SGW Electrical Standards - for SGW Contractors

STE-013
Revision 02

1 Background

South Gippsland Water has high standards in regards to Electrical installations. All electrical equipment shall be capable of operating under the climatic and environmental conditions for the location in which it is installed.

2 Purpose

The purpose of this procedure is to ensure all SGW contactors and any other person completing electrical works on behalf of SGW have an extensive list of minimum standards to follow.

3 Definitions

For the purpose of this procedure only, the following shall mean:

CITECT: was a software development company specialising in the Automation and Control industry.
CT: Current Transformer.
EMI: Electromagnetic interference.
LED: Light-emitting diode.
PC: Desktop computer.
PLC: Programmable Logic Controller.
RFI: Radio Frequency Interference.
RTU: Remote Terminal Unit.
SCADA: Supervisory Control and Data Acquisition.
SGW: South Gippsland Water.
TIA: Telecommunications Industry Association.
VSD: Variable Speed Drive.

4 Procedure

4.1 General Requirements

South Gippsland Water requires that all electrical installation work be carried out to a high standard. Prior to commencing construction, the Contractor shall submit design drawings for approval that include details of electrical equipment, panel layouts, materials and location of wiring runs.

All electrical equipment shall be capable of operating under the climatic and environmental conditions for the location in which it is installed. All items shall be readily and safely accessible for testing, maintenance and replacement.

Standard items shall be used that can be replaced from equipment supplied from the manufacturer without modification. All equipment shall be new and of current model and manufacture.

Electrical equipment shall be of the type specified in the contract or from the Preferred Equipment Schedule attached. Where an equivalent is proposed, prior approval from South Gippsland Water is required.

All electrical works shall be completed to a high standard of workmanship and comply with all wiring regulations in force at the time of installation. These regulations are to act as a minimum and are to work in conjunction with any additional requirements requested by South Gippsland Water on any given installation. The Contractor shall be responsible for the rectification of any defects or sub-standard workmanship deemed to be present based on non-compliance of the standards set out in this document.

All Electrical Equipment shall be supplied new and without any modification from the manufacturer. All equipment is to be installed to the manufacturer's specifications.

Where works are to be integrated into existing systems, or involve an upgrade of an existing system, consultation with South Gippsland Water's project officer shall occur before any proposal is submitted.

South Gippsland Water's objective is to consolidate electrical control systems wherever possible, to ensure that the scope of work includes all aspects that may be relevant and to take into account future requirements that may be relevant and to take into account future requirements.

South Gippsland Water requires a Certificate of Compliance for all prescribed and non-prescribed work carried out by the Licensed Electrical Contractor.

5 Responsibilities

All **SGW Contractors** or **any person completing electrical works** shall follow the minimum standards set out in this document.

6 References

Appendix 1: SGW Electrical Standards

This document is to be reviewed in October 2013 or earlier as required.

This document must not be released to external parties without approval by the Managing Director.

DOCUMENT APPROVAL		
Responsible Manager Approval	Name: Ravi Raveendran	Date: 31/10/2011
SMT Approval	SMT Meeting N^{o}: N/A	Date: N/A
Senior Manager Signature:		

Appendix 1: SGW Electrical Standards

The following standards shall be followed by all SGW contractors and any person completing electrical works on behalf of SGW.

1 Electrical Supply

1.1.1 Voltages

Unless otherwise stated, the electrical supply shall be 3-phase, 400/230 V MEN system.

1.1.2 Fault Level

The selection of the switchgear and the design of the switchboard shall take due regard to the prospective maximum fault level of the supply to the site.

1.1.3 Load Balancing

As far as practical, load shall be balanced equally across all 3 phases of the installation.

1.1.4 Generator Change-Over Switches and Connections

Where deemed necessary, switchboards shall be provided with a generator changeover switch and a socket to readily connect a generator to supply the total maximum switchboard load as listed in 15 - Preferred Equipment List.

1.1.5 Power Failure Relay

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

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

The status of the power supply may be monitored from other intelligent devices in the installation and then effectively displayed.

1.1.6 Surge Protection

Surge protection shall be provided on all switchboards with a separate surge diverter device installed on each phase.

All sensitive equipment including PC, PLC, telemetry or electronic/instrumentation equipment, shall be further and individually protected by dedicated surge diverter.

2 Electrical Standards and Regulations

All work shall conform to the requirements of the relevant Power Supply Authority and any other Statutory Authority having jurisdiction over the work.

Work on, and installation of all electrical equipment and cabling shall comply with the following standards:

- AS/NZS 1125 – Conductors In Insulated Electric Cables And Flexible Cords
- AS/NZS 1319 – Safety Signs For The Occupational Environment
- AS/NZS 1574 – Copper And Copper Alloys – Wire For Electrical Purposes
- AS/NZS 1660 – Test Methods For Electric Cables, Cords And Conductors – Conductors And Metallic Components
- AS/NZS 1680 – Interior Lighting
- 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 2700 – Colour standards for general purpose
- AS/NZS 3008 – Electrical installations – Selection of Cables
- AS/NZS 3010 – Electrical Installations – Generating sets
- AS/NZS 3012 – Electrical Installations – Construction and Demolition Sites
- AS/NZS 3017 – Electrical Installations – Verification Guidelines
- AS/NZS 3100 – Approval and test specification – General Requirements for Electrical Equipment
- AS/NZS 3111 – Approval and test specification - Miniature Overcurrent Circuit-Breakers
- AS/NZS 3439 – Low Voltage Switchgear and Control gear Assemblies
- AS/NZS 3947 – Low-Voltage Switchgear and Control gear
- AS/NZS 4836 – Safe working on Low Voltage Electrical Installations
- AS 60204.1 – Safety of Machinery – Electrical Equipment of Machines
- AS 61800 – Adjustable Speed Electrical Power Drive Systems
- AS 62061 – Safety of Machinery – Functional Safety of Safety-Related Electrical, Electronic and Programmable Electronic Control Systems
- Service and Installation Rules for the relevant Distribution Company
- Industry Standard for Electrical Installations on Construction Sites

3 Installation Requirements

3.1.1 Degree of Protection

All electrical equipment shall be installed to comply with the following:

- Outdoors and wet areas – minimum IP65;
- Indoors – minimum IP42;
- Buried equipment and equipment submerged in pits or wet wells – IP68.

3.1.2 Equipment Installation

To minimize interference between power and control/instrumentation equipment, separate compartments shall be provided as follows:

- PLC and Telemetry equipment shall be installed in a dedicated cubicle. Except for AC supplies to this equipment, no other AC equipment or wiring (including 24V AC) shall be installed or distributed in this compartment. Where the PLC requires output isolation relays, these shall not be installed in the PLC/Telemetry cubicle;
- Socket outlets are to be provided for the telemetry and alarm dialler. Power boards and double adaptors within position;
- All control cabling (single cores) located within a control panel shall be identified at each end with a numbering system, Critchley or Brady or similar. These cables are to be a minimum of V75 rating and to be segregated from power cables;
- Screening of cables is to be in accordance with variable speed drive (VSD) manufacturer's recommendations. Steel Wired Armoured Cable is not sufficient for this purpose.

3.1.3 Brackets and Stands

All brackets shall be manufactured from hot dip galvanized steel, stainless steel or marine grade aluminium.

4 Operator Control Panels and Access to Equipment

For each installation, an operator panel shall be provided for indication and control of all plant operations from the panel. The panel shall normally be an inner escutcheon door. For larger plant, several panels may be required.

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

- Access to all isolators, circuit breakers and switches. Circuit breakers shall be grouped to provide clear separation between AC and DC and circuit breakers controlling differing voltages;
- Fault resets;
- Access to indicators, displays and instrumentation;
- Equipment control panels e.g. VSD controls;
- All Main Switches and Circuit Breakers are to be lockable by means of a "Brady" lockout device.

Equipment shall be arranged in a logical manner to allow ease of operation and labels shall be provided to indicate the function of each item. All outer doors shall be labelled to indicate the function of equipment installed behind the door. Access doors to panels with exposed electrical equipment shall be labelled "Danger – Electrical Equipment – Authorised Personnel Only".

5 Switchboards and Junction Boxes

5.1.1 General

Enclosures shall have doors, which are readily removable and capable of opening through an angle of at least 90 degrees, fitted with locking "T" type handles and stainless steel hinges. Doors with a height of greater than 1 meter 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 90 degrees from the close position. Doors shall be hinged so that, where access is likely to be required to adjacent enclosures at the same time and, where double doors are fitted to enclosures, the doors shall open away from one another where practicable.

All external electrical switchboards shall be fitted with CL001 locks.

Roof canopies shall be provided on all outdoor enclosures.

All connections and equipment shall be accessible from the front of panels without requiring rear access.

Indoor junction boxes and cubicles shall be constructed of steel not less than 2.0 mm thick and surface treated by Powder Coating. Plastic type junction boxes may be approved for limited applications. Junction boxes or cubicles installed in wet areas or areas which may be subject to corrosion from chemicals or sewage gases shall be considered as outdoor.

Outdoor junction boxes and cubicles shall be constructed using non-corrosive stainless steel (Grade 316, minimum thickness 2.5 mm), or marine grade aluminium (minimum thickness 3.0 mm). Plastic type materials are not acceptable for outdoor use.

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

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

The internal surfaces of all switchboards are to be painted gloss White.

Switchboards are to be provided with vents to prevent build up of heat. Vents are to be sealed with termite mesh.

Switchboards shall be installed on galvanised plinths.

There shall be at least 20% free space on the back plane within the switchboard for the installation of equipment in the future.

The mounting location of the monitoring and control equipment on the switchboard shall be between 1.1 and 1.6 metres high.

5.1.2 Outdoor Switchboards

Outdoor cubicles shall be mounted on a concrete pad extending at least one metre in front of the cubicle. The top of the pad shall be constructed approximately 150 mm above the surrounding ground level.

Panels of all outdoor cubicles shall have a fluorescent or LED emergency light installed that is energized upon opening the door. The light shall have its own independent backup power supply with test pushbutton.

The external surfaces of outdoors switchboards are to be painted Bronze Olive.

6 Identification

6.1.1 Electrical Hardware/Labelling

All electrical equipment installed shall be identified with labels that are securely attached and correlate to the schematics supplied by the Contractor i.e. contactors, relays, timers, motors, buttons, etc. In the case of components located within a panel, the labels are to be fixed to the ductwork directly above that component.

The following labelling shall be used:

- Identification labels and nameplates: BLACK LETTERING ON WHITE BACKGROUND.
- Warning and Emergency Stop Labels: WHITE LETTERING ON RED BACKGROUND.

All terminal strips inside a panel shall be numbered sequentially and documented.

The size of the lettering shall be as follows:

General equipment inside enclosure	5 mm
Name of enclosure or cubicle compartment	10 mm
Main cubicle name	15 mm

All terminal strips shall be provided with a strip number and each terminal numbered.

6.1.2 Cables

All cables that leave a switchboard or control cabinet shall be labelled (Critchley type or similar) at that point and at their destination point – motor, junction box, stop button, etc. The numbers/letters are to be the same at each end of any given cable. In turn, these cable numbers and runs are to be included in the documentation and submitted to South Gippsland Water (i.e. cable schedules are required).

7 Cable Installation

7.1.1 General

- All control cabling shall be lugged and numbered within the control panel. These cables are to be neatly housed within appropriately sized duct within the panel;
- Control cables that leave the switchboard and go to the panel door shall be neatly loomed and secured to the door until their destination point;
- All field wiring (with the exception of motors) shall come back to the control panel through terminal strips and not directly to the hardware devices within the control panel;
- Terminal strip numbers shall be identified by clip-on markers and to be sequential at all times;
- All power cables that are exposed to the elements and not in conduit shall be “Orange Circular” unless otherwise stated;
- Control cable runs (to the field) shall include a minimum of 10% of spare cores. The spare cores shall be identified as such and be terminated in spare terminals;

- All underground cables must be located in conduit. Burying direct in the ground with sand and covers is not an option.

7.1.2 Minimum Cable Sizes

Fixed Control Cable Applications	1.0 mm^2
Flexible Control Cable Applications	1.0 mm^2
Fixed Power Applications	2.5 mm^2
Flexible Power Applications	1.5 mm^2
Instrumentation Cables	0.5 mm^2

Cable sizes shall be selected with due regard to load current and voltage drop and shall be suitably derated for environmental effects. Adequate allowance shall be made for future expansion.

7.1.3 Cables in Switchboards and Junction Boxes

The wiring of all cubicles shall conform exactly to schematic and wiring diagrams. Any amendments shall be marked up and appropriate drawings revised.

Not more than two wires shall be connected in one terminal.

7.1.4 Cables in Conduits or Pipes

All cabling to be installed in high damage risk areas shall be enclosed in conduits.

Underground cables shall be installed as follows:

- All bends shall be sweep type;
- Separate conduits shall be used for power and control, with a minimum of 200 mm between power and control conduits. Direction markers shall be installed at every change of direction;
- Spare draw wires shall be installed;
- Conduits shall be sized to suit the cables being installed with an additional minimum 20% spare space/capacity;
- Conduits shall be grouped and be installed in straight runs wherever possible. Easy set or sweep bends shall be used for all changes of direction of continuous conduit runs and shall be in no part under mechanical stress.

All underground conduit rises, external to buildings, shall not be exposed to the elements or reliant upon sealing compounds to prevent the ingression of moisture. Conduit rises shall enter junction boxes with the cables leaving via glands or conduits.

7.1.5 Flexible Cables

Flexible cables shall be used where the cable is to be installed between structures and/or equipment that move relative to each other, or where equipment is required to be removed without disconnecting the cable (such as pumps in wet wells).

All wiring to equipment on doors of cubicles shall be made using flexible cables.

Hooks shall support flexible cables with sufficient bearing area for supporting cables without causing damage to the cable.

Data/voice transmission cables such as Dekron cables shall be treated as flexible cables.

7.1.6 Segregation

As far as practical, control, instrumentation and data cables shall be separated by a minimum of 200 mm from power cables. This includes cables installed on racks, underground and other runs.

Cables carrying heavy current shall be segregated from those carrying low current.

Separate cables shall be run for power and controls. Voltage levels shall not be mixed in the one cable e.g. Low Voltage signals shall not be run in the same cable as Extra Low Voltage signals.

7.1.7 Cable Screens

Cable screens shall be earthed at one end only (normally at the supply end).

Signal and control cables to VSDs, instruments and other equipment shall be run with the screen intact up to the final connection point to the terminating device or terminal strip. Where signal cables and AC cables enter the same cubicle, separation is to be maintained as far as practical. Cable entry points and panel layouts shall take into account provision for maximum separation between cables.

Cables terminating at VSDs shall be earthed in accordance with the manufacturer's recommendations.

7.1.8 Data and Computer Cabling

All data and computer cabling shall be installed to current TIA standards.

Where cabling is to be installed in an office environment, a suitably segregated trunking system shall be used with power and data points located at places to suit the installed equipment.

8 Cable and Cable Core Identification

8.1 8.1 General

All cables shall be permanently and legibly identified at both ends and with the appropriate cable number as identified on the wiring diagram, indicating where they originate. Single core cables shall be identified by their voltage/insulation colour as specified below.

CIRCUIT/ CABLE	COLOUR
Power	
3 Phase Low Voltage Power	Red, White, Blue
230 V AC Active (Control)	Red
AC Neutral	Black

CIRCUIT/ CABLE	COLOUR
Analogue 4 to 20 mA Positive + Negative –	 White Black
24 V AC 24 V AC A 24 V AC N	 Brown Grey
24 V DC fed from external supply for instrumentation and control wiring +24 V DC 0 V DC	 Orange Purple
12 V DC fed from and RTU/Alarm Dialler +12 V DC 0 V DC	 Pink Blue
Voltage Free Switching	White
Earth Conductors	Green/Yellow

Note: At exiting sites the wire colours shall match those already installed, unless there is a major upgrade to the site.

Multicore control cables shall have each control core identified by means of numbers printed on the core insulation and spaced at intervals of not more than 100 mm apart. Cables with less than six cores may have the control cores identified by individual colours.

Multicore control cables with twisted pair cores used for data/voice transmission shall have one black core and one white core to each twisted pair.

At each point of termination, each conductor shall be provided with a cable identification ferrule.

8.1.1 Cable Numbering

All cables installed at a site shall be numbered for ease of identification, with the cable schedule or layout drawing included as part of the documentation package.

All DC supplies (both positive and negative) shall be terminated at a common supply rail and not looped from one device to another. Individual cable numbers shall be provided for each DC negative and positive supply to enable ready identification of the device that they supply.

Cables shall be numbered in a logical fashion.

9 Terminations

All control and instrument cable terminations shall be terminated using suitably crimped pin connectors of the bootlace type. Power cables where connected to a stud shall be terminated using crimped lugs of the appropriate size.

Sufficient slack shall be provided at each termination to enable stripping and reconnection.

All terminals shall be suitably tightened for protection against loosening by vibration.

Connections to or from a cubicle, a junction box or any item of electrical equipment, shall be made via terminal strips in the enclosure.

10 Test and Isolation Points

Test and isolation points shall be provided as required by AS3000, with additional requirements for:

- All instrumentation milliamp loops. This shall be provided by means of removable links to allow insertion of test equipment without open circuiting the loop;
- All CT circuits. This shall be provided by means of a removable link to allow insertion of test equipment without open circuiting the loop.

A warning label shall be installed near each CT terminal strip warning of the dangers of open circuit CT secondary circuits.

11 Earthing

All equipment shall be earthed in accordance with the requirements of AS3000 and manufacturer's recommendations.

Effective earthing shall be provided to ensure safe plant operation and to remove the effects of induced noise in instrumentation and control circuits.

Equipment shall be earthed by direct connection to its respective voltage earth bus and not through mounting panels or holding down bolts.

Earthing bars for 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.

All cubicle doors shall be bonded to earth with a flexible earth lead.

12 Testing and Commissioning

12.1.1 Testing

Prior to delivery of equipment to site, it shall be workshop tested. Tests shall include:

- Visual inspection for finish, construction, standard of work;
- All labelling;
- Insulation resistance tests of all wiring;
- Earth continuity tests on all earth conductors;
- Setting and calibration of all protection and instrumentation equipment;
- Application of power to all wiring;
- Functional tests of all controls, interlocks and protection, for both manual and automatic operations.

The final setting positions of all adjustable devices shall be clearly marked on the equipment. All adjustable devices shall be clearly recorded stating the applied settings.

Test certificates for all tests shall be included in the Operation and Maintenance Manuals.

Equipment shall not be delivered to site until workshop testing has been satisfactorily completed.

12.1.2 Commissioning

Following completion of the site installation works, commissioning tests shall be conducted. A Commissioning Schedule shall be submitted at least one week prior to the proposed tests. As a minimum, the following tests shall be conducted:

- Rotation checks for all pumps and motors;
- Testing of emergency stop limit switches and safety devices;
- End to end telemetry checks from South Gippsland Water's SCADA to each field device;
- Site calibration checks for instrumentation;
- Full functional tests for all equipment, controls and modes of operation;
- Where autodiallers are installed, a comprehensive test to South Gippsland Water's relevant telephones.

At the completion of testing, a complete list of all settings applied to each item of equipment and instrumentation and any PLC programmes, RTU programmes and CITECT projects shall be provided.

13 Drawings

The following electrical drawings shall be provided:

Design Phase:

- Schematic Drawings;
- Field Wiring Diagrams;
- Cubicle General Arrangement Drawings;
- Electrical Equipment Layout Drawings;
- Power Supply location diagram (showing cable route from supply point).

As Constructed:

- Final Schematic Drawings;
- Final field wiring diagrams;
- Site layout with location/dimensions of all underground cables.

Schematic and wiring diagrams shall be consistent with all "as constructed" wiring.
Wiring and schematic drawings shall show cable and core numbers, terminal numbers and all electrical equipment.

14 Documentation

The Contractor shall provide but not be limited to providing the following:

- All CITECT projects on disc (.ctz Files);
- All Allen Bradley projects on disc including specific I/O lists;
- A copy of the RTU project. Electronic and hardcopy, including I/O lists;

- The program files for any type of Operator Interface panel that is installed, including a copy of the latest software;
- A hard copy of any ladder logic that has been installed;
- If a Personal Computer is installed, it must have all relevant software installed on it and be communicating to the relevant hardware devices i.e. RTU and PLC;
- Any PCs installed at WTPs or WRPs shall have licensed RS Logix and RS linx installed on it (latest version);
- All technical manuals for all devices installed (eg. flow meters, electrical valves, VSDs, etc.) These manuals shall be in both electronic and hardcopy format;
- All PLC programming manuals including "Device Net" if installed;
- Drawings detailing communications ports and protocols. This shall include an overview of how devices communicate. ie DH+ , RS232, Serial etc;
- Plans of all underground cable routes.

All schematics and I\O lists shall be supplied to South Gippsland Water upon completion of an upgrade, new installation or add-on. They shall be submitted in binder format and form part of the Operations and Maintenance Manual. An additional copy in digital format shall also be provided. The schematics shall be marked clearly, neatly, be accurate and complete in their entirety and in AutoCAD format.

15 Preferred Equipment List

ITEM	REQUIREMENT
Level Control	MJK MultiTrode
Electromagnetic Flow Meter	ABB MJK
Signal Isolator	APCS Weidmuller
Soft Starter Variable Speed Drive (VSD)	Allen Bradley Danfoss NHP
Programmable Logic Controller (PLC)	Allen Bradley latest model (ControlLogix)
Touch Screen	Allen Bradley with Ethernet protocol
Pump Controller	MultiTrode – MultiSmart (with built in motor protection module) and sun saver screen (display)
Remote Telemetry Unit (RTU)	Elpro, 5 watt Wireless telemetry unit.
Alarm Dialler	Edac
Main Switch Isolator	Clipsal NHP Terasaki
Moulded Case Circuit Breaker (MCCB)	Clipsal Sprecher + Schuh Terasaki
Miniature Circuit Breaker (MCB)	Clipsal NHP Terasaki
Contactor	NHP Sprecher + Schuh

ITEM	REQUIREMENT
Relay	Finder (with LED) GEC (with LED) Omron (with LED)
Push Button Switch Mimic Light	Allen Bradley GEC Sprecher + Schuh Telemecanique
Ammeter Voltmeter Hour run meter	Crompton NHP
Control Transformer	Meanwell
24 V Power Supply	Meanwell
Power Filter Surge Protection Lightning Arrestor	Critec Eritco
UPS	Powerware, A.P.C
Generator Sockets	Marechal 90A DS6 3pm N & E for applications greater than 30A Clipsal 32A N & E for Apps less than 30A

NOTE: Equivalent alternative products, other than PLCs and Human Interface Screens, will be considered. Contractors seeking to provide alternative equipment shall make a submission to South Gippsland Water for consideration and evaluation.

16 General Requirements

16.1.1 Isolators

All isolators shall be Load-Break type, and lockable in the open position.

16.1.2 Moulded Case Circuit Breakers

Circuit Breakers shall be used in preference to fuses. They shall be of thermal magnetic type.

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

16.1.3 Power Fail Relay

Where the power supply to the installation is three-phase, a power fail 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.

16.1.4 Motor Starters

The selection of motor starters shall be based upon the starting currents, capacity of the motors and requirements of the electricity supply authority and for motors rated 5.5kw or greater shall be VSDs. They shall be rated at least 125% of motor full load current.

16.1.5 Voltmeters/Ammeters

Voltmeters shall be installed to display the incoming supply voltage for each installation. For three phase supplies, a phase selector switch shall be provided.

Similarly, ammeters provided shall display incoming current.

Both meters shall be appropriately scaled and ammeters exceeding 60 A shall employ current transformers.

16.1.6 Control Relays

All control relays shall include indication LED's and manual toggle switch built in.

16.1.7 Switchboard Heaters

Each Switchboard shall be fitted with an anti-condensation heater controlled by a thermostat. The heater shall be sized for the switchboard and shall be mounted at the bottom of the switchboard and protected to prevent inadvertent contact with the heater element or other high temperature parts.

16.1.8 Fans

Cubicles shall be provided with ventilation to provide adequate cooling under all ambient conditions. Where a fan is required, it shall be controlled by a thermostat. All air vents shall be provided with removable filters to prevent ingress of dust and insects.

16.1.9 Push Buttons

Push buttons shall be coloured as follows:

Emergency Stops	Red
Start	Green
Stop	Red
Reset	Blue
All Others	Black

16.1.10 Indicating Lamps

Indicating lights shall be:

- Removable from the front;
- Use cluster LEDs, not incandescent;

- 24 V AC unless otherwise specified.

Indicator lamps shall be coloured as follows:

Start	Green
Stop	Red
Reset	Blue
Fault	Yellow
All Others	White

17 Instrumentation

Surge protection shall be provided on all switchboards where electronic/instrumentation equipment is installed. A separate phase to earth protection device shall be installed on each phase.

Instrument current outputs shall be rated 4 to 20 mA, individual fusing to each PLC/RTU analogue output card and individual fusing for each PLC/RTU analogue output loop shall be installed.

All instrument current outputs shall be isolated. Instruments that do not have inbuilt isolated outputs shall have externally powered loop isolators installed.

18 Variable Speed Drive

The variable speed drive shall not be a general-purpose product, but of dedicated water engineered design.

The manufacturer shall demonstrate a continuous period of manufacture and development of frequency converters, for at least 15 years.

The manufacturer shall provide full local technical support, spares holding and troubleshooting capability. A training course on drive setup, commissioning and application options shall be provided by the manufacturer South Gippsland Water's consultant/ contractor/ maintenance engineers.

19 RFI/EMC Prevention

19.1.1 Cable Types

To minimize the effects of EMC, cables between the VSD and motor shall be of the following type:

- Braided copper screen minimum 85% coverage;
- For non-submersed cables, conductor insulation shall be XLPE 90°C rated;
- For submersed cables, insulation shall be EPR/CPE 90°C rated;
- Where motors are fitted with thermistors, a separate screened thermistor cable shall be installed between the motor and VSD.

Cables that meet these requirements include Olex Varoflex Flexible VSD cable.

19.1.2 Cable Installation and Earthing

Cables shall be installed as follows:

- A minimum of 200 mm separation between control cables, VSD power supply cables, and motor power cables for the length of the cable runs;
- Earth cables shall be installed between the main supply and the VSD earth bar, and VSD earth bar and motor. These cables shall be appropriately sized;
- All screened cables shall be terminated at both ends with the cable sheath stripped to expose the screen and a cable clamp used to earth the screen. The use of “pigtails”, lead out wire and other means of terminating screens are not permitted. These terminations shall be made at the earth rail in the appropriate compartment and at the VSD;
- Cables shall not exceed the maximum length as recommended by the VSD manufacturer.

19.1.3 Commissioning

The Contractor shall commission the VSD and/or filter in accordance with performance/operating requirements and manufacturer recommendations. This shall include programming of all settings as appropriate to the specific installation and may include:

- Motor protection curves;
- Upper and lower speed settings;
- I/O and serial link communication (if called for);
- Ramp up/down rates;
- Alarm and fault outputs.

The Contractor shall provide detailed manufacturer documentation, including operation and programming manuals, copies of any software and a detailed list of all configuration settings applied to the VSD as applied at the time of commissioning.

19.1.4 Control Modes

VSDs shall be capable of remote, local and automatic control.

In LOCAL control, an operator shall be able to start, stop and control the VSD speed via the VSD control panel.

In REMOTE control, the VSD shall be controlled by the South Gippsland Water SCADA system.

In AUTO mode, the VSD shall be controlled by the appropriate level, pressure or other device site control device.

20 Power Quality Standards

VSDs and other non-linear loads are a source of harmonic interference to electronic equipment located at South Gippsland Water sites (such as instrumentation and telemetry)

and to other Powercor customers. Australian Standards and Electricity Supply Authorities limit this interference to levels specified within the relevant Standards.

The supplier of the VSD shall provide full installation instructions for the equipment to minimize EMF. The Contractor shall ensure that there is no interference to the public or to South Gippsland Water facilities as a result of the operation of the VSD. The generated Electromagnetic Interference shall be limited through appropriate selection of equipment such as RFI filters to provide appropriate dampening of the interference. The appropriate filters shall be supplied and installed by the Contractor.