

General Electrical Specification

Part 1

Design and Construction of Switchboards, Motor Control Centre and Automation Panels

Version 4.0



This specification should be read in conjunction with:

- A) Particular Electrical Specification (related to specific project)
- B) General Electrical Specification – Part 2 - Electrical Components
- 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	10/02/11	DAT	Cable colour chart updated
4.00	23/05/21	Design Team	Reformatted as Wellington Water document and minor revisions

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Appendix A – Particular Electrical Specification

Definitions

Term/Acronym	Definition
AS/NZS	Australian Standard/New Zealand Standard
EMC	Electromagnetic compatibility
IEEE	Institute of Electrical and Electronics Engineers
Manufacturer	Manufacturer or supplier of switchboard/MCC
MEN	Multiple earth neutral
MCC	Motor Control Centre
PLC	Programmable logic controller
STS	Static transfer systems
UPS	Uninterruptible power systems
Wellington Water	Wellington Water Ltd or their representative

1 BASIS OF DESIGN

1.1 Intended audience

- 1.1.1 These documents are intended for engineers, designers and developers providing products and services to Wellington Water.

1.2 Design criteria

- 1.2.1 The design shall take notice of the requirements in the Electrical (Safety) Regulations of New Zealand in respect of safe access for Operations and Maintenance personnel.
- 1.2.2 The design criteria for each Switchboard or Motor Control Centre (MCC) are individually defined by the project details and needs that are defined in the 'Particular Electrical Specification'. If not specified above, the following requirements shall prevail:

Item	Detail	Notes
Service conditions	Indoors / outdoors, with adequate ventilation	
Supply voltage (V)	11 kV 3 phase, 400 V 3 phase, 4 wire	
Supply frequency (Hz)	50 Hz	Equipment installed should be rated to support 50 Hz + 5%
Fault level (kA)	10 kA minimum	Rated short time withstand current (I _{cw}). Designer to update if calculated fault level exceeds 10 kA
Fault duration (sec)	1	
Diversity	1	
Neutral	Solidly earthed (MEN system)	
Ambient temperature	-5 to 40°C	
Relative humidity	Up to 90%	Damp conditions
Hydrogen sulphide	Present at wastewater sites	
Atmospheric conditions	Coast/marine	
Coordination	Type 2	
Segregation	4a (Classification in AS/NZS 61439.1 – No ELV or LV terminals in wire way except for Neutral and Earth Bars)	Switchboards constructed to AS/NZS 61439 Form 2 and 3 may be provided but must be approved by the Wellington Water
Degree of protection	IP42 for indoor IP56/IP66 for outdoor	Live parts, ingress of foreign bodies (dust) and liquids (water spray)

Australian Standard/New Zealand Standard (AS/NZS); multiple earth neutral (MEN)

1.2.3 National and international standards to be used:

- (a) NZ Electricity (Safety) Regulations 2010
- (b) AS/NZS 3000:2007 - Electrical installations (known as the Australian/New Zealand Wiring Rules)
- (c) NZ Electricity Act 1992
- (d) NZ Building Act 2004
- (e) NZ Building Code
- (f) NZ Health and Safety at Work Act 2015
- (g) NZ Radiocommunications Regulations 2001
- (h) AS/NZS 1768:2007 - Lightning protection
- (i) AS/NZS 1680.2.4:2017 - Interior and workplace lighting - Part 2.4: Industrial tasks and processes
- (j) AS/NZS 1158 - Lighting for roads and public spaces
- (k) AS 60529-2004 (R2018) - Degrees of protection provided by enclosures (IP Code)
- (l) AS/NZS 61386:2015 - Conduit systems for cable management
- (m) AS/NZS 60079 Electrical apparatus for explosive gas atmospheres
- (n) IEC 61300-3-35:2015 - Fibre optic interconnecting devices and passive components. Basic test and measurement procedures. Examinations and measurements. Visual inspection of fibre optic connectors and fibre-stub transceivers
- (o) NZ Electrical Codes of Practice
- (p) AS/NZS IEC 60947 - Low-voltage switchgear and controlgear
- (q) NZS 5807:1980 - Code of practice for industrial identification by colour, wording or other coding
- (r) NZECP36 - New Zealand Electrical Code of Practice for Harmonic Levels (NZECP 36:1993)
- (s) AS/NZS 61000 - Electromagnetic compatibility (EMC)
- (t) AS/NZS 4024 - Safety of machinery
- (u) AS/NZS 4024.1604:2019 - Safety of machinery - Part 1604: Design of controls, interlocks and guarding - Emergency stop - Principles for design
- (v) PC62.41.1 - Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits
- (w) PC62.41.2 - Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits
- (x) PC62.41.3 - Institute of Electrical and Electronics Engineers (IEEE) Draft Guide for Interactions Between Power System Disturbances and Surge Protective Devices
- (y) AS/NZS 61439 - Low-voltage switchgear and controlgear assemblies
- (z) AS/NZS 3010:2017 - Electrical installations - Generating sets
- (aa) BS EN 62040-3:2011 - Uninterruptible power systems (UPS). Method of specifying the performance and test requirements
- (bb) IEC 62310-1:2005 - Static transfer systems (STS)
- (cc) AS/NZS 1359 - Rotating electrical machines

- (dd) AS/NZS 5000.1:2005 - Electric cables - Polymeric insulated - For working voltages up to and including 0.6/1 (1.2) kV
- (ee) AS/NZS 5000.2:2006 - Electric cables - Polymeric insulated - For working voltages up to and including 450/750 V
- (ff) AS/NZS 5000.3:2003 - Electric cables - Polymeric insulated - Multicore control cables
- (gg) AS/NZS 3008 - Electrical installations - Selection of cables
- (hh) AS/NZS 3008.1.2:2017 - Electrical installations - Selection of cables - Part 1.2: Cables for alternating voltages up to and including 0.6/1 kV - Typical New Zealand conditions
- (ii) AS/NZS 2373:2003 - Electric cables - Twisted pair for control and protection circuits
- (jj) AS/NZS 4853:2012 - Electrical hazards on metallic pipelines
- (kk) AS/NZS 4961:2003 (Reconfirmed 2016) - Electric cables - Polymeric insulated - For distribution and service applications
- (ll) AS 2239-2003 (R2016) - Galvanic (sacrificial) anodes for cathodic protection

1.2.4 In the event of conflict of information, the order of precedence will be as follows:

- (a) New Zealand Electricity Act 1992 and Electricity Amendment Act 2006
- (b) New Zealand Electricity (Safety) Regulations 2010
- (c) NZS 3000:2007 Australian/New Zealand Standard on Wiring Rules (including amendments), or the latest version (if superseded)
- (d) AS/NZS 61439.1:2016 - Low-voltage switchgear and controlgear assemblies - Part 1: General rules
- (e) AS/NZS 60079.10.1:2009 Classification of Areas – Explosive Gas Atmospheres
- (f) Wellington Water General Specification
- (g) Wellington Water Particular Electrical Specification
- (h) Drawings and schedules

1.3 Earthing

1.3.1 Unless otherwise stated all installations will be designed as a MEN electrical installation (as defined in the Electricity (Safety) Regulation 2010) and switchboards should be designed to comply.

1.4 Motor Control modes

1.4.1 Unless otherwise specified in the project 'Particular Electrical Specification', the following control mode shall be features of each motor starter:

- (a) LOCAL mode: an operator shall be able to start, stop and control the motor from the MCC.
- (b) OFF mode: the motor shall be inhibited from operation.
- (c) AUTO mode: the motor shall be controlled by the PLC, telemetry unit or other intelligent device.

1.5 Motor Control requirements

- 1.5.1 Unless otherwise specified in the project 'Particular Electrical Specification', the following local indicators will be a feature of each motor starter:
- (a) AVAILABLE: the motor is available for operation.
 - (b) RUNNING: the motor is operating.
 - (c) STOPPED: the motor is not operating.
 - (d) FAULT: the motor starter is in a fault condition, motor operation may be inhibited. Various fault states may exist.
 - (e) EMERGENCY STOP: the motor emergency stop has been operated, motor operation is inhibited.
- 1.5.2 Unless otherwise specified in the project 'Particular Electrical Specification', the following local pushbuttons will be a feature of each motor starter:
- (a) START: the motor shall start when operated if selected to LOCAL.
 - (b) STOP: the motor shall stop when operated in any mode.
 - (c) FAULT RESET: when operated all faults will be reset if fault is cleared.
- 1.5.3 Where specified in the project 'Particular Electrical Specification', additional motor protection and interlocks will be a feature of each motor starter.
- 1.5.4 Emergency-Stop facilities shall be supplied according to AS/NZS 4024, in accordance with Safety In Design and HAZOP design processes.
- 1.5.5 Where an emergency stop pushbutton is required, the design of the control circuit shall be such that release of the pushbutton and a separate and independent hardwired reset action is required before the power circuit shall re-energise.

2 CONSTRUCTION

2.1 Manufacturer

- 2.1.1 The manufacture of the Switchboards or MCC shall be by a company qualified and specialising in this type of work, with quality assurance accreditation to a sufficient level appropriate to the contract.
- 2.1.2 The manufacturer shall supply all special tools necessary for operating and servicing.

2.2 Construction details

- 2.2.1 Unless otherwise specified, the Switchboards or MCC shall be of sheet steel construction when housed inside a building structure or Aluminium when located external. In either case the construction shall form a rigid frame cubicle enclosure.
- 2.2.2 Sheet and structural members shall be of commercial quality drawn, machine bent and folded, flat, smooth, and free from warps, twists or other distortions.
- 2.2.3 Steel construction will utilise SPC1 bright zinc coated, mild steel, with the minimum thickness of sheet steel shall be as follows:
- (a) 1.2 mm for panels side plates

- (b) 1.5 mm for doors
 - (c) 2.0 mm for frames
 - (d) 2.5 mm for component mounting plates
 - (e) 6.0 mm for gland plates
- 2.2.4 Marine grade aluminium construction for outside use will be IP54 minimum with the following minimum thicknesses:
- (a) 2 mm for panels side, doors and frame
 - (b) 3 mm for component mounting plates
 - (c) 6.0 mm for gland plates (non-magnetic)
- 2.2.5 External panels shall be fitted with vandal-proof locks to suit the appropriate council's key designation.
- 2.2.6 Where angle framing is used it shall not be visible from the outside of the Switchboards or MCC.
- 2.2.7 Dimensions shall be sized to suit the components needed, plus 25 percent future space.
- 2.2.8 Dimensions shall be sized to suit building constraints and access for installation through doorways and passages.
- 2.2.9 The manufacturer shall submit details of the final layout, connections and construction details for approval by Wellington Water before commencing manufacture.
- 2.2.10 Suitable sized and rated removable lifting lugs shall be included.
- 2.2.11 Doors and large panels shall be stiffened where necessary to prevent panel deformation due to weight of equipment or stresses of switching operations.
- 2.2.12 Hinges on doors shall be concealed or semi-concealed type.
- 2.2.13 Door catches shall be of the flush lockable type and of the same combination for the complete installation.
- 2.2.14 Suitably sized gland plates will be provided for cable entry. Non-ferrous metal gland plates shall be used with single core cabling.
- 2.2.15 Door restraints will be fitted to prevent wind damage.
- 2.2.16 Floor standing cubicles shall be mounted on a 100 mm rigid steel plinth.
- 2.2.17 The design shall allow for earthquake loadings and restraints.
- 2.2.18 All components and materials shall be non-flammable under normal operating conditions.
- 2.2.19 The manufacture shall be such that no sharp edges or corners will be accessible.

2.3 Corrosion

- 2.3.1 Where equipment is installed in atmospheres suspected to cause corrosion and deterioration of electrical equipment, the manufacturer shall ensure that all relevant corrosion protection methods are employed. All methods utilised are to be reported to Wellington Water for approval.

2.4 Discrimination

- 2.4.1 Protection devices on incoming and outgoing switchgear within the switchboard shall be correctly coordinated with the protection devices on both the upstream and downstream supplies.

2.5 Earthing details

- 2.5.1 Doors on which apparatus is mounted shall be effectively earthed by flexible earthing leads.
- 2.5.2 A copper earth busbar running the entire length of the switchboard, and adequately sized to carry the design fault current for the specified duration, shall be provided.
- (a) All non-current carrying metal parts shall be connected to this earth busbar.
 - (b) The earth bar shall be suitably sized for the board fault level.
 - (c) Suitable holes shall be provided in the earthing busbar, preferably at each end of the assembly, for connection to the plant earthing system at two distinct locations.
- 2.5.3 All metal parts shall be earthed in an approved manner to the earthing system. Terminals necessary for this purpose shall be provided on each part of the equipment.
- 2.5.4 An integral earthing device shall be provided to connect each external circuit and circuit breaker to earth (when required) without the use of loose attachments.
- (a) A similar earthing device shall be provided for each section of busbars, if required in the 'Particular Electrical Specification' or the drawings.
 - (b) The earthing device shall be rated to withstand full fault rating of the Switchboard.
- 2.5.5 The cross-sectional area and construction of the earthing busbar shall be capable of withstanding a minimum of 60 percent of the busbar fault capacity.

2.6 Busbars

- 2.6.1 Generally, all internal wiring carrying current 100A or greater shall be solid copper bar. Alternative methods may be submitted for approval.
- 2.6.2 Busbars shall be high conductivity copper and shall be:
- (a) Colour identified red, white, blue on phases and black for neutral for three phase systems.
 - (b) Adequately supported using propriety tested and certified support mechanism.
- 2.6.3 Busbar links shall be the same carrying capacity as the bar and shall be secured at each end by at least two bolts.
- 2.6.4 Busbar connection points for both supply tails and outgoing circuits shall be bolted using electro-plated zinc bolts and nuts locking washers. Alternative methods may be submitted for approval.
- 2.6.5 All busbar connections shall be tightened to the approved torque, checked and documented in accordance with the manufacture's quality control procedures.
- 2.6.6 No live metal shall be exposed to touch or accessible to tools under normal conditions when the panel or cubicle door is open.

2.7 Power factor correction

- 2.7.1 If specified in the 'Particular Electrical Specification', power factor correction shall be incorporated to maintain an overall power factor of between 0.95 and 0.99 by individual units or a common unit.

2.8 Metering provisions

- 2.8.1 This specification does not cover high-voltage revenue meters. Separate requirement can be obtained from Wellington Water.
- 2.8.2 Metering shall meet the requirements of the Wellington Water contracted energy retailer. The metering equipment appropriate to capacity of the supply, will be 'Free-Issued' upon request to be installed in the board before it is dispatched to site.
- 2.8.3 Sufficient space shall be provided for the installation of power meters by a third-party.
- 2.8.4 Unless otherwise specified in the 'Particular Electrical Specification', all main incomers will be fitted with a power monitor with provision to monitor, Voltage (phase to phase and phase to earth), Ammeter (per phase), Frequency, kVA, kVAr and power factor.

2.9 Distribution boards

- 2.9.1 Circuit ways shall be complete with miniature circuit breakers as required for the ways in use only. Spare ways are to be left with blank legs.
- 2.9.2 Allow 25 percent space for future extensions.
- 2.9.3 The board shall be constructed so that no metal cutting, or busbar extensions are required for the fitting of additional fuse ways or miniature circuit breakers.

2.10 Equipment layout

- 2.10.1 Equipment layouts shall be symmetrical and allow 25 percent space for future additions.
- 2.10.2 Sufficient space is to be provided to allow all internal components to be mounted to comply with the manufacturer's requirements, particular attention should be paid to heat dissipation and ventilation.
- 2.10.3 Control gear, terminals, labels and wiring within compartments shall be arranged so that each component can be identified, inspected, maintained, removed and replaced without the need to enter any other compartment and without moving or dismantling any other component or wiring. If a special tool is required to remove a component, the tool shall be supplied.

2.11 Equipment mountings

- 2.11.1 Mounting of equipment inside the cubicle shall be either directly onto galvanised/mild steel back-plates or onto standard DIN mounting rails.
- 2.11.2 Panel mounted equipment and equipment plates shall be fixed by screws into captive nuts using rust resistant screws. Self-tapping screws are not acceptable but tapped threads may be accepted at the discretion of Wellington Water.
- 2.11.3 Mounting of equipment on cubicle doors or similar shall be such that the integrity of the cubicle is not compromised. Manufacturer's mounting brackets and the use of gaskets and shall be used.

2.12 Main switch

- 2.12.1 Unless specified in the project 'Particular Electrical Specification', the 'Main Switch' shall be triple pole, all insulated type with auxiliary contacts as required and arranged to be lockable in the off position.
- 2.12.2 Except for externally mounted panels, the main isolation switch shall be interlocked with the door to prevent access when live. This interlock shall have an override facility by special tool.

2.13 Terminals

- 2.13.1 All wiring shall be terminated with suitable crimp or lug type termination device.
- 2.13.2 Where several conductors terminate at a common terminal each wire shall be removable without dislodging the remaining conductors.
- 2.13.3 For cables with a cross-sectional area of up to and including 16 mm², individual terminals shall be of a feed-through design.
- 2.13.4 For conductors with a cross-sectional area of greater than 16 mm², stud type terminals shall be used.
- 2.13.5 External connections of non-earthed conductors shall be at rail mounted terminals.
- 2.13.6 Terminal compartments for external cables shall be located a minimum of 500 mm above floor level.
- 2.13.7 All terminals and live metal shall be shrouded using proprietary components or suitable tool, or accessed only by special tool, regulated key or multiple bolted security, with clear warning labels.
- 2.13.8 All terminals shall be numbered and held in place with proprietary end clamps.
- 2.13.9 Terminals shall be segregated and grouped into low voltage, extra- low voltage and analogue.
- 2.13.10 Terminal blocks shall be correctly sized for the conductors connected.
- 2.13.11 A minimum spare space of 25 percent shall be allowed for on all terminal rails.

2.14 Cables

- 2.14.1 All cables shall be suitably rated for the circuit voltage.
- 2.14.2 Internal cables shall be multi-strand flexible conductors with tri-rated insulation.
- 2.14.3 Analogue cables shall be single twisted pair, overall screened type.
- 2.14.4 Internal cables shall be suitably coloured to indicate their function as follows:

Circuit/Cable	Colour
POWER	
3 Phase low voltage power	Red, white, blue
240V AC active (control)	Red
AC neutral	Black
Insulated Earth Conductors	Green/yellow
110 Vac	

Circuit/Cable	Colour
Active	Yellow
Neutral	Black
Extra low voltage	
24 VDC +	White
24 VDC -	Brown
DIGITAL SIGNALS	
Digital inputs Switch positive or negative (ground)	Orange
Digital output	Purple
ANALOGUE SIGNALS	
Analogue inputs	Pink
Analogue outputs	Violet
INTRINSICALLY SAFE	
All conductors	Blue

2.14.5 Internal cables shall be suitably sized for the designed load, but as a minimum the size should be as follows:

Circuit	Cable CSA
Power	1.5 mm ²
Control	0.75 mm ²
PLC I/O	0.5 mm ² (or manufacturer standard for multicore)

2.15 Shrouding

- 2.15.1 Control cabinets shall have no exposed 230V equipment. This shall be shrouded with a transparent insulating cover of suitable construction.
- 2.15.2 Safety Extra Low Voltage components shall be protected to IP21.

2.16 Finish

- 2.16.1 External and internal surfaces are to be finished to comply with the 'Particular Electrical Specification', or if not specified the manufacturer's standard finish and colour.
- 2.16.2 All enclosure metal parts shall be suitably protected against corrosion.
- 2.16.3 The minimum substrate pre-treatment/protective coating system shall be applied:
- All surfaces shall be dry and free from contaminants, corrosion and grease.
 - One coat of phosphating primer shall be applied to enhance adhesion to the paint.
 - One coat of epoxy-based powder paint shall be electrostatically applied and cured at high temperature to give a dry film thickness of approximately 50-75 µm.

- 2.16.4 A minimum of 100 ml of air-drying paint shall be supplied with the enclosure for reparation of painted surfaces.

2.17 Labels

- 2.17.1 All components shall be clearly labelled.
- 2.17.2 Labels shall be manufactured from laminated plastic to provide black letters on a white background, the exception to this is for 'Emergency Stop' labels that shall be red letters on a yellow background.
- 2.17.3 The following size letter shall be used in a plain and clear font:
- (a) 20 mm high for board identification and warning labels
 - (b) 6 mm high for major items
 - (c) 3 mm for the minor items
- 2.17.4 Labels shall be attached using a mechanical means or an agreed adhesive.
- 2.17.5 A manufacturer's 'Rating Plate' shall be attached to the outside of each cubicle with all relevant information.
- 2.17.6 Multi-compartment enclosures shall have a label on each compartment door to identify its purpose and rating.
- 2.17.7 Busbar warning labels to be securely fixed to all sections containing potentially live and exposed conductors.
- 2.17.8 Internal component labels shall be fixed in a suitable position to prevent accidental removal or exchange (i.e. not on trunking lids).

3 TESTING

3.1 Factory acceptance testing

- 3.1.1 The distribution board or MCC shall be tested by the manufacturer in accordance with AS/NZS 61439.1:2016 and shall include as a minimum:
- (a) A thorough visual inspection externally and internally
 - (b) Verification of earthing arrangements
 - (c) Insulation resistance tests
 - (d) Verification of barriers and protection
 - (e) Verification of mechanical interlocks
 - (f) Verification of labels and signage
- 3.1.2 All motor starter circuits shall be tested for functionality and protective devices set to the appropriate level for each motor. Variable speed drives and softstart units will have all the necessary parameters entered.
- 3.1.3 All functional testing of instrument, control and automation, telemetry and programmable logic controller (PLC) circuits (including software if supplied) shall be carried out.
- 3.1.4 Factory acceptance test - the distribution board or MCC shall be witness tested by the Wellington Water or their representative and approval attained before delivery.

3.2 Site acceptance testing

- 3.2.1 Site acceptance test – the equipment shall also be tested once installed, with a representative of the manufacturer present.

4 DOCUMENTATION

4.1 Operation and maintenance manuals

- 4.1.1 The manufacturer shall supply accurate and clear documentation including drawings and operation and maintenance manuals in accordance with Wellington Water standards.
- 4.1.2 Before manufacture, as a minimum, the following documents shall be supplied and approval attained:
- (a) General Arrangement drawing – external (Status – Draft)
 - (b) General Arrangement drawing – internal (Status – Draft)
 - (c) Typical Motor Starter Schematic drawing (Status – Draft)
 - (d) Control Schematic drawings (Status – Draft)
- 4.1.3 Before Wellington Water witness testing, as a minimum, the following documents shall be supplied and approval attained:
- (a) As 1.20.2 (Status – Factory acceptance test)
 - (b) Operation and maintenance manual (Status – Draft)
 - (c) Test certificates (Status – Factory acceptance test)
- 4.1.4 Before delivery, as a minimum, the following documents shall be supplied and approval attained:
- (a) As 1.20.3 (Status – Approved for installation)
 - (b) Certificate of compliance (Status – Approved for installation)
- 4.1.5 Before final payment, details of equipment warranty shall be included in the operation and maintenance manual.

4.2 Certification

- 4.2.1 Low-voltage switchgear and control gear assemblies shall be type- tested or partially type- tested as defined in AS/NZS 61439.1:2016.
- 4.2.2 Certificates shall be provided by a laboratory registered by TELARC or equivalent overseas registration scheme.