Standard Electrical Specification

Gippsland Water Business Management System	
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ELECTRICAL SPECIFICATION

1.1 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.

1.1.1 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.

1.1.2 Design Life

All GW electrical installations are expected to have a design life of 25 years. Specifically, each installation is expected to function at designed capacity without major repairs for 25 years.

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.

1.1.3 Safety

The safety of employees, contractors and the public is the highest priority of Gippsland Water. To manage the control of access to electrical compartments Gippsland Water has implemented a system of cabinet labelling.

Level 1 – A dead front and there are no air circuit breakers, or the cabinet only contains extra low voltage.

Level 2 – Not level 1 and has at least IP2X protection from contact with live parts, and the current supply is limited to 100 A, and the fault level is less than 7 kA, and there are no door mounted isolators or air circuit breakers.

Level 3 – Not level 1 or Level 2.

Any equipment or controls requiring access by non-electrical personnel shall be arranged such that it conforms to Level 1 access specification (a dead front).

1.2 STANDARDS, CODES AND REGULATIONS

1.2.1 Australian Standards

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

The latest version or amendment is to be used.

- 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 Control gear - 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 61439 – 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 control gear
- 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 S009 – 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
- AS/NZS 5033 Installation and Safety Requirements for Photovoltaic (PV) arrays
- AS/NZS 4777.1 Grid Connection of Energy Systems via Inverters – Installation Requirements
- AS/NZS 4777.2 Grid Connection of Energy Systems via Inverters – Inverter Requirements
- AS/NZS 4777.1 Grid Connection of Energy Systems via Inverters – Grid Protection Requirements
- IEC 61730 Photovoltaic (PV) Module Safety Qualification
- IEC 61730 – Part 1: Requirements for Construction
- IEC 61730 – Part 2: Requirements for Testing
- IEC 62109 Safety of Power Converters for use in photovoltaic power systems
- IEC 62109 Part 1: General Requirements
- IEC 62109 Part 2: Particular Requirements for Inverters

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.

1.2.2 GW Standards

GW has full electrical standard drawings for:

- Sewer Pump Station up to 5.5 kW DOL (A1-47731)
  - Document location: ADC-1 and alternatively within 09/02/01/02/01/01
- Sewer Pump Station 7.5 to 22 kW VSD (A1-47775)
  - Document location: ADC-1 and alternatively within 09/02/01/02/02/01
- Sewer Pump Station 30 to 160 kW VSD (A1-52770)
  - Document location: ADC-1
- Water Pump Station up to 5.5 kW DOL (A1-51700)
  - Document location: ADC-1
- Water Pump Station 7.5 to 45 kW VSD (A1-51734)
  - Document location: ADC-1
- Water Pump Station 55 to 200 kW VSD (A1-52650)
  - Document location: ADC-1
- Monitoring Site (A1-51930)
  - Document location: ADC-1
- PRV Site (A2-48380)
  - Document location: ADC-1
- Chlorinator Site (A2-49547)
  - Document location: ADC-1 and alternatively within 08/04/01/01
- Standard flow monitoring cubicle (A2 – 53493)

Standard drawings are being developed for:

- Standard Odour Control Dosing System.

The Gippsland Water Scada Group also has standard programming specifications:

- Standard RTU Programming Specification COR/12/17533
  Standard PLC Programming Specification COR/11/33961

Where possible designs are to fully comply with these existing GW standards.

Standard drawings are to take precedence over this standard electrical specification.

1.3 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 2014).

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

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.

1.4 VERIFICATION

Electrical installations shall be verified as per AS/NZS 3000:2018 section 8 and AS/NZS3017.2007. Signed test sheets with completed verification test results are to be provided to Gippsland Water.

1.5 LIGHTING AND GENERAL PURPOSE POWER

Designs shall include lighting and general purpose power appropriate for the installation.

Generally indoor operational areas should be illuminated to a minimum level of 240 lux or as otherwise specified per AS1680.2 2009.

Outdoor lighting shall be designed as per the outcome of the HAZOP and functional design process.

Light switches should be positioned in a consistent location – between 900 mm and 1100 mm above the finished floor level. GPO's should be installed no lower than 300 mm above the finished floor level.

1.6 ENCLOSURES

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 or other reactive chemical areas to be made of suitable chemically compatible and UV stabilised plastic.
- Powder coated mild steel may be used indoors and for indoor MCC rooms with low atmospheric contaminants, subject to Gippsland Water approval. Steel thickness shall be at least 1.6 mm.
- Stainless steel cabinets of 316 grade may be used. When outside and in public view they should be powder coated wilderness green. Cabinets larger than 400 mm shall have a sheet thickness of at least 1.5 mm thickness. Smaller cabinets may use 1.2 mm sheet.
- Small plastic prefabricated distribution boards and junction boxes may be used indoors if appropriately IP rated and adequately protected from mechanical damage.

Outdoor enclosures shall be powder coated (colour bond) "Wilderness Green".

Indoor enclosures shall be powder coated to suit existing enclosures, using these commonly used colours:

- RAL7032 Pebble Grey
- N42 Storm Grey
- ColourBond Wilderness Green

No brushed aluminium enclosures shall be permitted.

Outdoor enclosures shall have a double layered roof and heat shields should be considered for CT chambers and meter compartments.

Outdoor enclosures should be positioned or otherwise sheltered to minimise exposure to summer sunlight so as to maintain the contained equipment within manufacturers temperature limits. Strategies such as mounting boards against shaded walls, under bus shelter type structures or in an enclosed air-conditioned room should be considered.

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

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

Enclosures rated greater than 800 A, or where high availability is required, shall be a minimum of form 3B assembly in accordance with AS 61439. Form 3Bi and form 3Bih will not be accepted.

For switchboards rated greater than 250 A or containing sensitive equipment, - consideration should be given to installation in air conditioned switch rooms such that the ambient temperature of the switch room does not exceed 25 °C. Air conditioning shall be sized to suit heat load and room volume.

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

Junction boxes shall be used for marshalling cables – not extending cables.

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 (ie 30% more CB's, IO terminations, instruments etc).

1.6.1 Fabrication

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

All joins will be correctly aligned, mitred and seems shall be fully 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.

1.6.2 Installation and Mounting

All enclosures shall be bolted to a galvanised plinth base of not less than 75 mm height, and shall be of adequate thickness to support the enclosure and be 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 because of reaction with various metals during curing.

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.

Small boards may be directly mounted to walls.

Boards should be designed and located such that egress and access is not restricted as per AS3000.

1.6.3 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 ^{o}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 with filtered vents at the bottom to allow maximum circulation.

1.6.4 Compartment Lighting

Compartment lighting shall be of ELV LED type as specified in the preferred equipment list.

For outdoor enclosures, - all compartments shall be provided with lighting incorporating diffusers and operated by the site attended switch.

For indoor enclosures, compartment lighting 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.

1.6.5 Compartment General Purpose Power

The telemetry compartment will be fitted with a dual 10 A GPO supplied from a dedicated RCD, with no other loads on the circuit.

1.6.6 Access to Equipment

An operator control panel shall be provided for monitoring and control as determined in the HAZOP or functional design.

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

- Access to low voltage and extra 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 voltage types and levels.

1.6.7 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

1.6.8 Enclosure Compartments

Telemetry equipment shall be installed in a separate dedicated compartment.

Variable Speed Drives, 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 vented connection compartments to provide an effective double barrier against the entry of toxic gases to the enclosure from cable conduits.

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 not connected.

1.6.9 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.

Where cable zones are used they should be a minimum of 300 mm wide.

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

1.6.10 Mounting of Equipment

Equipment can only be mounted in enclosures on an equipment chassis or escutcheon door. The only exceptions will be door switches, lighting and 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. If equipment has rear connections then a mechanism must be provided to allow easy access e.g. a hinged door or slide out rails.

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.

1.6.11 Doors

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 compartment and escutcheon doors capable of becoming live shall be effectively bonded to earth with flexible braided straps or flexible wiring and 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. Three point locking is not allowed in Ausnet CT chambers.

For switchboard compartments that need to be regularly accessed (eg control, telemetry, distribution) there shall not be any 400/230 Volt wiring on the doors.

1.6.12 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 20 mm
- Name of compartment 10 mm
- General equipment inside or on fascia of enclosure 6 mm

1.7 CABLES AND WIRING

1.7.1 General

All cables shall be high conductivity circular type with stranded copper conductors and insulated with 0.6/1 kV PVC, XLPE or rubber. Insulation shall be a minimum of V-75 rated.

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 and glands 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.

All wiring shall be neatly arranged and ferruled.

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

1.7.2 Consumers Mains Cable

Consumers mains cables (ie from point of supply to main switch) shall have voltage drop not exceeding 3% of the nominal voltage of 400/230 Vac. This reserves 2% of the voltage drop from main switchboard to final equipment.

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.

Maximum demand for each site is to calculated as per AS3000, except for pump stations where it shall be calculated by adding the full load current of the number of pumps running together, plus 10 A (3 phase) for instrumentation and control.

1.7.3 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.

1.7.4 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 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.

1.7.5 Data and Networking Cables

All data and networking cabling must fully comply with Gippsland Water ICT Network Cabling Standard (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 50 mm 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 50 mm 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 100 mm above the cable. Conduits installed under footways or roadways must be 450 mm 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.

1.7.6 Extra Low Voltage Minimum Cable Sizes

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

Application	Minimum Size
External Control Wiring (one pair)	0.5 mm^2
External Control Wiring (multi-pair)	0.5 mm^2
Internal/PLC Control Wiring	0.75 mm^2
RTU IO Wiring	0.5 mm^2

1.7.7 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.

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

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.

1.7.8 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 intervals of no more than 1200 mm.

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

1.7.9 Underground Cables

All trenches and underground cabling shall be installed in straight lines (not curved).

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 50 mm.
- 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-instated (including appropriate compaction) following all trenching and excavations.

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

1.7.10 Electrical Pits

Pit widths shall be sized based on the size and number of conduits:

Guide to maximum number of conduits for pit sizes. This includes spare and empty conduits for future use.

Pit width (mm)	300	600	900	1200
DN50 conduits	8	16		
DN100 conduits	4	8	16	
DN150 conduits		4	8	16

Pits shall be sized to allow ease of installation including future works. Pit sizing shall be approved by Gippsland Water prior to installation.

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.

1.7.11 Aboveground Cables

Cable trays and racking shall be galvanised steel. Stainless steel or FRP (to IEC 61537) should be considered in corrosive areas. Properly formed bends shall be used and all sharp edges shall be removed to prevent damage to cables and personnel.

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. Loose ends must be trimmed off 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.

Manufacturer’s bend radius requirements are to be followed.

1.7.12 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 are not to be used.

1.7.13 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 200 mm from those carrying low current.

1.7.14 VSD (to motor) Cables

Cables screens shall be installed to minimise all electrical interference. There shall be an overall screen around all conductors. Individual screens are not allowed due to inferior EMI performance.

There shall be 1 or 3 dedicated protective earth conductors, not a combined screen and protective earth.

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.

The cable screen shall be installed as per the VSD manufacturer's recommendations, including with a 360 degree clamp or EMC cable gland, and not a pigtail type bond.

For some specialist cables, European phase colours (brown, black, grey) may be permitted if AS/NZS colours (red, white, blue) are not available. Approval in writing must be obtained from GW.

1.7.15 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.

Cable colour coding shall be as follows:

TYPE	CIRCUIT/CABLE	COLOUR	EXAMPLE
Power	400 Vac Active (3 phase) 230 Vac Active 230 Vac Neutral	Red, White, Blue Brown Black	
24 Vac Motor Control	24 Vac 0 Vac	Grey Black	

24 Vdc from Power Supply	24 Vdc 0 Vdc	Orange Black	24 Vdc power supply (external) to PLC, or 24 Vdc rail, terminal, constantly at 24 Vdc potential
24 Vdc from RTU or PLC	24 Vdc Common	Purple Pink	24 Vdc supplied by internal power supply imbedded in RTU/PLC hardware (not switched by RTU/PLC)
Control	Control and Instruments	White	All switched or modulated signals (ie DI, DO, AI, AO). Does not included signals at constant potential (ie 0 Vdc, 24 Vdc)
4-20 mA	Positive negative	White black	Third wire +24 V /+12 to be white and appropriately labelled.
12 Vdc	Positive negative	Red/white black	

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.

1.7.16 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.

1.7.17 Terminations

All control and instrument cable terminations shall be terminated using 'bootlace' type 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.

1.7.18 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.

1.8 POWER DISTRIBUTION AND PROTECTION

1.8.1 EARTHING

Testing shall be conducted to ensure installations are safely and effectively earthed and results recorded in Test Plans.

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.

1.8.2 Power Distribution and Load Control

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.

1.8.3 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 250 A for ready connection to a generator to supply the full-load-current of the enclosure.

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

Separate lockable access to the generator connection point shall be provided to provide protection from the elements and to prevent unauthorised access to the connection point.

Gippsland Water shall advise if automatic changeover equipment is required. Any automatic changeover system shall include an option for manual operation.

1.8.4 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.

1.8.5 Load Centres and Circuit Breakers

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

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

All circuit breakers, Switches and other equipment normally required to be accessed by non-electrical personnel shall be accessible without exposure to live conductors or arc

fault hazards. This shall normally be achieved by bringing the operational part of these devices through an escutcheon panel. The escutcheon panel shall be fixed in place such that it may only be opened with the use of tools.

1.8.6 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.

The Phase failure relay shall have two sets of contacts; one contact to be wired direct to an RTU digital input, the other contact to be wired direct to a PLC digital input or to a relay.

Where the power supply to the installation is single-phase, an under voltage relay shall be installed.

1.8.7 Lightning and Surge Protection

Surge protection shall be provided on all main boards with a separate surge diverter device installed on each phase. Protection shall also be provided at any board where a generator connection point is provided.

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.

1.8.8 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.

1.8.9 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, excluding general power and lighting.

1.8.10 Arc Fault Detection

Arc fault detection shall be installed in switchboards where the transformer is 750 kVA or above.

1.8.11 Remote Switching

Remote switching (outside arc fault boundary) shall be installed for main switches for switchboards where the transformer is 750 kVA or above.

1.8.12 Arc Fault Containment

Arc fault containment (in accordance with AS/NZS 61439 Appendix ZD) is required for switchboards where the transformer is 750 kVA or above.

1.9 MOTORS

1.9.1 Three phase above ground low voltage motors

Minimum requirements for three phase above ground low voltage electric motors:

- IE3 efficiency
- IP66 ingress protection
- Insulation class F 155C
- Ambient temperature 55C
- Duty rating service factor 1.15
- Thermistors (for motors 7.5 kW and above)
- Grounding brush at drive end, insulated bearings at non drive end (for VSD driven motors 75 kW and above)

1.9.2 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. Where VSD's are used motor cables should be appropriately shielded.

All motor starter designs must be fully compliant with Gippsland Water standard drawings A1-49670, A1-49671 and A1-49672, or Drouin WWTP standard motor starter drawings.

1.9.3 Motor Protection

All motors shall be protected against overload by a thermal overload device or VSD setting.

For DOL motors for screw conveyors, rotating screens and similar duties, an electronic shear pin is required to provide motor and equipment protection. This is to be a type that measures power not just current. It is to be set to trip on manufacturer's advice, or if this advice is not available, then at around 125% of rated power for 2 seconds.

1.9.4 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.

1.9.5 Variable Speed Drives

All installation, design, commissioning and interfacing of each VSD shall be as per manufacturer's recommendations; including the requirements to effectively ensure that the electromagnetic interference and harmonic distortion are controlled to acceptable limits.

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:

Digital Inputs	Digital Outputs	Analog Inputs	Analog Outputs
Start/Stop	Fault	Speed Reference/ PID Feedback	
Interlock	Running		
Jog			
Reset			
Thermistor (as req)			

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

Each VSD shall have a minimum speed (around 35 Hz) 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 50 Hz, and is to be coordinated with the motor and operational requirements.

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

All wall mounted VSDs shall have covers over exposed terminals.

1.9.6 Harmonic Filters

The design shall include harmonic filters to limit RFI and Harmonics to levels as required by the appropriate supply authority and Australian standards.

All VSDs of 7.5 kW and greater shall include harmonic filters.

This may be an individual passive harmonic filter for each VSD, or low harmonic drives, or an active harmonic filter for a group of VSDs or site, or a combination of these. The

preference for pump stations is individual PHFs for each VSD, and for treatment plants is one AHF for the total harmonic load.

Harmonic filters are to provide a digital output indicating filter status. This signal shall inhibit the VSD where there is one VSD connected to one passive filter.

Passive 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.

1.9.7 Emergency Stop Circuits and Pushbuttons

A risk assessment in accordance with AS3000 and AS4024 shall be performed to determine the requirements for emergency stopping.

All equipment determined by the risk assessment to require emergency stopping 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.

1.10 INSTRUMENTATION AND CONTROL

1.10.1 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.

24 Vdc 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.

1.10.2 Control Voltage

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

1.10.3 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 24 Vac supplies shall be included for noisy loads like solenoids and motor contactors.

1.10.4 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.

1.10.5 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**.**

1.10.6 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:

Function	Colour
Start	Green
Stop	Red
Reset	Blue (with a white R on the button)
Others	Black

Indicating lamp colours shall be used as follows:

Function	Colour
Running	Green
Open	Green
Standby	White/Yellow
Available	Blue
Closed	Blue
Fault	Orange
Other Status	White/Yellow

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

1.10.7 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.

1.10.8 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 meters shall be installed in pits where possible.

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).

Each flow meter shall also include a MODBUS, Modbus/TCP or Ethernet/IP link for reading Totalisers.

1.10.9 Submersible Level Sensors

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

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 level for zero useable capacity from the storage's capacity tables.

1.10.10 Ultrasonic / Radar Level Sensors

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

Ultrasonic /radar 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.

For wet wells, Vega radar level transmitters are preferred. MJK ultrasonic level transmitters can be installed with GW agreement.

1.10.11 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.

1.10.12 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 and PLC IO wiring must fully comply with standard RTU/PLC designs. Refer to the Standard PLC/RTU Programming Specification documents.

1.10.13 PLCs and RTUs Power Wiring

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

1.10.14 RTU Battery Backup

A minimum 6 hours of battery backup shall be provided for each RTU. A minimum battery of a 17 Ahr 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.

1.10.15 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.

1.10.16 Remote Telemetry Units (RTU)

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

All RTUs will be supplied by the Gippsland Water SCADA Group.

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.

1.10.17 Radio Communications

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