive state (such as both open and closed indicated).

Motorised Valves
The logic used for a motorised valve shall be similar to a reversing drive. Positioning and feedback considerations shall be generally added to the logic while maintaining essentially the same basic structure as a reversing drive.

Minimum alarms implemented shall be as for reversing drives, plus:
- Failed to open
- Failed to close
- Valve Position Switch Discrepancy.

Valve Operator Interface and Status Indication
The control logic for a valve shall provide the necessary flags for faceplates and popup graphic windows that shall be provided for the operator. These displays shall include the following:
- Position Status Indication—Open/Closed/Indeterminate.
- Analogue Position Indication—% Open and % Feedback.
- Fault Control Status Indication—Interlocked, Tripped, Ready for Sequence Control.
- Valve Icon.
An Alarms Section shall display the possible alarm conditions for the valve. Existing alarms shall be differentiated from dormant alarms by colour change or highlighting. Alarms to include ‘Failed to Open’ and ‘Failed to Close’ indications.
An Interlocks Section shall display the permissive conditions for valve operation. The current state of each permissive shall be differentiated by colour change or highlighting.

Control buttons for mode control.
Control buttons for manual control.

Valve Interlocking
Valve interlocks
Valve interlock logic shall reflect the specific tripping requirements of the particular valve.

Sequence interlocks
A sequence interlock may cause a valve to change state but will not generate a valve trip alarm for that valve.
This is because the operation of the valve is a consequence of another event that is subject to the alarming defined for that event. This is a similar concept as described in Section 0 Drive Interlocking—Process Interlocks.

**PID Control**
Standard logic for PID control shall include the following:
- Mode Selection (Manual/Auto/Cascade).
- Standard methods for interfacing with Interlocking logic.
- Tracking (make the output track another value when certain conditions occur).
- Bumpless transfer. (The integral term tracks the output while in manual mode to provide a bumpless transfer from manual to automatic mode. When transferring from auto to manual, initial manual output value is the last determined value from automatic mode.)
- Outputs limit parameters.
- Integral limiting on output (The integral term is prevented from further wind-up once an output limit is reached).
- Integral limit parameters.
- Provision for external logic to force modes, set points and outputs (for example during a start up sequence).
- Provision for synchronisation of controller with input sampling. This is a sample and hold type control.

**PID Loop Tuning**
The software must be able to monitor and adjust PID Loop parameters. Tuning trend pages for each loop must be provided with facility for adjusting PID parameters, Setpoint, Output and control mode.
Help screens must be available to facilitate loop tuning.

**Operator Stations**

**Operating Philosophy**
The overall philosophy for structuring the operator work station displays is that the operator will primarily work from custom graphics displays that mimic the actual process rather than working from a group of faceplates.

**Security Levels**
Security levels shall be defined to limit the scope of access that is available to the user logged onto the system.
Security level types that shall be defined include ‘Monitoring Only’, ‘Operator’, ‘Supervisor’, ‘Engineer’ and ‘Administrator’.
When the system is started the workstation shall default to a ‘Monitoring Only’ access level that shall not require login. All other access levels require login.
‘Monitoring Only’ access level shall not allow any interaction with the control system variables or parameters other than monitoring.
‘Operator’ access level shall allow access to all ‘Monitoring Only’ functions plus the control mode, set point, manual output, ratio settings of regulatory control loops unless otherwise specified. Access to stopping/starting of drives, opening/closing of valves, control of sequences, selectors is also permitted by ‘Operator’ access level. Initiation of pre-configured reports is also permitted at this level.
‘Supervisor’ access level shall allow access to all ‘Operator’ functions plus alarm settings and other plant operational parameters that may need to be changed by a supervisor. Resetting of Plant Throughput Counters are also permitted at this level.
‘Engineer’ access level shall allow access to all ‘Supervisor’ functions plus all alarm, trip and parameter settings, configuration/download and programming access but shall not permit access to any system administrator functions such as password administration.
‘Administrator’ access level shall allow unrestricted access to the control system including all the functions enabled by other access levels. Creating and modifying accounts is also permitted at this level.
The default access security level for regulatory control and monitoring faceplates shall be set to ‘Operator’ access unless specified otherwise.
The default access security level for motor stop/start control faceplates shall be set to ‘Operator’ access unless specified otherwise.
Each user must be assigned an individual logon. Individual user logon shall enable that user to the level of access granted by the security levels assigned to that user. Logon security shall be provided by an identity verification system. The minimum acceptable verification is a password-based system. The capability to enable an automatic logout system shall be provided. This function must be enabled per individual workstation. When activated, any workstation that is logged on at a level higher than ‘Monitoring Only’ shall revert to a ‘Monitoring Only’ access level after a specified duration of workstation inactivity.

Operator Event Logging
The software must support logging of all operator actions to disk, printer or screen. The software must be capable of logging the following information, User Name, Action, Time, Date, Value, and Comment in a user definable format.

Further Details Security
Security must be fully integrated into the SCADA system to allow access to any individual part of the system only to users with appropriate security levels. Preference will be given to systems that allow users to administer their own password. The system must then have a facility that can force users to change password at a frequency determined by the system administrator. Preference will also be given to systems that ensure manage passwords through policies that ensure password complexity and password length meets the business requirements.
The software must support an unlimited number of users. For each user, it must be possible to define a password and the privilege level(s) and areas that are available to that user. The software must monitor the actions of the user currently logged on at each node, and automatically log the user out of the SCADA software after an adjustable time period. Logging out a user will not shut down the system. The software must check to ensure that the user logged on has the correct privilege level for all functions. If the user does not have the correct privilege for a function or object the software must display a message informing the operator of insufficient privilege.
For each graphic object it must be possible to assign it to a plant area, define its’ privilege level, and define whether operator input is enabled or disabled or whether the object will be visible or not. The software must have a mechanism to restrict access to different areas of the plant for each individual user or group of users. Preference will be given to systems that allow privileges to be altered automatically depending upon time of day.
It must be possible to prevent access to the operating system by unauthorised personnel. It must be possible to disable Windows “hot” keys such as Ctrl Esc, Ctrl Alt Del to prevent unauthorised operator access to operating system functions or other application software that has not been specifically configured as part of the SCADA system.
In Microsoft Windows environments, local security policies for normal user accounts must ensure users are not be permitted to install hardware or software or make changes to the desktop. All network adaptors not in use must be disabled. It is preferable if USB storage devices are inoperable without a supervisor account being used.

Reports
The SCADA software must perform all report generation, scheduling and management internally and must not require a third party package to perform these functions. The software must permit reports to be scheduled for a specific time of day, on a periodic basis, upon operator request, or event initiated (eg. alarm condition), or end of batch.
The software must support printing to the designated report printer. The software must also have the capability to log all reports to a disk file or database (SQL, ODBC, DBF) or to a Web Server in a HTML format file.
The software must have the capability to display all reports on the screen, in user definable fonts and colours.
The software must permit reports to be defined based on archived data. Single-point-in-time reporting (online and historical) and time-range reporting are both essential, as is the ability to report on an unlimited number of points in one report.
Reports must include extensive calculations on both instantaneous and historical data or any other data from the system.
Reports must have the ability to write to any tag in the system at any stage during the execution of the report.

Reports are to be automatically sent to a designated report printer.

The software must provide for on-screen reporting. It must also be capable of interfacing to third-party report generation packages, and importing data from, or exporting data to external databases.

**Graphics—General Principles**

Graphics shall show all necessary detail. Detail not generally required while operating shall be accessed at a lower level of graphic windows accessed from touch/cursor points.

Process line colour shall conform to project colour standards.

Equipment colours shall be animated to conform to project colour standards. These colours are detailed in clause GRAPHIC COLOUR CONVENTIONS.

Process line thickness shall be defined based on a philosophy that the main process lines shall be thicker than minor or ancillary process lines.

To avoid cluttering graphics with information that is only needed occasionally, techniques to hide or display detail unless required shall be employed. For example, options to hide or display descriptors, tag names, minor process lines or data lines can be provided to the operator. A standard approach shall be described.

To assist in reducing the ‘cluttered look’ of complex graphics, it may be beneficial to group related data into tables rather than display them individually.

Where possible, the location and orientation of equipment and piping shall be displayed in an orderly fashion. All process lines shall be displayed either vertically or horizontally. Minor equipment that are being displayed graphically (e.g. valves) should be aligned both vertically and horizontally, where possible.

**Hierarchy Of Graphic Displays**

**Overviews**

A single Custom Overview graphics of the whole plant shall be provided. This shall provide access to Custom Overview graphics of individual plant areas.

**Major Plant Areas**

Custom Overview graphics of individual Plant Areas shall be provided. These shall provide critical control parameter monitoring information for each plant area. In general these will not provide operator with control access, but will enable the operator to access Custom Operating Graphics.

Trend Overviews shall permit the operator to easily navigate to a particular trend display.

**Operating graphics**

Custom Operating Graphics shall be provided as the basic operating graphics used by the operator to monitor and control the plant.

The objective is to provide the operator with clear yet comprehensive monitoring and control of the process, using a process view (similar to a P&I diagram) that mimics the plant.

The number of Custom Operating Graphics developed per plant operating area shall be determined by the complexity of the plant being depicted.

**Detail graphics**

When the operator needs more detail than provided by the normal operating graphic, a more detailed level of graphic shall be provided. For example the operating graphic may show a compressor as a single graphic entity complete with ‘group’ states of the entity but the detail graphic for the compressor displays all the drives (main and auxiliary, oil lines and filters) with individual status of each device shown.

**Diagnostic/status graphics**

Diagnostic/Status Graphics shall be provided for all drives, valves and systems where interlocking can trip or interlock out that equipment.

**Control group displays**

Control group graphics display groups of faceplates. These shall not be required as the philosophy is to operate directly from operating graphics.

**Trends**

Unless otherwise specified, trend pens shall be assigned for all analogue process variables.

**Trend Collection System**

The software must not limit the number of trends collected.

The software must be capable of logging historical trend information at configurable Sample Periods from 1 Millisecond to 24 Hours.
It must be possible to collect trend data on a periodic basis; one sample every period of time or on an Event basis; Sample is read each time a condition goes true.

**Trend Display**

Trend displays must comprise line graphs with time on a linear, continuous horizontal or vertical axis and the trended variable on the vertical or horizontal axis. Where more than one variable is graphed, the graph of each variable and associated information must be displayed in a different colour. Each trend graph must be capable of displaying up to eight plots with adjustable time base to one-second accuracy.

It must be possible to trend multiple pens or multiple plots of the same pen over various time spans. Each pen must display individual ranges and engineering units. The system must display historical information as far back in time as desired.

The trend display must have a slide wire that can be moved over the page that will provide indication of the date, time and value at the intersection of the slide wire and the trend point.

The software must provide a method of producing trends that are customisable by the operators in runtime. This customisation must include the ability to select any individual trend pen.

The software must provide "zoom" and "pan" facilities for both the trended variable range and the time axis range. The "zoom" facility must allow an operator to compress or expand the axis range whilst the "pan" facility must allow an operator to shift the origin of the axis. The software must allow a user to define any zoom area by dragging a mouse across the trend.

The software must provide the capability of printing out either instantaneous or historical based trends on the designated trend printer. The software must have the capability to perform a trend print (not a screen print). The trend printout must include the engineering units and ranges for each trend, a trend grid and the time base for each trend. Each trend must be identified by a different line style (i.e. dotted, dashed or solid) on monochrome printers, and a different colour for colour printers.

**Trend Redundancy**

Trend collection and management must be performed utilising Primary and Standby Trend servers. Both servers must contain all trend information. If the Primary Trend Server fails then the Standby Trends server must ensure all trend functions continue to operate. Upon restoration of the Primary, the Standby must automatically update the primary server such that there are no gaps in the historical trend data. No operator involvement must be required. Failure of the servers must be monitored such that a failure of either server will produce a diagnostic alarm.

**NAVIGATION**

The configuration for a standard method of navigation provided for the plant operator shall be described. An important objective to be achieved is consistency in methods of interfacing the operator with a hierarchical structure of display screens.

**Alarms**

**Signal Monitoring**

Whenever possible, signal monitoring functions for alarming and or tripping shall be implemented by the built-in signal monitoring capabilities of loop instruments.

‘High’ and or ‘low’ alarm points shall be configured. Additionally, smart alarming practices shall be used where required.

**Alarm Categories**

All projects will use the following three categories of alarms: -

- Urgent (Immediate operator action required)
- Warning (Operator Action required)
- Event (Logging Only - No action required).

Each alarm category shall be differentiated to the operator by specifically assigned colour. The colours to be used are listed in “GRAPHIC COLOUR CONVENTIONS”.

The system must be capable of assigning a specific audible tone for each category of alarm.

**Alarm Minimisation**

The management of alarms is critical to plant operation. An important requirement is the minimisation of alarms that are merely consequences of other alarmed conditions.

Alarms shall be minimised by:

- Masking of process alarms caused by drives not running.
- Masking of high motor current alarms during motor run up times.
Filtering of transient alarms on process variables (both analogue and discrete). Use of time delay or hysteresis functions included in standard function blocks may be applicable here.

First alarm trapping and disabling of alarms consequent to the first alarm.

Masking of plant area alarms depending on the status of the plant area.

Further Details Alarms & Events

The software must not limit the number of Alarms supported. The vendor will state the number of alarms that can be calculated per second.

The software must be integrated such that an alarm acknowledged on one Node must receive acknowledgment on the other nodes. The alarms must be configured as one common database, with no other programming necessary to enable global acknowledgment of alarms from any PC on the network.

Alarm Detection

The SCADA software must monitor analogue and discrete variables and calculated conditions, and determine if the variable is in an alarm condition.

For each Analogue Tag, an alarm for each of the following conditions must be configurable:
- Variable LOW-LOW, Variable LOW, Variable HI, Variable HI-HI
- Deviation LO, Deviation HI
- Rate of Change

Analogue alarms must have an adjustable dead band. All Analogue alarm properties must be adjustable without shutting the system down. Changes must automatically be saved to the database so that if the system is restarted then the Alarm Settings will be correct.

For each Discrete Tag, an alarm for each of the following conditions must be configurable:
- Variable ON, Variable OFF
- Combination of any two Discrete Variables

Discrete alarms must have facility for time stamping, to enable tracking to a precision of 1 millisecond. It must be possible to determine the order of occurrence of discrete alarms to a precision of 1 millisecond.

Alarm Display

It must be possible to display or acknowledge any alarm and/or the most recent alarm on all SCADA pages.

Sound indication for each alarm category must be configurable. This must be possible at each node.

It must be possible to have the alarm sound either by internal or external speaker.

The software must have a standard alarm display page that can be user modified. The standard alarm page must have the facility for scrolling alarms up and down the page and for acknowledgment of individual alarms.

It must be possible to display the following information for each alarm as it appears on an alarm display page:
- Alarm Tag Name
- Alarm Description
- Value of the Variable
- Trip point
- Alarm Status - Disabled, Acknowledged, Unacknowledged
- Alarm Category
- Alarm Priority
- Time & Date in International Formats
- Operator Comments
- Value of any Tag or result of any calculation.

It must be possible to display each alarm category in a different colour (including flashing colours) dependent on whether the alarm is Active Unacknowledged, Active Acknowledged, Acknowledged Cleared, Unacknowledged Cleared or Disabled. All alarm colours are detailed in clause GRAPHIC COLOUR CONVENTIONS.

At any node on the system it must be possible to acknowledge alarms individually, by category or by page.

The software must allow for operator comments to be attached to any alarm when it is acknowledged or at a later time. It must be possible to automatically display any graphic display when an alarm occurs or to dynamically change the appearance of any graphical object based on whether an alarm is On, Off, Acknowledged, Communications Error, Disabled or any other available parameter.
The alarm display must have a mechanism for operators to dynamically define filtering of alarms by alarm name, tag name, date/time range, state or type.

**Alarm summaries**

Alarm Summary displays shall provide a chronological listing of all alarms. Filtering and sorting functions shall be available.

**Alarm Logging**

For each alarm category it must be possible to define a different method of logging alarms. It must be possible to define if alarms are to be logged when the alarm transitions to ON, to OFF or on Acknowledgement.

The alarms must be able to be logged to a designated printer, disk file or database with alarm text and time and date labels. Alarms must be printed or filed in a user-configurable format.

The SCADA software must allow logging to any printer on the network. The software must be able to redirect printing to another printer while the system is on-line. Alarms that are logged to disk must be available for viewing while the system is on line or off line without causing any interruption to data collection. The software must not limit the number of alarms logged to disk.

**Alarm Redundancy**

All alarm calculations and management must be performed in the Primary Alarm Server. The software must automatically ensure that if the Primary Alarm Server fails, all alarm functions must continue to operate normally. The software must automatically generate a diagnostic alarm to indicate that the Primary or Standby alarm server has failed. Adding, deleting or modifying alarms must not require any changes to the software that handles the redundancy.

It must be possible to archive data and restore it via simple point and click method.

**SPC/SQC Alarms**

Particular projects may require that the SCADA software provides on-line full feedback capability that will allow for the adjustment of operating conditions based on statistical deviations. It must provide periodic and event sampling, manual data entry and facility for masking of subgroups from being included in calculations if the subgroup data is incomplete.

The software must not limit the number of historical SPC variables collected.

The SCADA software must be capable of accessing all historical SPC trend data and using any of that data as part of a user defined calculation or algorithm that can be used to adjust process set points.

Control Chart Line Constants to ANSI Z1.1-1985, Z1.2-1985 & Z1.3-1985 should be provided together with documentation detailing the formulas used for all calculations performed.

**SPC/SQC Displays**

The software should provide the following standard displays.

**X,R & S Bar Display:**

- Control limits must be displayed numerically alongside SPC trends and there must be facility to modify control limits by manually entering data or by automatic calculation. Control limits must be displayed as lines on top of the SPC trends.
- Subgroup Size must be displayed and must be an adjustable parameter. A slide wire must be provided to select each subgroup on the trend and thereby display each sample in the subgroup. It must be possible to select areas of each trend using the mouse and then send the data within the defined area to a .dbf, .csv or .txt file.

**Cp & Cpk Display:**

- A Cp & Cpk chart with Upper specification limit (USL) and lower specification limit (LSL) and facility to adjust the number of bars displayed. On the same display an Xbar chart together with latest sample data for X,R & S bar and subgroup information must be provided.
- Cp Index to 6 sigma, Cpk Index, Skewness & Kurtosis values must be displayed.

**Pareto Display:**

- This display must show a Pareto frequency histogram together with data labels and numerical values for each tag monitored.
- If the project requires SPC alarms, the software should provide facility for calculating the following SPC alarms:
  - Single point greatly differs (2 sigma) from the centre line.
  - Process mean outside either of the control limits (UCL or LCL).
  - Process mean above the upper control limit (UCL).
Process mean below the lower control limit (LCL).
Process mean outside the warning limits which are 67% of the UCL and LCL.
Process mean is gradually drifting up to a new level indicated by a number of consecutive points above the mean.
Process mean is gradually drifting down to a new level indicated by a number of consecutive points below the mean.
A number of points continuously increasing in value.
A number of points continuously decreasing in value.
Large fluctuations that are greater than the control limits.
Artificial constancy. A number of consecutive points are close to (within 1 sigma of) the centre line.
A number of consecutive points are far from (outside 1 sigma of) the centre line.
Process range outside either of the control limits (UCL or LCL).
Process range above the upper control limit (UCL).
Process range below the lower control limit (LCL).

All of the above alarms rely on n number of consecutive points to generate the alarm.
The value of n must be adjustable for each type of alarm.

**Graphic Standards**
The standard colours defined and approved for the plant upgrade shall be used throughout the plant on graphic displays for various purposes. The standard colours are defined in clause “Graphic Colour Conventions”. Standard colours have been defined for process lines, equipment status and fault colours, alarm colours to achieve a common look and feel plant-wide. Other standards shall be defined in the revised specification to suit the selected process control system.
The revised specification shall be submitted for approval as part of the detailed configuration specification prior to configuration work being carried out.
Typically these standards will include but not be limited to the following items:

**Custom Graphics**
The graphics builder must be interactive and menu-driven and require no programming.
The graphics builder must be capable of creating screens composed of both static and dynamic objects. To create these objects, the software must provide sample screens and a set of standard shapes in a library. The developer must be able to include these symbols by reference, or create new symbols/objects.
The graphics builder must provide the following tools:-
Grid and guidelines (which can be displayed on screen) together with snap to grid and snap to guidelines to assist in aligning objects precisely.
Horizontal and vertical alignment together with even spacing.
Send to front/back. Bring Forwards one layer, Send backwards one layer.
The software must be designed with the ability to make changes to the graphics while the system is running. Shutting down the system must not be required to make changes.
The Graphics Builder must be able to modify all displays in the system including standard displays supplied with the software such as alarm, trend, startup, tag, reports and utilities displays.

**Display of data**
Data shall generally be displayed in engineering units, not as a percentage of full scale. Exceptions to this shall include level indication where 0 to 100% indication shall be used except in special cases requiring the display of an engineering value.
Levels may be depicted graphically as a bar. In any case, the level will also be indicated as a numerical value located as required near the vessel.
Data shall be displayed in at least 3 digits, plus a decimal point if applicable.

**Graphical buttons**
Graphical buttons shown on mimic displays and faceplates shall:
Visually distinguish between the ‘pressed’ and ‘normal’ states.
Be selectable and operable by mouse. In general, graphical buttons shall activate on ‘mouse-
Button-up’ so that it will be possible to cancel the action of clicking on a button by moving the mouse pointer away from the button before releasing the mouse button. Remain visible but shall be ‘greyed out’ when their functions are not currently available. Shall be selected to a sensible default on dialog boxes, pop-ups and control faceplates. Examples of sensible defaults are ‘Cancel’, ‘Exit’ and ‘Ok’.

Display of drives
Drives shall be displayed on the Process Graphics as an icon or symbolic representation (drive symbol). The method for displaying the status of the drive shall be described. Typically this is by dynamic colour modification of the drive symbol (see Standard Colours). The method for displaying Maintenance/Manual/Auto Mode and Tripped/Interlocked states of the drive shall be achieved by dynamic text display. The text colour may be modified to reflect normal or alarm indication as appropriate. The method of displaying the running status of a reversing type drive shall be similar to single direction drives but with the addition of direction arrows. The colour of each direction arrow shall be dynamically set depending on the direction/running status (see Standard Colours). An individual Diagnostic/Status Graphic shall be associated with each drive. An individual Drive Control Faceplate will be associated with each drive. Drive Control Faceplates permit stopping/starting of drives and display the status and mode of the drive.

Diagnostic/status graphics
Diagnostic/Status Graphics are generally pop-up window graphics that provide diagnostic/status information for a drive, valve or system. Generally this is mainly in a tabular format that comprehensively gathers together the status of interlocks alarms and states. The sense of the text describes the alarm/interlock state. The Diagnostic/Status Graphic indicates:
- The current state of each interlock (healthy/unhealthy)
- The cause of the last trip
- The mode of the drive or system
- The running/starting/stopped, tripped, ready/not ready state of the drive or system.

Display of valves
The status of the valves shall be displayed on the process graphic as an icon or symbolic representation. The mode of the valve shall be indicated adjacent to the associated valve icon on the process graphic. An individual Diagnostic/Status Graphic shall be associated with each interlocked valve. An individual Device Control Faceplate will be associated with each valve. Device Control Faceplates permit opening/closing of valves and display the status and mode of the valve.

Sequence status displays
Sequence Status Displays are single, comprehensive operator graphic displays, each tailored to provide operational/diagnostic information dedicated to an individual sequence. Sequence Status Displays shall not require the operator to read/decipher any logic or coding that is part of the configuration of the system. Each Sequence Status Display shall display the status of a sequence to enable the operator to quickly determine the overall status of a sequence. States that shall be displayed as appropriate are ‘Inactive’, ‘Starting’, ‘Stopping’, ‘Tripped’, ‘Ready/Not Ready’. Each Sequence Status Display shall display the progress of a sequence in a manner that is meaningful to the operator. The operator shall be able to determine the full sequence of actions that the sequence performs from the relevant Sequence Status Display. The current action that the sequence is performing shall be highlighted. If a sequence involves time delays, the relevant Sequence Status Display shall show the progress of the time delay (by a numeric display of the remaining time). If the time delays are short, this requirement may be waived.

Recipes
Particular projects may require that the software is capable of recipe management including recipe development and down loading to the control system.

Pop-up forms should be displayed to allow operator choice and selection of recipe batching. Pop-up forms must provide users (with appropriate access level) ability to add new recipes, modify existing recipes and delete old recipes. There must be no limit to the number of recipes or any limit to the number of variables in a recipe.

**Display of Duty/Standby Systems**

The duty/standby selection of any drive that is part of a duty-standby arrangement shall be depicted on operating and detail graphics where that drive appears. Individual Diagnostic/Status graphic popup displays shall be provided for each duty/standby system. From this display the operator shall be able to determine:

- ‘Running’/’Stopped/Ready’/’Stopped/Not Ready’ status of each drive
- ‘Duty’/’Standby’/’Out of Service’ status of each drive
- ‘Tripped’ status of each drive (Tripped drives in a duty/standby arrangement shall require an operator reset of the trip before any restart can occur. Note that if the plant is undergoing transitions from normal power to emergency power and vice versa, then automatic resetting of any latched software drive trip will be required).

**Display of PID control**

The process variable and the engineering units of each PID loop shall be displayed on the Operating Graphic. The control mode (MAN/AUT/CAS) of each PID loop shall be displayed on the Operating Graphic.

**Operator Displays**

**General Requirements**

The software must not limit the number of graphic displays possible. The points (in the current screen) scanned in the system must be guaranteed to be scanned and displayed in the system within 2 seconds. The I/O Server should read trend points according to the configured trend period, alarms points should be scanned always, and other information only on an as-needed basis, i.e. when the page is displayed.

The I/O Server must perform read & write caching of data for a time configurable for each Device Driver. This is to prevent data being read needlessly and therefore maximise I/O device communication bandwidth. If only one read is needed if the same I/O point is needed for multiple reasons.

It must be possible to display other graphics pages by selecting screen targets, and to automatically display any screen based on the condition of a variable. e.g. automatically call a particular graphic display when an alarm occurs.

It must be possible to configure keyboard macros on a per graphic basis or global keyboard macros that apply to all displays.

The colour palette must include at least 255 colours. User-configurable colours must be available. It must be possible to define colours as flashing between any two colours. When multiple objects on a page are configured for flashing then each object must flash synchronously.

The software must have the capability to provide pop-up windows for trends, loops and device status pages. All displays must include the page name, current time and date together with details of the last alarm that has occurred.

Runtime graphics must consist of the following dynamic objects:- freehand lines, lines, polylines, rectangles, ellipses, text, and graphic images. Preference will be given to packages that make use of vector graphics rather than bitmap based graphics.

It must be possible to group together dynamic graphic objects and then apply dynamic properties to the group as a whole such that articulated machinery can be represented dynamically on the screen. The software must support full screen, live camera video images and video from disk (MPEG, AVI) concurrently with screen displays with no interruption to data collection. Update times in the Process Control System windows must not be affected.

If communications to a particular I/O point is has failed for any reason, then wherever that data is displayed the software must post a visual indication that the point is not valid.
The software must be designed with the ability to make changes to the graphics while the system is running. Shutting down the system must not be required to make changes.

The SCADA software must be an ActiveX container and allow for instantiation of ActiveX objects. It must be possible for the SCADA software to interact with ActiveX objects in the following ways:

- Dynamically change properties of an ActiveX object via a Tag from an I/O Device
- Dynamically change properties from SCADA software high-level language.
- ActiveX object to trigger actions in the SCADA software based on events in the ActiveX Object.
- ActiveX property values can be read by the SCADA software.

Specification Documentation Requirements

Mouse/Cursor/Touch Points

The items that will be accessible via mouse/cursor/touch points shall be defined in the specification document for the process control system. This definition shall include access to drives, valves, control loops, data, selections, sequences, pop-up windows, detail graphics and menus.

Trend Assignment

The criteria defining the parameters that will be assigned to trend pages shall be defined in the specification.

History Assignment

The criteria defining the parameters that will be assigned to historical data logging shall be defined in the specification.

Associated Documentation

The following standards are relevant:

- IEC 61131.1:2004 Programmable Controllers Particularly Programming Languages.
- AS 4009 Software Reviews and Audits
- AS 2700 Colour Standards for General Purposes Process Parameter Management

Control Systems Support

The HMI and PLC systems shall be supported via regular support arrangements. Support shall include a 24hr telephone service for software problems and spare hardware equipment shall be ensured to be locally available (within Australia).

GRAPHIC COLOUR CONVENTIONS

The following default colour conventions shall be used for all graphic pages:

Non-animated graphics

<table>
<thead>
<tr>
<th>Component</th>
<th>Colour</th>
<th>Colour Components (Note 1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Red</td>
</tr>
<tr>
<td>General</td>
<td>Dark Cyan (The main criterion is high level of contrast with red, green and yellow).</td>
<td>0</td>
</tr>
<tr>
<td>Background Colour-Operating Graphic</td>
<td>Light Grey or other approved colour</td>
<td>192</td>
</tr>
<tr>
<td>Graphic Title</td>
<td>Grey</td>
<td>192</td>
</tr>
<tr>
<td>Pipes or Process Lines</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Untreated Water</td>
<td>Brown</td>
<td>79</td>
</tr>
<tr>
<td>Potable Water</td>
<td>Blue</td>
<td>0</td>
</tr>
<tr>
<td>Untreated Effluent</td>
<td>Brown</td>
<td>79</td>
</tr>
<tr>
<td>Treated Effluent</td>
<td>Purple/Lilac</td>
<td>0</td>
</tr>
<tr>
<td>Air</td>
<td>Cyan</td>
<td>0</td>
</tr>
<tr>
<td>Process Chemical Lines</td>
<td>Magenta</td>
<td>255</td>
</tr>
<tr>
<td>Optical Profibus Network</td>
<td>Yellow</td>
<td>255</td>
</tr>
<tr>
<td>Optical Ethernet Network</td>
<td>Red</td>
<td>255</td>
</tr>
<tr>
<td>Copper Profibus Network</td>
<td>Magenta</td>
<td>255</td>
</tr>
<tr>
<td>Copper Ethernet Network</td>
<td>Dark Green</td>
<td>0</td>
</tr>
</tbody>
</table>
**Base Colour**

| Light Grey | 192 | 192 | 192 |

Various lighter or darker shades of grey may be used for contrast or shading.

---

### Animated Graphics

<table>
<thead>
<tr>
<th>Component</th>
<th>Component State</th>
<th>Colour</th>
<th>Red</th>
<th>Green</th>
<th>Blue</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drives, Motors</td>
<td>Stopped (Ready to Run)</td>
<td>Red</td>
<td>255</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Stopped (Not ready to run)</td>
<td>Yellow</td>
<td>255</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Running</td>
<td>Green</td>
<td>0</td>
<td>255</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Stopped (Blocked by process</td>
<td>Dark Grey</td>
<td>96</td>
<td>96</td>
<td>96</td>
</tr>
<tr>
<td></td>
<td>interlocks)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drive Direction Arrows</td>
<td>Running in that direction</td>
<td>Green</td>
<td>0</td>
<td>255</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Not running in that direction</td>
<td>Invisible</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valves</td>
<td>Closed (Ready to Open)</td>
<td>Red</td>
<td>255</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Open</td>
<td>Green</td>
<td>0</td>
<td>255</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>In Transition (Position indeterminate)</td>
<td>Flash Red/Green</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electrical Switches</td>
<td>Switch Open (equipment de-energised)</td>
<td>Red</td>
<td>0</td>
<td>255</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Switch Closed (equipment energised)</td>
<td>Green</td>
<td>255</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Warning (Diagnostic) Alarms</td>
<td>Inactive, outstanding alarm</td>
<td>Yellow on</td>
<td>255</td>
<td>255</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>acknowledged</td>
<td>black background</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Active, not yet acknowledged</td>
<td>Flashing</td>
<td>255</td>
<td>255</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Yellow on black background</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Active, acknowledged by operator</td>
<td>Yellow on</td>
<td>255</td>
<td>255</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>operator</td>
<td>black background</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Condition cleared but not yet</td>
<td>Flashing</td>
<td>255</td>
<td>255</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>acknowledged</td>
<td>Yellow on black background</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Critical (Trip) Alarms</td>
<td>Inactive, outstanding alarm</td>
<td>Red</td>
<td>255</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>acknowledged</td>
<td>Red on black background</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Active, not yet acknowledged
- Flashing Red on black background
- **Color Code**: 255 0 0

### Active, acknowledged by operator
- Red on black background
- **Color Code**: 255 0 0

### Condition cleared but not yet acknowledged
- Flashing Red (on black background)
- **Color Code**: 255 0 0

### Sequence Steps

<table>
<thead>
<tr>
<th>Step Description</th>
<th>Color Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current Step, Sequence active</td>
<td>Green</td>
</tr>
<tr>
<td>Steps that have been completed</td>
<td>Dark green</td>
</tr>
<tr>
<td>Steps that have not yet been executed</td>
<td>Grey</td>
</tr>
<tr>
<td>Last transition that occurred</td>
<td>Dark red</td>
</tr>
</tbody>
</table>

### Status text

<table>
<thead>
<tr>
<th>Status Description</th>
<th>Color Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Field mode active</td>
<td>Black text on yellow background</td>
</tr>
<tr>
<td>Auto mode active</td>
<td>Black text on green background</td>
</tr>
<tr>
<td>Manual mode active</td>
<td>Black text on white background</td>
</tr>
</tbody>
</table>

### Creation Colour of all dynamic items
- Grey 192 192 192

### STANDARD Suffixes for I/O TAGS

<table>
<thead>
<tr>
<th>Suffix</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>__FLT</td>
<td>Fault feedback</td>
</tr>
<tr>
<td>__TOL</td>
<td>Thermal overload feedback</td>
</tr>
<tr>
<td>__AUTO</td>
<td>Automatic mode feedback</td>
</tr>
<tr>
<td>__MAN</td>
<td>Manual mode feedback</td>
</tr>
<tr>
<td>__FIEL</td>
<td>Field mode feedback</td>
</tr>
<tr>
<td>__ESTOP</td>
<td>Emergency stop control feedback</td>
</tr>
<tr>
<td>__RNNG</td>
<td>Motor running feedback</td>
</tr>
<tr>
<td>__STPD</td>
<td>Motor stopped feedback</td>
</tr>
<tr>
<td>__STRT</td>
<td>Motor start command</td>
</tr>
<tr>
<td>__STOP</td>
<td>Motor stop command</td>
</tr>
<tr>
<td>__FWD</td>
<td>Motor forward command</td>
</tr>
<tr>
<td>__REV</td>
<td>Motor reverse command</td>
</tr>
</tbody>
</table>
Valves

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>OPND</em></td>
<td>Valve opened feedback</td>
</tr>
<tr>
<td><em>CLSD</em></td>
<td>Valve closed feedback</td>
</tr>
<tr>
<td><em>OPEN</em></td>
<td>Valve open command</td>
</tr>
<tr>
<td><em>CLOS</em></td>
<td>Valve close command</td>
</tr>
</tbody>
</table>

4.5.10 Instrumentation General Technical Requirements

**Accuracy**
The accuracy of each instrument shall be within $\pm 1$ percent of span unless otherwise specified. Accuracy in the case of primary elements and their associated signal converters/transmitters shall relate the analogue signal output to the actual measured variable value. For secondary instruments, accuracy shall relate the output signal or indication or pen record (as appropriate) to the analogue input signal.

**Instruments**
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.

**Transmitters**
For new Plants or existing Plants where the predominant PLC communications method for instruments is Profibus, preference shall be given to Profibus PA or DP protocol transmitters. Where manufacturers do not manufacture Profibus equipment, "smart" transmitters shall be offered.

For Plant’s provided with a DCS or existing Plants where the predominant PLC communications method for existing instruments is analogue, all new instrumentation shall be provided with analogue output signals.

**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 fibreglass 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, presetting 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/NZS CISPR 14.1. The generation of harmonics of the mains frequency shall not exceed the limits defined in AS/NZS 61000.3.6.

**Signals**
PLC Equipped Facilities - Signals
In general in Facilities provided with PLCs, analogue transmitters shall use Profibus PA or DP technology. The analogue signal will therefore be transmitted using Profibus PA or DP protocol.
Where a Profibus device is not available, "smart" transmitters shall be offered. For those instruments where only an analogue output is available, it shall be a live zero 4 to 20 mA direct - current signal. Each output shall be capable of operating into a load in excess of 600 ohms.

Discrete outputs (on/off) of all electromechanical equipment such as flow switches, pressure switches, level switches, valve position switches, relay circuits, etc., and of all electronic switching devices such as electronic level and limit switches, etc., shall be voltage-free contacts rated for at least 1 A at 110 V AC.

DCS Equipped Facilities - Signals
In general in Facilities provided with a distributed control system (DCS), analogue transmitters shall provide/use a live zero 4 to 20 mA direct - current signal. Each output shall be capable of operating into a load in excess of 600 ohms.

Power Supply Units

Instruments can be of the "two wire" type deriving electrical power from the loop 24 V DC supply. Where a separate power supply is required for an instrument, integral power supplies shall be provided to allow reliable operation directly from a suitable power supply.

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 Vrms, 40 kA on a single shot 8/20 microsecond impulse with an 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 front panel without the need to open 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.

Environmental Considerations

All instrumentation and control equipment supplied shall be suitable for continuous operation in the environment nominated as follows:
Temperature 0°C to 50°C
Relative Humidity 10% to 90% (Non-condensing)

Enclosures

All electrical components, terminals and linkages of field instruments shall be contained in hose-proof dustproof enclosures to Class IP65 AS 60529 unless otherwise specified. Tapped cable entries shall be provided to accept cable glands. Enclosures shall be treated with an epoxy paint or similar durable corrosion resistant finish unless materials of construction afford this protection inherently.

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 3 way manifold to provide for isolation and pressure equalising.

All wetted materials of the differential pressure transmitter, and 3-way manifold shall be as specified or as otherwise suitable for the application.

When part of a flow measurement system, the range and maximum working pressure of the differential pressure transmitter shall suit the associated flow element.

**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. The transmitter shall include an integral indicator accurate to ± 2% and scaled from 0 to 100%.

All wetted materials shall be suitable for the application. The range and maximum working pressure shall be as specified or as otherwise suitable for the application. 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.

**Pressure Switches**

Wetted materials shall be suitable for each application. Each pressure switch shall satisfy enclosure Class IP65 or better and 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 percent of the adjustable range. The switch shall be of the automatic reset type with an adjustable switching differential.

**Pressure Gauges (Bourdon)**

All pressure gauges unless otherwise specified shall be of the Bourdon tube type complying with AS1349, of Budenberg or equivalent manufacture and shall be fitted with a gauge isolating cock. The gauge and isolating cock shall be constructed from materials which are corrosion resistant to the fluid being measured or as otherwise specified. Pressure gauges shall have a concentric dial of 80 mm diameter unless otherwise endorsed by the APMT and shall be calibrated in kPa with a range as specified. Where specified, or as required, pressure gauges shall be oil-filled and fitted with isolating diaphragm to ensure the process material does not foul the gauge. Snubbers shall be fitted to pressure gauges subject to pulsations.

Where pipework is subject to mechanical vibration, pressure gauges shall be mounted adjacent to the pipework and connected to the pipework tapping via pipework. Where specified or as otherwise required where gauges are subject to a process medium of high temperature that would affect operation, a syphon shall be provided to isolate the medium from direct contact with the gauge. Pressure gauges shall be accurate to ± 1% of full scale.

**Pressure Gauges (Magnehelic)**

Pressure gauges where specified shall be of the diaphragm actuated “Magnehelic” type of Dwyer or equivalent manufacture and shall be fitted with a gauge isolating cock and vent valve.
The gauge and accessories shall be constructed from materials which are corrosion resistant to the fluid being measured or as otherwise specified.

Pressure gauges shall have a quadrant dial of 120 mm diameter unless otherwise specified and shall be calibrated in kPa with a range as specified.

Where gauges are to be utilised for differential pressure measurement across a filter, the gauges shall be provided with all accessories required including static pressure tips, vent valves, tubing and mounting brackets.

Pressure gauges shall be accurate to ± 2% of full scale.

**PH Measurement**

Equipment for pH measurement shall include either single combination electrodes or discrete measurement and reference electrodes. The reference electrode shall be sealed, gel filled and non-flowing with a ceramic or similar junction that resists fouling. Each pH electrode housing shall comply with the requirements of enclosure class IP68 (AS 60529) and shall contain a sealed high impedance amplifier to all pH signals to be transmitted over low impedance circuits. A differential high impedance amplifier shall be preferred, to reduce ground loop noise and the effects of reference electrode coating and plugging. Automatic temperature compensation shall be provided for each pH measurement.

The pH electrodes shall be equipped with an automatic electrode cleaning device to reduce routine manual cleaning. The cleaning method utilised shall be entirely suitable for the process fluid monitored. The pH electrode housing shall be manufactured from glass fibre reinforced polypropylene or similar.

The pH monitor/converter shall be of the “two-wire” type deriving its electrical power from the loop 24 V DC supply and shall provide an isolated 4-20 mA DC signal for remote transmission. An indicator should be provided as part of the unit to display the output on a scale directly calibrated in pH units, to accuracy better than ± 2% of span.

The monitor/converter shall include facilities for manual range changing, zero and span adjustment and for any other adjustment necessary for accurate calibration of the instrument.

All input circuits shall be isolated from the mains supply and output circuits.

**Temperature Transmitters (Resistance Type)**

Unless otherwise specified resistance thermometers shall be utilised for temperature measurement. Each resistance thermometer shall include a 3-wire platinum resistance temperature detector complying with BS EN 1904 (Ro=100 ohms). The sensing element shall be sealed in a ceramic former and enclosed in a 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 equivalent to IP65 AS 60529 allowing cable entry via a compression type cable gland.

Pockets (thermowells) shall be provided for installation of the resistance thermometers. Pocket material shall be 316 stainless steel. Inside diameter of the thermowells shall be sized to match the 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 “3 wire” circuit shall be used between each thermometer and the associated converter. The converter shall be located in the 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.

**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 stainless steel sheath.
Each thermometer shall include a suitable connector head, with enclosure class equivalent to IP65 AS 60529 allowing cable entry via a compression type cable gland. Pockets (thermowells) shall be provided for installation of the thermocouples. Pocket material shall be 316 stainless steel. Inside diameter of the thermowells shall be sized to match the thermocouple so as to permit ready removal whilst providing close contact for maximum heat transfer and fast accurate temperature measurement.

Thermocouples and signal converters shall be interconnected with wire that will maintain the specified accuracy of the temperature measurement. The converter shall be located in the thermocouple connector head.

Signal converters 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. Converters 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.

**Temperature Switches (Thermostats)**
Temperature switches (thermostats) shall be of the mercury bulb type of Danfoss manufacture or equivalent.
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 percent 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. Each temperature switch shall satisfy enclosure class IP65 or better and shall be provided with voltage free, changeover contact.

**Temperature Indicators (Thermometers)**
All temperature indicators (thermometers) shall be of the mercury bulb type, of Budenburg or equivalent manufacture.
Thermometer gauges shall have a concentric dial of 80 mm diameter unless otherwise specified and shall be calibrated in Deg.C.
Each thermometer system shall be of all welded steel construction filled with mercury at high pressure.
Copper tube protected capillaries shall be provided where specified or as otherwise required for connection of the gauge to remote bulb installation.

**Level Switches (Float Type I)**
Each level switch shall be of the encapsulated immersible mercury switch type. Each 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 entirely suitable for the application.

**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 entirely suitable for the application.
Each level switch shall be provided with a voltage free, changeover contact.

**Level Switch (Paddle Type)**
Level switches 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. Shafts and paddles 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 or better and shall be provided with a voltage free, changeover contact output.

**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 electrical enclosure class IP65 (AS1939). Each electronic signal converter shall satisfy enclosure class IP65 AS 60529 or better and shall be provided with a voltage free, changeover contact output.

**Level Transmitters (Capacitance Type)**

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 (AS1939). 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.

**Level Transmitters (Ultrasonic Type)**

Each ultrasonic level measurement system shall consist of a transducer, an electronic unit in the head of the transducer and a signal converter unit.

The transducer shall transmit ultrasonic pulses and receive the echo from the surface of the tank contents. The ultrasonic frequency shall be suitable for the application. The electronics in the head shall operate at low voltage and shall be encapsulated. The head enclosure shall provide enclosure class of IP65.

The electronic signal converter unit shall generate a 4-20 mA DC current analogue output based on time of flight with temperature compensation. Provision shall be made for span and zero adjustment. The converter shall incorporate an analogue or digital indicator. Overall accuracy shall be better than ± 1% of full scale.

**Indicators**

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 metres 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 (AS1939).

**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 (AS1939). The maximum air consumption for each transducer shall be less than 0.04 litres/sec. Output pressure shall be in the range of 20 to 100 kPa.

**Rotameter (Variable Area Flowmeter)**

Each rotameter shall be of the tapered tube and float type, of straight through construction, with flanged or threaded end connections as required.

The flowmeters shall have tempered glass tubes, stainless steel end fittings and stainless steel floats. The flow meters shall incorporate a metering tube that can be removed and cleaned without removing the meter body from the line.

The flow meters shall be selected to suit the range for each individual application and shall be accurate to ± 2% of full scale over a minimum turndown ratio of 10:1. The flow meters shall be fitted with a direct reading scale, nominally 250 mm long and scaled in litres/second as appropriate for the flow ranges of each application.

**Rotameter (Purgemeter)**

The Flowmeters required for monitoring purge air flow shall include an integral inlet needle valve to allow adjustment of the flow of air. Flowmeters shall be of Fischer & Porter 10A3620 type or equivalent.

Each rotameter shall be of the tapered tube and float type, of straight through construction with screwed end connections.

All materials shall be suitable for the application.

The flowmeters shall be selected to suit the range for each individual application and shall be accurate to ± 2% of full scale over a minimum turndown rates of 10:1. The flow meter shall be fitted with a direct reading scale, nominally 70 mm long and scaled in litre/second or as appropriate for the flow ranges of each application.

**Electromagnetic Flow Meters**

The flow meter shall comprise an electromagnetic detector, power supply and converter providing an overall system accuracy of ± 0.5%.

The detector shall have a 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.

**Dissolved Oxygen**

The dissolved oxygen analysers used at wastewater treatment plants shall comprise of two units; the sensor probe and the display/transmitter unit. The sensor probe shall work on the principal of either dissolved oxygen luminescence or galvanic action. If of the galvanic type, the cell unit should be self contained, maintenance free and be of a type with a good service and shelf life. If the probe is of the luminescence type, the cell unit shall work on the time delay principal to minimise the requirement for regular calibration. The probe assembly should be the floating ball type and come complete with at least 10 meters of cable. At installation, at least two extra metres of cable must be supplied to allow relocation of the sensor.

The transmitter unit should be complete with LCD display panel. The unit will be powered by 230V AC. The transmitter shall incorporate all range settings, zero settings and necessary controls and shall have a range able linear isolated analogue output circuit rated 4-20 mA, the signal being capable of driving into a minimum resistive load of 750 ohms. The transmitter unit shall be self-
diagnostic of faults and be complete with appropriate error messages. The transmitter unit shall feature user-friendly calibration sequences complete with all necessary maintenance prompts. The transmitter unit should be capable of working in a continuous air temperature of 50°C and offer long-term corrosion resistance to atmospheric conditions typical for wastewater plant aeration areas.

**Turbidity Analyser**

Turbidity units for use in treatment plants shall be low range and comprise of two units, the flow cell and the display/transmitter unit. The turbidity unit should be specifically designed for the expected operating range and not be a high range unit used at the bottom of its operating range. The flow cell should be capable of handling minor flow variations without affecting instrument accuracy. The instrument should be supplied with a self-contained stable secondary calibration standard (cal-cube) with a value appropriate for the operating range of the instrument. The instrument also should be supplied with all required equipment for primary calibration. In turbidity units for wastewater plants the flow cell optics should be self-cleaning. The transmitter unit should be complete with LCD display panel. The unit will be powered by 230V AC. The transmitter shall incorporate all range settings, zero settings and necessary controls and shall have a range able linear isolated analogue output circuit rated 4-20 mA, the signal being capable of driving into a minimum resistive load of 750 ohms. The transmitter unit shall be self-diagnostic of faults and be complete with appropriate error messages. The transmitter unit shall feature user-friendly calibration sequences complete with all necessary maintenance prompts. The transmitter unit should be capable of working in a continuous air temperature of 50°C and offer long term corrosion resistance to atmospheric conditions typical for the application (water or waste water).

**On-Line Analysis Meters**

The analyser system shall comprise dual membrane sample filters for each sample stream, automatic stream switching facilities, the evaluation instrument, reagent solutions, calibration solutions, precision peristaltic pump, all interconnecting pipework and valves, and connections to mains power, a control system, a sample stream and a drain. The membrane filters shall be provided in duplicate for each sample stream on the basis of one in service and one on standby. Changeover to the standby filter shall be by manual valving. The filters shall be entirely suitable for the nominated sample stream, and produce a filtrate entirely suitable for the associated analysers. Provide all cleaning equipment and chemicals required for routine maintenance of the filter membrane. Stream splitting shall be fully automatic and programmable. Facilities must be provided to sequence streams in any order. The evaluation output of the analyser for any stream shall hold its value while other streams are analysed. Reagent solutions shall be supplied in robust containers neatly housed in a cubicle manufactured from materials entirely resistant to the reagent chemicals. Interconnecting tubing shall be concealed yet easily replaceable. If reagents are to be prepared on site, provide one spare reagent container for each reagent. Reagent volume in one container should last for 4 weeks of normal operation. Calibration solutions shall be supplied for two-point calibration of the evaluation instrument and shall be housed similarly to the reagent solutions. Calibration shall be fully automatic at programmable time intervals. The peristaltic pump shall be suitable for long-term continuous operation without scheduled maintenance of any type including lubrication or replacement of metering tubing. Replacement of the tubing shall be a simple procedure undertaken by the operator without special tools. The evaluation instrument and any associated reactors shall be preferably temperature controlled, or at least temperature compensated. Front of panel indication shall include digital (3 Digit) readout of the species concentration, and LED indication of alarms and calibration sequence. The whole system shall be housed in a corrosion proof cabinet protected to IP31 for liquid handling systems and IP55 for electrical/electronic systems.

**Nitrate Analyser**

Nitrate evaluation shall be by specific ion electrode and shall report nitrate ion concentration in the range of 0-20 mg/l with a total measurement accuracy of ±2% of reading.
The electrode shall be easily replaceable by the operator without the use of special tools. Electrical connection shall be by plug and socket.

**Ammonium Analyser**
The ammonium evaluation shall be by ammonia gas sensing probe and report ammonium ion in the range 0-10mg/l with a total measurement accuracy of ±3% of reading.

**Phosphate Analyser**
The Phosphate evaluation shall be by phosphate reagent system and report phosphorous/orthophosphate in the range 0-5mg/l with a total measurement accuracy of ±3% of reading.

**Autosamplers**
Refrigerated autosamplers shall be provided for the following process streams:
- Degritted sewage at the PTA downstream of the grit removal system;
- Class B Recycled Water at the pump station transferring flow to Coombabah STP / Pimpama River, and,
- Class A+ Recycled Water at the pump station transferring flow to the Recycled Water Network.
The autosamplers shall be configured to enable both time-based and flow-paced sample collection as required, and shall be capable of both discrete and composite sample collection.
5 Section 5 – Materials

The "Material" section of SS10 identifies the materials that can be used in the construction of the assets. It will primarily be the approved products list with specifications of each component to be used in the configuration of the asset.

The guidelines in this section should be read in conjunction with relevant GCCC Standard drawings. It should also be noted that a number of Australian Standards form parts of this section of SS10 and must be referred to for details of materials, workmanship and construction procedures. A list of Australian Standards is in the clause “Standards and Codes” below.

Council’s Development Guidelines, Standard Specifications and Standard Drawings shall take precedence over the Department of Natural Resources and Water Planning Guidelines and the WSAA Water Supply Code and Drawings and the Dual Water Reticulation Supplement.

5.1 COMMON MATERIAL REQUIREMENTS

5.1.1 Scope

This specification covers all materials used for construction of Water Supply and Sewerage, Wastewater Treatment Plants, Systems, Reservoir covering civil, electrical and mechanical installations.

All materials used in the Works shall be handled, transported and stored in accordance with the relevant Australian Standard and the manufacturers’ recommendations.

All materials used in the Works that will be in contact with water or be located within the interior of a reservoir (whether in contact with water or otherwise) shall comply with the requirements of AS4020. Materials specified within this Specification are current at the date of issue. Alternative materials may be approved by the Superintendent upon written approval from City of Gold Coast.

5.1.2 Standards and Codes

This specification makes reference to the following Australian Standards:

<table>
<thead>
<tr>
<th>STANDARD</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS1478</td>
<td>Chemical admixtures for concrete</td>
</tr>
<tr>
<td>AS/NZ4158</td>
<td>Thermal-bonded polymeric coatings on valves and fittings for water industry purposes AS4321</td>
</tr>
<tr>
<td>AS/NZ4158</td>
<td>Thermal-bonded polymeric coatings on valves and fittings for water industry purposes</td>
</tr>
<tr>
<td>AS/NZ4680</td>
<td>Hot-dip galvanized (zinc) coatings on fabricated ferrous articles</td>
</tr>
<tr>
<td>AS/NZS 4020</td>
<td>Testing of products for use in contact with drinking water. Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications</td>
</tr>
<tr>
<td>AS/NZS 5065</td>
<td>Welding consumables - Tubular cored electrodes for gas shielded and non-gas shielded metal arc welding of non-alloy and fine grain steels - Classification (ISO 17632:2004, MOD)</td>
</tr>
<tr>
<td>AS/NZS ISO 17632</td>
<td>Welding consumables - Tubular cored electrodes for gas shielded metal arc welding of creep-resisting steels - Classification (ISO 17634:2004, MOD)</td>
</tr>
<tr>
<td>AS/NZS ISO 18276</td>
<td>Welding consumables - Tubular cored electrodes for gas shielded metal arc welding of high-strength steels - Classification (ISO 18276:2005, MOD)</td>
</tr>
<tr>
<td>AS/NZS1260</td>
<td>PVC-U pipes and fittings for drain, waste and vent application</td>
</tr>
<tr>
<td>AS/NZS1477</td>
<td>Unplasticized PVC (UPVC) pipes and fittings for pressure applications</td>
</tr>
<tr>
<td>AS/NZS1554.1</td>
<td>Structural steel welding - Welding of steel structures</td>
</tr>
<tr>
<td>AS/NZS2032</td>
<td>Installation of PVC pipe systems</td>
</tr>
<tr>
<td>AS/NZS2280</td>
<td>Ductile iron pressure pipes and fittings</td>
</tr>
<tr>
<td>AS/NZS2566.1</td>
<td>Buried flexible pipelines – Structural design</td>
</tr>
<tr>
<td>AS/NZS2648.1</td>
<td>Underground marking tape – Non-detectable tape</td>
</tr>
<tr>
<td>Standard Number</td>
<td>Description</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------</td>
</tr>
<tr>
<td>AS/NZS3000</td>
<td>Electrical installations - Buildings, structures and premises (known as the SAA Writing Rules)</td>
</tr>
<tr>
<td>AS/NZS3518</td>
<td>Acrylonitrile Butadiene Styrene (ABS) compounds, pipes and fittings for pressure applications</td>
</tr>
<tr>
<td>AS/NZS3679</td>
<td>Structural steel – hot-rolled Solvent cements and priming fluids for PVC (PVC-U and PVC-M) and ABS pipes and fittings</td>
</tr>
<tr>
<td>AS/NZS3879</td>
<td>Testing of products for use in contact with drinking water</td>
</tr>
<tr>
<td>AS/NZS4129</td>
<td>Fittings for polyethylene (PE) pipes for pressure applications</td>
</tr>
<tr>
<td>AS/NZS4130</td>
<td>Polyethylene (PE) pipes for pressure applications</td>
</tr>
<tr>
<td>AS/NZS4131</td>
<td>Polyethylene (PE) compounds for pressure pipes and fittings</td>
</tr>
<tr>
<td>AS/NZS4586</td>
<td>Slip resistance classification of new pedestrian surface materials</td>
</tr>
<tr>
<td>AS/NZS4671</td>
<td>Steel reinforcing materials</td>
</tr>
<tr>
<td>AS/NZS4765</td>
<td>Modified PVC (PVC-M) pipes for pressure applications</td>
</tr>
<tr>
<td>AS/NZS4854</td>
<td>Welding consumables - Covered electrodes for manual metal arc welding of stainless and heat-resisting steels - Classification</td>
</tr>
<tr>
<td>AS/NZS4855</td>
<td>Welding consumables - Covered electrodes for manual metal arc welding of non-alloy and fine grain steels - Classification</td>
</tr>
<tr>
<td>AS1012</td>
<td>Polyethylene and polypropylene pipes and fittings for drainage and sewerage applications</td>
</tr>
<tr>
<td>AS1023</td>
<td>Steel tubes and tubulars for ordinary service</td>
</tr>
<tr>
<td>AS1044</td>
<td>ISO metric hexagon commercial bolts and screws</td>
</tr>
<tr>
<td>AS1074</td>
<td>ISO metric hexagon bolts and screws – Product grade C – Bolts</td>
</tr>
<tr>
<td>AS1111.1</td>
<td>ISO metric hexagon bolts and screws – Product grade C – Screws</td>
</tr>
<tr>
<td>AS1112</td>
<td>ISO metric hexagon nuts, including thin nuts, slotted nuts and castle nuts</td>
</tr>
<tr>
<td>AS1112.3</td>
<td>ISO metric hexagon nuts – Product grade C</td>
</tr>
<tr>
<td>AS1141</td>
<td>Methods for sampling and testing aggregates</td>
</tr>
<tr>
<td>AS1159</td>
<td>Polyethylene pipes for pressure applications</td>
</tr>
<tr>
<td>AS1163</td>
<td>Structural steel hollow sections Non-destructive testing - Magnetic particle testing of ferromagnetic products, components and structures</td>
</tr>
<tr>
<td>AS1180</td>
<td>Cement mortar lining of steel pipes and fittings</td>
</tr>
<tr>
<td>AS1214</td>
<td>Methods of testing soils for engineering purposes</td>
</tr>
<tr>
<td>AS1237</td>
<td>Steel reinforcing bars for concrete BL</td>
</tr>
<tr>
<td>AS1281</td>
<td>Welded wire reinforcing fabric for concrete</td>
</tr>
<tr>
<td>AS1289</td>
<td>The specification and manufacture of concrete</td>
</tr>
<tr>
<td>AS1302</td>
<td>Steel sheet and strip – hot-dipped zinc-coated or aluminium/ zinc-coated</td>
</tr>
<tr>
<td>AS1304</td>
<td>Wrought alloy steels – stainless and heat resisting steel plate, sheet and strip</td>
</tr>
<tr>
<td>AS1314</td>
<td>Chemical admixtures for concrete</td>
</tr>
<tr>
<td>AS1379</td>
<td>Copper and copper alloys – ingots and castings</td>
</tr>
<tr>
<td>Standard</td>
<td>Description</td>
</tr>
<tr>
<td>----------</td>
<td>-------------</td>
</tr>
<tr>
<td>AS1567</td>
<td>Copper and copper alloys – wrought rods, bars and sections</td>
</tr>
<tr>
<td>AS1568</td>
<td>Copper and copper alloys – forging stock and forgings</td>
</tr>
<tr>
<td>AS1579</td>
<td>Arc welded steel pipes and fittings for water and wastewater</td>
</tr>
<tr>
<td>AS1627.4</td>
<td>Metal finishing – preparation and pre-treatment of surfaces-abrasive blast cleaning of steel</td>
</tr>
<tr>
<td>AS1646</td>
<td>Elastomeric seals for waterworks purposes</td>
</tr>
<tr>
<td>AS1650</td>
<td>Hot-dipped galvanised coatings on ferrous articles</td>
</tr>
<tr>
<td>AS1657</td>
<td></td>
</tr>
<tr>
<td>AS1668</td>
<td></td>
</tr>
<tr>
<td>AS1683</td>
<td></td>
</tr>
<tr>
<td>AS1720.1</td>
<td>Timber Structures – Design Methods</td>
</tr>
<tr>
<td>AS1722.1</td>
<td>Pipe threads of Whitworth form – sealing pipe threads</td>
</tr>
<tr>
<td>AS1734</td>
<td>Vitrified clay pipes and fittings with flexible joints - Sewer quality</td>
</tr>
<tr>
<td>AS1741</td>
<td>Iron castings – grey cast iron</td>
</tr>
<tr>
<td>AS1768</td>
<td>Iron castings - Spheroidal or nodular graphite cast iron</td>
</tr>
<tr>
<td>AS1830</td>
<td>Ductile cast iron</td>
</tr>
<tr>
<td>AS1831</td>
<td>Code of practice for application of ergonomics to factory and office work</td>
</tr>
<tr>
<td>AS1858</td>
<td></td>
</tr>
<tr>
<td>AS1891.3</td>
<td></td>
</tr>
<tr>
<td>AS1939</td>
<td>Conduits and fittings for electrical installations</td>
</tr>
<tr>
<td>AS2053</td>
<td>Non-destructive testing - Penetrant testing of products and components</td>
</tr>
<tr>
<td>AS2129</td>
<td>Flanges for pipes, valves and fittings</td>
</tr>
<tr>
<td>AS2187</td>
<td>Explosives – Storage, transport and use (known as the SAA Explosives Code)</td>
</tr>
<tr>
<td>AS2200</td>
<td>Design charts for water supply and sewerage</td>
</tr>
<tr>
<td>AS2203</td>
<td></td>
</tr>
<tr>
<td>AS2240</td>
<td></td>
</tr>
<tr>
<td>AS2279</td>
<td></td>
</tr>
<tr>
<td>AS2317</td>
<td>Collared eyebolts</td>
</tr>
<tr>
<td>AS2321</td>
<td>Short-link chain for lifting purposes</td>
</tr>
<tr>
<td>AS2345</td>
<td>Dezincification resistance of copper alloys</td>
</tr>
<tr>
<td>AS2544</td>
<td>Grey iron pressure fittings</td>
</tr>
<tr>
<td>AS2549</td>
<td></td>
</tr>
<tr>
<td>AS2550</td>
<td></td>
</tr>
<tr>
<td>AS2576</td>
<td></td>
</tr>
<tr>
<td>AS2638.1</td>
<td>Gate valves for waterworks purposes – Metal seated</td>
</tr>
<tr>
<td>AS2638.2</td>
<td>Gate valves for waterworks purposes – Resilient seated</td>
</tr>
<tr>
<td>AS2643</td>
<td>Colour Standards for general purposes – Lilac</td>
</tr>
<tr>
<td>AS2700S-1996(P23)</td>
<td></td>
</tr>
<tr>
<td>AS2728</td>
<td>Shackles</td>
</tr>
<tr>
<td>AS2741</td>
<td>Concrete aggregates</td>
</tr>
<tr>
<td>AS2758.1</td>
<td>Aggregates and rock for engineering purposes - Concrete aggregates</td>
</tr>
<tr>
<td>AS2758.1</td>
<td>Aggregates and rock for engineering purposes – Concrete aggregates</td>
</tr>
<tr>
<td>AS2837</td>
<td>Wrought alloy steels – stainless steel bars and semi-finished products</td>
</tr>
<tr>
<td>AS2865</td>
<td>Safe working in a confined space</td>
</tr>
<tr>
<td>Standard</td>
<td>Description</td>
</tr>
<tr>
<td>--------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>AS3000</td>
<td>Electrical installations – buildings, structures and premises (known as the SAA Wiring Rules)</td>
</tr>
<tr>
<td>AS3168</td>
<td>Glass filament Reinforced thermosetting Plastics (GRP) pipes – Polyester based – water supply, sewerage and drainage applications</td>
</tr>
<tr>
<td>AS3439.1</td>
<td>Supplementary cementitious materials for use with Portland and blended cement – Fly ash</td>
</tr>
<tr>
<td>AS3500</td>
<td>Concrete structures</td>
</tr>
<tr>
<td>AS3610</td>
<td>Formwork for concrete</td>
</tr>
<tr>
<td>AS3678</td>
<td>Structural steel – hot-rolled plates, floor-plates and slabs</td>
</tr>
<tr>
<td>AS3680</td>
<td>Polyethylene sleeving for ductile iron pipelines</td>
</tr>
<tr>
<td>AS3681</td>
<td>Guidelines for the application of polyethylene sleeving to ductile iron pipeworks and fittings</td>
</tr>
<tr>
<td>AS3688</td>
<td>Water supply – metallic fittings and end connectors</td>
</tr>
<tr>
<td>AS3706</td>
<td>Geotextiles – methods of test</td>
</tr>
<tr>
<td>AS3776</td>
<td>Lifting components for Grade T chain slings</td>
</tr>
<tr>
<td>AS3799</td>
<td>Non-conductive coatings – continuity testing – high voltage (brush) method</td>
</tr>
<tr>
<td>AS3894.1</td>
<td>Site testing of protective coatings - Non-conductive coatings - Continuity testing - Wet sponge method</td>
</tr>
<tr>
<td>AS3952</td>
<td>Water supply – DN80 spring hydrant valve for general purposes</td>
</tr>
<tr>
<td>AS3972</td>
<td>Portland and blended cements</td>
</tr>
<tr>
<td>AS3996</td>
<td>Metal access covers, road grates and frames</td>
</tr>
<tr>
<td>AS4037</td>
<td>Pressure equipment - Examination and testing</td>
</tr>
<tr>
<td>AS4087</td>
<td>Metallic flanges for waterworks purposes</td>
</tr>
<tr>
<td>AS4097</td>
<td>Information processing – SGML support facilities – registration procedures for public text owner identifiers</td>
</tr>
<tr>
<td>AS4100</td>
<td>Fibre ropes - Care and safe usage</td>
</tr>
<tr>
<td>AS4124.1</td>
<td>Stainless steel clamps for waterworks purposes</td>
</tr>
<tr>
<td>AS4198</td>
<td>Pre-cast concrete access chambers for sewerage applications</td>
</tr>
<tr>
<td>AS4254</td>
<td>Fusion-bonded medium density polyethylene coating and lining for pipes and fittings</td>
</tr>
<tr>
<td>AS4441(Int.)</td>
<td>Oriented PVC (PVC-O) pipes for pressure applications</td>
</tr>
<tr>
<td>AS4672</td>
<td>Non-return valves – Swing check and tilting disc</td>
</tr>
<tr>
<td>AS4792</td>
<td>Butterfly valves for waterworks purposes</td>
</tr>
</tbody>
</table>

In this specification Australian Standards are referred to only by their allocated AS number. The latest available edition (including interim editions) at the date of close of Tenders shall be deemed to apply.
5.2 COMMON MATERIAL REQUIREMENTS – CIVIL WATER AND SEWAGE INSTALLATIONS

5.2.1 Acts, Regulation, By-Law And Joint Committee
The Contractor shall comply with all Acts, By-Laws and Regulations having jurisdiction over work under the Contract and shall be fully responsible for any breaches thereof.
Notwithstanding the requirements of this specification, the whole of the work under the Contract shall be executed in conformity with the relevant sections of the Sewerage and Water Supply Act 1949 (as amended).
Where reference is made in this specification to Joint Committee Approval it shall be as defined under the Sewerage and Water Supply Act 1949 (as amended).

5.2.2 Bedding Material
Bedding shall be crushed rock material complying with AS2758.1 and AS1141 and of the nominal sizes shown in Table 4.1 herein.

Table 4.1 – Bedding Material

<table>
<thead>
<tr>
<th>AS Sieve (mm)</th>
<th>Crushed Rock Nom Size 5 - 7mm</th>
<th>Crushed Rock Nom Size 10mm</th>
<th>Crushed Rock Nom Size 30mm (Additional Bedding)</th>
</tr>
</thead>
<tbody>
<tr>
<td>37.5</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26.5</td>
<td></td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>19.0</td>
<td></td>
<td>25 - 60</td>
<td></td>
</tr>
<tr>
<td>13.2</td>
<td>100</td>
<td>5 - 20</td>
<td></td>
</tr>
<tr>
<td>9.5</td>
<td>100</td>
<td>85 - 100</td>
<td></td>
</tr>
<tr>
<td>6.7</td>
<td>85 - 100</td>
<td>30 - 50</td>
<td></td>
</tr>
<tr>
<td>4.75</td>
<td>30 - 85</td>
<td>5 - 30</td>
<td></td>
</tr>
<tr>
<td>2.36</td>
<td>0 - 30</td>
<td>0 - 5</td>
<td></td>
</tr>
<tr>
<td>1.18</td>
<td>0 - 5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.2.3 Backfilling
For the purposes of this specification, backfilling material shall consist of:
all material used in the trench above the Bedding Zone 3 material as specified in sub-clause “Bedding Material” herein;
all the material as designated for Type 7 Construction.
b) In addition to the requirements specified herein, no backfill material shall contain rocks larger than 150mm diameter or lumps of material that may prevent the compaction specified herein. Backfill material with rock larger than 150mm shall be screened to exclude material larger than 150mm diameter.
c) In locations other than under roadways and footpaths (ie. within allotments and parks, etc.) the backfill material shall consist of material complying with a) and b) and either of the following: the best of the material (selected and approved by the Superintendent) from trench excavation; or material from ‘On-Site’ earthworks selected and approved by the Superintendent; imported material.
d) If, in the Superintendent's opinion, material from c) i) above is not suitable for backfilling then material from c) ii) above shall be used by the Contractor. If, in the opinion of the Superintendent, the ‘On-Site’ material is not suitable for backfilling over pipes and conduits, the Contractor shall import a material acceptable to the Superintendent at the rate nominated in the schedule (material with a soaked CBR not less than 15% will be acceptable).
e) The backfill material shall be compacted to the standard specified in Table 7 herein. Any settlement shall be made good by the Contractor, prior to the end of the Defects Liability Period.
f) Except as specified in h) herein, under roadways the backfill material shall be as shown on the drawings and nominated in herein. The materials shall be compacted in layers not greater than 200mm thick to the standard specified in Table 7 herein.
g) The Contractor shall comply with the nominated HOLD points detailed within the Hold/ Witness Inspection Checklist for Water Reticulation.

Table 7

<table>
<thead>
<tr>
<th>Area of Work Backfill to Trenches</th>
<th>Relative Compaction Required</th>
<th>Min Test Frequency¹, ³</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under roads to a depth 0.3m below subgrade level</td>
<td>&gt; 98% Std Density Ratio</td>
<td>&gt; 80% Density Index</td>
</tr>
<tr>
<td>Commercial development areas</td>
<td>&gt; 98% Std Density Ratio</td>
<td>&gt; 70% Density Index</td>
</tr>
<tr>
<td>Elsewhere including under roads</td>
<td>&gt; 95% Std Density Ratio</td>
<td>&gt; 65% Density Index</td>
</tr>
</tbody>
</table>

Notes:

Unless directed otherwise by the Superintendent.

a) Non-cohesive material shall be defined as material which contains up to 5% by mass of soil particles passing a 75 \( \mu \text{m} \) sieve, except that silty sands with non-plastic fines may contain up to 12% passing a 75 \( \mu \text{m} \) sieve.

b) For non-cohesive material, each compaction test may be replaced by three (3) Perth sand penetrometer tests provided that a correlation between the penetrometer test and the compaction test is established by the NATA accredited testing authority and approved by the Superintendent.

c) Under State-controlled roads the provisions of clause “State–Controlled Roads” herein shall apply.

d) The Contractor shall arrange for compaction control testing of all backfill by a NATA accredited testing authority approved by the Superintendent. Testing shall be carried out in accordance with the appropriate test methods, sourced from either Australian Standard AS1289 or the Queensland Department of Main Roads, Materials Testing Manual. The selection/ application of test methods shall be made on a consistent basis. Inter-related tests shall be performed by methods from the same Standard/ Testing Manual.

**Flowable Fill**

Where approved by the Superintendent, Flowable Fill may be used as an alternative backfill under roadways.

Flowable Fill shall comply with the following requirements:

a) cement shall be Portland cement, Type GP or Type GB and shall conform to AS3972;

b) if used, fly ash shall conform to AS3582.1;

c) fine aggregates shall conform to AS2758.1;

d) if used, chemical admixtures shall conform to AS1478. Any chemical admixture must be approved by the Superintendent;

e) minimum compressive strength @ 28 days – 0.5 MPa;

f) maximum compressive strength @ 28 days – 1.5 MPa;

g) maximum size aggregate – 4.75 mm;

h) minimum cement/ cementious content – 5% by weight;

i) the consistency of flowable fill shall suit the job application;

j) flowable fill shall have the ability of being placed by concrete pump when required;

k) the mix design of flowable fill shall be such as not to cause segregation while being placed;

l) flowable fill will be required to produce the necessary flowability and self-compaction without the use of immersion vibrators.

m) Lean mix concrete containing 85 kg cement per cubic metre may be used for backfilling under roadways with the approval of the Superintendent.

**Metallic Detection Tape**

Detection tape shall be provided in accordance with Clause “Polyethylene Pipe Sleeving and Marker Tape” that is located as shown in the drawings.
5.2.4 Structures, Reinforcing, Timber, Formwork

The grade of concrete to be used in the Works shall be as shown on the drawings. The manufacture, supply, handling and placing of concrete shall comply with the requirements of AS1379 and AS3600. Portland and blended cements shall comply with the requirements of AS3972. Steel reinforcing bars and welded wire reinforcing fabric shall comply with the requirements of AS/NZS4671. Structural steel shall comply with the requirement of AS3678 and AS/NZS3679. Galvanising shall comply with the requirements of AS/NZS 4680. All structural timber shall comply with the requirements of AS1720.1 and timber species shall conform to unseasoned stress Grade F17. Formwork shall comply with the requirements of AS3610.

5.2.5 Effect On Potable Water

All pipes, fittings and joint seals shall comply with the requirements of AS4020 with regard to their effect on potable water.

5.2.6 Pressure Pipes (Water and Recycled Water)

Polyvinyl Chloride Pipes (PVC)

All types of PVC pipe shall be manufactured using lead free stabilisers.

uPVC pipes shall comply with AS/NZS1477.

PVC-M pipes shall comply with AS/NZS4765.

PVC-O pipes shall comply with AS/NZS4441 at a material classification of MRS400 or MRS450 only. MRS500 pipe shall not be used.

PVC-O pipes shall not be used for pumped mains in locations where bad ground conditions exist and pipe support is poor due to low to very low soil modulus. Where shown on the drawings, PVC-O pipes may be used where certified calculations in accordance with AS2566 show that pipe buckling due to external loads, depth of cover, water table level and traffic live loads, etc. is not an issue.

No PVC pipe socket of any approved material shall be joined to a Ductile Iron Spigot. PVC pipes shall not be less than 600mm in length with pipes less than this length to be DI.

Handling and storage of PVC pipes and fittings shall comply with the requirements of AS2032. If there is any discrepancy in the requirement of this specification and AS/NZ2032 then the requirements of this specification shall take precedence.

Joint seals shall be as specified in the clause below.

Pipe colours shall be as specified in clause “Pipe Colours” [SMR-Water] or “Pipe Colour” –[SMR-Wastewater].

Rubber rings shall be as specified in this clause “Joint Seals” below.

Ductile Iron (DI (Water and Recycled Water))

DI pipes shall be internally lined with cement mortar as set out in AS/NZS2280. Pipes of DN450 and larger, in addition to the mortar lining, shall be internally coated with a Seal Coat that provides water quality management of the mortar lining.

DI pipes shall comply with AS/NZS2280 or EN545 compliant DI pipes can be used with appropriate marking as ISO Pipe as specified in Clause “Polyethylene Pipe Sleeving and Marker Tape” herein.

DI pipes shall be bitumen coated externally in accordance with AS/NZS2280 and sleeved as specified in Clause “Polyethylene Pipe Sleeving and Marker Tape” herein.
DI PN35 pipes shall be used for road crossings with the pipe or pipes to extend 1.0 metre past the NKL at each end. DI pipes for use in locations other than underground shall be either thermal bonded polymeric corrosion protective coating or epoxy painted in accordance with Clause “Protective Coatings” herein.

Joint Seals shall be as specified in the clause below.
Rubber rings shall be as specified in this clause “Joint Seals” below.

*DI Flanged Pipe*

All DI flanged pipework shall be manufactured in accordance with AS/NZS2280 – Class K 12 wall thickness ductile iron pipe to which has been fitted threaded boss flanges in accordance with AS4087. **EN545** compliant DI pipes can be used with appropriate marking as ISO Pipe as specified in Clause “Polyethylene Pipe Sleeving and Marker Tape” herein.

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 AS4087 – Figure B.5 unless connecting on to existing mains where the connecting flange shall match existing.

All pipes shall be internally cement mortar lined and externally coated as specified for DI Pipe above in accordance with AS/NZS2280 and sleeved as specified in Clause “Polyethylene Pipe Sleeving and Marker Tape” herein.

Coatings for Steel Used in Sewage Works.

Within the pump wet well, flange/flange DI Class K12 pipes shall be utilised conforming to clause **????** herein except that they shall have applied to the external surfaces of the pipe and flanges, a factory applied high build, 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 –

The pipes shall be supplied with two (2) coats of the protective coating system that has been applied over a compatible primer following the pipes abrasive blast cleaning in accordance with AS1627.4 at Class 2.5.

The two applied coats shall have a combined dry film thickness of 300 microns minimum with the dry coatings to be continuity tested, by wet sponge in accordance with AS3894.2 with any defects to be repaired in accordance with the manufacturers instructions.

*Glass Reinforced Plastic (GRP)*

GRP pipes and couplings shall comply with AS3571 or ISO10467. GRP couplings shall not be jointed to ductile iron spigot.

GRP pipes shall be joined with GRP couplings with full width rubber membranes. The rubber membranes shall comply with the requirements for rubber rings as specified in “Joint Seals” clause below.

*Steel (Water and Recycled Water)*

Steel pipes shall comply with AS1579. The minimum wall thickness shall be 5 mm.

The pipes shall be cement lined in accordance with AS1281 and shall be internally coated with a Seal Coat that provides water quality management of the mortar lining.
The pipes shall be coated with a fusion bonded medium density polyethylene (FBMDPE) coating in accordance with AS4321.

Pipe joints shall be either welded slip-in, welded butt, welded ball and socket, welded collar, flanged or elastomeric ring as specified in “Joint Seals” clause below.

Pipe welding shall be in accordance with “Pipe Welding” clause below.

Steel flanged pipework shall be handled and tested as specified herein.

When cathodic protection is required on elastomeric ring jointed pipelines, cable attachment lugs shall be provided on all pipe ends approximately 125 mm from the end of the coating.

Steel Flanged (Water and Recycled Water)
Steel flanged pipework shall be manufactured from AS1579 pipe to which has been fitted plate flanges in accordance with AS4087 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 AS4087 - Figure B.7 unless connecting on to existing mains where the connecting flange shall match existing. All pipes shall be cement mortar lined and coated as specified in “Protective Coatings” clause below.

The pipes shall be coated with a fusion bonded medium density polyethylene (FBMDPE) coating in accordance with AS4321.

Prior to welding the flange to the pipe, the FBMDPE coating shall be cut back to a neat edge 50mm 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 “Protective Coatings” clause below.

Pipe welding shall be in accordance with clause “Pipe Welding” below.

Steel flanged pipework shall be handled and tested as specified in clause herein.

The joint between the coatings shall be covered using a U.V. stabilised heat shrink sleeve.

5.2.7 Pressure Pipe Fittings

DI Socket Fittings
DI socket fittings shall comply with AS/NZS2280 and shall be PN16(min) and shall be rubber ring jointed as specified in “Joint Seals” clause below. EN545 compliant DI socket fittings can be used with appropriate marking of the ISO Pipe as specified in clause “Polyethylene Pipe Sleeving and Marker Tape” herein.

DI reticulation fittings and pipe shorts shall be internally and externally coated as specified in sub-clause “Thermal Bonded Polymeric Coatings” herein. Pipe or fittings with this coating system shall not be cut.

Sockets shall be of a design which provides an effective sealing length. At assembly of the socketed fittings joints, care shall be taken when cutting pipes that the pipe ends are cut square and evenly, not excessively bevelled and that the end is fully inserted into the socket by use of the witness mark.

DI trunk fittings shall be either internally lined with cement mortar and externally bitumen coated in accordance with AS/NZS2280 or coated as nominated in sub-clause “Thermal Bonded Polymeric Coatings” herein. DI fittings shall be rubber ring jointed as specified in sub-clause “Rubber Rings” herein.

Only bitumen coated cement mortar lined pipe and fittings in accordance with AS/NZS2280 may be cut.

Ductile Iron Flanged Fittings
Flanged pipe fittings shall be manufactured in accordance with AS/NZS2280. EN545 compliant DI flanged pipe fittings can be used with appropriate marking of the ISO Pipe as specified in Clause 8.0 herein. All flanged pipe fittings shall be in accordance with AS4087 Figure B5 unless connecting onto existing mains, where the connecting flange shall match existing. DI reticulation fittings and pipe shorts shall be internally and externally coated as specified in sub-clause “Thermal Bonded Polymeric Coatings” herein. Trunk fittings shall be either coated as nominated in sub-clause “Thermal Bonded Polymeric Coatings” herein or internally lined with cement mortar and externally bitumen coated in accordance with AS/NZS2280. Flanges shall be raised face as detailed in Appendix C of AS4087. Joint Seals shall be as specified in Clause 9.2 herein.

Fittings for use underground shall be coated externally with a bituminous compound in accordance with AS/NZS2280. Fittings for use in locations other than underground shall be epoxy painted as specified in Clause 12.1.2 herein.

**Ductile Iron Puddle Flanges**

Puddle flanges shall comply to AS/NZS2280 except that all nuts, bolts and washers used in the assembly of puddle flanges shall be of Grade 316 stainless steel.

Puddle flanges shall be attached to Flange Class pipe by a machined groove complying with AS/NZS2280.

**Steel Fittings**

Steel fittings shall comply with AS1579 with a rated pressure of 1.4 MPa.

Fittings shall be manufactured from sections of pipe which have been cement lined in accordance with AS1281 and coated or lined and coated with fusion bonded medium density polyethylene in accordance with AS4321.

Fittings shall have square plain spigot ends for collar jointing.

Fittings shall generally comply with the suggested configurations and dimensions shown in Appendix G of AS1579.

Fittings such as wyes, tees, angle branches, etc. shall be reinforced in accordance with the provisions of American Water Works Association Manual M11, Clause 13.3.

At all welds, the FBMDPE coating shall be cut back to a neat edge 50mm clear of the weld. After the completion of welding and inspection, the exposed surface shall be coated with a spray application of the FB or FBMDPE coating material. Any gap in the cement mortar lining shall be packed with cement mortar.

Pipe welding shall be in accordance with “Pipe Welding” herein.

Steel flanged pipework shall be handled and tested as specified in Clause “Additional Requirements for Laying and Jointing of Steel Pipes” herein.

**Polyethylene (PE) Fittings for Mains**

Reticulation main Polyethylene (Poly) fittings for DN63 and DN110 pipe, such as pipe couplings, tees and bends shall be PE electrofusion fittings compatible with the pipe specified in Clause “Water Main Pressure Pipes” herein and shall be manufactured in accordance with either/ or EN 1555 and EN 12201 and EN 13244 and UNI 10910 at PN16 for water.

Reticulation DI main fittings for Poly main connection oftakes shall be PN 16 flange restraint fittings equal to the Hawle Flange Adaptor, System 2000 fitting or the AVK Supa Plus Flange Adaptor 623/10 fitting that has been installed directly downstream from a restrained section of flanged DI pipe as shown in the drawings. The Poly restraint fittings flange shall be in accordance with AS4087 – Figure B5. All bolts used in the fitting shall be Grade A4 or shall comply with sub-clause “Jointing Bolts” herein.

DN63 flushing point PE risers shall be terminated with an electrofusion Transition coupling with a brass 1½” Male BSP threaded oftake. Onto this BSP thread shall be attached either a Potable or Recycled Flushing Valve assembly as shown in the drawings.

Tapping fittings shall comply with sub-clause “PE Electrofusion Tapping Fitting” herein.

### 5.2.8 Polyethylene Pipe Sleeving and Marker Tape

**Australian Standard Pipe**

Polyethylene sleeving shall be manufactured to satisfy the requirements of AS3680.
Polyethylene sleeving shall be installed on all DI pipes and fittings to satisfy the requirements of AS3681 except that cross-connection assemblies shall not be provided with PE Sleeving for the Cross Connection Tees and **Sluice valve**. Where shown on the drawings for pipe materials other than DI, Polyethylene sleeving shall be provided to satisfy the requirements of AS3681. The colour of Polyethylene sleeving installed on a pipe shall be in accordance with Clause “Colours of Pipe” -SMR Water herein. All mains shall be marked by the use of underground detectable warning tape. A coloured detection tape in accordance with Clause “Colours of Pipe” -SMR Water herein shall be located at a depth of 300 mm below finished surface and within the trench vertically above the pipeline being marked. Underground detection/ tracer tape shall conform to AS2648.1. The tape shall be coloured polyethylene as noted above with a continuous metal core. The tape shall feature sub-surface graphics incorporating a warning ‘Caution Buried Water Line’ or ‘Caution Recycled Water – Do Not Drink’. The graphics shall be continuous along the tape.

**ISO Standard Pipe**
ISO Standard pipe systems and fittings in addition to the requirements of the previous clause herein shall be clearly marked as an ISO pipe system. Marking shall be through the use of either AS3681 compliant sleeving that additionally states that the pipe system is to an ISO Standard or the pipe system shall be marked over the standard sleeving with a spirally wound detection/ tracer tape that states that the pipe system is to an ISO Standard. The spirally wound tape shall be at 1.0 metre spaces circumferentially along the pipe.

### 5.2.9 Jointing Systems

**Gibault**
Only elongated gibault joints complying with WSA 105 shall be used in the Works. They shall be approved by the Superintendent and shall be on City of Gold Coast ‘s list of approved products. All bolts used in the joint shall comply with **sub-clause “Jointing Bolts”** herein. Gibault joints shall be tolerant of pipe axial deflection at the joint pipe and axial movement and forces applied perpendicular to the pipe axis. Joint Seals shall be as specified in **sub-clause “Rubber Rings”** herein.

**Dismantling Joints**
Dismantling joints shall be PN16 minimum, either thrust type or non-thrust type depending on the pipeline arrangement. They shall be manufactured from ductile iron in conformance with AS/NZS2280 and drilled to **Figure B5 or 7 (as appropriate)** of AS4087 and be provided with natural rubber seals and flange gaskets in accordance with **Clause 9.2** herein. Bolts shall comply with **sub-clause “Jointing Bolts”** herein. The ductile iron components shall be provided with a thermal bonded polymeric corrosion protective coating as specified in **sub-clause “Protective Coating”** herein.

**Flanged Assembly Joints**
Flanged Assembly Joints (UniFlange or equal) shall be DI fittings manufactured in conformance with AS/NZS2280 and drilled to **Figure B5 or 7 (As appropriate)** of AS4087. Jointing bolts shall be in accordance with **sub-clause “Jointing Bolts”** herein. Set screws shall be stainless steel Grade 431 that have been heat treated following manufacture. Joint Seals shall be as specified in **sub-clause “Rubber Rings”** herein and coatings shall be as specified in **sub-clause “Protective Coating”**. The pressure rating shall be nominated by the manufacturer and shall be equal to the test pressure for the pipeline. Flanged Assembly Joints shall only be used on DI Flange Class pipe.

**Flexible Couplings/ Clamps**
Flexible couplings shall be suitable for jointing the type of pipe used in the work.
Couplings such as the Straub Flex range shall be manufactured from Grade 316 stainless steel, with Grade 316 stainless steel fasteners and EPDM sealing sleeves. Washers shall be provided under all bolt head and nuts where rotation may occur to prevent damage to the coatings. Couplings shall be suitable for in ground installation on pipelines laid in soils which may be subject to ground movement. The couplings shall be tolerant of pipe axial deflection at the joint pipe and axial movement and forces applied perpendicular to the pipe axis. For axial restraint of metal pipes, the Straub Metal-Grip range is acceptable.

**Pipe Joint Seals**

**Rubber Rings**

All socketed pipes shall be rubber ring joined. Unless otherwise specified rubber rings shall be either natural rubber, a Nitrile (NBR) compound or an Ethylene Propylene – Diene Terpolymer (EPDM) material complying with AS1646. Rubber rings for water reticulation/pressure pipe shall not contain root inhibitor.

**Flange Gaskets**

Flange Gaskets shall comply with the requirements of Figure B 5 or 7 and Appendix D of AS4087. Gaskets shall be manufactured from an elastomer complying with AS1646 and may contain a reinforcement material. The minimum working pressure for gaskets shall be 1600 kPa at 3.0mm thick. Flange gaskets for DN600 and larger mains shall comply with the manufacturer’s requirements.

**Jointing Bolts**

All nuts, bolts and washers (including assembly nuts and bolts) shall be stainless steel Grade 316 Class 50 minimum, with an anti-seizing paste, such as Koprkote or equal, used in assembly. All stainless steel nuts and bolts, other than bolts which form an integral part of an article, shall comply with the metric standards AS1111, AS111.3 and AS1112. Bolt length shall be equal to the sum of the thickness of the flanges, gaskets, nut and washer and rounded up to the nearest standard size. Flange gaskets shall comply with Clause 9.2.2 herein. 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.

Torque used to tighten bolts with clean flat lubricated surfaces shall comply with the pipe manufacturer’s recommendations or the bolt supplier’s recommendations.

### 5.2.10 Valves

**General**

In general, the type of elastomer and trim materials are not specified. The Contractor 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.

50mm square wrench nuts shall be provided on all buried valves, on all valves to be operated through floor holes and where shown. Operating keys shall be a minimum 900mm long with a minimum “tee arm” length to suit a maximum operating force of 130N required to open the valve. Operating keys shall be fabricated of 25mm 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.

All water and effluent valves shall be anti-clockwise in closing and all sewer valves clockwise in closing. Wherever possible, direction should be marked on the valve. Unless otherwise shown or specified, all ball, butterfly and plug valves shall be lever operated and each valve shall be equipped with an operating lever. All operating levers 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.

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.

Connections for valves shall conform to the requirements of clause “Pressure Pipe Fittings –DI Flanged” herein.

The actual positioning of valves shall be selected so that:

a) Manually operated valves can be operated safely with ease, and
b) 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.

c) Each valve shall be supplied with adequate bolts, nuts, washers and gaskets for connection to adjoining pipework and equipment.

Sluice and Scour Valves ≤ DN600

Sluice and scour valves shall be PN 16 resilient seated with double ‘O’ ring stem seals and shall comply with AS2638.2. In addition to the Standard Type Tests, each valve shall be tested in accordance with Section 5.2 of AS2638.2.

All nuts and bolts used in the assembly of valves shall be of Grade 316 stainless steel. Fasteners other than stainless steel shall be of high grade steel and shall be isolated from the external environment.

Valves shall be treated as specified in sub-clause “Thermal Bonded Polymeric Coatings!” herein.

Wedges shall be fully encapsulated in an approved synthetic rubber in accordance with AS1646.

Potable and Recycles sluice and scour valves shall have anti-clockwise spindles for closing and shall be tested to the requirements of Section 5 of AS2638.1. Spindles shall be turned out of high tensile brass or stainless steel.

End configurations shall be either flanged or double socket or double spigot or combinations. Sockets shall incorporate an elastomeric sealing ring as specified in Clause 9.2 herein.

Valves shall be supplied with a standard square spindle cap.

DN750 and larger sluice valves shall be provided with a gearbox that will allow the valve to be opened and closed against an unbalanced head of 100m (1,000kPa) by a person using a T key on the spindle cap and applying a torque no greater than 160 NM.

For PE mains, the Hawle E2 System 2000 valve or the AVK Supa Plus Coupling Series 01/70 valve or equal DI bodied valve is acceptable. End configurations shall be double socket with a City of Gold Coast approved mechanical restraint system or factory fixed electrofusion stubs for fusion joining to the main. Mechanical restraint sockets shall incorporate an elastomeric sealing ring as specified in sub-clause “Rubber Rings” herein.

DN750 and Larger By-Pass Valves

Valves shall be PN 16 and similar to AVK Series 54 or the Tyco Figure 500 with By-pass. Unless specified otherwise, the By-pass Valve shall comply with sub-clause “Sluice and Scour Valves” herein and shall be a minimum of DN100.

The main valve and the By-pass valve shall be DI and coated as specified in sub-clause “Thermal Bonded Polymeric Coatings!” herein.

The valves shall have a 316 Stainless Steel tag attached and be clearly labelled indicating size of valve (lettering not smaller than 5mm in height). The valve spindles and valve cover and surround shall be colour coded, white for the main valve and yellow for the DN100 By-pass valve.

Butterfly Valves ≥ DN450

Butterfly valves shall be installed in a pit in accordance with the drawings and shall be manufactured in accordance with AS4795.

Butterfly valves for waterworks purposes shall be double-flanged with replaceable resilient seat that is physically retained in the body and wraps onto the flange faces eliminating the need for gaskets, a disc of 316 stainless steel, a one piece stainless steel shaft, ductile iron body, corrosion resistant bearings and shaft seals.

Valves such as the Keystone Figure 631 or equal shall be suitable at a pressure rating of PN16. The valve seat shall be field replaceable, with integral O-rings moulded to it that cover the flange face, eliminating the need for gaskets. It is to be retained by a bed groove design that fully encapsulates the wetted area of the valve body.

The valve shaft shall use the dry shaft principle, with self lubricating bearings and a rigid shaft/disc connection.

The valve shall be fitted with upper and lower bearings.

The valve shall not require routine gland adjustment or lubrication.

The butterfly valve bodies shall preferably be coated as specified in sub-clause “Thermal Bonded Polymeric Coatings!” herein.
The butterfly valves shall be manually operated through a gearbox. The gearbox shall comply with Clause “Valve Spindles, Actuators and Gearboxes” herein. The butterfly valves shall be works tested. The test shall include:

a) a test to demonstrate that the valves will operate correctly from fully closed to fully open and return to fully closed;

b) a disc test with pressure applied on upstream side. No leakage. Check operation of actuator under this condition;

c) a body test with disc partly open. No leakage.

The Contractor shall check that there is adequate clearance between the valve disc and the adjacent pipes when the valve is opened and closed.

The sealing surfaces of the valves shall bed on the metal face of the pipework flanges, not on the cement lining. If the valve sealing surface does not bed on the metal face, the Contractor shall provide minimum 6mm thick Grade 316 stainless steel insertion rings and additional rubber insertion joint rings.

**Air Valves**

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

Smaller air valves up to and including 50mm in size 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 50mm BSP threaded stainless steel riser pipe (where required to place the valve as shown in the drawings), with the riser pipe fitted to a 50mm BSP threaded DN80 blank flanged fitting drilled in accordance with AS4087 Figure B5.

For small air valves, sealing of air bleed hole shall preferably be by a float made of non-corrosive non-flexible material sealing against a rolling flexible seat. Where the float is a flexible material, the float shall be restrained from rotating i.e. it seals on the same place at all times. The A.R.I range of valves or equal is acceptable.

Where specified in the drawings, each valve shall 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.

Smaller air valve assemblies shall be installed onto the main with a suitable size DN80 of take hydrant tee.

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 AS4087 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. The large orifice part of the valve shall 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 A.R.I range of D-050 valves or equal are acceptable.

The valve installation shall incorporate a resilient seated flanged sluice valve complying with Clause “Sluice and Scour Valves ≤ DN600” herein or a resilient seated butterfly valve complying with Clause “Air Valve Butterfly Control Valves” herein and a gearbox for either valve format that complies with Clause “Valve Spindles, Actuators and Gearboxes” herein.

The butterfly valve shall be bolted between the mains flanged hydrant tee and a flanged hydrant riser in a manner that will allow removal of the air valve without removing the butterfly valve. All 80 mm diameter air valves shall connect to a 80 mm diameter hydrant tee or flanged pipe branch and all 100 mm diameter air valves shall connect to a 100 mm diameter hydrant tee or flanged pipe branch. The surface of the cast iron body and cover of the air valves and the body of the butterfly valves shall be coated as specified in sub-clause “Thermal Bonded Polymeric Coatings” herein.

**Air Valve Butterfly Control Valves**

The location, size and type of air valve Butterfly control valve together with an Actuator (gearbox) shall be as shown on the drawings. The installation shall be provided within an adequately sized valve box or chamber as shown on the drawings.

Air valve Butterfly control valves shall:
a) be manufactured from Cast or Ductile iron. When components of the valve are manufactured from a corrosive material then these components shall be coated in accordance with AS4158 thermal-bonded polymeric coatings on valves and fittings for water industry purposes;
b) be of a wafer or lugged format incorporating integral o-rings that cover the flange faces and is suitable for installation between flanged fittings drilled in accordance with AS4087 Figure B5. Where a non-lugged wafer butterfly valve is used then a flanged hydrant riser short shall be used above the butterfly valve as shown in the drawings;
c) be compatible to attach a 90 degree actuator (gearbox) with extension spindle brought to under side of pit cover. Refer Clause “Valve Spindles, Actuators and Gearboxes” herein for actuator details;
d) have a resilient valve seat of nitrile materials conforming to the requirements of AS1646 and be pressure rated in full vacuum to 1200 kPa and have a minimum temperature rating of minus 10°C to plus 90°C. Wafer Butterfly valves shall be a Keystone AR1/AR2 wafer type or equal.

Check Valves
Check valves shall comply with the requirements of AS4794 – Swing check non-return and shall incorporate a counterweight and extended spindle with flanges in accordance with AS4087 Figure B5. The counterweight leaver shall control the valve disc for opening and closing. AVK valves or Dobbie Dico Valves or equal are acceptable. Non-lever controlled valves such as the Val-matic Swing-Flex check valves or equal are acceptable where a check valve by-pass valve and by-pass pipeline arrangement is provided that will allow the main to be drained. Check valves shall be coated internally and externally with an approved thermal bonded coating in accordance with sub-clause “Protective Coating” herein. Valves shall be suitable to operate within the pressure ranges of the system within which they are being installed and shall be located as shown on the drawings. The type and pressure rating of the check valve shall be as shown on the drawings.

Wafer Check Valves ≥ DN375
Wafer check valves shall incorporate a wafer type ductile iron body suitable for installation between AS4087 (Figures B5 or B7, as appropriate) flanges, Grade 316 stainless steel disc and EPDM seal. The body shall be coated in accordance with sub-clause “Thermal Bonded Polymeric Coatings” herein. The type and pressure rating of the Check valve shall be as shown on the drawings.

Pressure Reducing Valves
Pressure reducing valves shall be installed as shown on the drawings. The type, size and range (setting) of the pressure reducing valve shall be as shown on the drawings. Pressure reducing valves, flow meter, sluice valves and associated pressure and flow controls and telemetry and fittings including the valve chamber shall be constructed to the details shown on the drawings. Within the pit, any discharge shall be directed out of the pit to the stormwater system or to a natural gully as shown on the drawings or as directed by the Superintendent. For non-trafficked areas, lightweight aluminium covers shall be coated as detailed in Clause “In-Ground Water Supply Pump Stations” herein. For trafficable areas, appropriately classed DI covers complying with SS10 at a minimum diameter of 700mm shall be used.

Ball Valves
Ball valves shall be manufactured from de-zincified copper alloy and shall comply with the following standards: AS1565, AS1567, AS1568, AS2345. The ball shall be manufactured from polytetrafluoroethylene (PTFE) coated copper alloy complying with the above or stainless steel complying with AS2837, Series 300, containing not less than 8% nickel. Grade 303 stainless steel is not permitted. Alternatively, the ball shall be manufactured from PTFE filled thermoplastic. Resilient seats shall be manufactured from PTFE, elastomeric material or PTFE filled thermoplastic. The main tap ball valves shall connect to the ductile iron Property Service fitting by a 20mm BSP male connection with the ball valves outlet to have a 20mm BSP male connection to provide for the DN25 or DN32 property service pipe fitting.
The working pressure of the ball valve and its integral or attached property service pipe fitting, refer clause “Medium Density polyethylene property Service Pipe and Fittings” herein, shall not be less than 1600kPa.

All ball valves shall have non-corrosive componentry such as de-zincified copper alloy or Grade 316 stainless steel.

The ball valve shall have a minimum clear bore of 19mm with a de-zincified copper alloy handle of 38mm minimum length for the maintap ball valve and 50mm minimum length for the locking water meter ball valve that is located within the water meter box assembly, refer “Property Service Water Meter Box” herein. Pins used to attach the handle to the ball valve stem shall be Grade 316 stainless steel.

Valve Spindles, Actuators and Gearboxes

Extension spindles for direct vertical attachment to sluice valves shall comply with AS2638. Spindle caps and keys shall be manufactured from Ductile iron and the extension shaft shall be solid alloy steel with the assembly of these components to be by the use of stainless steel spring pins. Welded joints on the extension spindle are not permitted.

Extension spindles for off-set vertical attachment to sluice valves shall generally comply with AS2638 and Clause “Valve Spindles, Actuators and Gearboxes”) herein. The extension spindle shall be supported every 1800mm with 316SS triangular brackets with integral bearings and shall be extended into the pit top slab to be terminated with an approved spindle cap and surface box lid. Universal joints shall be attached where shown on the drawings and shall be provided by the Valve supplier and installed to the manufacturer’s recommendations.

Where shown on the drawings, sluice valves shall be provided with Spur Gear gearboxes that will allow the valve to be opened and closed against an unbalanced head of 100m (1,000kPa) by a person using a T key on the spindle cap and applying a torque no greater than 160 NM. Gearboxes shall be in the Rotork IS Range of multi turn Spur gear products or equal.

Butterfly valves ≥ DN450 shall be manually operated through a totally enclosed lubricated for life gearbox. The gearbox shall be of weatherproof ductile iron construction with carbon steel spur and worm gear, ductile iron segment gear, bronze bushes and ball thrust bearings. The gear box shall have open-shut position indication. All bolts, nuts and screws including those to cover plates and end cap fixings shall be 316 stainless steel.

Where shown on the drawings, provide above ground automated vale controllers such as the Rotork range and associated supports, cabinets, power and telemetry.

Unless approved otherwise, air valve wafer butterfly valve actuators (gearboxes) shall:

a) be manufactured from Cast or Ductile iron or an approved alternative material for the housing and cover. When components of the actuator system are manufactured from a corrosive material then these components shall be coated in accordance with AS4158 thermal-bonded polymeric coatings on valves and fittings for water industry purposes or other approved protective coating;

b) the Actuator input shafts, extension system (spindle) and triangular brackets with integral bearings shall be made of a non-corrosive material such as 316 stainless steel;

c) the Actuator shall have a minimum of 6 turns to close/ open the valve by worm and segment gear or bevel gear operation;

d) the Actuator shall be a 90 degree actuator (gearbox) with extension system (spindle) brought to under side of cover;

e) the Actuator shall be a Keystone F427 BAF gearbox type or similar and shall be provided with a non-corrosive handwheel.

Valve Installation

Valve Boxes

All buried sluice valves shall be provided with a valve box and surround that enables personnel on ground access to the valve spindle cap or extension spindle cap. Valve boxes and lids shall be in accordance with the requirements of SS10 and Standard Drawing No. 08-06-124 and 08-06-125. Marking of valve boxes and lids shall comply with the requirements of sub-clause “Markings for Location of Pipes, Hydrants, Flushing Points, Valves, Other Fittings and Pressure Zones” herein.

Valve Pits

Valves for in ground water pumping stations, pressure reducing facilities and butterfly valves shall be installed within the chamber or pit in accordance with the drawings.

Thrust restraining reinforced concrete valve pits shall be constructed in accordance with the drawings.
Marking of valve chambers and pits shall comply with the requirements of sub-clause “Markings for Location of Pipes, Hydrants, Flushing Points, Valves, Other Fittings and Pressure Zones” herein.

Valve Thrust Restraint
Valve installations shall provide thrust restraint for the valve in accordance with City of Gold Coast Standard Drawing or as shown on the job specific drawings.

Rural Valve Installation
Rural valve installation shall be where there are no residential allotments or Park Domain allotments. The valve installation shall:

a) use an Iron Box with an Iron Lid; and
b) have a 1000mm x 1000mm square concrete slab that is 100mm thick and contains reinforcement sheet; and
c) have the concrete slab grade away from the valve box; and
d) have the slab integral cast with the iron box with all cast at ground level; and
e) for Verge/footway installations be provided with a SS10 defined marker post with attached marker plate defining the valve function and contained product; or
f) for all other installations be provided with a Gal Steel street sign post that has a concrete footing and is provided with a marker plate defining the valve function and contained product; and
g) have the installation painted the appropriate product/system colour as shown in the drawings; and
h) where a roadway is adjoining the valve installation the asphalt paving marking shall be as shown in the drawings with a white V with no background for Potable and a white background with Purple V for recycled waters.

5.2.11 Protective Coating

Thermal Bonded Polymeric Coatings
Where specified that valves and other fittings are to be treated internally and externally with a factory applied thermal bonded polymeric corrosion protective coating that shall comply with the requirements of AS/NZS4158 and be applied by the fluidized bed technique.

Epoxy Painted Coatings
Where specified that ferrous fittings are to be painted with an epoxy painted coating, the surface shall be abrasive blast cleaned to AS1627.4 Class 2½ and painted with a 2 coat system of two pack high build, solvent free cycloaliphatic amine cured epoxy coating to a dry film thickness of 500 microns. All applications shall be strictly in accordance with the manufacturer's specification.

Anti-slip Coating System - Sewerage Lift Stations & Pump Stations and Dual Water Supply Pump Stations
All external surfaces of the lightweight aluminium covers shall be coated with an anti-slip coating system. The anti-slip coating system shall comply with AS/NZS4586 including slip resistance classifications Class W of Table 2 and Classification R11 of Table 5. The anti-slip system shall be applied according to the manufacturers’ recommendations over a suitable aluminium chemical etchant and primer.

The anti-slip coating system shall be either a:

a) 100% solids moisture curing MDI based polyurethane prepolymer including a crumbled rubber binder such as Huntsman Daltobond CR2, or
b) A liquid applied acrylic-polyurethane composite coating including a 16/30 crumbled rubber such as Neoferma Neotop, or
c) A high solid content (>90% vol) epoxy flooring system suitable for marine and industrial environments such as Epirez Supatuff AS-550 or
d) A medium solids content (>50% vol to <80%vol) water base polyurethane flooring system suitable for marine and industrial environments such as Parbury Tex·Cote Strata Grip.

5.2.12 Geotextile
Geotextile shall be used where shown on the drawings or as directed by the Superintendent. The geotextile shall have the following minimum properties that shall be marked on the roll in accordance with AS3705:

a) Nominal weight 180g/m² (as per AS3706)
b) Load 750N  (as per ASTM 1682)  
c) Mean Trapezoidal Tear Strength 350N  (as per ASTMD 1117)  
d) Mean CBR. Puncture Resistance 2500N  
e) Percolation Rate 340 L/m²/ sec (as per AS3706)  
f) The geotextile shall be a non-woven fabric made from continuous filament, synthetic fibres. 
g) Minimum lap shall be 300mm. 
h) Installation shall be as shown in the drawings to the manufacturer's recommendations. 

5.2.13 Pipe Welding Materials  

Welding Consumables  

All welding consumables used in welding procedures shall comply with the standards/codes listed below unless otherwise authorized by the City of Gold Coast. 

Manual metal arc welding: AS/NZS4854 and AS/NZS4855  
Flux cored electrodes for flux cored arc welding ferritic steel: AS2203  
Electrodes and fluxes for submerged arc welding: AS1858 Parts 1 and 2  
Welding consumables for build up and wear resistance: AS257
5.3 COMMON MATERIAL REQUIREMENTS - MECHANICAL INSTALLATIONS

5.3.1 General
All materials used in the works shall be handled, transported and stored in accordance with the relevant Australian Standard, the manufacturer’s recommendations and the requirements of Section 1 of this specification.

5.3.2 Structural Steel
Structural steel shall comply with the requirement of AS/NZS 3678 and AS/NZS 3679.
All steelwork shall comply with AS 4100 and all welding shall comply with AS 1554.
All joints shall be seal welded or otherwise detailed to prevent crevice corrosion.
Hot dip galvanizing of black steel components shall comply with the requirements of AS/NZS 4680.

5.3.3 Treatment Plant Pipework And Fittings
General
Pipes used for pressure pipework shall comply with the Table below.

Table: Mechanical Installations – Pressure Pipe Type and Class Requirements

<table>
<thead>
<tr>
<th>Nominal Size DN</th>
<th>Type of Pipe</th>
<th>Class of Pipe</th>
</tr>
</thead>
<tbody>
<tr>
<td>100, 150, 225, 300 and larger</td>
<td>PVC</td>
<td>Series 2 PN 16</td>
</tr>
<tr>
<td></td>
<td>Ductile Iron</td>
<td>K9 &amp; K12</td>
</tr>
<tr>
<td></td>
<td>Glass Reinforced Plastic</td>
<td>SN 10,000 PN 12.5</td>
</tr>
</tbody>
</table>

Subject to the following conditions the only types and classes of pipes and fittings to be used in the gravity pipelines shall be as specified in Table Mechanical Installations – Gravity Pipe Type and Class Requirements herein:
- The fittings are compatible with the type and class of pipe being used;
- The pipes and fittings conform with the relevant Australian Standard.
For each diameter of pipe, the same type of the pipe and fittings must be used throughout the whole of the work unless specifically approved by The Superintendent.

Table: Mechanical Installations – Gravity Pipe Type and Class Requirements

<table>
<thead>
<tr>
<th>Type of Pipe</th>
<th>Class</th>
<th>Nominal Diameter DN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>300</td>
</tr>
<tr>
<td>Unplasticised PVC</td>
<td>SN8</td>
<td>✔</td>
</tr>
<tr>
<td>Vitrified Clay</td>
<td>4</td>
<td>✔</td>
</tr>
<tr>
<td>Glass Reinforced Plastic</td>
<td>SN 10000</td>
<td>✔</td>
</tr>
<tr>
<td>Polyethylene</td>
<td>To suit design 4</td>
<td>✔</td>
</tr>
<tr>
<td>Reinforced Concrete</td>
<td></td>
<td>✔</td>
</tr>
</tbody>
</table>
5.3.4 uPVC Pipe And Fittings  
See General Material Requirements - Civil

5.3.5 Ductile Iron (DI) Pipe  
See General Material Requirements - Civil

5.3.6 Steel Pipe  
Black Steel  
See General Material Requirements - Civil

**Steel Pipe – Black or Galvanised**  
Black and/or galvanised steel pipe shall comply with AS 1074 and be Heavy tube.

**Stainless Steel Pipe**  
Stainless Steel pipe shall comply with EN 10088-2 and shall be Grade 316. Stainless Steel fittings used for this pipe may be compression fittings to DIN 2353 for diameters up to 25 mm. Pipework joints larger than 25 mm shall be TIG welded. Butt welded fittings with flanged dismantling joints shall be used.

5.3.7 Glass Reinforced Plastic Pipe (GRP) Pipe  
See General Material Requirements - Civil

GRP couplings shall not be jointed to ductile iron spigot. No GRP pipe shall be tapped.

In instances where GRP is exposed to sunlight a surface protective system such as a thick application of Flowcote or similar approved by the Superintendent shall be provided.

Where GRP pipes are joined to poured concrete by casting in, the coupling shall be treated by the manufacturer to ensure that a watertight joint is attained.

5.3.8 MDPE Pipe  
See SPECIFIC MATERIAL REQUIREMENTS -WATER

5.3.9 Reinforced Concrete Pipe  
Concrete pipes and fittings shall be manufactured from steel reinforced concrete and lined with polyethylene (PE).

The thickness of the polyethylene that shall be bonded by means of integral locking extensions embedded in the concrete, shall have a minimum thickness of 1.65 mm. Liner plate that is to be bonded to concrete pipe surface by a means of adhesive shall have a minimum thickness of 2.4 mm and a maximum thickness of 4 mm. Additional requirements for wastewater set in “SPECIFIC MATERIAL REQUIREMENTS –WASTEWATER”

5.3.10 ABS Pipe  
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.
5.3.11 Copper Pipe
Copper pipework shall not be used within sewerage pump stations or within wastewater treatment plants other than where not exposed to sewer gases even at low concentrations or where fully enclosed within the fabric of buildings. Copper pipe shall comply with AS 1432 with the particular type used to be suitable for operating at a minimum safe working pressure of 1600kPa. Copper pipe and fittings shall have silver soldered joints.

5.3.12 Polyethylene Pipe Sleeving
See - COMMON MATERIAL REQUIREMENTS – CIVIL WATER AND SEWAGE INSTALLATIONS

5.3.13 Above Ground Installations
A UV protection system in accordance with the drawings and approved by the superintendent shall be provided on all pipework that is not buried or embedded. The contractor shall provide and install all pipe support systems required to fully and adequately support all pipework, valves and fittings to the manufacturer’s recommendations. 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:
- 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 combined stresses in the pipe shall not exceed the allowable stresses for the pipe material.
- The maximum spacing of pipe supports, unless otherwise shown on the drawings, shall not exceed 3000 mm.
- Pipework shall not be fastened in direct contact with any wall, floor, ceiling, beam, column, equipment item or other surface.
- 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 20mm for pipes up to 25mm diameter, 40mm for pipes up to 80mm diameter and 50mm for pipes over 80mm diameter.

5.3.14 Treatment Plant Valves
NOTE: SEE GMR – CIVIL for valve specifications used for reticulation.

Gas Release Lugged Butterfly Valve and Actuator
The location, size and type of gas release lugged butterfly valve together with an actuator (gearbox) shall be as shown on the drawings. Unless approved otherwise, gas release butterfly valves shall:
- Be class 16 Lugged butterfly valve complying with AS 4795
- Be manufactured from Cast or Ductile iron or an approved alternative material. When components of the valve are manufactured from a corrosive material then these components shall be coated in accordance with AS 4158 thermal-bonded polymeric coatings on valves and fittings for water industry purposes or other 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 AS4087 Figure B.5;
- Be compatible to attach a 90 degree actuator (gearbox) with extension system (spindle) brought to under side of cover; and
- Have a resilient valve seat of nitrile materials conforming to the requirements of AS1646 and be pressure rated in full vacuum to 1200 kPa and have a minimum temperature rating of minus 10° C to plus 90° C.
- Unless approved otherwise, gas release lugged butterfly valve actuators 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 AS4158 thermal-bonded polymeric coatings on valves and fittings for water industry purposes or other 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 extension system (spindle) brought to under side of cover.

**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. 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.

**Knife Gate Valves**

Knife gate Valves shall not be used within any pressure system and may only be used where specifically specified.

**Penstocks**

Where approved for use in the work penstocks shall be constructed from Grade 316 stainless steel with seals of an EPDM material complying with AS1646. Alternate details based on fabrication from marine grade aluminium sections may be considered.

**Needle Valves**

Needle valves shall have a bronze body to AS 1565, grade 836B, with a precision machined integral seat. The bonnet, gland and stem shall be arsenically inhibited brass and the pack nut shall be brass to AS 1567, grade 385C. ABS materials may be permitted for needle valves and where used shall be as shown on the drawings. The valve shall be hydrostatically tested to 2.1 MPa.

**Solenoid Valves**

Solenoid valves shall be rated at 24V DC as specified or shown. All coils shall be continuously rated with protection rating IP 65. Electrical connection shall be for 20mm (minimum) conduit. Coils shall have Class H insulation and shall be continuously rated. All valves shall be equipped with a manual means to operate the valve in the case of power failure. Valve body material shall be brass or stainless steel and valves shall be provided complete with all necessary mounting brackets whether shown or not. Default, fail safe wiring to be included in drawings. 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. Coil replacement shall be possible without shutting off water supply to the valve. 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
- Orifice size
- Normally open or closed
- Pressure Relief Valves
- Pressure Relief valves shall be installed as shown on the drawings.
- The type, size and range (setting) of the Pressure Relief valve shall be suitable for the pressure reducing valve as shown on the drawings.

Electric Motor Actuators
Electric motor actuators shall be as per General Assembly Requirements - Electrical

Protective Coatings
Where specified that Valves and other fittings are to be treated internally and externally with a factory applied thermal bonded polymeric corrosion protective coating this shall comply with the requirements of AS4158 and be applied by the fluidized bed technique.

Installed pipe and fittings within a pump wet well shall have one (1) finishing coat of a protective coating system as specified by the superintendent applied to the installed flanged pipe, the flanged fittings flanges and to the associated Stainless Steel bolts, nuts and washers.

Uni-Flanges
Flanged Assembly Joints (UniFlange 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 specification. Set screws shall be Grade 431 Stainless Steel and shall be heat treated following manufacture.

Teflon Tape & Paste
Use only suitable proprietary products that do not contain lead.

P.E. Pipe and Fittings
Jointing of P.E. Pipe and fittings shall be in accordance with SS10 Section 5 Specific Material Requirements- WATER

5.3.15 Pumping Equipment

Water and Sewage Pumps
Pumps shall generally be in accordance with the Water Services Association of Australia Pump Code 101 except for the nominated requirements listed below.

Submersible Pump Units
(i) Impeller
Each impeller shall:
be of an approved grade of cast iron (AS1830-2002 - Grey cast iron, grade T250 or superior), and shall be accurately finished to reduce friction and leakage losses to a minimum;
have clearing vanes integrally cast into the backs of shrouds;
be of the screw centrifugal type or other proven non-clog design; and
be dynamically balanced prior to assembly in accordance with AS3709- Vibration and shock - Balance quality of rotating rigid bodies, Grade G6.3.

(ii) 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 - Grey cast iron, 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 wet-well service shall have the volute shaped so that the discharge nozzle aligns with the centralise of the pump, such that the pump induces a single plane moment only on the discharge support bend.
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).

(iii) Wear Rings/Plates
Renewable sealing rings and wearing rings shall be fitted to each pump with shrouded impellers. Wear ring(s) shall:
be of dissimilar corrosion and erosion resistant materials;
have a minimum hardness 50 Brinell higher than the impeller sealing ring(s), to prevent galling during operation; and
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.

(iv) Pump Shaft The shaft shall:
be machined from solid one-piece bar stock of stainless, grade 316 or better;
have a ground finish over its entire length; and
be equipped with replaceable shaft sleeves in areas subjected to wear.

The shaft shall be designed such that the first lateral critical speed is not less that 150% higher than the maximum operating speed of the pump. The first lateral critical speed shall be calculated for the maximum diameter impeller able to be fitted to the pump, without any support from wearing ring(s) or neck ring(s).
The maximum lateral deflection of the shaft shall be determined to establish permissible internal clearances, taking into account all lateral hydraulic reactions on the impeller and any external loads.

(v) Bearings
The bearings shall be of metric dimensions and stocked in Gold Coast/Brisbane by specialist bearing suppliers. Bearing mountings shall be designed to allow for variations in shaft temperature.
The shaft bearings shall be ball or roller bearings designed for a L10 Rating Fatigue life of 100,000 Hours at the maximum operating speed.
Bearings shall be lubricated by oil bath or grease lubrication.
Oil bath lubricated bearings shall 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.
The bearing housing shall be sealed at the shaft openings by lip type seals.

(vi) Shaft Seal Sealing of the shaft shall be:
The Seal Chamber shall incorporate:
(vii) Motor General

Generally, the motor shall be in accordance with the requirements of Standard Specification 1251/42 Electric Motors and shall be driven by variable speed drives, DOL or softstarter on motor ratings above 5kW in suburban areas, 15kW in Treatment Plants. The motor starters shall be provided by others pursuant to the requirements of Common Assembly Requirements –Electrical SS10.

(viii) Housing - The motor housing shall:
- by tandem mechanical seal arrangement or other approved arrangement such that no external flushing and cooling of the seal arrangement is required;
- of robust construction, designed to withstand the adverse operating conditions; 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. Oil fill and drain points; and
- a leakage detection device in pump units 7.5 kW and over, in order that water leakage past the lower mechanical seal is detected and an alarm signal generated.
- be machined from a single grey iron casting complying with AS1830-2002 - Grey cast iron grade T250 or superior;
- be designed to withstand submergence to a depth of 20 metres head without leakage;
- incorporate cable entry glands;
- facilitate cooling of the motor; and
- incorporate lifting brackets (or lifting eyes) for ease of installation, such that the pump unit (when suspended) hangs vertically plumb.

The motor protection rating shall be IP68. All motor protection instruments including moisture ingress and seal failure detection shall be provided.

(ix) Insulation

The motor shall have class F insulation, or better, with a maximum temperature rise to class B (80°C).

(x) Cables and Motor Entry Glands

Cables shall be multi-core flexible neoprene sheathed, suitable for immersion in sewage. Other sheathing materials are not acceptable. Cables incorporating cores for power, stator thermal protection and moisture detection shall have the protection and detection cores provided with secondary sheaths. Motors that are to be driven by Variable Speed Drives shall be provided with screened cables. All cables entering the motor are to be glanded to a single demountable flange. Each pump and motor set will be supplied with sufficient cable to connect to supply. A minimum of 10 m of electrical cable shall be supplied with each pump and motor set unless authorized by the Superintendent. Cables shall be provided with intermediate lifting cleats/devices to facilitate their removal from the sump as the pump is lifted.

(xi) Bearings

The motor bearings shall:
- be of metric dimensions;
- be fully sealed and pre-greased;
- be designed for a L10 Rating Fatigue Life of 100,000 hours at the operating speed;
- be stocked in Gold Coast/Brisbane by specialist bearing suppliers; and
have bearing temperature thermistors with analogue or digital display unit providing a 2 stage alarm and shutdown sequence.
- Bearing mountings shall be designed to allow for variations in shaft temperature.
- Thrust bearings shall be fitted to take all axial loads due to hydraulic thrust.

Schedule of Preferred Pump Models

Sewerage Pumps

ABS models AF and AFP
FLYGT CP & NP series
HIDROST
GRUNDFOS (now included in recognition of their willingness to meet our standards, and their establishment of a national distribution and spare parts facility within our city boundary)

Vacuum Generator Pumps (Sewerage)

BUSCH Model R5 Series with oil heater
BUSCH MINK series pumps (dry rotary lobe)
VOGELSANG Rotary Lobe

Vacuum Sewerage Pumps

HIDROSTAL
VOGELSANG Rotary Lobe

Water and Recycle Water Pumps

KSB Meeting Australian Standard specifications ONLY.
ABS
SOUTHERN CROSS
TKL
GRUNDFOS

5.3.16 Pump Wells, Wet Wells and Valve Pits

(i) Guide Rails & Lifting Chains

Round guide rails shall be continuous lengths of 50 mm or 65 mm ID x 3.6 mm (medium) wall thickness black pipe to AS 1074. Square guide rails shall be continuous lengths of 50 x 50 x 2.5 mm or 75 x 75 x 3.5 mm wall thickness black SHS steel tube to AS 1163. Guide rails shall be hot dip galvanized after cutting to length in accordance with the requirements of AS/NZS 4680. DuraGal ® tube shall not be used for guide rails

Where a guide rail is required that is longer than the standard pipe length then the pipe sections shall be welded together to the requirements of AS/NZS 1554 prior to hot dip galvanising.
Lifting chains, shackles and eyebolts shall be designed to have a minimum factor of safety of 4 with the minimum SWL to be 1000 kg. Lifting eyes shall be designed to have a minimum factor of safety of 4 with the minimum SWL to be 3200 kg. Lifting chains complying with the above Clause shall be a minimum of either 10 mm or 13 mm Grade L chain that complies with AS 2321, Section 6. The chain yoke shall be two 500 mm lengths of chain that are each attached to the pump eye bolts by two shackles with the two free ends attached by a combination of three shackles to a single length of lifting chain that is hooked by shackle to the stainless steel retaining hook in the wet well opening. The free end of the lifting chain shall be provided with a lifting eye that has been attached to this chain by shackle. Shackles shall be sized to suit the chain installed. For 10 mm chain, shackles shall be 10 x 1 mm yellow pin anchor bow shackles and lifting eyes shall be Pewag A18-8W or similar oblong Grade 80 alloy master links at 18 mm thick with an ID of 135 x 75 mm. All lifting equipment except the shackles yellow pin and the lifting eye shall be hot dip galvanized in accordance with the requirements of AS/NZS 4680. Lifting eyes shall be coated with Pewacoat ® or similar at 8 microns thick.

(ii) Safety Netting
Wet well and valve chamber openings shall be provided with a personnel safety netting system. The safety net shall be made from black polyethylene rope complying with AS4142.1 at 10 mm dia for the net mesh and 16 mm dia for the border rope. The safety net shall be constructed to the requirements of AS/NZS 4576 Appendix F Industrial Safety and fixed with 150 mm long by 12 mm dia grade 316 stainless steel twisted “J-Hooks”. The hooks shall be centrally fixed into the wet well and valve chamber top slab openings with Reid Swiftchem 3+3 EA or similar at a maximum spacing of 1200 mm and at a minimum insertion depth of 110 mm. The hooks shall be placed so that they do not interfere with the pump volute removal and in accordance with the drawings 03-07-503.

(iii) Aluminium Covers
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 manufacturers 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 a;
100% solids moisture curing MDI based polyurethane prepolymer including a crumbled rubber binder such as Huntsman Daltobond CR2, or
A liquid applied acrylic-polyurethane composite coating including a 16/30 crumbled rubber such as Neoferma Neotop, 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 medium content =>50% & <=80% by volume of solids content, water base polyurethane looring system suitable for marine and industrial environments such as Parbury Tex·Cote

5.3.17 Hoisting Equipment

Preferred Equipment

Equipment and Plant Access
Handrails and Guardrails
Handrails and guardrails shall be an approved proprietary aluminium system. The
system shall be designed and installed to comply fully with the requirements of AS
1657.
Handrails and guardrails shall be fixed to the structures in accordance with the
approved design drawings.
Kickplates shall be provided in locations where they are necessary under the
provisions of AS 1657 and in all locations over open tanks or tanks, sumps etc. which
can be left open.

Platforms & Walkways Covers
All platforms and the supporting structure shall be fabricated from aluminium.
The minimum size load bar to be used shall be such as to limit the maximum
deflection in the grid panel to Span/360 under conditions of loading required by AS
1657. Aluminium load bars shall be alloys 6063-T6 and 6063-T5 respectively.

Ladders
All ladders shall be of the external fixed type, designed and installed with ladder
cages complying fully with the requirements of AS 1657.
No internal ladders are permitted.
### 5.4 COMMON MATERIAL REQUIREMENTS - ELECTRICAL INSTALLATIONS

#### 5.4.1 Equipment list

City of Gold Coast preferred list of equipment is included in the following table.

<table>
<thead>
<tr>
<th>EQUIPMENT FUNCTION</th>
<th>PREFERRED 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>Annunciator Panel/Operator Panel</td>
<td>Omron, UniOP</td>
</tr>
<tr>
<td></td>
<td>Magells Model ABC123</td>
</tr>
<tr>
<td><strong>Battery</strong></td>
<td><strong>Panasonic</strong></td>
</tr>
<tr>
<td>C.F.S. units</td>
<td>Stromberg</td>
</tr>
<tr>
<td>Cable – Submersible</td>
<td>Australian Cable Manufacturers EPR/EPR</td>
</tr>
<tr>
<td></td>
<td>Olex</td>
</tr>
<tr>
<td></td>
<td>Bambach Wires and Cables</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>Brass Cable Glands</td>
<td>Utilux Chrome Brass</td>
</tr>
<tr>
<td></td>
<td>Cable Accessories</td>
</tr>
<tr>
<td>Cable lugs</td>
<td>Utilux</td>
</tr>
<tr>
<td></td>
<td>Cable Accessories</td>
</tr>
<tr>
<td>Cable Marking System</td>
<td>Critchley</td>
</tr>
<tr>
<td></td>
<td>Graftoplast</td>
</tr>
<tr>
<td></td>
<td>Partec</td>
</tr>
<tr>
<td>Circuit Breakers</td>
<td>Terasaki</td>
</tr>
<tr>
<td></td>
<td>HPM</td>
</tr>
<tr>
<td></td>
<td>Merlin Gerin</td>
</tr>
<tr>
<td></td>
<td>ABB</td>
</tr>
<tr>
<td>Circuit Breakers - Moulded Case</td>
<td>Terasaki</td>
</tr>
<tr>
<td></td>
<td>Merlin Gerin</td>
</tr>
<tr>
<td></td>
<td>ABB</td>
</tr>
<tr>
<td>Conduit</td>
<td>Anaconda</td>
</tr>
<tr>
<td></td>
<td>Iplex</td>
</tr>
<tr>
<td>EQUIPMENT FUNCTION</td>
<td>PREFERRED COMPONENT</td>
</tr>
<tr>
<td>--------------------------------------------</td>
<td>-------------------------------------------</td>
</tr>
<tr>
<td>Control relays - D.C</td>
<td>FINDER</td>
</tr>
<tr>
<td></td>
<td>Telemecanique</td>
</tr>
<tr>
<td>Control Relays –AC</td>
<td>FINDER</td>
</tr>
<tr>
<td></td>
<td>Telemecanique</td>
</tr>
<tr>
<td>Current Transformer</td>
<td>Nilsen</td>
</tr>
<tr>
<td></td>
<td>Crompton Instruments</td>
</tr>
<tr>
<td>Cooling Fan</td>
<td>COSMOTEC</td>
</tr>
<tr>
<td>Drawing Pocket (not forming an integral</td>
<td>Sarel</td>
</tr>
<tr>
<td>part of the switchboard.)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Selectrix</td>
</tr>
<tr>
<td>DC Converters</td>
<td>AMTEK</td>
</tr>
<tr>
<td>DC Power Supply</td>
<td>Meanwell</td>
</tr>
<tr>
<td>Emergency Stop Pushbuttons</td>
<td>NHP FT1-DESL</td>
</tr>
<tr>
<td></td>
<td>Telemecanique</td>
</tr>
<tr>
<td></td>
<td>Cutler Hammer ESM9/P</td>
</tr>
<tr>
<td>Electronic Protection Relay</td>
<td>Simocode Pro C or Pro V</td>
</tr>
<tr>
<td></td>
<td>TeSysU system</td>
</tr>
<tr>
<td></td>
<td>(Optional comms modules may be required)</td>
</tr>
<tr>
<td>Float Switches (must activate within 50mm</td>
<td>Siemens</td>
</tr>
<tr>
<td>of contact)</td>
<td>Kelco - K Series Heavy Duty Level Regulator</td>
</tr>
<tr>
<td>Flowmeter – Electromagnetic</td>
<td>ABB</td>
</tr>
<tr>
<td></td>
<td>Siemens</td>
</tr>
<tr>
<td></td>
<td>E&amp;H</td>
</tr>
<tr>
<td><strong>Flowmeter Electromagnetic (Battery)</strong></td>
<td>ABB Aquamaster, Siemens Mag 8000W</td>
</tr>
<tr>
<td>Fuse Holders/Carriers</td>
<td>MEM M Type</td>
</tr>
<tr>
<td></td>
<td>GEC “Redspot”</td>
</tr>
<tr>
<td></td>
<td>MEM NH Type</td>
</tr>
<tr>
<td>Hours run meters</td>
<td>Siemens</td>
</tr>
<tr>
<td></td>
<td>Wattmaster</td>
</tr>
<tr>
<td>HMI SCADA</td>
<td>Siemens PCS7, WinCC</td>
</tr>
<tr>
<td></td>
<td>CiTect</td>
</tr>
<tr>
<td>Indicating Lamp Fittings</td>
<td>Sprecher &amp; Schuh</td>
</tr>
<tr>
<td></td>
<td>G.E.</td>
</tr>
<tr>
<td></td>
<td>Telemecanique</td>
</tr>
<tr>
<td>EQUIPMENT FUNCTION</td>
<td>PREFERRED COMPONENT</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>----------------------------------------------------------</td>
</tr>
<tr>
<td>Indicating Lamps</td>
<td>Light Emitting Diode type (high intensity)</td>
</tr>
<tr>
<td>Integration SCADA Services</td>
<td>Parasyn Controls Pty Ltd – Brisbane Qld 07 3396 6388</td>
</tr>
<tr>
<td>Wastewater Network</td>
<td></td>
</tr>
<tr>
<td>Isolators</td>
<td>Clipsal</td>
</tr>
<tr>
<td></td>
<td>Kraus &amp; Naimer (blue line series)</td>
</tr>
<tr>
<td></td>
<td>Bremas</td>
</tr>
<tr>
<td></td>
<td>Merlin Gerin</td>
</tr>
<tr>
<td>Level Transmitters – Hydrostatic</td>
<td>Vegawell 52 or VegaWell series</td>
</tr>
<tr>
<td>Level Transmitters – Ultrasonic</td>
<td>Vegason 61 or Vegason series</td>
</tr>
<tr>
<td>Level Transmitters – Radar</td>
<td>Vegapuls PS 61 or PS 62 (subject to range)</td>
</tr>
<tr>
<td>Lighting</td>
<td>Pierlite</td>
</tr>
<tr>
<td></td>
<td>Eye Lighting</td>
</tr>
<tr>
<td>Locks (external doors)</td>
<td>DORE ELECTRIC SHKSS stainless steel swing</td>
</tr>
<tr>
<td></td>
<td>handle Push to lock</td>
</tr>
<tr>
<td>Micro Switches</td>
<td>Honeywell Microswitch</td>
</tr>
<tr>
<td></td>
<td>Omron</td>
</tr>
<tr>
<td>Motor Contactors</td>
<td>Sprecher &amp; Schuh</td>
</tr>
<tr>
<td></td>
<td>G.E</td>
</tr>
<tr>
<td></td>
<td>Telemecanique</td>
</tr>
<tr>
<td>Motor Protection</td>
<td>Sprecher &amp; Schuh CEF 1</td>
</tr>
<tr>
<td></td>
<td>Telemecanique</td>
</tr>
<tr>
<td>Motors</td>
<td>Pope</td>
</tr>
<tr>
<td></td>
<td>Teco</td>
</tr>
<tr>
<td></td>
<td>WEG</td>
</tr>
<tr>
<td>Multi-sensored Level Probes</td>
<td>Multitrode</td>
</tr>
<tr>
<td>Poles - Antenna</td>
<td>Polo Pty Ltd</td>
</tr>
<tr>
<td>Poles - Lighting</td>
<td>Polo Pty Ltd</td>
</tr>
<tr>
<td>Pressure Transmitter –Pressure and</td>
<td>ABB Kent-Taylor Model K – GP</td>
</tr>
<tr>
<td>level measurement</td>
<td>Vegawell 52 or Vegabar series</td>
</tr>
<tr>
<td></td>
<td>ROSEMOUNT</td>
</tr>
<tr>
<td>Pressure Transmitter –Differential</td>
<td>VegaDif 65</td>
</tr>
<tr>
<td>Pressure</td>
<td></td>
</tr>
<tr>
<td>Programmable Logic Controller output</td>
<td>Finder. 60/13 series. 10A. Round pin, press to test flag</td>
</tr>
<tr>
<td>relays</td>
<td>indication. 24 Volt A.C.</td>
</tr>
<tr>
<td>EQUIPMENT FUNCTION</td>
<td>PREFERRED COMPONENT</td>
</tr>
<tr>
<td>----------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Programmable Logic Controllers</td>
<td>SIEMENS S7 series</td>
</tr>
<tr>
<td></td>
<td>Omron Series</td>
</tr>
<tr>
<td></td>
<td>KOYO</td>
</tr>
<tr>
<td>Proximity Switches</td>
<td>Honeywell</td>
</tr>
<tr>
<td></td>
<td>Omron</td>
</tr>
<tr>
<td></td>
<td>Telemecanique</td>
</tr>
<tr>
<td>Pump Controller</td>
<td>Multitrode MTRA</td>
</tr>
<tr>
<td></td>
<td>Multitrode MT2PC</td>
</tr>
</tbody>
</table>

**Radio**

- Icom IC-F210 (Options Required)
- OPC-617 External Modem Connection Cable
- Link ‘D’ Installed
- Swap the screws in the external modem cable for jack nuts
- Programming Equipment
- CS-F100S Dealer Programming Software disc
- OPC-1122U USB Programming Cable

**Programming Requirements**

- CSF100 programming software is used for personality programming
- A ‘personality file’ will be supplied with all the channels of our current system. The radio shall be programmed for single channel operation relevant to the switchboard. The simplest method of achieving this outcome is to delete the non relevant channels.

**Adjustments Required**

- CSF100 ADJ is used for parameter programming
- 3 adjustment are to be made using CSF100 ADJ, they are:
  - Mod W set to 128. (modulates carrier to between 3 & 3.3Kc)
  - Power(L1) set to 55. (Low power adjustment)
  - Sql set to 250. (receiver gating level)

**Installation Considerations**

- Microphone shall be connected to radio with grommet fitted
- Microphone clip shall be installed
- Display shall be easily visible to switchboard attendees

**Seal Fail Relays**

- Tritronics
- AIC

**Sealing compound**

- Denso Mastic
<table>
<thead>
<tr>
<th>EQUIPMENT FUNCTION</th>
<th>PREFERRED COMPONENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selector Switches</td>
<td>Kraus &amp; Naimer (Blue Line series)</td>
</tr>
<tr>
<td></td>
<td>Telemecanique</td>
</tr>
<tr>
<td>Sockets</td>
<td>Marechal Decontactors DS2 or DS6</td>
</tr>
<tr>
<td></td>
<td>Clipsal</td>
</tr>
<tr>
<td>Solid State Starter</td>
<td>Telemecanique/Schneider Altistart/TeSys U</td>
</tr>
<tr>
<td></td>
<td>Emsby (with programming software)</td>
</tr>
<tr>
<td>Stop / Start Stations</td>
<td>Sprecher &amp; Schuh</td>
</tr>
<tr>
<td></td>
<td>Telemecanique</td>
</tr>
<tr>
<td>Systems Monitor</td>
<td>Environmental Data Services – PSM</td>
</tr>
<tr>
<td>Telemetry - Wastewater System</td>
<td>Kingfisher Series II</td>
</tr>
<tr>
<td></td>
<td>Kingfisher LP-2, LP-3</td>
</tr>
<tr>
<td></td>
<td>ELPRO</td>
</tr>
<tr>
<td>Telemetry – Water System</td>
<td>RAD-TEL Series 5000, 8000, 3000</td>
</tr>
<tr>
<td>Terminal Strips</td>
<td>Sprecher &amp; Schuh</td>
</tr>
<tr>
<td></td>
<td>Telemecanique</td>
</tr>
<tr>
<td>Thermal Overloads</td>
<td>Sprecher &amp; Schuh</td>
</tr>
<tr>
<td></td>
<td>Telemecanique</td>
</tr>
<tr>
<td>Thermostats</td>
<td>STEGO</td>
</tr>
<tr>
<td>Timing Relays</td>
<td>Anly (plug in)</td>
</tr>
<tr>
<td></td>
<td>Omron</td>
</tr>
<tr>
<td></td>
<td>Telemecanique</td>
</tr>
<tr>
<td>Transient Protection</td>
<td>Critec</td>
</tr>
<tr>
<td></td>
<td>Precision power products</td>
</tr>
<tr>
<td></td>
<td>Novaris Technologies Pty Ltd.</td>
</tr>
<tr>
<td></td>
<td>MTL</td>
</tr>
<tr>
<td>Variable Speed Drive</td>
<td>Danfoss VLT</td>
</tr>
<tr>
<td></td>
<td>Fuji</td>
</tr>
<tr>
<td></td>
<td>Schneider ALTIVAR</td>
</tr>
<tr>
<td>Voltmeter Meters etc</td>
<td>Crompton</td>
</tr>
<tr>
<td></td>
<td>Siemens</td>
</tr>
</tbody>
</table>
5.5 SPECIFIC MATERIAL REQUIREMENTS – WASTEWATER TREATMENT PLANT

<table>
<thead>
<tr>
<th>EQUIPMENT FUNCTION</th>
<th>PREFERRED COMPONENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage Relays</td>
<td>Rhomberg Braisler</td>
</tr>
<tr>
<td></td>
<td>Crompton</td>
</tr>
<tr>
<td></td>
<td>Telemecanique</td>
</tr>
<tr>
<td>Alarm Dialler</td>
<td>EDAC</td>
</tr>
<tr>
<td>Conductivity Measurement</td>
<td>E&amp;H Torroidal type -Transmitter unit CLM253-IDO105*, toroidal sensor probe CLS50</td>
</tr>
<tr>
<td>Conductivity Measurement (Potable water)</td>
<td>Burkert 8225</td>
</tr>
<tr>
<td></td>
<td>HACH Digital probe with SC100 Transmitter</td>
</tr>
<tr>
<td>Chlorine Residual</td>
<td>Siemens Depolox 3, Yokogawa EXAFC</td>
</tr>
<tr>
<td>Colour Meter</td>
<td>Sigrist</td>
</tr>
<tr>
<td>Controller Local (stand alone)</td>
<td>PMA KS98, ABB 505 or 355.</td>
</tr>
<tr>
<td>Dissolved Oxygen Measurement (W.W)</td>
<td>ABB, Hach LDO, SIEMENS</td>
</tr>
<tr>
<td>Flow Measurement Open Channel</td>
<td>Vega Vegason 60,</td>
</tr>
<tr>
<td>Flow Measurement Ultrasonic</td>
<td>Siemens Single or Dual Track</td>
</tr>
<tr>
<td>Flow Measurement Strap on</td>
<td>Panametrics, Polysonic</td>
</tr>
<tr>
<td></td>
<td>Endress &amp; Hauser</td>
</tr>
<tr>
<td>Flow Measurement DP Cell</td>
<td>ABB, Rosemount, Krone</td>
</tr>
<tr>
<td>Gas Detection H2S</td>
<td>Draeger, Zellweger Analytics</td>
</tr>
<tr>
<td>Gas Detection CL2</td>
<td>Wallace &amp; Tiernan (Acutec 35)</td>
</tr>
<tr>
<td>Level Transmitter Ultrasonic</td>
<td>Vega Vegason series</td>
</tr>
<tr>
<td>Nutrient Analyser</td>
<td>HACH</td>
</tr>
<tr>
<td>Particle Counter</td>
<td>Laser Trac PC2400D</td>
</tr>
<tr>
<td>PH Measurement</td>
<td>Yokogawa 450 Sensor probe PH20, Great Lakes Instruments, Rosemount, ABB,</td>
</tr>
<tr>
<td>Pressure gauge</td>
<td>Budenberg, VDO, Dwyer</td>
</tr>
<tr>
<td>Pressure transmitter</td>
<td>Vega Bar, ABB, Krohne, Rosemount</td>
</tr>
<tr>
<td>Sludge Density Measurement</td>
<td>Hach Solitax</td>
</tr>
<tr>
<td>Signal Isolator Units</td>
<td>Weidmuller, APCS, Transtech,</td>
</tr>
<tr>
<td>Component</td>
<td>Description</td>
</tr>
<tr>
<td>------------------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Surge Unit Analogue (20kA)</td>
<td>Critec UTB 36v, Transtech TLP-30L, Novaris SL36</td>
</tr>
<tr>
<td>Surge Unit 240V</td>
<td>MTL Technologies MA15 (Power on Australia)</td>
</tr>
<tr>
<td>Temperature Indicators</td>
<td>Budenburg</td>
</tr>
<tr>
<td>Turbidity Measurement (Potable water)</td>
<td>HACH Ultraturb (self cleaning) with SC100</td>
</tr>
<tr>
<td>Turbidity Measurement (W.W)</td>
<td>ABB 4670-211 (Self cleaning)</td>
</tr>
<tr>
<td>UPS (Control System back up supply)</td>
<td>Power Com Solutions Vanguard Range</td>
</tr>
<tr>
<td></td>
<td>Powerware Double Conversion Range</td>
</tr>
</tbody>
</table>
6 Section 6 – Auditing

6.1 Common Auditing Requirements

The ‘Auditing’ section of SS10 provides users with a method for checking whether City of Gold Coast minimum standards have been met and implemented correctly. The guidelines in this section should be read in conjunction with relevant City of Gold Coast Standard drawings. It should also be noted that a number of Australian Standards form parts of this document and must be referred to for details of materials, workmanship and construction procedures.

Council’s Development Guidelines, Standard Specifications and Standard Drawings shall take precedence over the Department of Natural Resources and Water Planning Guidelines and the WSAA Water Supply Code and Drawings and the Dual Water Reticulation Supplement.

The purpose of these guidelines is to define City of Gold Coast requirements for Inspection and Testing during construction and at the completion of all works carried out by the developers/contractors. Strict compliance with City of Gold Coast requirements is necessary to ensure that the contributed and constructed assets perform adequately for their design lives. All works will be inspected and tested before final acceptance.

6.1.1 City of Gold Coast Inspections

General

During the construction phase the Consultant is expected to have adequate inspection systems in place and is responsible for exercising reasonable skill and diligence to ensure that the works are constructed in accordance with the approved Engineering Drawings. Notwithstanding the Consultants responsibility City of Gold Coast will conduct Inspections generally as set out in this Section 5. The mandatory Inspection Checklists used by City of Gold Coast for Water (both potable and recycled), Sewerage and ‘On-Maintenance’ and ‘Off-Maintenance’ are included in Clause: Checksheets in this section. A set of optional comprehensive checklists containing ‘Hold/Witness’ Point for traditional Potable Water Reticulation, Dual Water System and Sewerage, are included in CHECKSHEET 1A, 1B 1C and 1D. These checklists can be used for further enhancing the quality of the final products received by the City of Gold Coast. Use of these checklists is recommended but not mandatory.

On Maintenance Inspection

The purpose of the ‘On Maintenance’ inspection is to ensure that the Development has been completed in accordance with the approved Engineering Drawings and City of Gold Coast requirements.

On Maintenance Inspection – Civil Works

‘On Maintenance’ inspections will generally include, but are not limited to, inspection of the following:

- Water Supply Reticulation and Dual Water Reticulation
- Alignment and location check of system
- Hydrants and valves in accordance with the approved design
- Ensure height of valves and hydrants in accordance with City of Gold Coast Standard Drawing No 05-06-105 and 05-06-106 respectively
- Hydrant, valve and property service locations markers completed
- Specialised infrastructure complete (pumps, PRV’s, reservoirs etc)
The Consultant is to provide written certification to City of Gold Coast that Pressure and Water Quality Testing results have been carried out in accordance with Section 5 of City of Gold Coast Standard Specification SS 10. These results are to be submitted with an accompanying plan (‘as constructed’), for approval prior to any domestic connections to allotments and as soon as they are available to ensure City of Gold Coast can expedite water connections.

In the case of Dual Water Reticulation, the Consultant shall provide City of Gold Coast with a final copy of the ‘Hold/Witness’ Point Inspection Checklist, duly completed and signed in accordance with CHECKSHEET 1C and 1D.

In addition the Consultant shall ensure live water supply connections are completed. Sewerage Reticulation and Reduced Infiltration Gravity Sewers (RIGS) Alignment and location check of the system Manholes have been constructed in accordance with the Approved Engineering Drawings and the convertor slabs and surrounds are sealed watertight Visual Inspection of all sewer lines including benching Where applicable pump and lift stations constructed in accordance with the Approved Engineering Drawings with all pumping and electrical facilities in working order City of Gold Coast requires that the Consultant provide:

(i) Written certification that the Consultant or an approved NATA registered testing company has witnessed:
- Air Testing of Sewers
- Vacuum Testing of Manholes
- Ovality Testing of Sewers
- Hydraulic Testing of Pressure Mains

in accordance with this section of City of Gold Coast Standard Specification SS10.

(ii) Certification from the supplier of ready mixed concrete that all concrete supplied for sewerage pump/lift stations is in accordance with clause “Certification of Concrete and Warranty For Protective Coating of Wet Wells” [SMR-Wastewater].

A written warranty in City of Gold Coast name jointly from the manufacturer and applicator of the protective coating system of sewerage pump/lift stations in accordance with City of Gold Coast Standard Specification as per “Certification Of Concrete and Warranty For Protective Coating Of Wet Wells” [SMR-Wastewater].

A copy of the CCCTV inspection report and video in accordance with clause “CLOSED CIRCUIT COLOUR TV INSPECTION (CCCTV)” [STR-Wastewater].

In the case of RIGS, the Consultant shall provide City of Gold Coast with a final copy of the ‘Hold/Witness’ Point Inspection Checklist, duly completed and signed in accordance with CHECKSHEET 1A.

In addition the Consultant shall ensure live sewer connections have been completed.

**Off Maintenance Inspection**

The purpose of the ‘Off Maintenance’ inspection is to ensure that the constructed works have performed satisfactorily during the ‘Maintenance Period’ (normally 12 months) and those omissions and defects have been rectified.

**Off Maintenance Inspection – Civil Works**

The Consultant is responsible for ensuring that the works are presented in accordance with the approved Engineering Drawings/Job Specification and accepted engineering practice prior to requesting an ‘Off Maintenance’ inspection.

Failure to do so may result in cancellation of the inspection and/or the charging of a re-inspection fee.

‘Off Maintenance’ inspections will generally include, but are not limited to, inspection of the following:
• Water Supply Reticulation
  • Hydrants, valves and other fittings functioning and surrounds and associated
    markings shall be still clearly visible
  • Ensure height of valves and hydrants in accordance with City of Gold Coast
    Standard Drawing No 05-06-105 and 05-06-106
  • Signs of any surface subsidence along alignment
  • Other infrastructure components operational ie reservoirs, pump stations

• Sewerage Reticulation
  • A CCCTV inspection of defective sewer lines
  • Manholes and associated benching
  • No infiltration of groundwater into sewer lines/system
  • Signs of any surface deformation along alignment
  • No ponding of surface water above manholes
  • Other infrastructure components operational, ie sewerage lift and pump
    stations

Service Conduit Inspection
Inspection of the service conduits by City of Gold Coast shall be arranged by the
Consultant prior to the request for the Pre-seal Inspection

Water And Sewerage Inspection
Where deemed necessary by City of Gold Coast random ‘potting’ inspections may be
ordered in order to ensure compliance with sections 3 and 4 of City of Gold Coast
Standard Specifications SS10.
The Consultant shall confirm all testing and certification is satisfactory prior to the ‘On
Maintenance ‘inspection.

6.2 SPECIFIC TESTING REQUIREMENTS- WATER

6.2.1 Hydraulic Pressure Testing Of Water Mains
Pressure testing shall be undertaken as soon as possible after the concrete thrust
blocks have developed their design strength and prior to pavement sealing of any
roadway over the main.
Testing shall include the water main and fittings and any water service pipes with the
length of test section of main normally to be between 500m and 1000m. It is strongly
recommended that under no circumstances shall test lengths exceed 1600m. All
tests shall be carried out in a manner approved by the Superintendent.
Hydraulic pressure testing of the pipeline shall be carried out at the lowest point of
the line or lines being tested.
Care shall be taken to remove all air from mains under test when filling with test
water. The rate of filling of the test section with water shall be such that the water
velocity within the test section shall nowhere exceed 0.05m/s.
The test head for water mains shall be 1350kPa. Test gauges shall be Certified by a
NATA registered testing laboratory with the gauges Certification being no more than
6 months old.
Within the ITP, the testing of the water main is a Hold point for the Superintendent.
The test pressure shall be maintained for one (1) hour minimum without any drop in
the gauge reading and during this period the whole line shall be inspected for
leakage or movement. Any defects shall be repaired and the main re-tested until the
gauge pressure remains steady for one (1) hour minimum.
The length of main or mains under hydraulic pressure test shall be deemed to have
passed the test provided the pressure gauge remained steady for one (1) hour
It is recommended that the testing of PE mains be carried out separately to the testing of PVC-DI mains due to the different material properties of these mains and the effects of these different properties during the testing process. Guidance on the testing of PE mains can be obtained from the PE pipe and fitting manufacturer or from the WSAA Polyethylene Pipeline Code WSA 01.

6.2.2 Water Quality Testing

At the completion of the flushing of the sterilisation water specified in clause “FLUSHING OF WATER MAINS” the system shall be sampled and tested by a NATA registered laboratory accredited for the sample collection and testing of the water to the parameters nominated in Table “Water Quality Limits” herein. Tests shall be considered satisfactory when they fall within the water quality limits specified in this table.

Table: Water Quality Limits

<table>
<thead>
<tr>
<th>Analysis</th>
<th>Unit</th>
<th>Required Result Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>pH (all main types)</td>
<td></td>
<td>6.9 - 8.5</td>
</tr>
<tr>
<td>Chlorine (free)</td>
<td>mg/L</td>
<td>Potable = &gt; 0.5 and &lt; 1.5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Recycled A+ = &gt; 0.5 and &lt; 2.5</td>
</tr>
<tr>
<td>Total Coliform count (all main types)</td>
<td>cfu/100mL</td>
<td>&lt;1</td>
</tr>
<tr>
<td>E.Coli count (all main types)</td>
<td>cfu/100mL</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Heterotrophic Plate count (all main types)</td>
<td>cfu/mL</td>
<td>0 – 100</td>
</tr>
<tr>
<td>Turbidity (all main types)</td>
<td>ntu</td>
<td>&lt;0.5</td>
</tr>
<tr>
<td>Conductivity</td>
<td>micro Siemens/cm</td>
<td>Potable = &lt;250 Recycled A+ = &gt;700 and &lt;1500</td>
</tr>
</tbody>
</table>

Should any sample analysed not comply with the water quality limits shown in the table above, the corresponding section of new main shall be re-sterilised, re-flushed and re-tested until the test results are satisfactory.

Notwithstanding the water quality limits set out in Table 1 herein, test results of new sections of mains may be deemed satisfactory when the following conditions apply:

- water quality in the new sections of mains is no worse than in a sample of influent existing mains water,
- the sample referred to immediately above was collected by the NATA registered laboratory referred to in this clause at the same time as it sampled water from the new sections of mains

6.2.3 Dual Water Service Commissioning And Tests

The plumbing contractor prior to commissioning should undertake the following Class 1 building testing procedures for the recycled and potable water service systems. There shall be no cross connections between the potable and recycled supplies. To ensure that there are no cross connections, Council’s plumbing inspectors shall retest the installations as follows:
Turn off the potable water supply to the property at the potable water dual check valve water meter (recycled water meter is coloured purple). The recycled water supply is to remain on.

Turn on all sink, bidet and shower taps (both hot and cold) one by one. All taps should run dry after a short period of time.

After taps have run dry, flush all toilets. The toilets should refill as normal provided they are connected to the recycled water supply.

Turn on all outside taps. The external drinking water tap should run dry. Taps that continue to run are connected to the recycled water supply and should be clearly identified via appropriate warning signs.

To check appliances within the home such as dishwashers and washing machines turn off the recycled water supply and turn the potable supply back on. Run the recycled water supply dry via the outside taps or by toilet flushing.

Turn on internal appliances. If the appliances do not fill, they are connected to the incorrect supply.

Turn recycled water supply back on at the lilac coloured meter. Turn on the tap connected to the recycled water supply that is located furthest away from the meter. Turn the tap back on slowly so that all air will be purged from the pipeline while it is being recharged.

Should any part of this test indicate a possible cross connection the problem shall be identified and repaired by a licensed plumbing contractor before undertaking the above testing process again.

For installations in Community Title Scheme or Commercial or high density Residential developments, the above system test shall be applied to the water supplies from the City of Gold Coast connection point up to the individual unit or premises off takes and repeated separately for each and every individual unit or premises.

In addition to the above cross connection test, there shall be a minimum of three (3) water services installation inspections (including the final) carried out by City of Gold Coast inspectors, when both supplies are connected to the property and prior to final approval being issued. The required inspections are listed below.

Hydrostatic testing and commissioning of dual water services shall be conducted in accordance with AS/NZS 3500 1.2 (Section 13).

Inspection 1: Dual Water Service – Meter to House Installations.

City of Gold Coast shall inspect both potable and recycled pipes from the meter to the house (or sub meter as appropriate) to ensure the correct pipes have been installed and connected to the correct meters and fixtures. Pipe bedding and trench backfilling shall be carried out in accordance with AS/NZS 3500.1.2 – Water Supply Acceptable Solutions. “As constructed” information is to be completed by the inspector at this stage.

Inspection 2: Rough-In Inspection: Household Dual Water Services Installations.

City of Gold Coast shall inspect both potable and recycled water services (or common supply pipes) both internally to the house and externally within the property. The purpose is to ensure services have been installed in accordance with these Guidelines and in accordance with AS/NZS 3500.1.2. This inspection is to be done prior to cladding and/or cover up and/or backfilling of pipe work.

Inspection 3: Final Cross Connection Testing Inspection

It is during this cross connection test that the recycled supply shall be made live by the Plumbing Inspector removing the recycled water supply water meter ball valve lock.

City of Gold Coast shall carry out an inspection at each property to ensure there are no cross connections. Testing shall be carried out in accordance with the procedures set out above in this Section.
6.3 SPECIFIC TESTING REQUIREMENTS- WASTEWATER

6.3.1 Testing of Gravity Sewers and Maintenance Shafts

Guidance on the acceptance testing of sewers and maintenance shafts is available within the Sewerage Code of Australia WSA 02-2002, Clause 22.4. For sewers and maintenance shafts the following requirements shall apply:
- the Contractor shall provide all labour, materials and appliances required for use in connection with acceptance testing;
- all rectification work required shall be at the cost of the Contractor;
- it is recommended that pipes and maintenance shafts and each length of pipe between manholes be tested on a daily basis.

6.3.2 Air Testing General

a) Manholes shall be tested to the requirements of Clause “Manhole and Wet Well Testing” herein.

Air testing shall be either pressure testing or vacuum testing. Prior to testing commencing, the Contractor shall nominate either vacuum or pressure testing as the method of acceptance testing. The Contractor shall not be permitted to change from one method to the other.

The test shall include manhole drops, house connection branches (including inspection tee) maintenance shafts, rodding ends and any in line bends.

Test gauges shall be Certified by a NATA registered testing laboratory with the gauges Certification being no more than 6 months old.

Within the ITP, the testing of the sewer is a Hold point for the Superintendent.

6.3.3 Air Testing – Pressure

b) The sewer, maintenance shaft or rodding end to be tested shall be pressurised to the ‘Initial Pressure’ shown in Table 8 herein for a minimum of 3 minutes to stabilise the temperature.

<table>
<thead>
<tr>
<th>Sewer Depth Range (metres)</th>
<th>0 – 1.5</th>
<th>1.5 – 3.0</th>
<th>3.0 – 4.5</th>
<th>4.5 – 6.0</th>
<th>Over 6.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Pressure (kPa)</td>
<td>30</td>
<td>35</td>
<td>40</td>
<td>45</td>
<td>50</td>
</tr>
<tr>
<td>Test Start Pressure (kPa)</td>
<td>25</td>
<td>30</td>
<td>35</td>
<td>40</td>
<td>45</td>
</tr>
</tbody>
</table>

After the 3 minute stabilisation period the pressure shall be dropped to the ‘Test Start Pressure’ shown in Table 8 herein and the test timing for the particular sewer diameter shall then commence.

The sewer line, maintenance shaft or rodding end under test shall be considered to have passed the test when the ‘Time to Drop by 5 kPa’ exceeds the time shown in Table 9 herein for the sewer diameter nominated.

<table>
<thead>
<tr>
<th>Nominal Pipe Size DN</th>
<th>Maximum test length (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>DN150</td>
<td>150m</td>
</tr>
<tr>
<td>DN225</td>
<td>150m</td>
</tr>
<tr>
<td>DN300</td>
<td>150m</td>
</tr>
<tr>
<td>DN375</td>
<td>200m</td>
</tr>
<tr>
<td>DN450</td>
<td>200m</td>
</tr>
<tr>
<td>DN525</td>
<td>200m</td>
</tr>
<tr>
<td>DN600</td>
<td>250m</td>
</tr>
</tbody>
</table>

Minimum Time to Drop 5 kPa
- 3 min
- 8 min
- 14 min
- 29 min
- 41 min
- 56 min
- 92 min

For sewers larger or longer than those shown above in Table 9 up to DN1050, the testing lengths, times and required pressures shown within Table 22.4 of the Sewerage Code of Australia WSA 02-2002 at Clause 22.0 shall be used to define that the sewer has passed or failed the test.

For sewers larger than DN1050, including the manholes and shafts, the acceptance test at a minimum of 21 days after the sewers installation, shall be that the sewer has
no visibly flowing leaks occurring but the pipe may exhibit damp patches and that the measured infiltration, at the lowest end of the pipeline under test, over a 24 hour period is less than 5 L/mm diameter/km/day.

6.3.4 Air Testing – Vacuum
c) From the sewer, maintenance shaft or rodding end to be tested, a vacuum of 27 kPa shall be drawn and the vacuum gauge monitored for a 3 minute stabilization period. The test shall commence where the sewer under test is at a vacuum between 23.6 kPa to 27 kPa after the stabilization period. The start pressure shall be recorded.

The sewer and/or maintenance shaft under test for the maximum test lengths shown in Table 9 above shall be considered to have passed the test when the vacuum does not fall by more than 5 kPa from the pressure recorded at the start of the test and during the nominated time period in Table 9.

For sewers larger or longer than those shown above in Table 9, the testing lengths, times and required pressures shown within Table 22.4 of the Sewerage Code of Australia WSA 02-2002 at Clause 22.0 shall be used to define that the sewer has either passed or failed the test.

6.3.5 Ovality Testing
d) All flexible pipe materials such as PVC, PE, PP and GRP gravity sewer pipes shall be tested to determine any excessive pipe deflection (ovality) by using a proving tool.

Testing for ovality shall be carried out no sooner than 14 days after all backfilling operations have been completed. Testing shall be by pulling a proving tool, for the nominal size pipe in Table 10 herein, through each section of pipe by hand winching to demonstrate that the maximum allowable deflection is not exceeded.

Where DN150 to DN300 bends are used within the sewer system then ovality testing shall only be carried out with a rigid, non-adjustable circular ball.

Except for as stated above, the proving tool shall be fabricated from steel with pulling rings at each end and marked to indicate the nominal pipe size and the provers' outside diameter and shall be rigid and non-adjustable and shall have an odd-number of legs (min 9) and an effective length of not less than its nominal diameter.

The minimum diameter (at any point along the length) shall be as shown in Table 10 herein.

Table 10

<table>
<thead>
<tr>
<th>Nominal Pipe Size DN</th>
<th>PVC Solid Wall</th>
<th>PVC Ultra Rib</th>
<th>GRP Pipes</th>
<th>Nominal Pipe Size DN</th>
<th>PVC Solid Wall</th>
<th>PE and PP Pipes</th>
<th>GRP Pipes</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>95</td>
<td>-</td>
<td></td>
<td>375</td>
<td></td>
<td>351</td>
<td></td>
</tr>
<tr>
<td>150</td>
<td>140</td>
<td>142</td>
<td></td>
<td>450</td>
<td></td>
<td>424</td>
<td>465</td>
</tr>
<tr>
<td>225</td>
<td>220</td>
<td>211</td>
<td></td>
<td>525</td>
<td></td>
<td>525</td>
<td>538</td>
</tr>
<tr>
<td>300</td>
<td>278</td>
<td>283</td>
<td>310</td>
<td>600</td>
<td>567</td>
<td>613</td>
<td></td>
</tr>
<tr>
<td>375</td>
<td>362</td>
<td>390</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

For flexible sewers not shown in Table 10 or larger than DN600, the prover tools diameter shall be as shown within the Sewerage Code of Australia WSA 02-2002, Clause 22.6.2 – Ovality proving tools, based on the tool size being relative to the percentage of maximum deflection nominated at 14 days. The base pipe Internal Diameter for the calculation shall be the nominated diameter within the Australian or Manufacturer’s Standard for the particular pipe material.

Sewer pipes that exhibit excessive ovality (by failing the maximum allowable deflection shown in Table 10 herein) shall be replaced and the re-laid section retested for ovality.
6.3.6 Closed Circuit Colour TV Inspection (CCCTV)

The Contractor shall have a CCCTV inspection of 100% of sewer pipes carried out in accordance with the guidelines of the WSA 05-2006 Conduit Inspection Reporting Code of Australia and Sewrat Data Capture Software. The following requirements shall apply to the CCCTV inspection:

- only CCCTV operators certified with the Australian Water and sewage Association (AWWA) or the Water Services Association of Australia (WSAA) are approved to conduct the inspections;
- the CCCTV inspection record shall be of such quality that an accurate assessment of the internal condition of the sewer can be made;
- the following items shall be provided to the Superintendent:
  - one set of digital survey data from either Sewrat Data Capture Software on 3½” disk/CD or as detailed within the WSAA Sewer Inspection Reporting Code. The disk/CD shall be clearly labelled as such;
  - one hardcopy printout of survey data from Sewrat Data Capture Software or as detailed within the WSAA Sewer Inspection Reporting Code.

The cost of providing the CCCTV inspection shall be offset against the relevant PC item in the Bill of Quantities.

6.3.7 Testing of Pressure Mains

Pressure testing shall be undertaken as soon as possible after the concrete thrust blocks have developed their design strength, all backfilling operations have been completed and prior to pavement sealing of any roadway over the main. Testing shall include all pipes and fittings with the length of test section of main normally to be between 500m and 1000m.

Hydraulic pressure testing of the pipeline shall be carried out at the lowest point of the line or lines being tested. Care shall be taken to remove all air from mains under test when filling with test water. The rate of filling of the test section with water shall be such that the water velocity within the test section shall nowhere exceed 0.05m/s.

The test head for the pipeline shall be 900kPa. Test gauges shall be Certified by a NATA registered testing laboratory with the gauge Certification being no more than 6 months old.

Within the ITP, the testing of the pressure main is a Hold point for the Superintendent.

The test pressure shall be maintained for one (1) hour minimum without any drop in the gauge reading and during this period the whole line shall be inspected for leakage or movement. Any defects shall be repaired and the main re-tested until the gauge pressure remains steady for one (1) hour minimum.

The length of pipeline under hydraulic pressure test shall be deemed to have passed the test provided the pressure gauge remained steady for one (1) hour minimum and there is no failure of any thrust block, anchor block, pipe, fitting, valve, joint or any other pipeline component and there is no visible leakage.

6.3.8 Manhole and Wet Well Testing

After all manholes have been constructed (including benching and fitting of convertor slab surround frame and cover) they shall all be tested. Backfill operations shall be completed before testing of all manholes commences. The minimum number of manholes to be tested shall be as shown in Table 11 herein.

<table>
<thead>
<tr>
<th>Number of Sewer Manholes in Contract</th>
<th>Percentage Tested Initially</th>
</tr>
</thead>
<tbody>
<tr>
<td>≤ 5</td>
<td>100%</td>
</tr>
<tr>
<td>6 to 10</td>
<td>50%</td>
</tr>
<tr>
<td>11 to 20</td>
<td>33%</td>
</tr>
</tbody>
</table>
Note: If 20% or more of the sample manholes fail the initial test – all manholes shall be tested.
The vacuum test head shall be placed in the top of the manhole and the seal inflated. Draw a vacuum of 33.5 kPa on the manhole then close the valve on the vacuum line and turn the pump off.
The manhole shall have passed the vacuum test if the time taken for the reading to drop to 30.0 kPa meets or exceeds the time shown in Table 12 herein.

Table 12

<table>
<thead>
<tr>
<th>Manhole Depth</th>
<th>Manhole Diameter (mm)</th>
<th>1050</th>
<th>1200</th>
<th>1500</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time in Seconds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 2400</td>
<td>17</td>
<td>20</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>3000</td>
<td>21</td>
<td>25</td>
<td>30</td>
<td></td>
</tr>
<tr>
<td>4000</td>
<td>28</td>
<td>33</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>5000</td>
<td>35</td>
<td>41</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>6000</td>
<td>42</td>
<td>49</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>7000</td>
<td>49</td>
<td>57</td>
<td>70</td>
<td></td>
</tr>
</tbody>
</table>

For manholes larger or deeper than those shown above in Table 12, the testing requirements shown within Tables 22.5 and 22.6 of the Sewerage Code of Australia WSA 02-2002 at Clause 22.0 shall be used to define that the manholes have passed or failed the test.

All wet wells and manholes with a protective coating system in accordance with Clause "Discharge Manholes Protective Coating System" and Clause "Protective Coating of Wet Well" herein shall have the continuity of the Protective Coating spark tested in accordance with Clause 7 of AS3894.1 at a minimum of 12,000 volts. Any discontinuity of the coating shall be repaired in accordance with the coating manufacturer's recommendations.

In addition to the above, Cast in place sheet plastic Protective Coating systems shall be tested in accordance with Clause 22.8.3 of the Sewerage Code of Australia WSA 02-2002 to define that the coating has passed or failed the required Locking Key pull out test.

6.3.9 Cleaning of Sewerage Reticulation System

Prior to the commissioning and live connection referred to in clause “Live Connection, Disconnection,, Commissioning and Decommissioning” herein the Contractor shall flush all sewers, manholes, house connections and pressure mains with clean water so that all lines present a clean and clear barrel that is free of obstructions.

Cleaning of GRP pipe shall be carried out with the equipment recommended by the manufacturer.

The Contractor shall ensure that the cleaning water does not pass into the live sewer. The cleaning water shall pass through a silt trap before being allowed to enter a stormwater drain or a natural water course in accordance with the environmental approvals.

6.3.10 Certification Of Concrete And Warranty For Protective Coating Of Wet Wells

The Defects Liability Period for the Contract shall not commence and furthermore the Superintendent will not be required to issue a Certificate of Practical Completion until all of the following conditions have been met:
Pursuant to the requirements of Clause “Sewerage Lift Stations and Pump Stations” herein the Contractor has furnished the Superintendent with the originals of certification (in a format approved by the Superintendent) relating to:
concrete test cylinder results (from a NATA registered laboratory approved by the Superintendent) and the suppliers certification that the requirements of Clause “Sewerage Lift Stations and Pump Stations” herein have been met;
Pursuant to the requirements of clause “Protective Coating of Wet Wells” in that the Contractor has furnished the Superintendent with the certifications and warranties required.

6.3.11 SPECIFIC TESTING REQUIREMENTS - LAYING OF STEEL PIPE

Testing Of Coating
Before the pipe is placed onto Bedding Zone 1, (refer to section 3. of SS10) the pipe shall be tested for defects in the external coating by means of a high voltage holiday testing apparatus capable of testing at 12,000 volts (+/- 1000V) (for Water) and 15,000 volts (for Sewerage). Testing shall be in accordance with AS3894.1 and safety procedures must be strictly followed. The earth should be on the current mortar lining. At any place where the apparatus gives a spark or discharge through the coating to the steel pipe it will be taken that a defect in the coating exists and all such defects shall be repaired at the contractor’s own expense and retested to the satisfaction of the Superintendent.

6.3.12 Pipe Welding

Inspection and Testing
(i) Inspector

All welding work inspection shall be carried out by a person who:
Complies with the requirements of Section 3 of SS10; or
Holds current Welding Technology Institute of Australia (W.T.I.A.) welding inspection certification.
Qualification/records of the inspection person/s are to be made available by the welding service provider on request.
(ii) Inspection

The welding service provider shall provide an inspection and test plan for the intended welding work, ten (10) working days prior to commencement of the work. The test plan shall contain the necessary elements to assure the completed welding work complies with the standards/codes stated in the work drawings and specifications.
(iii) Testing of Welds

Testing of welds shall be carried out by the welding service provider as follows:
For all joints welded externally and internally in accordance with the pneumatic procedure as set out below:
10% of internal and external welds by Magnetic Particle or Penetration methods in accordance with AS4037, AS1171 and AS2062.
(iv) Testing Records

The welding service provider shall maintain accountable testing records for all weld testing and provide the records upon request.
Pneumatic Testing
After completion of internal and external welding of the joint, air at a pressure of 200 kPa shall be applied through the test hole and soap solution applied to both internal and external welds to check for leaks. All leaks shall be repaired and the test hole filled with weld metal. Pipes shall be laid with the test hole at the top of the joint except for vertically deflected bends as shown on the drawings.

6.4 COMMON TESTING REQUIREMENTS–MECHANICAL INSTALLATIONS

6.4.1 Factory Acceptance Testing - Mechanical
The equipment shall be subject to inspection by the Superintendent or his 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 Superintendent. Tests shall be conducted to AS 2417 Part 2 Class C. The Contractor/Developer 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 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. Performance tests shall be as scheduled.

6.4.2 Specific FAT Requirements
Flow Measurement Equipment
Carry out testing and calibration of flow measuring equipment (for recording or controlling both water and air flow rates) at the suppliers works prior to delivery to site. Provide a Calibration Certificate for each primary element on completion of all tests. For orifice plates, supply calculations and carry out checks of machining and tolerances. Closed Conduit Flow Meters
All closed conduit flow meters used for recording or controlling of flow shall be certified tested. For orifice plates, supply calculations and carry out checks of machining and tolerances. Certified Testing
Certified testing at the Supplier's works of flow measuring equipment shall be as detailed below:
Hydrostatic testing of the primary device to twice the maximum working head. The pressure shall be indicated and maintained for a period of not less than ten (10) minutes. If a reduction in pressure occurs the item shall be corrected and re-tested to the specified requirement. Wet flow testing under simulated working conditions of the primary and secondary devices. Velocities passing through the primary device must be comparable with those that would occur under the flow rates previously nominated. Flows tested shall be at 10% intervals from the minimum to the maximum. Electrical inspection and checking of the secondary equipment utilising simulated input signals.
Supply, as part of this test, a certificate that shows the actual percentage error at 10% intervals over the whole range tested. Supply all equipment and labour for such tests. Tests shall be witnessed by an authority acceptable to the Superintendent. Accuracy shall be ± 2% and guaranteed figures must be achieved.
6.4.3 Chemical System Testing
CLEANING: Sweep and thoroughly flush all chemical tanks, lines and metering pumps clean of all solids, swarf, etc., before filling and testing. Avoid any metallic contamination of storage tanks.
CHEMICALS: The Principal will arrange for supplies of chemicals for testing and commissioning. Test chemical storage tanks to approval prior to supply of chemicals.
FAULTS: Rectify any leaks, vibrations, excessive splashing, sagging of pipe works, inaccessibility of valves, fittings and equipment, looseness of fixtures, poorly aligned pipe work etc., to the entire satisfaction of the Superintendent and re-test the equipment.

6.4.4 Pump Set Tests
The following tests shall be carried out at the manufacturer’s works:
Casing Hydrostatic Tests Certified
Pump Performance Test Certified
Performance Test Procedure To AS 2417 Part 2 Class B
Submit a pump test certificate and pump performance curves covering the tests.
Performance curves shall cover head, quantity, efficiency, power and NPSH.

6.4.5 Butterfly, Sluice, Gate, Non–Return, Knife Gate Valves
After satisfactory completion of the above tests the valve shall be subjected to performance testing as follows:
Manual Valves – Open and close valves to check the ease of operation and position indicator.
Pneumatic Actuated Valves – During the test only clean and dry compressed air shall be used. Check the operation of the limit switches where they are fitted.
Electric Actuated Valves – Check all functions of electric actuators, including limit switches operation, protection devices, position indicators, controls, etc.

6.5 COMMON TESTING REQUIREMENTS–ELECTRICAL INSTALLATIONS

6.5.1 Prior Delivery Inspections And Tests
Inspections and tests shall be carried out in accordance with the Clause ‘Inspections, Checking and Testing’ in the Section 3 “Integration” of SS10.

6.5.2 Testing Documentation Requirements
A complete test document must be prepared in advance of performing any Factory Acceptance or Site Acceptance testing. This document will cover all of the control and SCADA functionality required by the system. The object of this document will be that when testing is complete, then the system will 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, FAT is to use the actual PLC/RTU hardware where possible and will simulate all field devices.
SAT is to use the actual installed equipment and will be the testing required before commissioning commences.
The test documentation must 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 must be included as a list item.
Each aspect of the functionality required of the equipment must be included as a list item. These items will be as detailed as possible to ensure that all required functionality is fully tested.
Checkbox columns for FAT and SAT testing. These columns will include the initials of the tester and the date of the test.
For items such as pumps or instruments that will have identical testing routines, it will be acceptable to write one general testing routine for each type of device. Each step in the routine must 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 will include all configured PLC functionality and SCADA elements. All required alarm, trend display and report functionality must 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 must be noted.

A set of testing documentation is included as a Standard Drawing in Appendix C as a MS Word Document.

6.5.3 Factory Acceptance Tests - Electrical

Factory Acceptance Tests (FAT) shall be completed to the satisfaction of the Superintendent before the equipment will be released for delivery. Test certificates shall be submitted to the Superintendent prior to dispatch from the works.

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 City of Gold Coast.
- Insulation tests with 1,000 volt insulation tester on all low voltage cables, power wiring and equipment tested phase to phase, phase to neutral and neutral to earth. Insulation resistance of a complete circuit shall be measured from the isolator contacts. Note: Care must be exercised not to apply 1000V to sensitive equipment, such as thermistors and other solid-state equipment.
- For LV switchboards containing busbars, a 2.5 kV high potential test, maintained for not less than 1 minute, with minimum 5 mA leakage current followed by 1 repeat of test. The test to be applied phase to phase, phase to neutral and neutral to earth. Any leakage current or change in insulation resistance to be reported.
- Ductor Testing of busbars for LV Switchboards
- Test and record earth continuity of earth busbar and earthing conductors.
- Test all protection equipment and relays by secondary injection of the current transformers circuits.
- Test phase fail, phase reversal relays with correct and reversed phase sequence to ensure correct operation. Also test relay by removing one fuse.
- Test operation of all RCD circuit breakers and combined RCD/GPO units. Units shall trip when leakage exceeds 30 mA.
- Test voltmeter and voltmeter selector switch for correct voltage indication
- Test each motor starter for correct operation with all other drives and equipment turned off. Test shall include operation of thermal overload, phase failure, over temperature devices, etc, with starter selected for both manual and automatic operation. Test operation of all indicating lamps and control devices.
- Setting sheet for all control and protection parameters is complete. This includes Soft Starters and VSD parameters for correct indications and logic functionality.

6.5.4 Control and Instrumentation System

Elements of the control and instrumentation system shall be tested by the Contractor at the Manufacturer’s Works in a similar manner to the switchboards (MLCs, MCCs, SCAs, control panels etc). Simulate the operation of the Control System at the works by the Contractor and carry out all improvements and optimisation of the system.
operation. Elements of the control and instrumentation system to be assembled and connected at the works for testing shall include:
Test each PLC input from the connected device and ensure correct operation
Test each PLC output and ensure correct operation of connected devices.
Test operation of instrumentation loops by simulation of primary device
Communication links to instruments tested (where possible)
Software is provided.
Where practical, communication links between RTU and soft starters or VSDs are tested.
All PLC hardware configuration, PLC programming and SCADA configuration is tested. [For the purposes of functional testing, temporarily wire all inputs to labelled switches and/or analogue signal/function generators as appropriate. Temporarily wire all outputs to labelled indicating lights].
Commissioning sheet outlining commissioning tests and procedures provided.

6.5.5 Electric Motors
Each motor shall be routinely tested by the motor manufacturer at his works in accordance with AS 60034.1. Submit to the Superintendent for approval type test certificates for each motor type and size, together with the routine test certificates.

6.5.6 Protective Devices
All protective devices, eg. Thermistors, seal failure, shall be connected during testing.

6.5.7 Electrical Testing During Construction
At completion of installation work and prior to energisation of all medium and low voltage circuits, continuity and insulation testing, using a 1000V Insulation Tester shall be made as follows by the Contractor:
- Power circuits shall be checked, phase to phase, phase to neutral and phase to earth (as appropriate). Control circuits shall be checked core to core and core to earth. Circuits must show a minimum insulation resistance of 10 Megohms. Reading obtained shall be recorded and included in the Operation and Maintenance Manual.
- Switchboards (MLCs, MCCs, SCAs, control panels etc.) shall be retested to ensure the control functions are as per the Specification.
- Where instrument loops are such that the measured variable cannot be altered, the appropriate variations shall be simulated using pressure and/or current injection. The value of the earth resistance of the local earth station(s) shall be measured and recorded in the Operation & Maintenance Manual.

6.5.8 Site Acceptance Tests, Commissioning And Inspections
Site Acceptance Tests (SAT) shall be done 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.
- 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 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 back-up control mode for wastewater pump 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. Evacuation paths are maintained with switchboard doors open ie clearances. 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 all plants and pump stations to ensure that all equipment will return to operating status following a power blackout without generating alarms or callouts to operators.

- All settings, set points and software and firmware revisions are noted.
- HV and Hazardous areas audited

The City of Gold Coast Inspector/Superintendent may also wish to confirm that the items tested and inspected comply with the requirements by further testing. The City of Gold Coast representative shall witness checks and tests. An electrical test sheet shall be completed and submitted to City of Gold Coast as required. A written report shall be submitted to the Superintendent / Engineer. Other supplementary special tests including HV testing, partial discharge, loss factor, ratio tests, vibration, noise tests may be specified separately to this specification when required. Typical test sheets are included as part of the suite of Standard Drawings reference 08-08-900 test Sheets.

6.6 SPECIFIC TESTING REQUIREMENTS –TREATMENT PLANTS

6.6.1 Testing, Commissioning And Training
General
The Contractor shall provide all equipment, materials, labour, services, advice, instructions and all necessary ancillary and peripheral items necessary to inspect, test, commission and performance test the Works to demonstrate compliance and operation in accordance with the Contract Documents.

6.6.2 Preparation for Inspections and Testing
Any necessary work by way of temporary connections, connection of instruments, cleaning of tanks, pipelines and equipment, safety measures and other preparations for carrying out testing in a workmanlike and expeditious manner before commencement of testing shall be undertaken and made good or cleared away after completion of testing.

6.6.3 Flow Measurement Equipment –Treatment Plants
Testing and calibration of flow measuring equipment (for recording or controlling both water and air flow rates) at the supplier’s works shall be carried out prior to delivery to site.

The suppliers shall provide a Calibration Certificate for each primary element on completion of all tests.
All closed conduit flowmeters used for recording or controlling of flow shall be certified tested.

Certified testing at the supplier’s works of flow measuring equipment shall be as detailed below:

Hydrostatic testing of the primary device to twice the maximum working head. The pressure shall be indicated and maintained for a period of not less than ten (10) minutes. If a reduction in pressure occurs, the item shall be corrected and re-tested to the specified requirement;

Wet flow testing under simulated working conditions of the primary and secondary devices. Velocities passing through the primary device must be comparable with those that would occur under the flow rates previously nominated. Flows tested shall be at 10% intervals from the minimum to the maximum;

Electrical inspection and checking of the secondary equipment utilising simulated input signals;

Supply, as part of this test, a certificate that shows the actual percentage error at 10% intervals over the whole range tested;

Supply all equipment and labour for such tests;

Tests shall be witnessed by an authority reviewed by the Superintendent; and Accuracy shall be +/- 2 % and guaranteed figures must be achieved.

6.6.4 Pump Set Tests
See General testing Requirements –Mechanical Installations

6.6.5 Butterfly, Sluice, Non-Return, Knife Gate Valves
See General testing Requirements –Mechanical Installations

6.6.6 New Motor Control Centres and Switchgear and Controlgear Assemblies
See General Testing Requirements –Electrical Installations

6.6.7 Control and Instrumentation System
See General Testing Requirements –Electrical Installations

For treatment plants, the DCS/SCADA System including screen displays and connection to the PLCs; and DCS/PLCs including remote I/O units shall be tested.

6.6.8 Electric Motors
See General Testing Requirements –Electrical Installations

6.6.9 Equipment Testing
The Contractor shall ensure that all equipment is tested to ensure that the equipment supplied is operational and conforms to specified requirements. At the completion of testing, all internal and external building work shall have been completed and all rubbish removed, all sumps, drains, services etc. are finalised.

6.6.10 Electrical Testing During Construction
See General Testing Requirements –Electrical Installations

6.6.11 Inspections and Testing –Treatment Plants
Overview
The Contractor shall prepare and submit detailed Inspection and Test Plans (ITPs) as part of his Quality Management Plan deliverables to the Superintendent for review. Each Plan shall consist of a check list, inspections, performance and other tests that are proposed to carry out to ensure that the constructed works are complete and operational in all respects.

Inspections and Testing prior to commissioning shall include, but not be restricted to, the following:

- Checking completeness of installation;
- Checking conformance of equipment to the Contract Documents;
- Checking that all equipment and pipework labelling is complete and correct;
- Ensuring all equipment is correctly lubricated and lubrication reservoirs are charged with adequate quantities of suitable lubricants;
- Checking clearance, end play and operation of major bearings;
- Checking alignment of drive systems, tightness of couplings, mounting bolts, vibration etc;
- Checking electrical circuit continuity in accordance with drawings and the other Contract Documents;
- Checking electrical installations, particularly MLCs and MCCs, by thermal imaging to identify “hot spots” which are indicative of poor connections or faulty components;
- Checking electrical insulation integrity in accordance with the design requirements;
- Checking electrical earthing integrity in accordance with design and statutory requirements;
- Checking calibration and ratings of safety devices such as circuit breakers and overloads;
- Checking calibration of measuring and indication equipment such as instruments, signal converters, meters etc;
- Checking operational integrity of controlled equipment;
- Checking operational integrity of safety devices such as isolators and interlocks;
- Checking the direction of rotation of rotating electrical equipment;
- Checking the DCS/PLC input and output signals to ensure they are in accordance with the design drawings and specifications;
- Checking the DCS/PLC software logic for interlocking and operational correctness;
- Checking the communication system and the security system to ensure that they are operational and performing to design requirements;
- Checking DCS/SCADA system monitoring and control displays (local and remote) to ensure that it is operational and performing to minimum design requirements;
- Checking correctness of operation and correctness for setting of parameters for each instrumentation loop;
- Checking correct operation of all field connected items;
- Carrying out simulated fault testing and checking alarm reporting and logging;
- Carry out simulated failure of equipment and check start-up of all stand-by equipment;
- Running in new equipment;
- Checking for unusual heat and noise generation;
- Checking safety guards, safety showers and other personnel safety equipment for correct installation;
- Checking priming of all pumps;
- Verifying the accuracy of metering pump/feeder settings versus flow/feed rates graphs for all metering pumps/feeders;
- Checking stairway, walkway and platforms comply with the standards;
- Checking required security arrangements are in place;
- Checking pipework arrangements are to standards reviewed by the Superintendent; and
- Providing special tools.

ITPs shall include the following:

- Factory tests of all major items of equipment including all electrical components;
- Tests recommended by the manufacturer of any items of equipment;
- Inspections to ascertain that all equipment, as installed, is in good order and condition;
- Pressure tests on pipework and equipment;
- Water tightness tests of hydraulic structures;
- Noise tests;
- Electrical tests to prove the integrity of the safety systems;
- Running tests to prove that all equipment is capable of continuously, safely and reliably performing the operations and functions required under the PAA;
- Checking appropriate certification and approvals have been obtained for operation of equipment; and
- Checking appropriate signage and workplace health and safety equipment is in place to enable safe operation of the equipment.
- Defects shall be rectified and repeat tests carried out where necessary.

The results of all inspections and tests shall be recorded on suitable log sheets and incorporated into Inspection and Test Reports (ITRs). ITRs shall be forwarded to the Superintendent for review and incorporated into the Plant Information Portal.

6.6.12 Commissioning
Commissioning cannot commence until inspection and testing has been successfully completed.

6.6.13 Commissioning of Equipment
Commissioning of equipment involves the running of pumps, pipelines, valves, controls and instrumentation and carrying out all necessary adjustments and tuning until it is ready for normal starting and running under service conditions.

Commissioning shall only take place after the Superintendent receives ITRs which demonstrate satisfactory achievement of construction completion and after the Operations and Maintenance documentation has been made available to the Superintendent.

During the commissioning period, the Contractor shall ensure that each pump station is fully operational and reliable and that the following work has been completed:

- Activation of alarms by inducing actual fault conditions (electrical simulation is not acceptable);
- Functional check on interlocks and control system for the whole subproject;
- Calibration of all instruments and result sheets completed;
- Testing and commissioning of equipment electrics, instrumentation, control systems, alarms and set-points etc.;
e) Check completeness of entire installation, paying particular attention to integration of all sub-systems;
f) Check integration of control systems;
g) Undertake simulated fault condition tests; and
h) Initial training of operators.
i) The Contractor shall have responsibility for the following:
j) Develop, monitor and control equipment commissioning procedures;
k) Resolve performance problems; and
l) Arrange for outstanding work to be completed to enable the commencement of the Proving Period.

Non-conformances or defects shall be classified as:

**Minor:** Equipment commissioning can continue with action programmed for resolution.

**Severe:** Equipment commissioning to discontinue, urgent action required.

The Superintendent will participate in the equipment commissioning process. During commissioning, the Principal’s operations staff, working normal hours, will be made available to work under the direction of the Contractor.

### 7 CHECKSHEETS

<table>
<thead>
<tr>
<th>Preparation (if applicable).</th>
<th>Cast insitu</th>
</tr>
</thead>
<tbody>
<tr>
<td>Existing services located and marked clearly</td>
<td>Hydrophilic seal at all inlet and outlet pipes</td>
</tr>
<tr>
<td>Approved material supplier.</td>
<td>All construction joints (base to wall &amp; wall to wall) to have waterstops</td>
</tr>
<tr>
<td></td>
<td>Shaft to converter slab to surround to have reinforcement steel and appropriate joint preparation</td>
</tr>
<tr>
<td></td>
<td>Concrete has been vibrated appropriately</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Material Handling and Storage</th>
<th>Maintenance Shafts</th>
</tr>
</thead>
<tbody>
<tr>
<td>All pipe materials delivered as ordered without damage</td>
<td>Approved type and componentry</td>
</tr>
<tr>
<td>All fittings delivered as ordered without damage</td>
<td>Concrete supports installed</td>
</tr>
<tr>
<td>All bedding material to City of Gold Coast standard and stored on site without contamination</td>
<td>Drainage pipes installed (if applicable)</td>
</tr>
<tr>
<td>All precast manholes components supplied onsite without damage</td>
<td>Riser is vertical</td>
</tr>
<tr>
<td>Maintenance shafts &amp; rodding end components supplied on-site without damage.</td>
<td>Lock down quick release end caps</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trench Excavation</th>
<th>Rodding Ends</th>
</tr>
</thead>
<tbody>
<tr>
<td>Width and depth to City of Gold Coast standards</td>
<td>Approved type and componentry</td>
</tr>
<tr>
<td>If Ground water is present, diversion drains as required</td>
<td>Concrete supports installed</td>
</tr>
<tr>
<td>Pipe laid, level and grade</td>
<td>Drainage pipes installed (if applicable)</td>
</tr>
<tr>
<td>Pipe embedment, bedding depth to specification</td>
<td>Riser is vertical</td>
</tr>
<tr>
<td></td>
<td>Lock down quick release end caps</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Trench Backfill</th>
<th>Property Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Junctions – Type A, B &amp; C</td>
</tr>
</tbody>
</table>
## GOLD COAST WATER – WASTEWATER AND WATER INSPECTION CHECKLIST

### Subdivision Name & Stage:

<table>
<thead>
<tr>
<th>File Ref:</th>
<th>OPW No.</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Inspector:</th>
<th>Date:</th>
</tr>
</thead>
</table>

| Contractor: | Consulting Engineer |

| Backfill material in accordance with the drawings and/or City of Gold Coast specifications | □ Approved type and componentry |
| Backfill compaction tests meet City of Gold Coast specifications | □ Concrete supports |
| | □ Junctions – Type D only |
| | □ Approved type and componentry |
| | □ Location marker stakes installed |
| | □ Location uPVC pipes installed & attached to stake – 500mm clear |

### Manholes

**Manholes greater than 4 metres deep – approved protective lining**

<table>
<thead>
<tr>
<th>Survey/As Constructed</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ Detailed survey</td>
</tr>
<tr>
<td>□ All house connection branches GDA Coordinated</td>
</tr>
<tr>
<td>□ CCCTV of City of Gold Coast nominated lines</td>
</tr>
</tbody>
</table>

**Precast**

**Approved precast base and compression seals**

<table>
<thead>
<tr>
<th>City of Gold Coast Connections</th>
</tr>
</thead>
<tbody>
<tr>
<td>□ New main on grade and level with existing stub</td>
</tr>
<tr>
<td>□ End of main clearly marked – location pipe &amp; marker tape raised to surface</td>
</tr>
</tbody>
</table>

**Megapoxy circumference of concrete surround to Converter slab**

| □ Megapoxy conical shaft (converter shaft) to vertical shaft in 4 x 100mm long locations. |
| □ If gradient of surround is 1 in 3 or greater, the surround is to be doweled to the converter shaft |
| □ Rubber seal frame to cover |
| □ At type x drops, hydrophilic and Megapoxy incorporated into opening in manhole shaft |

### Passed Inspection □  Reinspection Required □

**Key:**

- Checked ☑
- Not Applicable ☐
- Outstanding/ Unsatisfactory ☑
WATER □

Preparation
Approved material supplier
Existing services located and marked clearly
Existing watermain exposed and level confirmed

Material Handling and Storage (All)
Pipe materials delivered as ordered without damage
Fittings delivered as ordered without damage
Bedding material to GCCC standard & stored on site without contamination

RECYCLED WATER □

Flushing Valves - Inline
- Vertical (+/- 5 degrees).
- Between 75mm-150mm from top of dust cap to top of box.

Property service lines
- Sand bedding required for all service lines
- Min 75mm bedding between service line & pipework
- SS316 Clamp unable to be rotated.
- Drilling doesn’t hit adjacent internal wall.
<table>
<thead>
<tr>
<th>Subdivision Name &amp; Stage:</th>
<th>OPW No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>File Ref:</td>
<td></td>
</tr>
<tr>
<td>Inspector:</td>
<td>Date:</td>
</tr>
<tr>
<td>Contractor:</td>
<td>Consulting Engineer</td>
</tr>
</tbody>
</table>

### Clamp angle (0-45 degrees to horizontal)
- Brass plugs fitted to unused service connections
- Dual Property service (Duplex sites)
- Service lines provided to the side of each VXO
- Ball valves connected to clamps
- Correct shape/orientation of bends
- All service lines charged – check ball valve
- Orange Marker tape at end ball valve

### Trench Excavation
- Width & depth to City of Gold Coast standards
- If ground water present, diversion drains as required

### Common Trenching
- No snaking of PE pipe
- Minimum 200mm pipe separation
- Pipes laid to level and grade, within tolerance
- Pipe embedment, bedding depth to specification

### Backfilling
- Backfill trench compaction

### Thrust Restraints
- Restraint on all uPVC/DI fittings

### Conduits
- All PE road crossings
- Property service lines

### Markings
- All valves and hydrants clearly marked
- All conduits have brass discs in place

### Butterfly Valves
- Coating (2-Pack Epoxy Coating)
- Stem/Key
- Control/stop bolts installed
- Shroud pipe
- Minimum 225mm dia (uPVC pipe)
- PVC to PE Transition flange
  - is to be either SS316
  - Fusion bonded coated

### Conduits
- PVC to PE Transition flange
  - Material to be ductile iron with puddle flange
  - Property service fittings
    - SS316 Clamp used
    - Tapping/Drilling does not hit adjacent internal wall
    - Readytap with brass plugs
**GOLD COAST WATER – WASTEWATER AND WATER INSPECTION CHECKLIST**

<table>
<thead>
<tr>
<th>Subdivision Name &amp; Stage:</th>
<th>OPW No.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>File Ref:</th>
<th>Inspector:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Contractor:</th>
<th>Consulting Engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Future & City of Gold Coast Connections

- Mains ended with puddle flange (uPVC) for thrust block
- New main laid at grade and level to match existing
- Property service pipework
  - Sand bedding required for all service lines
  - Min 75mm bedding between service & retic pipework
  - Angles at Clamp between 0-45 degrees from horizontal

### Testing

- Cross connection valve closed
- Flushing hydrants provided at main evacuation point
- Water quality and pressure tests passed
- Single Property services
  - Valves connected to clamps
  - Correct shape/orientation of bends

### Survey/As Constructed

- Detailed Survey
- Dual Property services (Duplex sites)
  - Service lines to be provided to the side of each VXO
  - Ball valves connected to clamps
  - Correct shape/orientation of bends
  - All service lines charged – check ball valve
  - Blue Marker tape at ball valve

### Pipe Installation

- Polyethylene flanges at valves
- Lilac coloured uPVC pipe, or PE - black with lilac stripe (PN16), no scars on pipe
- PE is black pipe with blue stripe (PN16)
- SS316 Bolts ("A4" marked on head of bolt)
- SS316 Backing Ring ("SS316" marked on ring)

### Tees and Bends

- If PE – no scars/scrapes on pipe
- If Ductile iron – fusion bonded coated

### Flushing Valves

- End of line Vertical (+/- 5 degrees)
### GOLD COAST WATER – WASTEWATER AND WATER INSPECTION CHECKLIST

<table>
<thead>
<tr>
<th>Subdivision Name &amp; Stage:</th>
<th>OPW No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>File Ref:</td>
<td></td>
</tr>
<tr>
<td>Inspector:</td>
<td>Date:</td>
</tr>
<tr>
<td>Contractor:</td>
<td>Consulting Engineer</td>
</tr>
</tbody>
</table>

- Between 75mm-150mm from top of dust cap to top of box: □
- Depth below top of box: □
- Adequate room for Camlock clip hose: □

Passed Inspection □  
Reinspection Required □

<table>
<thead>
<tr>
<th>Key: Checked</th>
<th>Not Applicable</th>
<th>Outstanding/ Unsatisfactory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre Start Inspection</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>On-Maintenance Inspection</td>
<td>□</td>
<td></td>
</tr>
<tr>
<td>Off-Maintenance Inspection</td>
<td>□</td>
<td></td>
</tr>
</tbody>
</table>

**Brief Report On Outstanding Matters:**

---

**Consultant / Inspector**

**Sign:**

**Data Entry**

**Sign:**

**Date:**

## GOLD COAST WATER – WATER INSPECTION CHECKLIST

<table>
<thead>
<tr>
<th>Subdivision Name &amp; Stage:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>File Ref:</td>
<td>OPW No.</td>
</tr>
<tr>
<td>Inspector:</td>
<td>Consulting Engineer</td>
</tr>
<tr>
<td>Contractor:</td>
<td></td>
</tr>
</tbody>
</table>

### WATER

- Has Water connection been completed? □
- Water service ‘W’ and or button kerb marker (Dwg No 05-06-602) □
- Has Recycled water connection been completed? □
- Recycled Water marker (No. 05-06-602) □
- Water service conduit marker (No. 05-06-104) □
- Water service near ENERGEX pillar box □
- Recycled Water Service near ENERGEX pillar box □
- Water service blue marker tape, correct depth □
- Recycled Water meter box installed □
- Water service ball valves □
- Water service pipe bedding □
- Recycled Water service pipe bedding □
- Water Hydrant buried / missing □
- Flushing Point buried / missing □

### SEWER

- Sewer house connection points marked (Refer DWG No 05-06-807) □
- CCCTV of sewer main (received) □
- Manhole – Missing/ buried □
- Manhole – Converter slab (Refer DWG No 05-06-202) □
- Manhole—Bolt down lid (Refer DWG No 05-06-205) □
- Manhole – Benching (Refer DWG No 05-06-201) □
- Manhole – Internal & external drop (Refer DWG No 05-06-201) □
- Manhole – Need’s raising/ lowering □
- Water infiltration □
- Manhole – Cleaned (Stones, rubbish) □
- Distance between manholes □
- Roding ends (Refer DWG No 05-06-804) □

### SEWER PRESSURE MAIN

- Scour valve (Refer DWG No 05-07-302) □
- Gas release valve (Refer DWG No 05-06-303) □
- Rising main road marking’s (Refer DWG NO 05-06-304) □
- Receiving manhole (Refer DWG No 05-06-301) □

- Hydrant box, lid, surround raising or lowering □
- Flushing box, lid, surround raising or lowering □
- Hydrant requires raising or lowering (No 05-06-605) □
- Flushing Point raising or lowering (No 05-06-605) □
- Hydrant box & lid facing correct direction (No 05-06-106) □
- Flushing Point box & lid facing correct direction (No 05-06-301) □
- Hydrant lid require painting □
- Flushing Point lid require painting □
- Hydrant surround broken □
- Flushing point surround broken □
## GOLD COAST WATER – WATER INSPECTION CHECKLIST

<table>
<thead>
<tr>
<th>Subdivision Name &amp; Stage:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>File Ref:</td>
<td>OPW No.</td>
</tr>
<tr>
<td>Inspector:</td>
<td>Date:</td>
</tr>
<tr>
<td>Contractor:</td>
<td>Consulting Engineer</td>
</tr>
</tbody>
</table>

- Hydrant marking roads (No05-06-304 & 305)
- Flushing point marking roads
- Swabbing hydrant (No 05-06-106)
- Swabbing Flushing point (No 05-06-106 & 606)
- Valve buried / missing
- Recycled Valve buried / missing
- Valve requires extension spindle
- Recycled Valve requires extension spindle
- Valve box & lid facing correct direction
- Recycled Valve lid facing correct direction
- Valve lid require painting
- Recycled Valve lid requires painting
- Valve surround broken
- Recycled Valve surround broken
- Valve marking roads (No 05-06-304)
- Recycled Valve marking roads (No 05-06-304)
- Recycled Valve location data provided and complete
- Scour valve (Refer DWG No 05-06-107)
- Recycled Scour (No 05-07-302)

- Passed Inspection □
- Reinspection Required □
| Key: Checked ☑ | Not Applicable ☐ | Outstanding/ Unsatisfactory ☐ |

Brief Report On Outstanding Matters:

Consultant/ Inspector Sign: ____________________________
Data Entry Sign: ____________________________
Date: ____________________________