Standard Electrical Specification

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B1 ELECTRICAL SPECIFICATION

B1.1 INTRODUCTION

This specification details the general requirements for design, manufacture, supply and installation of Gippsland Water (GW) Electrical Installations.

All Electrical Installations shall be designed for safe operation and maintenance as well as minimising total cost of ownership over the full service life.

Written approval from Gippsland Water is required to alter from this specification.

B1.1.1 Scope

This standard covers extra low voltage and low voltage only, ie less than 1000 VAC or 1500 VDC.

It does not cover hazardous areas (explosive atmospheres) or high voltage equipment.

B1.1.2 Design Life

All GW Electrical Installations are expected to have a design life of 20 years. Specifically, each Installation is expected to function at designed capacity without major repairs for 20 years.

B1.1.3 Service Life

All GW Electrical Installations are expected to have a service life of 40 years such that each Installation is expected to remain in service for 40 years.

B1.2 STANDARDS, CODES AND REGULATIONS

B1.2.1 Australian Standards

Work on, and installation of all electrical equipment and cabling shall comply with, but is not limited to, the following standards:

- AS 1125 – Conductors In Insulated Electric Cables And Flexible Cords
- AS 1574 – Copper And Copper Alloys - Wire For Electrical Purposes
- AS 1627 – Metal finishing - Preparation and pre-treatment of surfaces - Method selection guide
- AS 1660 – Test Methods For Electric Cables, Cords And Conductors - Conductors And Metallic Components
- AS 1680 – Interior Lighting
- AS 1746 – Conductors - Bare overhead - Hard-drawn copper
- AS 2053 – Conduits and fittings for electrical installations
- AS 2064 – Limits and methods of measurement of electromagnetic disturbances characteristics of industrial, scientific and medical (ISM) radio equipment
- AS 2184 – Low Voltage Switchgear and Controlgear - Moulded-Case Circuit-Breakers for Rated Voltages Up To and Including 600 V A.C. and 250 V D.C.
• AS 2467 – Maintenance of electrical switchgear
• AS 2700 – Colour standards for general purpose
• AS 3000 – Electrical Installations (Wiring Rules)
• AS 3008 – Electrical installations – Selection of Cables
• AS 3010 – Electrical Installations – Generating Sets
• AS 3012 – Electrical Installations – Construction and Demolition Sites
• AS 3017 – Electrical Installations – Testing and Inspection Guidelines
• AS 3100 – Approval and test specification - General Requirements for Electrical Equipment
• AS 3111 – Approval and test specification - Miniature Overcurrent Circuit-Breakers
• AS 3112 – Approval and test specification - Plugs and socket-outlets
• AS 3123 – Approval and test specification - Plugs, socket-outlets and couplers for general industrial application
• AS 3190 – Approval and test specification - Residual current devices (current-operated earth-leakage devices)
• AS 3439 – Low Voltage Switchgear and Controlgear Assemblies
• AS 3715 – Metal finishing - Thermoset powder coating for architectural applications of aluminium and aluminium alloys
• AS 3768 – Guide to the effects of temperature on electrical equipment
• AS 3947 – Low-Voltage Switchgear and Controlgear
• AS 4009 – Software reviews and audits
• AS 4251 – Electromagnetic compatibility (EMC) - Generic emission standard - Residential, commercial and light industry
• AS 4252 – Electromagnetic compatibility - Generic immunity standard - Residential, commercial and light industry
• AS4388 – A method of temperature-rise assessment by extrapolation for partially type-tested assemblies (PTTA) of low-voltage switchgear and controlgear
• AS 4836 – Safe Working on Low Voltage Electrical Installations
• AS 60204.1 – Safety of Machinery – Electrical Equipment of Machines
• AS 60947 – Low-voltage switchgear and controlgear
• AS 61131 – Programmable controllers
• AS 61800 – Adjustable Speed Electrical Power Drive Systems
• AS 662061 – Safety of Machinery – Functional Safety of Safety-Related Electrical, Electronic and Programmable Electronic Control Systems
• AS 5009 – Installation Requirements of Customer Cabling (ACIF)
• Service and Installation Rules for the relevant Distribution Company
• Victorian Electrical Safety Act 1998
• Industry Standard for Electrical Installations on Construction Sites

Building Code of Australia

Where a Standard or Code is not nominated the plant shall comply with the relevant Australian standard and shall be subject to the approval of the Gippsland Water project officer.

**B1.2.2 GW Standards**

GW has full electrical standards for:

• Sewer Pump Station up to 5.5kW DOL (A1-47731)
• Sewer Pump Station 7.5 to 22kW VSD (A1-47775)
• Monitoring Site (A1-51930)
• PRV Site (A2-48380)
• Chlorinator Site (A2-49547)

Where possible the Contractor is to fully comply with these existing GW standards.
Standard drawings are to take precedence over this standard electrical specification.

Future electrical standards are being developed for:

- Sewer Pump Station 30 to 160kW VSD (A1-52770)
- Water Pump Station up to 5.5kW DOL (A1-51700)
- Water Pump Station 7.5 to 45kW VSD (A1-51734)
- Water Pump Station 55 to 200kW VSD (A1-52650)

When designing an installation covered by these future GW standards, the contractor shall coordinate with the GW project officer to develop the project design.

**B1.2.3 Electrical Supply**

The Electrical Supply shall be three phase or single phase, 400/230 VAC 50Hz MEN system.

All work shall conform to requirements of the relevant Power Supply Authority and any other Statutory Authority including the Service and Installation Rules (SIR 2005).

The Contractor must ensure that there are no electrical supply issues including normal loading, electromagnetic interference and total harmonic disturbance.

Loads shall be equally balanced across all phases of the installation.

**B1.2.4 Metering**

A metering compartment shall be provided as part of the main electrical installation.

The Contractor must liaise with the electricity Supply Company to determine all metering requirements.

Copies of all Electrical Works Requests (EWR) and Certificates of Electrical Safety (CES) shall be forwarded to the nominated Gippsland Water representative.

The nominated Gippsland Water representative shall also be notified of any electrical inspections including the de-energisation and energisation of supply.

The Contractor shall upgrade metering if required to meet any additional demand from equipment to be installed.

Gippsland Water will provide retailer details prior to construction.
B1.3 EARTHING

Testing shall be conducted to ensure installations are safely and effectively earthed and results recorded in Test Plans. A standard earthing test sheet is included in the commissioning plan template.

Earthing bars or terminal strips shall be provided, and multiple earthing conductors shall not be grouped in a single terminal connection.

All compartment and escutcheon doors shall be effectively bonded to earth with flexible wiring fixed to earthing studs.

Copper coated mild steel earth stakes are to be used except in corrosive/alkaline soil where advised by Gippsland Water.

Earthing bars or terminal strips shall be provided, and earthing conductors shall not be grouped in a connection lug. Multiple earth lugs on a single stud are not preferred.
B1.4 LIGHTING AND GENERAL PURPOSE POWER

The Contractor shall design and install lighting and general purpose power for the installation.

General purpose outlets and light switches are to be readily accessible at approximately 1.2m above floor level for safe and easy operation.

- Outdoor security and emergency lighting shall be included for all installations. High efficiency fluorescent lighting with emergency battens shall be installed to provide lighting levels according to AS1680/Building Code of Australia.

All general purpose outlets and lighting shall be protected with 30mA RCD protection and tested at commissioning.
B1.5 ENCLOSURES

All enclosures shall be totally enclosed self-supporting metal structures and installed facing away from predominant weather and sun light.

Outdoor enclosures shall be powder coated colourbond “Wilderness Green”. Indoor enclosures shall be powder coated to suit surrounds or existing enclosures. No brushed aluminium enclosures shall be permitted.

All enclosures shall be constructed from marine grade aluminium sheet no less than 3 mm thick and ground smooth before painting, with the following exceptions:

- Enclosures in sodium hypochlorite areas to be made of suitable chemically compatible and UV stabilised plastic, or brushed aluminium.
- Powder coated mild steel may be used for indoor MCC rooms with low atmospheric contaminants, subject to Gippsland Water approval.

All fittings shall be stainless steel grade 316 including all hinges and dome nuts.

All enclosures shall be clearly labelled to clearly identify the function of equipment inside the enclosure.

All enclosures shall be labelled as per examples shown in standard drawings.

Enclosures rated less than or equal to 800A shall be a minimum of Form 1 Assembly in accordance with AS 3439.

Enclosures rated greater than 800A, or where high availability is required, shall be a minimum of Form 3B Assembly in accordance with AS 3439. Form 3Bi and Form 3Bih will not be accepted.

The fault withstand capability of switchgear and control gear shall be appropriate for its location relative to the prospective maximum fault level at the supply terminals of the existing switchboard or supply point. Any additional switchboard shall be rated to withstand the magnitude of a bolted short circuit fault at its incoming terminals.

Enclosures rated greater than 250A shall be installed in air conditioned switchrooms such that the ambient temperature of the switchroom does not exceed 25°C. Air conditioning shall be sized to suit heat load and room volume.

Duty and Standby motor starters rated at 7.5kW or above shall not be contained in the same compartment.

All extra low voltage circuits shall be completely segregated from all low voltage circuits within each compartment with exceptions for equipment power supplies only.

Dimensions of all enclosures shall allow for a minimum of 30% spare space for future expansion.

**B1.5.1 Fabrication**

All enclosure corners will be folded to uniform and even radius with no protruding sharp edges.

All joins will correctly aligned, mitred and continuously welded.
All welds will be ground smooth with all visible scale and splatter removed.

No bolts or fastenings will penetrate the external surface of the enclosure with exceptions for earthing and antenna cables.

All cut-outs will have sharp edges removed.

**B1.5.2 Installation and Mounting**

All enclosures shall be bolted to a galvanised plinth base of not less than 75mm height, and shall be of adequate thickness to support the enclosure and securely anchored to the floor. All plinths will be installed with a sealing gasket for separation from the enclosure.

Outdoor enclosures shall be mounted on a concrete pad extending at least 1 metre in front of the enclosure. The top of the pad shall stand above the finished ground level to eliminate rain fall and other run off. All enclosures shall be mounted above the 100 year flood level.

Enclosures will not be installed within 7 days after pouring of supporting concrete.

Enclosures will be fitted with a safe and effective lifting arrangement.

Roof canopies shall be provided on all outdoor enclosures to provide an effective double layered roof.

**B1.5.3 Compartment Cooling**

Compartments containing monitoring and control equipment including instruments and motor starters, shall be provided with effective and efficient ventilation to provide adequate cooling under all ambient conditions. Ventilation shall ensure the temperature in the enclosure does not exceed ambient temperature by more than 10°C and does not exceed equipment manufacturer’s temperature specifications.

Fans shall be controlled by a dedicated thermostat for each compartment. All air vents shall be provided with removable filters to prevent ingress of dust and insects and maintain the ingress protection rating of the enclosure. Fans shall be mounted to directly extract air from the top of the enclosure.

**B1.5.4 Compartment Lighting**

For outdoor enclosures, compartment lighting (meeting preferred equipment list) with diffusers shall be installed in all compartments.

For outdoor enclosures, the lights should be operated by the site attended switch.

For indoor enclosures, compartment lighting (meeting preferred equipment list) with diffusers shall be installed in the control and telemetry compartments, and the room should be sufficiently lit such that the other compartments do not require cubicle lighting.

For indoor enclosures, the lights should be operated by dedicated door proximity switches.

**B1.5.5 Compartment General Purpose Power**

The control compartment will be fitted with a dual 10A GPO supplied from dedicated RCD, which may include cubicle lighting.
The telemetry compartment will be fitted with a dual 10A GPO supplied from a dedicated GPO, with no other loads on the circuit. The GPO shall be labelled “250 W Max”

### B1.5.6 Access to Equipment

An operator control panel shall be provided for monitoring and control of all plant operations.

The control panel shall be suitable for access by non electrical personnel, and include the following:

- Access to low voltage isolators, circuit breakers and switches
- Fault resets, controls and touch panels
- Access to indicators, displays and instrumentation

Circuit breakers shall be grouped to provide clear separation between types and levels.

Extra-low voltage circuit breakers do not require access by non electrical personnel.

### B1.5.7 Degree of Protection

All electrical equipment installed in the following areas shall have specified ingress protection ratings:

- Inside Enclosures –Minimum of IP21
- Indoors –Minimum of IP42
- Outdoors –Minimum of IP65
- Buried –Minimum of IP68
- Wet Wells –Minimum of IP68

### B1.5.8 Enclosure Compartments

Telemetry equipment shall be installed in a separate dedicated compartment.

Variable Speed Drives, Soft Starters, DOL Starters and other equipment with potential to cause interference shall be installed in separate individual compartments from PLCs, RTUs, telemetry equipment and instrumentation.

A separate control compartment for control, monitoring, instrumentation, extra-low voltage switchgear and terminals shall be provided.

Enclosures for sewer, sludge or chemical dosing systems shall contain connection compartments to provide an effective double barrier against the entry of toxic gases to the enclosure from cable conduits which is also effectively vented.

Generator compartments shall be mounted to ensure safe and effective connection to a generator, which can be suitably locked to prevent access when the generator is connected.

### B1.5.9 Cable Entry

All enclosures shall include gland plates fitted with gaskets for all cable entries. The gland plates shall be sized to allow for 30% future expansion.

Cable entries should only be in the top or bottom of indoor enclosures.
Cable entries should only be in the bottom of outdoor enclosures.

**B1.5.10 Cable Zones**

Fully enclosed cable zones, of minimum width 300mm, shall be provided on all type 3B enclosures or enclosures rated at over 250A.

Cables zones shall have full provisions for the installation and support of cables.

**B1.5.11 Mounting of Equipment**

All equipment can only be mounted in enclosures on equipment chassis or escutcheon doors. The only exceptions will be door switches, lighting, heating and ventilation equipment.

Electrical equipment must be mounted as specified by the manufacturer with effective ventilation, sound proofing and ingress protection.

Equipment shall be installed to provide easy inspection, replacement, modification, operation and maintenance. All equipment shall be mounted to allow front access and front connection.

Mounting of electrical equipment, such as terminals and relays, must be no higher than 1800 mm or no lower than 200 mm above floor or ground level to the bottom of the equipment.

Mounting of control equipment, such as instruments and controllers must be no higher than 1800 mm or no lower than 600 mm above floor or ground level to the bottom of the equipment.

Dissimilar metal surfaces shall be effectively insulated by rubber or plastic fittings.

**B1.5.12 Doors**

Doors with a height greater than one metre shall be provided with multiple latching points. Enclosures shall have floors and restraining rods shall be provided to latch the doors open at a minimum of 100° from the closed position. Doors shall be hinged so that, where access is likely to be required to adjacent enclosures at the same time or, where double doors are fitted to enclosures, the doors shall open away from one another.

All doors shall be fully gasketed with neoprene or equivalent seals. A channel shall be provided on all sides of the doorframe and shall provide effective water run-off.

Enclosures shall have readily removable doors which shall be capable of opening through an angle of at least 100°. All doors shall be equipped with stays and fixable in the open position.

All doors with controls mounted shall include a mounting strip on the rear of the door to facilitate securing of equipment and wiring.

All compartment and escutcheon doors shall be effectively bonded to earth with flexible wiring fixed to earthing studs.

Doors shall be fitted with stainless steel hinges and lockable handles and shall be locked by a 3 point locking handle with Gippsland Water specified key.
B1.5.13 Junction Boxes

Junction boxes must not be used to extend or join cables.

Junction boxes or enclosures installed in wet areas or areas which may be subject to corrosion from chemicals shall be considered as outdoor enclosures.
B1.6 CABLES AND WIRING

B1.6.1 General

All cables shall be high conductivity circular with stranded copper conductors and insulated with 0.6/1 kV PVC, XLPE or rubber.

Individual power and signal cables shall be provided to each field device and not looped between devices.

Cables shall not contain cores of different voltage levels.

Outdoor cables shall be fully installed in conduit or covered cable tray and effectively protected and shaded from sunlight.

Cables for Variable Speed Drives, Soft Starters and other equipment with potential to produce interference shall be fully earthed and screened for EMC protection. EMC junction boxes shall be used for any connections of EMC cables.

Submersible cables shall be used for all cabling in wet wells and other wet areas.

All cables, conduits and tray shall be installed maintaining straight horizontal and vertical lines. Saddles and supports shall be evenly spaced to provide sufficient support.

B1.6.2 Busbars

All busbars shall be securely installed in completely dedicated bus-ways.

B1.6.3 Wiring Insulation

All wiring shall be a minimum of V-75 rated insulation.

B1.6.4 Single Insulated Wiring

Single insulated wiring shall only be used for wiring inside enclosures and shall be contained, as far as practical, in slotted insulated ducting.

All wiring shall be neatly arranged and ferruled.

Ducting shall not be filled to more than 50% of capacity.

B1.6.5 Control and Instrument Cables

Twisted pair cable with metallic screen shall be used on all external instrument and sensing circuits, extra low voltage analogue and digital circuits, and serial data transmission circuits.

All multi-core control cables shall incorporate an insulated green/yellow earth conductor.

All main control and instrument cable, shall allow a minimum 30% spare cores for future expansion.

All spare cores should be terminated.

A service loop of spare cable shall be left at the instrument end to allow easy removal of instrument for calibration.
**B1.6.6 Data and Networking Cables**

Refer also to Gippsland Water ICT Network Cabling Standard (Trim COR/13/22040)

All data and networking cabling must fully comply with AS 5009 Installation Requirements for Customer Cabling.

Ethernet communications external to any enclosure shall use Cat6 cable or multi-mode OM3 fibre with a minimum of six cores.

Any data and networking cabling installed external to any enclosure shall be fully contained in a separate and segregated 50mm white heavy duty PVC conduit for both above and underground wiring. All data and networking conduits must be labelled. All data and networking cabling must be segregated 50mm from any LV cabling.

Underground data and network cables shall be rated suitably and underground conduits shall be buried at least 300mm below ground level and require marking tape installed 100mm above the cable. Conduits installed under footways or roadways must be 450mm deep.

Ethernet communications internal to any enclosures shall use flexible moulded copper CAT 6 patch leads.

All network cables shall be labelled and straight-through cables coloured blue and cross-over cables coloured red.

Cat6 cable installations shall be tested and certified to Cat6.

All SCADA Ethernet cables connected to a corporate switch shall be coloured pink.

**B1.6.7 Extra Low Voltage Minimum Cable Sizes**

The minimum conductor size for extra low voltage cables shall be as follows:

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<th>Minimum Size</th>
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<td>External Control Wiring (one pair)</td>
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<tr>
<td>External Control Wiring (multi-pair)</td>
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<tr>
<td>Internal/PLC Control Wiring</td>
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<tr>
<td>RTU IO Wiring</td>
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**B1.6.8 Cable Installation**

All cables shall be installed without damage to the insulation or sheath, and adequately protected and supported to meet the service conditions, including stresses caused by the maximum expected fault current.

Cables shall not be exposed to UV radiation.

Control cables entering enclosures shall be terminated on a terminal strip and not wired directly to internal equipment. Instrumentation cables may be exempt if required by manufacturer.

All cable ends shall be terminated in lugs without cutting strands.

Sufficient slack shall be provided at each field termination to allow easy removal of equipment and re-termination of cables.
Cables will be installed without any joints or joins.

Cables shall be secured in suitable sized glands and all entries to enclosures and junction boxes shall be effectively sealed.

Manufacturer’s requirements should be followed, eg bend radius.

**B1.6.8.1 Cables in Conduit or Pipes**

All cabling to be installed in high damage risk areas shall be fully enclosed in galvanised steel conduits, or in anaconda for corners or around obstacles.

Conduits shall be saddled at 1200mm intervals.

Conduit ends shall be tightly plugged with foam filler or plugs or end caps to effectively prevent the ingress of moisture and other materials.

**B1.6.8.2 Underground Cables**

All trenches and underground cabling shall be installed straight and as per AS3000.

Underground cables shall be installed as follows:

- All cables installed fully in heavy duty UPVC conduit
- All bends shall be sweep type
- Separate conduits shall be used for power and control
- Power or control to be installed in orange conduits. Communications to be installed in white conduits.
- Pits shall be installed for changes of direction
- Conduits shall be sized to suit the cables being installed. The minimum size conduit permitted is 50mm.
- 100% spare space in conduits shall be installed for every run
- All conduits shall contain a “Telstra” draw rope including those with cables
- Identification/warning tape shall be used as per AS3000

All areas shall be fully re-instatement (including appropriate compaction) following all trenching and excavations.

Underground conduits shall be fully protected from mechanical damage as per AS3000.

**B1.6.8.3 Electrical Pits**

Pit widths shall be sized to be the largest of the widths selected from these three criteria:

- Depth Required:
  - 600 mm deep, use a pit at least 300 mm wide
  - 900 mm deep, use a pit at least 600 mm wide
  - 1200 mm deep, use a pit at least 900 mm wide
- Number of DN100 conduit entries:
  - Up to 4 DN100 conduit entries, use a pit at least 300 mm wide
  - 5 to 12 DN100 conduit entries, use a pit at least 600 mm wide
  - 13 to 24 DN100 conduit entries, use a pit at least 900 mm wide
- Cable size (largest cable that changes direction):
  - Up to 25 mm² (3 phase cable), use a pit at least 300 mm wide
  - 35 to 95 mm² (3 phase cable), use a pit at least 600 mm wide
  - 120 mm² and greater (3 phase cable), use a pit at least 900 mm wide
Minimum load ratings:

- Pits on grassed areas shall meet AS 3996 class B
- Pits on trafficable areas shall meet AS 3996 class D. This requires concreting below the pit, around the sides of the pit, and encasing the lid housing.

Sealing around conduits. Pit walls shall be sealed around conduits to prevent ingress of water or mud. Concrete pits shall use grout, and plastic pits shall use foam or tape.

Distance between pits shall not exceed 50 m unless approved by Gippsland Water.

**B1.6.8.4 Aboveground Cables**

Cable trays and racking shall be galvanised or stainless steel in corrosive areas. Properly formed bends shall be used and all sharp edges shall be removed to prevent damage to cables.

Cable racks or trays shall be mounted in the vertical plane. Large cable racks or trays may be installed on the horizontal plane.

All cables shall be securely and effectively fastened to cables trays with UV protected cable ties.

Where cables leave the cable rack, they shall be fully installed in conduits.

Cable tray will be covered to protect cables from UV (where outdoors) and mechanical damage

All metallic cable tray is to be effectively earthed.

Cut loose ends off cable ties.

Manufacturer’s bend radius requirements are to be followed.

**B1.6.8.5 Flexible Cables**

Flexible cables shall be used where the cable is to be installed between structures and/or equipment where movement is expected, or where equipment is required to be removed without disconnecting the cable. Nylon cable grips shall be used to support hanging cables.

All wiring to equipment on doors of compartments shall be by flexible cables.

Cable clips with stick on adhesive tape is not to be used.

**B1.6.8.6 Segregation**

Control, instrumentation and data transmission cables shall be separated by a minimum of 200 mm from power cables.

Low voltage control and power cables shall only cross at right angles.

Cables carrying high current (above 200 A) shall be segregated by a minimum of 200mm from those carrying low current.
**B1.6.8.7 Cable Screens**

Cables screens shall be installed to minimise all electrical interference.

Control cable screens shall be earthed at the supply end only. Cable screens at the field end shall be insulated.

VSD cable screens shall be of the braided type and earthed at both ends. VSD Braid shield rating to be suitable for the installation as recommended by the manufacturer.

Cable screens must not be broken or joined.

**B1.6.9 Wiring, Cable and Cable Core Identification**

All cables shall be permanently and legibly identified at both ends with the appropriate cable number as indicated on the cable block or wiring diagram. Single core cables shall be identified by their voltage/insulation colour as specified below.

Cable colour coding shall be as follows:

<table>
<thead>
<tr>
<th>TYPE</th>
<th>CIRCUIT/CABLE</th>
<th>COLOUR</th>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power</td>
<td>400VAC Active (3 phase)</td>
<td>Red, White, Blue Brown Black</td>
<td></td>
</tr>
<tr>
<td></td>
<td>230VAC Active</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>230VAC Neutral</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 VAC Motor Control</td>
<td>24 VAC</td>
<td>Grey Black</td>
<td>24VDC power supply (external) to PLC, or 24VDC rail, terminal, constantly at 24VDC potential</td>
</tr>
<tr>
<td></td>
<td>0 VAC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 VDC from Power Supply</td>
<td>24 VDC</td>
<td>Orange Black</td>
<td>24VDC supplied by internal power supply imbedded in RTU/PLC hardware (not switched by RTU/PLC)</td>
</tr>
<tr>
<td></td>
<td>0 VDC</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 VDC from RTU or PLC</td>
<td>24 VDC Common</td>
<td>Purple Pink</td>
<td>24VDC supplied by internal power supply imbedded in RTU/PLC hardware (not switched by RTU/PLC)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>Control and Instruments</td>
<td>White</td>
<td>All switched or modulated signals (ie DI, DO, AI, AO). Does not included signals at constant potential (ie 0VDC, 24VDC)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cables from secondary wiring terminals of current transformers shall have the respective phase identification colours for actives (i.e. Red, White and Blue). The neutrals shall be black between the CT neutral terminal and the earth terminal.

Standard colours for wiring are detailed on standard drawing A3-48318.

**B1.6.9.1 Cable and Core Numbering**

Cable numbering is to use the instrument or junction box tag and a suffix:

PC01, PC02, etc for power cables
CC01, CC02, etc for control cables

All cables cores shall be numbered in a logical manner.

PLC/RTU IO numbering to be used to the terminal strip, and field instrument tag to be used from terminal strip to instrument.

At each point of termination, each conductor shall be provided with a cable/core number identification ferrule. All spares shall be numbered or labelled as spare.

Multicore cables shall have each core identified by means of numbers printed on the core insulation.

Individual core numbers are to be provided for each DC positive and negative supply to enable ready identification of the device which they supply.

**B1.6.10 Terminus**

All control and instrument cable terminations shall be terminated using appropriate crimp connectors with labels.

Power cables connected to a stud shall be terminated using crimped lugs. Power cables connected in terminals shall be terminated using 'bootlace' type crimped connectors.

Sufficient slack shall be provided at each termination to enable numerous re-terminations.

All DC supplies (both positive and negative) shall be terminated at a common supply rail.

**B1.6.11 Terminal Strips**

All terminals shall be sequentially numbered in each enclosure. Terminals shall be segregated for power, control, signal supplies and barriers fitted to distinguish different voltages.

Cables entering enclosures shall be terminated on a terminal strip and not wired directly to internal equipment.

All I/O and interfacing equipment shall be terminated in a dedicated and separate terminal strip.

A full terminal strip for each IO card shall be installed, with enough terminals for all the points on the IO card. The terminal strip shall be named based on the IO card rack and slot.

Bridging of terminals within a terminal strip shall be provided only by screw in links, eg proprietary screw in links on centre of terminal, comb in top of terminals. Daisy chained wire in terminals is not allowed.

No more than one wire shall be installed in a terminal, unless a dual bootlace is used.
B1.7 NAMING AND LABELLING

All naming and labelling shall be fully consistent with Gippsland Water Standard – Identifying and labelling Gippsland Water's Assets (COR/07/41914).

Labels shall be provided for each individual item of electrical plant either within a compartment or enclosure or separately mounted on the plant. All labels shall be fully visible and not obscured.

All labels shall be of a permanent type engraved label made using laminated plastic with black lettering on a white background, and mounted in a suitable position adjacent to the equipment.

Nomenclature shall be according to a list of PLC I/O, drives, isolators, selector and control switches and approved by Gippsland Water. Labels will be fully consistent throughout the installation including all software and documentation.

The size of the lettering shall be as follows:

- Main Enclosure Name 20mm
- Name of Compartment 10mm
- General Equipment inside or on fascia of Enclosure 6mm
B1.8 POWER DISTRIBUTION AND PROTECTION

B1.8.1 Power Distribution and Load Control

Sites supplied by dedicated transformers must have mains cables sized to provide the total full-load-current available from the supply transformer, or up to 30% higher than the maximum demand.

Sites supplied by shared transformers must have mains cables sized to provide the maximum demand of the complete installation as calculated from AS3000 plus 30% spare.

All power distribution supplies and cables shall include 30% spare for future expansion.

All installations shall include a main supply load limiting device to effectively limit full load current available to the site.

B1.8.2 Generator Change-Over Switches and Connections

Where a generator, or provision for a generator, is required, all main electrical enclosures shall be provided with a generator changeover switch and a socket up to 250A for ready connection to a generator to supply the full-load-current of the enclosure.

Generator connection requirements for loads greater 250A will be specified as required.

Separate lockable access to the generator connection point shall be provided to allow connection without the need for doors or cabinets to be left open, and to prevent unauthorised access to the connection point when in use.

Gippsland Water shall advise if automatic changeover equipment is required. Any automatic changeover system shall include a bypass to effectively bypass and isolate the automatic changeover equipment.

B1.8.3 Power Metering

Secondary CT power metering is to be incorporated on all new sites with CT metering to measure power supply and consumption separate to the supply authority metering.

B1.8.4 Load Centres and Circuit Breakers

For load centres all circuit breakers should be installed in order of decreasing load from connection point of main supply.

For DIN mounting all circuit breakers should be installed in order of decreasing load from left to right.

B1.8.5 Power Failure Relay

Where the power supply to the installation is three-phase, a dedicated power failure relay shall be installed to detect failure of each phase.

Where the power supply to the installation is single-phase, an under voltage relay shall be installed.
**B1.8.6 Lightning and Surge Protection**

Surge protection shall be provided on all enclosures with a separate surge diverter device installed on each phase downstream of the generator changeover switch or equipment.

All sensitive equipment including PCs, PLCs, RTUs, or electronic/instrumentation equipment, shall be further protected by a dedicated surge diverter and surge filter.

All analog and digital instrument loops that go outside the PLC building are to have surge protection in the PLC cabinet.

**B1.8.7 Isolators**

All isolators shall be Load-Break type, and lockable in the open position. All isolators will be clearly marked and follow consistent positions.

Where required in AS3000 field isolators shall be included for each dry mounted motor adjacent to the motor.

Field isolators shall include auxiliary terminals wired to PLC or RTU to monitor and suppress alarms.

**B1.8.8 Circuit Breakers**

Thermal-magnetic type circuit breakers shall be used in preference to fuses.

Where circuit breakers are used as isolators they shall be lockable in the open position.

Multi-pole breakers shall have a common tripping mechanism.

A single circuit breaker shall be provided for each individual item of equipment.

**B1.8.9 Emergency Stop Circuits and Pushbuttons**

All equipment with potential to cause damage to persons or property shall include emergency stop functionality as per Gippsland Water standard drawing A1-49669. This shall include all equipment with moving parts that may come into contact with persons.

Emergency stop circuits shall be operated by red mushroom head push buttons wired fail-safe and directly to emergency stop devices to interrupt power supply to equipment. These shall incorporate a dedicated reset push-button separate to the emergency stop device.

Any emergency stop functionality will not require additional operations during or after a loss of supply.

**B1.9 MOTORS**

**B1.9.1 Motor Starters**

All DOL Starters will include a current transformer on at least one phase to monitor current.
Variable Speed Drives or Soft Starters shall be fitted for all motors 7.5 kW and above.


**B1.9.2 Motor Protection**

All motors shall be protected by an electronic motor protection device such as thermal overloads.

**B1.9.3 Motor Thermistors**

If specifically required by GW or motor manufacturers, motors shall be fitted with PTC thermistors sensors embedded in the motor stator winding (one per phase).

A separate and dedicated detection relay or VSD shall be provided to protect each motor individually.

**B1.9.1 Variable Speed Drives**

All installation, design, commissioning and interfacing of each VSD shall be as per manufacturers recommendations; including the requirements to effectively ensure that the electromagnetic interference and harmonic distortion are limited.

The normal method of operating the VSD shall be by wired signals from the control or telemetry system.

As a minimum, each VSD will be wired with the following signals

<table>
<thead>
<tr>
<th>Digital Inputs</th>
<th>Digital Outputs</th>
<th>Analog Inputs</th>
<th>Analog Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start/Stop</td>
<td>Fault</td>
<td>Speed Reference/ PID Feedback</td>
<td></td>
</tr>
<tr>
<td>Interlock</td>
<td>Running</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Jog</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reset</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thermistor (as req)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Each VSD shall also include a MODBUS, Modbus/TCP, DeviceNet or Ethernet/IP link for performance monitoring.

Each VSD shall have a minimum speed commissioned to prevent the VSD operating loads at lower frequencies that may cause damage to equipment such as no-flow and water hammer.

VSD Max Frequency is normally 50Hz, and is to be coordinated with the motor and operational requirements.

All Variable Speed Drives shall be protected by semiconductor fuses as specified by the manufacturer and in addition to circuit breakers. Fuse holders shall be fully shrouded.

All wall mounted VSD’s shall have covers over exposed terminals.
B1.9.2 Harmonic Filters

All harmonic filters must be passive type, unless otherwise approved by Gippsland Water.

The Contractor shall also supply and install harmonic filters to limit RFI and Harmonics to levels as required by the appropriate Supply Authority and Australian Standards.

All VSDs greater than 7.5 kW shall include harmonic filters.

Filter units are to provide a digital output indicating filter status. This signal shall inhibit all devices supplied by the filter.

Filters shall include a bypass circuit that may be operated from an external device to limit power consumption when idle. The bypass circuit shall include additional protection from thermal overloads.

Whilst the overall aim of filters is to limit harmonics and RFI to the specified levels at the Common Point of Coupling to the electricity network, in some cases high levels of harmonics may cause interference to other equipment within the GW site. In such cases it is required that reduction in harmonics is provided to the level specified at the appropriate sub-board.

B1.10 INSTRUMENTATION AND CONTROL

B1.10.1 Uninterruptible Power Supplies (UPS)

240 VAC UPS systems are not permitted in electrical installations.

If specifically required by GW, a separate 24 VDC UPS shall be included to supply critical instrumentation and monitoring equipment. Refer to A1-53568 and A1-53569.

UPS units shall be rated to provide 125% of process load. Battery to be sized to provide 6 hours of backup. A UPS fault signal shall be wired to the battery backed up RTU to provide an alarm.

B1.10.2 Control Voltage

All PLC/RTU IO and relay controls will be extra low voltage 24VDC.

B1.10.3 Control Supply Segregation

Power supplies for control and instrumentation circuits shall not be connected to large and noisy loads like solenoids and motor contactors.

Separate 24VAC supplies shall be included for noisy loads like solenoids and motor contactors.

B1.10.4 Analogue Current Loops

All instrument current signals shall be 4 – 20 mA.
All instrument current signals shall be fully isolated. Instruments which do not have isolated signals shall have externally powered isolators installed.

All external current signals shall be fully isolated using signal isolators and include separate lightning protection.

Standard terminal arrangements for current loops are detailed on standard drawing A3-48318. This is to be used for smaller numbers of current loops, and for all RTU installations. Where there are large numbers of current loops (eg PLC installations in larger treatment plants), the standard PLC analog drawings shall be used.

**B1.10.5 Test and Isolation Points**

Test and isolation points shall be provided for:

- Connection points for secondary circuit measurement and simulation of functional tests.
- All CT circuits (shorting and testing)
- All current loops

A warning label, and protection from accidental contact shall be installed near each CT terminal strip to warn of the dangers of open circuit CT secondary circuits.

**B1.10.6 Controls, Push Buttons and Indicators**

Controls, push buttons and indicators shall be included for all individual items of plant so that each item may be fully operated and observed.

Selector switches shall have a rotary action and shall be of the flush mounting type, complete with escutcheon plate engraved with position designations.

As a minimum, each device shall have a selector switch labelled ON/OFF/AUTO (or equivalent) to operate the device. Operation of the selector switch will bypass process interlocks only, safety and thermal interlocks will remain active at all times.

Push buttons shall be coloured as follows:

<table>
<thead>
<tr>
<th>Function</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>Green</td>
</tr>
<tr>
<td>Stop</td>
<td>Red</td>
</tr>
<tr>
<td>Reset</td>
<td>Blue (with a white R on the button)</td>
</tr>
<tr>
<td>Others</td>
<td>Black</td>
</tr>
</tbody>
</table>

Indicating lamp colours shall be used as follows:

<table>
<thead>
<tr>
<th>Function</th>
<th>Colour</th>
</tr>
</thead>
<tbody>
<tr>
<td>Running</td>
<td>Green</td>
</tr>
<tr>
<td>Open</td>
<td>Green</td>
</tr>
<tr>
<td>Standby</td>
<td>White/Yellow</td>
</tr>
<tr>
<td>Available</td>
<td>Blue</td>
</tr>
<tr>
<td>Closed</td>
<td>Blue</td>
</tr>
<tr>
<td>Fault</td>
<td>Orange</td>
</tr>
<tr>
<td>Other Status</td>
<td>White/Yellow</td>
</tr>
</tbody>
</table>

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All labels shall be located directly above the switch, push-button or indicator.

**B1.10.7 Control Transformers**

Control Transformers shall comply with the relevant current Australian Standard and shall be continuously rated for 150% of the maximum load VA taken from the secondary winding. Primary and secondary windings shall be electrically separate. An earthed barrier shall be provided between the primary and secondary windings.

**B1.10.8 Flow Meters**

Flow Meters shall be supplied with manufacturer cables.

Joins in Flow Meter cables are not permitted. Flow Meter cable shall be installed in conduit with 1 m of extra cable coiled at each end of the conduit.

Flow Meter elements shall have an IP68 rating and be capable of being submerged or buried to 5 metres depth. All Flow Meters and junction boxes shall be potted. All buried Flow Meters and junction boxes shall be fully wrapped in Denso tape.

The Flow Metering system shall be supplied with NATA test certificates.

All Flow Meters shall include a totaliser with a local indication.

Flowmeter elements shall be appropriately sized for a velocity of 1 to 3 m/s.

Flowmeter elements shall have earth rings installed as required by manufacturer (upstream and downstream).

**B1.10.9 Submersible Level Sensors**

Level sensors shall be calibrated to the full useable capacity of the storage or well.

Submersible sensors shall be installed in a 316 stainless steel stilling tube, with a pin fitted in the bottom of the tube and anchored to the structure with stainless steel brackets and fasteners. The tube shall be anchored so that the sensor is located at the RL for zero useable capacity from the storage's capacity tables.

**B1.10.10 Ultrasonic Level Sensors**

Level sensors shall be calibrated to the full useable capacity of the storage or well, ie sensor 0% shall be the basse and sensor 100% shall be the invert of the overflow.

Ultrasonic level sensors shall be installed so that the level sensor is a minimum 300 mm above the overflow level of the storage.

Sensors shall be installed at least 2 m away from any telemetry aerials.

Sewerage Wet Wells shall be configured as per standard drawing A1-22686.
**B1.10.11 Flow, Level, Pressure, Limit and Proximity Switches**

Switches shall be used for all critical alarms. Each switch shall be wired fail-safe with a closed contact used for the non-alarm state.

Critical alarms shall be derived from individual dedicated switches and not other sensors.

Separate individual switches shall be included for duty and standby plant items.

**B1.10.12 PLCs and RTUs IO Wiring**

All inputs and outputs shall be wired to separate terminal strips.

**Space** for 30% spare I/O shall be included for future expansion.

Each individual module of the RTU or PLC shall be separately protected from short circuit and over-current.

All analogue inputs and outputs shall be 4-20 mA and shall be separately fused and isolated.

All digital outputs shall be connected to interposing relays.

All digital inputs shall be individually fused.

I/O shall be connected to minimise disruption to plant upon the failure of an individual module with duty and standby equipment wired to separate modules where possible.

All RTU IO wiring must fully comply with standard RTU designs for:

- Gear Tray Layout (A1-50328)
- 4 AO 8 AI Card (A1-50329 & A1-50330)
- 8 DO Card (A1-50331)
- 16 DI Card with internal power supply (A1-50332)
- 16 DI Card with external power supply (A1-50323)
- Mixed IO Card with internal power supply (A1-50335 & A1-50336)
- 8 AI Card (A1-50337)
- 16 DO Card (A1-50340 & A1-50341)

All designs will be limited to use the above specified cards only.

**B1.10.13 PLCs and RTUs Power Wiring**

All PLCs and RTUs will be wired directly to separate and dedicated circuit breakers. ELCBs are not permitted for use with communications equipment.

**B1.10.14 RTU Battery Backup**

A minimum 6 hours of battery backup shall be provided for each RTU. A minimum battery of a 17Ahr sealed lead acid battery shall be provided for each installation and shall be suitably thermally insulated to maximise battery life.
Other equipment may be supplied from the RTU power supply but may not be supplied from the RTU battery.

**B1.10.15 Resetting of Faults**

All electrical hard wired latched faults shall include an individual fault reset relay that can be operated from the PLC or RTU as well as the local control panel, eg each motor with a thermal overload shall have its own reset.

**B1.10.16 Remote Telemetry Units (RTU)**

All installations will comply fully with the Gippsland Water SCADA Group Standard RTU Programming Specification.

All RTUs will be Motorola ACE 3640 and supplied by the Gippsland Water SCADA Group.

The Contractor is to liaise with the Gippsland Water project officer to ensure the correct procurement RTU equipment.

The RTU must be installed in a separate compartment within the enclosure. A space must be provided within the compartment for the installation of the RTU and radio as per drawing A1-50328.

The RTU compartment shall include provision for antenna cable entries.

If space is provided for extra RTU slots or a larger chassis, then extra space must be provided for associated terminal strips.

**B1.10.17 Radio Communications**

All radio communications equipment including masts, antennas and radios will be supplied by GW nominated Communications Contractor.

The Contractor is to liaise with the nominated contractor to ensure the installation of communications equipment.