Wellington Water

General Electrical Specification

Part 2

Electrical Components Specification for Switchboards, Motor Control Centre and Automation Panels

Version 3.0

Our water, our future

This specification should be read in conjunction with:

A) Particular Electrical Specification (related to specific project)
B) General Electrical Specification – Part 1 - Switchboards & MCC Design
C) General Electrical Specification – Part 3 - Installation
D) General Electrical Specification – Part 4 - Electrical Building Installation

Table of Amendments

Version	Date	By	Description
1.00	23/10/07	SRC	Original version
1.01	10/12/07	SRC	Issued for Construction
2.00	28/02/11	SRC	Revised with latest standards
3.00	23/05/21	Adrian S	Reformatted and revised

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Definitions

Term/Acronym	Definition
ACB	Air circuit breaker
AS/NZS	Australian Standard/New Zealand Standard
BS EN	British Standard European Norm
Client	Capacity Infrastructure Services
CT	Current transformer
Engineer	Project engineer acting for the Client
IEC	International Electrotechnical Commission
IP	Internet Protocol
LED	Light emitting diode
Manufacturer	Manufacturer or supplier of component
MCB	Miniature circuit breaker
MCC	Motor Control Centre
MCCB	Moulded case circuit breaker
PFC	Power factor capacitors
PLC	Programmable logic controller
PTC	Positive temperature coefficient
RCD	Residual current device
RFI	Radio frequency interference
RTU	Remote terminal unit
VSD	Variable speed drive

1 GENERAL

1.1.1 The selection of electrical components for Switchboards, Motor Control Centre (MCC) or instrument, control and automation panels shall comply with the requirements of this specification unless otherwise defined by the project 'Particular Project Specification'.

1.1.2 Component selection shall be selected from the latest list of 'Approved Electrical Components' supplied by the Client. If the component is not listed in the 'Approved Electrical Components' an alternative by a New Zealand supplier will be offered for approval in writing by the Engineer.

1.1.3 In the absence of a relevant and consistent Australian Standard/New Zealand Standard (AS/NZS), the International Electrotechnical Commission (IEC) standards shall apply. General standard for 'Low-voltage switchgear and controlgear' IEC 60947 applies to all components.

1.1.4 Motor starter components shall be designed to meet 'Type 2' coordination as defined in IEC 60947-4-1.

1.1.5 Unless otherwise stated, all motor starters and VSD units shall be suitable for centrifugal pump application.

1.1.6 All components, when supplied as a package for a Switchboard or MCC, shall be supported with commissioning spares, to allow for early-life failures during site acceptance testing.

2 GENERAL ELECTRICAL COMPONENTS

2.1 DIN rail

2.1.1 Unless otherwise specified, all DIN rail will be of the standard size 'Top Hat' type, electro-plated zinc coated or aluminium, in either the punched or plain format (aluminium punched type preferred).

2.2 Terminal blocks

2.2.1 Terminal blocks shall be rail mounted complete with mounting rail, supports, and identification accessories, unless cable size determines otherwise. Connectors, where used, shall provide the following facilities:

(a) Testing of circuits connected to the terminal.

(b) Linking of adjacent terminals.

(c) Screw clamp type connections (spring type may be used for control wiring with the Engineer's approval).

(d) Cross-linking facilities where terminals are associated with current monitoring facilities. This facility shall allow the current source to be short-circuited.

(e) Isolation facilities where the terminals are associated with voltage monitoring facilities.

2.2.2 Terminal blocks for programmable logic controller (PLC) inputs and outputs shall be supplied by the PLC supplier.

2.3 Isolators and fuse switch disconnectors

2.3.1 Isolators and fuse switch disconnectors shall be rated to meet the requirements of the application and comply with IEC 60947-3.

2.3.2 Isolators and fuse switch disconnectors shall have a rated short circuit capacity not less than the maximum prospective short circuit capacity available from the upstream device.

(a) Where designated for incomer or feeder duties, they shall have utilisation category AC22 for the switching of mixed resistive and inductive loads and moderate overloads.

(b) Where designated for starter duties, they shall have utilisation category AC23 for the switching of motor loads or other highly inductive loads.

(c) Isolators and fuse switch disconnectors shall be suitable for fault-make/load-break operation.

2.3.3 Isolators and fuse switch disconnectors rated up to a maximum of 400A frame size may be fitted.

2.3.4 Where designated for feeder duties, fuse switch disconnectors shall be of the 3-pole type, with a separate neutral link where necessary.

2.3.5 All switch disconnectors and fuse switch disconnectors shall have provision for locking in the 'OFF' position.

2.4 Fuses

2.4.1 Fuse type and size shall be selected to suit the application and be of the high rupturing capacity type conforming to British Standard European Norm (BS EN) 60269 unless an alternative is agreed with the Engineer.

2.4.2 Control circuit fuses of 6.3A and below shall be installed in suitable fuse terminal holders with light emitting diode (LED) blown indication.

2.4.3 Control fuses for PLC and telemetry remote terminal unit (RTU) shall be fitted as recommended by the manufacturer.

2.5 Circuit breakers

2.5.1 Air circuit breakers (ACBs), moulded case circuit breakers (MCCBs) and miniature circuit breakers (MCBs) shall comply with IEC 60947-2.

2.5.2 MCBs for the protection of wiring installations of buildings and similar applications (domestic') shall comply with AS/NZS 61009.1.

2.5.3 Residual current devices (RCD) shall comply with AS/NZS 3190, AS/NZS 61008.1 or AS/NZS 61009.1.

2.5.4 As a minimum, C-Curve 6 KA breakers shall be fitted for general and control purposes.

2.5.5 MCBs shall be fitted with thermal overload and instantaneous magnetic short circuit protection with a maximum rating of 63A.

2.5.6 Circuit breakers of 63A or more shall be of the moulded case type with clear indication of the open, closed and tripped positions.

2.5.7 Incomer and feeder ACBs and MCCBs shall be suitable for fault- make fault-break operation and have a rated service short circuit breaking capacity (Ics) not less than the maximum prospective short circuit capacity.

2.5.8 Incomer and feeder MCCBs shall be fitted with electronic trip units with adjustable short circuit protection (rating permitting) and adjustable thermal protection. Generator MCCBs shall be fitted with electronic trip units with adjustable short circuit and thermal protection, suitable for protection against typical generator low short circuit currents.

2.5.9 ACBs and MCCBs shall be assembled within the enclosures in accordance with manufacturers' recommendations, ensuring that the fault rating of the device and assembly is maintained.

(a) All control and power connections to the devices shall be accessible without removing internal shrouding.

(b) For withdrawable devices, the minimum internal protection shall be to IP 2X with the device removed or in the test position.

(c) Where an ACB trolley is required, there shall be one provided for each switchboard/MCC room and for each type of ACB, be capable of reaching each ACB, and be purpose made by the ACB manufacturer.

(d) Tools for withdrawing the ACB or spring charging shall be provided for each ACB.

(e) Motorised spring charging shall be provided where necessary. All ACBs shall be of the withdrawable type.

2.5.10 Where designated for feeder duties, breakers shall be of the 3-pole type, with a separate neutral link where necessary.

2.5.11 All circuit breakers shall have provision for locking in the 'OFF' position.

2.6 Push buttons

2.6.1 Push buttons shall be 22 mm in diameter and be of the flush bezel type. They shall match the indicating lamps in style.

2.6.2 Emergency stop push buttons shall be of the 'latching', mushroom- headed type and comply with AS/NZS IEC 60947.5.5. They shall be of the quarter-turn or pull-to-release type. Key type release buttons shall not be used.

Push button switches shall have the following colour designations:

Function	Colour
STOP / OFF	RED
START / ON	GREEN
FORWARD / REVERSE	BLACK
OPEN	BLACK
CLOSE	BLACK

Function	Colour
RESET	BLUE

2.7 Signal lamps

2.7.1 Indicating lamps shall be designed to match the pushbuttons and switches and be 22 mm in diameter, high intensity LED type,

2.7.2 In compliance with IEC 60947 or similar approved equivalent standard for all indicator and operator colours:

Function	Colour
ON / RUNNING	GREEN
OFF / STOPPED	RED
FAULT	AMBER
AVAILABLE	WHITE
EMERGENCY STOP OPERATED	RED
OPEN	WHITE
CLOSED	WHITE

2.8 Pushbuttons (illuminated)

2.8.1 Indicating pushbuttons may be used with the Engineer's approval.

2.8.2 Indicating pushbuttons shall be 22 mm in diameter with illumination from LED.

2.9 Voltage sensing relays

2.9.1 Voltage sensing relays shall have:

(a) Connections from back-up non-essential busbar mounted fuses to relay protection fuses.

(b) Operating set point adjustable between normal mains voltage and 15 percent of normal mains voltage on any or all phases.

(c) Switching differential adjustment between 0 and 5 percent of normal mains voltage.

(d) Delayed operation adjustable up to three seconds.

(e) Contacts minimum of one normally open and one normally closed.

(f) Wiring from contacts brought back to terminals in a compartment accessible to external wiring.

2.10 Control relays

2.10.1 Control relays shall conform to IEC 61810-1 and be supplied by 24V dc. Other control circuit voltages may be used with the approval of the Engineer, but in these cases the operating voltage shall be clearly visible without removing the relay from the base.

2.10.2 Control relays shall have the following functions and features:

(a) Plug in flat pin type, with 8 pin, 11 pin or 14 pin configuration.

(b) Socket shall be 'Top Hat' DIN rail mounting.

(c) Relay shall incorporate label legend.

(d) Provide indication of the status of the contacts by mechanical means or LED.

(e) Guaranteed for more than 1 million mechanical operations.

2.10.3 The relay contact rating shall be suitable for the connected load.

2.10.4 Heavy relays shall have wire retention clips.

2.10.5 Timer relays will utilise the same base format.

3 MOTOR CONTROL COMPONENTS

3.1 Motor starter circuit breakers

3.1.1 Motor starter MCCBs shall be fitted with motor starter magnetic or electronic trip units for short circuit (but not thermal) protection.

3.2 Contactors

3.2.1 Contactors shall comply with IEC 60947-4-1.

3.2.2 Contactors shall be rated for the application and:

(a) Continuous operation

(b) Intermittent duty - Class 0.1

(c) Utilisation Category AC-3, under standard conditions and in non- ventilated enclosures.

3.2.3 Be fitted with a minimum of one set of change over type auxiliary contacts rated at 230 Vac 10A, additional sets of the same rating shall be fitted as necessary to the design.

3.2.4 Incorporate visual external indication of the open or closed condition.

3.2.5 Have wiring from the coils and auxiliary contacts brought out to accessible terminals.

3.2.6 Be rated for making and breaking short-circuit current in coordination with their associated short-circuit protection devices.

3.3 Overloads

3.3.1 Fixed speed starters shall provide overload protection up to and including 15 kW thermal overloads and above 15 kW electronic overloads.

3.3.2 Softstart and VSD motor starters shall be provided with 'built-in' motor protection overload facility.

3.3.3 Overloads shall be 'direct mounted' to the contactor or (with the agreement of the Engineer) mounted beside the contactor on the DIN rail.

3.3.4 The overload 'Reset' facility will be selectable for manual or automatic reset.

3.3.5 The overload shall display status through an indicator and auxiliary contacts.

3.3.6 All three phases will be monitored and a phase imbalance of greater than 10 percent will activate the overload.

3.4 Integrated motor starters

3.4.1 The use of 'Integrated Motor Starters' is permitted with the Engineer's approval. The provided equipment shall be totally coordinated and meet IEC 60947-4-1.

3.5 Variable speed drives

3.5.1 Variable speed drives (VSDs) will comply with IEC 61800-2 and meet the following general requirements:

(a) All installation, design, commissioning and interfacing to the VSDs shall be as per manufacturers recommendations, including the requirements to ensure that the radio frequency interference (RFI) and harmonic distortion (on the mains supply) are limited to or below that required by IEC 61800-3.

(b) Particular attention shall be taken with ventilation and cooling requirements to maintain normal operating temperatures as recommended by the manufacturer.

(c) The faceplate panel for control shall be user friendly and simple to use. The Contractor shall supply a step-by-step user guide for use of the panel, as well as a detailed operator manual for programming and any other complex functions.

(d) A contactor shall be provided within the control cubicle to isolate the power section of the VSD from the control circuitry on the operation of an external lock out stop switch.

(e) The VSD shall not be affected by the use of mobile phones or any radio transmitting device which is in use external to the VSDs control cabinet.

(f) The VSD shall have the option to be supplied with the appropriate communication ports to allow communications with the PLC and/or RTU.

3.5.2 As a minimum, each VSD shall have the following hardware functions and features:

(a) Short term rating of 110 percent of maximum continuous rating for one minute.

(b) All components shall be protected against external short circuits and internal short circuits.

(c) Motor protection including over current, ground fault, and motor thermal protection.

(d) Internal voltage surges and external voltage surges. Operation of the VSD shall not be affected by spurious noise emanating from adjacent electrical switchboards.

(e) VSD fault conditions or over temperature shall initiate a safe shutdown of the VSD. Manual reset shall be necessary prior to restart.

(f) The VSD internal control equipment shall automatically correct the VSD output voltage for variations in mains voltage over a +10 percent -15 percent range.

(g) The VSD equipment shall withstand, without damage, any motor regenerative voltages that may occur on the load side terminals.

(h) The rate of rise of output voltage shall be limited to a value that does not cause long term degradation of the motor insulation, in particular, installations with deep bore pumps, and long cable runs, and shall comply with the manufacturers recommendations.

(i) The VSD shall be controllable from either a 4-20 mA signal for automatic control and have a speed dial for manual speed control. It is permissible for the raise/lower controls to be integral to the VSD unit providing easy operator access and operation is maintained.

(j) A remote mounted control panel (where the VSD is installed inside a switchboard).

(k) All VSD faults, alarms and control signals are to be available from the VSD keypad.

(l) All VSDs shall incorporate internal filters to reduce harmonics and RFI to comply with the relevant Supply Rules and New Zealand standards.

(m) All VSDs shall accept inputs from positive temperature coefficient (PTC) directly.

3.5.3 As a minimum, each VSD shall have the following programmable functions and features:

(a) Speed control over the range 0-120 percent of the driven electrical device.

(b) Acceleration/deceleration ramp time 0-600 seconds.

(c) Selection of up to two 'Preset' speeds.

(d) The ability to skip 'problem' frequencies.

(e) The ability to adjust switching frequency.

(f) Automatic or manual fault reset of selected faults.

(g) Minimum and maximum speed settings.

(h) Output filters where the VSD is driving an older style motor and insulation may be questionable, as per the manufacturer's recommendations for cable length (typically 100 m) and motor design.

(i) Return, ready for operation without operator interaction after power re-start.

3.5.4 As a minimum, VSDs will meet the following input and output requirements:

(a) Digital inputs (provide by clean contact inputs)

(i) Start/stop

(ii) Start inhibit/interlock

(iii) 3 additional programmable inputs.

(b) Digital outputs (240V AC 5 amp, 100V DC 2 amp changeover contacts)

(i) Motor running

(ii) VSD fault

(c) Analogue inputs

(i) Speed control (4-20 mA)

(ii) Motor thermistor protection input (0-10 V)

(d) Analogue outputs

(i) VSD speed/frequency (4-20 mA)

(ii) Current (4-20 mA)

3.6 Harmonic filters

3.6.1 Provide all power conditioning equipment required to meet harmonic standards required by the line company specific to the installation. See also Powerco and Wellington Electricity network connection standards.

3.6.2 VSDs shall be provided with harmonic filter units (either internal to the VSD or as a separate filter unit) to reduce harmonics to levels as specified. Where multiple VSDs are connected to one MCC, a single active filter unit may be provided to afford compensation for all the VSDs connected to that sub-board.

3.6.3 Active filters shall measure and analyse the harmonics induced by the VSD or other load and inject an appropriate harmonic load to neutralise these harmonics. The filter unit shall be sized appropriately to meet the local Distribution Company's requirements to neutralise harmonics.

3.6.4 Whilst the overall aim of filters is to limit harmonics to the specified levels at the Point of Common Coupling to the electricity network, in some cases high levels of harmonics may cause interference to other equipment that share the MCC. In such cases, the harmonics shall be reduced so that there no detrimental effect on other equipment at the MCC.

3.6.5 The proposed manufacturer/model and location of filter units to be provided shall be subject to approval by the Engineer.

3.7 Softstart units

3.7.1 Where required, softstart units shall be installed in a manner to minimise potential interference to other equipment. This may require separate cubicles for such equipment.

3.7.2 A separate by-pass contactor shall be provided if not incorporated into the softstart unit.

3.7.3 The protection class shall be selectable at the softstart unit.

3.7.4 As a minimum, each softstart unit shall have the following functions and features:

(a) The maximum starting current can be adjusted from 200 percent to 700 percent of the nominal motor current.

(b) Accelerating ramp time shall be adjustable from 1 to 30 seconds.

3.7.5 After the motor has stopped or the starter has been switched off, the thermal state of the motor is calculated (even if the control circuit is not energised) and thermal control prevents the motor from restarting if the temperature rise is too high.

3.7.6 In addition to the necessary digital inputs to operate the softstart unit, the following digital outputs will be available in the form of 'volt-free contacts':

(a) Softstart unit at full speed

(b) Spare – (programmable)

3.7.7 The following analogue outputs will be available:

(a) Motor current

(b) Motor power

(c) Motor torque

3.7.8 The softstarter should also display all active faults.

3.7.9 If the motor is fitted with thermistor devices, the softstarter unit shall be capable of incorporating these, thus avoiding the use of an external thermistor relay.

3.8 Thermistor protection relays

3.8.1 The thermistor protection relay shall conform to IEC 60034-11 and be suitable for the PTC characteristics of the installed device.

3.8.2 As a minimum, each thermistor protection relay shall have the following functions and features:

(a) Automatic reset facility
(b) Display status through an indicator and auxiliary contacts
(c) DIN rail mounted

3.9 Pump protection relays

3.9.1 Pump Protection relays shall be provided in accordance with the manufacturers recommendations and shall have at least:

(a) Water-in-oil detection
(b) Thermal limit detection

4 INSTRUMENTATION

4.1 Panel Mounted Instrumentation

4.1.1 Door mounted instruments shall be:

(a) Industrial grade or approved equivalent standard.
(b) Flush mounted
(c) Minimum size 96 mmx 96 mm (DIN) or approved by the Engineer.
(d) Have suitable Internet Protocol (IP) rating for the application.

4.1.2 Ammeters for motor starters shall be:

(a) Scaled so that 75 percent of full-scale deflection corresponds to full load current of device connected.
(b) Accurate to ± 2.5 percent of full-scale reading (unless specified greater).
(c) Ammeters with full scale deflection less than 5 amps can be connected directly.
(d) Capable of 6 times full-load account for startingcurrents.

4.2 Current transformers

4.2.1 Current transformers (CTs) shall comply with IEC 61869-2 or approved equivalent standard.

4.2.2 Shall have an accuracy class of:

(a) 0.5 for check meter and revenue metering applications.
(b) 3 for general purpose metering applications.
(c) 10P for protection applications.

4.2.3 Shall have a 5 VA minimum burden unless otherwise specified.

4.2.4 Test links shall be provided in switchboards for all CTs.

4.3 Hour-run meters

4.3.1 Hour-run meters shall:

(a) Be minimum 5-digit type.

(b) Be complete with concealed reset facility.

(c) Have provision for retaining their latest value for a minimum of 250 hours on loss of power (when electric type).

5 EXTRA LOW VOLTAGE POWER SUPPLIES

5.1.1 Extra low voltage supplies shall be suitably rated for the connected load and duty.

5.1.2 Extra low voltage DC supplies shall:

(a) Be supplied from a 24 Vdc regulated power supply.

(b) Have the ability to monitor the state of the low voltage output.

(c) Where required, shall be capable of charging back-up batteries.

(d) The negative of a DC power supply shall be connected to earth.

5.1.3 Extra low voltage AC supplies shall have:

(a) The secondary winding fully isolated from the primary winding.

(b) One leg of the secondary winding connected to earth.

(c) One leg circuit breaker protection or approved equivalent.

6 POWER FACTOR CAPACITORS

6.1.1 Power factor capacitors (PFCs) shall comply with the Electricity Network Connection Standard.

6.1.2 Where required, PFCs shall be installed in the switchboard for each pump. The PFCs size shall be selected, based on the pump manufacturers' data sheets, to correct the full load power factor to the value specified by the Power Supply Company to avoid any reactive power charges (normally no less than 0.95 PF).

6.1.3 Capacitors 2 kVAr and above shall have an overpressure disconnect system for use in the event of internal faults. The capacitors shall be manufactured and tested to comply with IEC 60831-1/2.

6.1.4 The connection of power factor connection capacitors shall be switched by a contactor connected to the line (upstream) side of the motor starter protection and CT modules.

6.1.5 Fit air cored inductors to each capacitor phase to limit capacitor inrush current. Capacitor contactors shall be rated for capacitor switching. Rating of the capacitor contactor(s) is to be verified by the designer.

6.1.6 PFCs shall be installed outside the switchboard multi-boxes as follows:

(a) Indoor pump stations - in stainless steel enclosures mounted on the wall away from the multi-box switchboard.

(b) Outdoor pump stations - in the ventilated cable base of the outdoor enclosure. The capacitors shall be installed in stainless steel containers.

6.1.7 Power factor capacitors 2 kVAr (at 400 V) and above shall be 440 Volt rated Vishay-Estaprop brand mounted in stainless steel enclosure with air chokes and cable terminations - Supplier, Lees Technology.

6.1.8 Power factor capacitors below 2 kVAr (at 400 V) shall be 440 Volt rated epoxy-cased capacitors mounted in stainless steel enclosure with air chokes and cable terminations - Supplier, Metalect Industries

7 STANDBY GENERATORS

The following factors shall be considered in the design of a standby generator, with final approval of design by the Engineer.

7.1.1 General

(a) Enclosure ratings
(b) Prime power rating
(c) Voltage specs – variation and regulation
(d) Earthing
(e) Isolation
(f) Radio interference

7.1.2 Generator controls

(a) Preferred controller?
(b) Synchronising/parallel operation?
(c) Auto mains fail operation
(d) Lockouts: AUTO/MANUAL? MAINS OPEN/CLOSE? GENERATOR OPEN/CLOSE?

7.1.3 Generator instrumentation and indications

(a) Over temperature
  (i) Low oil pressure
  (ii) Over speed
  (iii) Low coolant flow
  (iv) Low coolant level
(b) Local Indications
  (i) Hour meter
  (ii) Engine water temperature gauge
  (iii) Lubricating oil pressure gauge
  (iv) Lubricating oil temperature gauge
  (v) Tachometer
(c) SCADA indications
  (i) Not in Auto [Contacts closed in Remote Auto], Engine Running [Contacts closed for running], Fail safe common fault including: diesel alarm (low oil pressure, high temperature, over speed, low engine tank water, fail to start) [Contacts open for

alarm] , Fail safe charger fault. [Contacts open for fault], Alternator on – equivalent to Generator closed onto bus [Contacts closed for on], Diesel running [Contacts closed for running]

(ii) Low diesel tank level, float switch at 25 percent of diesel tank volume [Contacts closed if > 25 percent full],

(iii) Generator real power output in kW [4-20mA 0-110 percent rating]

(iv) Generator Tank Leak detection (if fitted)

(v) Remote Commands:

A. Run Islanded, Run Parallel?

7.1.4 Physical Installation

(a) Marine/Urban installation

(b) Material requirements

(c) Acoustic limits (minimum, but also site and application dependant)

(d) Fuel storage; minimum runtime at full load

(e) Easements

(f) Hazardous Substance certification for fuel storage

(g) Resource Consents - Fuel storage, Air discharge and Noise consents