

# General Electrical Specification

## Part 3

Electrical Installation

Version 3.0



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 2 - Electrical Components
- D) General Electrical Specification – Part 4 - Electrical Building Installation

### Table of Amendments

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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
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## Definitions

Term/Acronym	Definition
AC	Air conditioning
AS/NZS	Australian Standard/New Zealand Standard
BS EN	British Standard European Norm
Client	Capacity Infrastructure Services
ELV	Extra low voltage
Engineer	Project engineer acting for the Client
HV	High voltage
IP	Internet Protocol
LV	Low voltage
Manufacturer	Manufacturer or supplier of component
MCB	Miniature circuit breaker
PVC	Polyvinyl chloride
VSD	Variable speed drive

## 1 GENERAL

### 1.1 Basis of Design

- 1.1.1 The design criteria for each installation shall be individually defined by the project details and needs that may be defined in a project specific specification or Scope of Work.
- 1.1.2 All installations shall comply with the standards in Part 1.
- 1.1.3 The Contractor shall be responsible for any installation design that has not been provided or specified by Wellington Water and seek approval from Wellington Water for the design.

### 1.2 Installation Contractor

- 1.2.1 The Contractor shall comply with Wellington Water's general and site-specific health and safety requirements and be approved in our Pre-Qual verification system.

## 2 INSTALLATION REQUIREMENTS

### 2.1 Cable support systems

- 2.1.1 All cable support systems shall meet the following general requirements:
  - (a) Bends, tees, and fittings shall be of the same manufacture as the straight lengths and of similar material and finish.
  - (b) Installation shall be in accordance with the manufacturers recommendations and when complete shall be free from sharp edges or other such projections.
  - (c) Ensure that no conflict will occur with other services before installation commences.
  - (d) Earth continuity straps shall be fitted between sections.
  - (e) Material shall be suitable for the installation atmosphere to minimise any corrosion.
- 2.1.2 Cable tray installation shall meet the following requirements:
  - (a) Cable tray shall be a proprietary brand and subject to approval.
  - (b) Material shall be plain sheet steel, perforated or rolled with folded strengthening side flanges.
  - (c) Cable bends shall be not less than the minimum recommended and shall be achieved without cables changing their relative position or breaking contact with the tray or ladder.
  - (d) Thickness shall not be less than 1.5 mm for dry situations and 2.5 mm for damp situations.
  - (e) Provide tray with a minimum 8 mm high return and complete with all necessary proprietary bends, tees, junctions, etc.
  - (f) Allow to size tray such that, with a completed installation, a nominal 60 percent of the tray or ladder is filled.
  - (g) Finish shall suit the following conditions:
    - (i) Dry - zinc plating, minimum thickness 0.005 mm
    - (ii) Damp - hot dip galvanized

(iii) Corrosive - polyvinyl chloride (PVC) coated

2.1.3 Cable ladder installation shall meet the following requirements:

- (a) Cable ladder shall be a proprietary brand and subject to the Engineer's approval.
- (b) Span distance shall be suitable for 3500 mm and rungs spaced at not more than 300 mm.
- (c) Covers with 15 degrees rise peak shall be fitted for solar and weather protection when installed outdoors.
- (d) The structural capacity of the cable support system shall be certified as able to resist the earthquake induced loads for installations where the ladder is fully utilised, the per metre weight of the ladder and cables is greater than 15 kg.

2.1.4 Brackets for cable tray and ladder support shall meet the following requirements:

- (a) Hot dip galvanised channel and brackets are to be used. All cut edges are to be deburred and coated with suitable anti-corrosion treatment such as Zinc Galv.
- (b) Custom made brackets may be used with the approval of the Engineer.
- (c) Supports must be adequate in strength and spaced (as manufacturer recommendations) to prevent sagging of the tray or ladder.
- (d) The structural capacity of the cable support system shall be certified as able to resist the earthquake induced loads for installations where, when the tray is fully utilised, the per meter weight of the tray and cables is greater than 15 kg.

2.1.5 Fastenings for cable tray and ladder support shall meet the following requirements:

- (a) All fastenings associated with the erection of cable tray or ladder are to be adequate for the applied load and environment.
- (b) Care should be taken to avoid corrosion caused by the use of dissimilar metals.

## 2.2 Conduit

2.2.1 All conduit installations shall meet the following general requirements:

- (a) Conduits shall not be partially buried in concrete or plaster, or placed in floor slabs subject to hydrostatic pressure.
- (b) Conduits shall not be installed over seismic joints without provision for movement equal to the width of the joint gap.
- (c) Conduits shall not be installed complete with cabling.
- (d) Conduits shall not be installed such that the cabling cannot be removed and re-installed.

2.2.2 All conduit runs shall be installed square and parallel with the building features.

2.2.3 Conduit supports shall be at regular intervals of not more than:

- (a) 1.2 m horizontal
- (b) 1.5 m vertical

2.2.4 All saddles shall be of stainless steel or PVC.

2.2.5 Masonry plugs for screw fixings shall be of the metal or plastic type only.

- 2.2.6 Terminations into metal enclosures without tapped spouts shall be by means of couplers and smooth bore male bushes.
- 2.2.7 Bends or other changes of directions may be set on site to suit local conditions.
- 2.2.8 All fittings are to be glued together with PVC cement.
- 2.2.9 Bends in PVC conduit are to be neatly formed using a bending spring, to prevent crushing of the conduit.
- 2.2.10 The size of conduit used should be such that it must be possible to add a further 30 percent more of the same size conductors, at a later date, without dismantling the conduit.
- 2.2.11 Conduit runs must be arranged so that open ends are pointing down to prevent water ingress. If this is not possible, a compression cable gland must be fitted on the end of the conduit run.
- 2.2.12 Where flexible conduit connects to solid PVC conduit, the correct fittings are to be used, (i.e. it is not acceptable to just insert flexible conduit inside solid conduit to make the transition).
- 2.2.13 Conduit types shall conform to Australian Standard/New Zealand Standard (AS/NZS) 61386.1:2015 and be either:
- (a) Rigid PVC (grey)
  - (b) Galvanised steel
  - (c) Flexible conduit
- 2.2.14 Embedded conduit installations shall meet the following general requirements:
- (a) Cover not less than 40 mm in concrete or 5 mm in plaster.
  - (b) Position all runs as close as possible to the centre of concrete slabs or columns.
  - (c) Brace conduits to prevent movement when concrete is poured.
- 2.2.15 Flexible conduit shall not be used in any run of rigid conduit except where a conduit is terminated at an appliance or accessory that may be subject to movement and/or vibration and shall meet the following general requirements:
- (a) Adapters shall be impact resistant plastic type and crimped or screwed to the conduit.
  - (b) Bending radius shall not be less than that recommended by the manufacturer or to suit the installed cable, whichever is greatest.
  - (c) Shall be supported to prevent mechanical damage or sagging.
- 2.2.16 Steel conduit installations shall meet the following general requirements:
- (a) Shall be galvanised for conduit and fittings.
  - (b) Boxes shall be galvanised malleable cast iron.
  - (c) Box lids and boxes shall have mating machined surfaces. Secure box lids by brass screws into blind tapped holes in the box.
  - (d) Machined surfaces shall be protected against corrosion at all times and greased before final assembly.
  - (e) Terminations into boxes without tapped spouts shall be by means of couplers and smooth bore male bushes gasketed with non-perishable material between coupler and box.
  - (f) Entries where possible shall be on the underside of equipment.

## 2.3 Trunking

- 2.3.1 All trunking systems shall meet the following general requirements:
- (a) Trunking shall be a proprietary brand and subject to the Engineer's approval.
  - (b) Allow to size trunking such that, with a completed installation, a nominal 55 percent of the trunking is filled.
  - (c) All sleeves, joints, bends and end plates shall be proprietary components supplied by the trunking system manufacturer.
  - (d) Fixing of trunking to masonry walls and in damp situations shall be arranged to provide a minimum air space of 5 mm.
  - (e) Vertical runs shall have pin racks or other means of supporting the wiring at intervals not greater than 2 m.
  - (f) Accessories such as switches, socket outlets and other devices shall be attached to the body of the trunking.
  - (g) Where accessories are fitted to the trunking, provide a short length of lid that extends 100 mm either side of the accessories.
  - (h) Metal trunking shall have lid bonding straps attached or sufficient bare metal to enable a satisfactory earth connection.
- 2.3.2 Steel trunking installations in dry conditions shall meet the following general requirements:
- (a) Zinc plated steel
  - (b) 0.005 mm minimum zinc thickness with a minimum metal thickness of 0.8 mm.
- 2.3.3 Steel trunking installations in damp conditions shall meet the following general requirements:
- (a) Steel with a minimum thickness of 0.8 mm
  - (b) Galvanised after manufacture
- 2.3.4 Steel trunking installed with the lid down or side-wise, cable retention straps shall be inserted.
- 2.3.5 Extruded aluminium trunking systems shall meet the following general requirements:
- (a) Lid sections to be snap fit type.
  - (b) Finish shall be the manufacturer's standard powder coat type finish colour.
  - (c) Finish shall be a powder coat type finish colour.
- 2.3.6 PVC trunking systems shall meet the following general requirements:
- (a) Material shall be high impact grade PVC.
  - (b) Lids shall be snap fit type.
  - (c) Colour shall be white unless nominated otherwise.

## 2.4 Cables

- 2.4.1 All mains and submains will carry clear identification at time of installation, using a proprietary method approved by the Engineer.
- 2.4.2 Cables shall be of the type and size suitable for the application and comply with manufacturer's general recommendations for installation and current ratings.
- 2.4.3 The colour of cable outer sheath shall meet the following requirements:



Circuit/Cable	Colour
Power, control and instrumentation	Black
Intrinsically safe circuits	Blue
Fire detection/alarm circuits	Red

2.4.4 The colour of cable cores shall meet the following requirements:

Circuit/Cable	Colour
Power	Red, white, blue
AC neutral	Black
Control	White
Insulated earth conductors	Green/yellow

Air conditioning (AC)

2.4.5 Cables and flexible cords shall be suitable for the duty and installation. In general, cables shall be:

- (a) Stranded conductor type (unless otherwise specified)
- (b) Minimum size 1.5 mm<sup>2</sup>
- (c) Run parallel with building lines.
- (d) Multi-core control cables shall have white, numbered cores.
- (e) Power cables for variable speed drive (VSD) motors shall be in accordance with the manufacturer's instructions.

2.4.6 Joints in point-to-point cable runs are prohibited.

2.4.7 Heat resistant wiring shall be used where ends are exposed to temperatures above 35°C.

2.4.8 During installation, the Contractor will take all reasonable care to avoid damage to the cables by:

- (a) Pulling cables over rollers spaced to avoid the cable rubbing on other cables or suffering mechanical damage.
- (b) Use the appropriate cable stockings to pull cables.

2.4.9 Generally, cables shall be installed with the following minimum distances (unless otherwise approved by the Engineer):

Cable Type	ELV & LV	HV	Telephone	Co-axial	Piped
ELV & LV	25 mm	300 mm	150 mm	150 mm	300 mm

Cable Type	ELV & LV	HV	Telephone	Co-axial	Piped
HV	300 mm	50 mm	300 mm	300 mm	300 mm
Telephone	150 mm	300 mm	50 mm	50 mm	200 mm
Co-axial	150 mm	300 mm	50 mm	50 mm	200 mm

Extra low voltage (ELV); High voltage (HV); Low voltage (LV)

2.4.10 A thermoplastic-sheathed cable will not be allowed unless approved by the Engineer.

## 2.5 Instrument cables

2.5.1 Instrument cables shall

- (a) Be those screened cables connected to the switchboard and field instruments for the purpose of sequential or process control excluding communications cables.
- (b) Be vertical or horizontal and parallel or perpendicular to the principal axis of the building.
- (c) Be run between fittings, accessories or equipment enclosures without joints.

2.5.2 Conductors shall be terminated with tinned pre-insulated compression bootlace pins. A maximum of two cable cores shall be connected to any equipment terminal.

2.5.3 Instrument cables shall conform to the Belden industrial instrumentation series cable specification for screened multicore cables.

- (a) All cores shall use tinned copper stranded conductors.
- (b) Cable cores shall be in white and black pairs for loop powered or active instruments, or red, white and black for resistance temperature detectors or DC powered instruments.

2.5.4 Single paired or single triple conductors shall have a cross sectional area of approximately 1.5 mm<sup>2</sup>, Belden catalogue number 1030B and 1031B, respectively.

2.5.5 Multi-cored paired conductors shall have a cross sectional area of approximately 0.55 mm<sup>2</sup>, 2 pair and 4 pair overall screened, Belden catalogue number 3016B and 1056B, respectively.

## 2.6 Security system cables

2.6.1 Security system cables shall be those cables connected to the security panel and remote switchboards for the purpose status or analogue monitoring.

2.6.2 Cables runs shall be segregated from power cables by a minimum distance of 300 mm. Cables shall be run between fittings, accessories or equipment enclosures without joints.

## 2.7 Above ground installation

2.7.1 Cables shall be secured with nylon ties at nominal 600 mm intervals, suitably sized for the duty but not less than 3.6 mm wide.

- 2.7.2 Acceptable methods for supporting cables up to 6 mm<sup>2</sup> are:
- (a) Enclosed within cable ducts
  - (b) In suitably sized trunking
  - (c) In suitability sized conduit
  - (d) On catenary wire
  - (e) On cable tray
- 2.7.3 Acceptable methods for supporting cables greater than 6 mm<sup>2</sup> are:
- (a) On cable trays
  - (b) On ladder rack
  - (c) Fixed direct to continuous timber or concrete.
  - (d) On structural supports (with Engineer's approval)
  - (e) In suitably sized conduit
- 2.7.4 Install circuit wiring in plant rooms and service areas as follows:
- (a) Where multiple circuits follow a similar route, install wiring in trunking.
  - (b) Install single circuits in conduit.
- 2.7.5 All surface run cables, installed below luminaire level, shall be installed in conduit or cable trunking and subject to the approval of the Engineer.
- 2.7.6 Space utilisation factors within conduits or trunking shall not exceed 35 percent.
- 2.7.7 A clearance of not less than 150 mm from other services or suspended ceiling surface shall be maintained.
- 2.7.8 Where a catenary system is used to support as part of the installation, the following will apply:
- (a) Supports shall be minimum 4 mm<sup>2</sup> plastic coated steel wire between adjustable tensioning devices and secure fixing points.
  - (b) No more than 6 cables shall be attached to a single catenary support.
- 2.7.9 All cables shall be installed flat and free from twists.
- 2.7.10 Installation of wiring in conduit or trunking systems shall be:
- (a) Simultaneously drawn in for all conductors in the same conduit.
  - (b) Fed as well as pulled into conduits.
  - (c) Without crosses or twists.
- 2.7.11 Installation of mineral insulated cables (MIC) shall be:
- (a) Grade 600V class minimum
  - (b) PVC sheathed
  - (c) Secured with stainless steel straps or proprietary clips.
  - (d) Installed in accordance with the manufacturer's instructions.

## 2.8 Underground installation

2.8.1 Where underground cables are to be installed, the Contractor shall check records to ascertain position of all possible services along route before trenching and locate by hand digging such services as indicated and which could be affected by this work before commencing excavation.

2.8.2 Trenches shall provide the minimum cover specified below:

Cable Type	Open areas or under footpaths	Under roadways	Other situations
ELV & LV	600 mm	750 mm	As indicated
HV	750 mm	1000 mm	

2.8.3 The Contractor shall report immediately any services exposed or damaged during trenching.

2.8.4 Excavations shall be open for the minimum possible time and shall be kept free of water and shored up as necessary.

2.8.5 Protection in the form of day and night marking, barricades or covers shall be provided.

2.8.6 Grade trench floors evenly and remove all stones.

2.8.7 Where cables are buried directly into the ground, the cables shall be enclosed:

- (a) By a minimum 50 mm of sand on all sides of the cables.
- (b) Alternatively, by soil which has passed through a sieve with a mesh no greater than 10 mm.

2.8.8 Where cables are buried encased in duct, the duct may be enclosed in the material previously excavated, providing the material is compacted to the same bearing capacity as the surrounding ground.

2.8.9 Trenches under roads, walkways and the like shall be covered with suitable material to allow traffic movement to continue during the installation.

2.8.10 Cable ducts shall be checked to ensure they are clear of obstructions, have draw wires fitted and installed to allow easy installation of the cable.

2.8.11 Backfilling shall not be carried out until the Engineer has inspected the cable installation.

2.8.12 Backfilling and reinstatement shall meet the following general requirements:

- (a) Backfilling in 100 mm layers, hand ramming the first two layers, followed by power consolidation.
- (b) A polythene signal strip 100 mm wide and coloured orange with a printed warning shall be laid at a depth of 150 mm.
- (c) Complete backfilling and consolidation to finish shall finish to match original surface.

2.8.13 Cable end markers shall be fitted in accordance with the latest requirements of AS/NZS 3000:2007.

## 2.9 Rodent proofing

- 2.9.1 Where cables are run between buildings (whether in ducting, troughs or on cable tray), provision must be made for sealing the entry points to the buildings to prevent rodent ingress. Rubber block type cable separators are to be used at building points of entry.
- 2.9.2 PVC ducts between manholes, chambers, etc., must be sealed at both ends by an expanding foam type filler. Where expanding type filler is applied, a means of preventing the filler from extending into the duct by more than 100 mm should be used.

## 2.10 Circuit isolation and protection

- 2.10.1 For the protection of subcircuits in new installations, miniature circuit breakers (MCBs) shall be used in preference to high rupturing capacity fuses.
- 2.10.2 All power outlet circuits are to be protected by a 30 mA residual-current circuit breaker device.
- 2.10.3 Isolators provided for motor circuits shall be capable of breaking the full load current of the load.

## 2.11 Cable entry and termination

- 2.11.1 Proprietary cable glands shall be used for "making off" all metal sheathed, armoured and neutral screened cables.
- 2.11.2 Cable bends shall be followed by a minimum of 50 mm of straight cable before the cable enters a gland where practical.
- 2.11.3 Glands must be appropriate for the cable type and installation conditions.
- 2.11.4 Terminate conductors with compression jointed or soldered cable lugs for direct bolting to equipment terminals, except where equipment terminals are designed to accept cable ends directly under clamp fittings.
- 2.11.5 Compression joints shall comply with British Standard European Norm (BS EN) 61238-1 or an approved equivalent standard and be made with correct sized die.
- 2.11.6 Soldered joints shall be made with Silfos hard solder for copper conductors.
- 2.11.7 Tinned copper in aluminium to copper joints, or aluminium conductors shall be terminated with bi-metal composite cable lugs.
- 2.11.8 Aluminium surfaces for mechanical jointing shall be prepared and jointed with Utilux No. 4C or equal oxidation inhibiting compound.
- 2.11.9 Fit neoprene or PVC insulating sleeves over all exposed cable tails within switchboard enclosures. Cut back PVC serving on cables the minimum necessary. Terminate serving with PVC tape wrapping close to the cable gland.
- 2.11.10 Fully shroud connections and terminals of switchgear.
- 2.11.11 Provide phase identification on all cable cores with a coloured PVC sleeve firmly attached to the core.
- 2.11.12 Termination of cables in VSD power circuits shall be strictly in accordance with the manufacturer's instructions.

- 2.11.13 Wherever possible, cables and conduits should enter panels and fittings from underneath to prevent potential moisture ingress. Each cable must have its own gland of an appropriate size.
- 2.11.14 All wiring shall have crimped termination ferrules of the appropriate type and size.

## 2.12 Junction boxes and enclosures

- 2.12.1 All junction boxes and enclosures installed outdoors must be of either polycarbonate or alloy construction. ABS plastic enclosures are not acceptable for outdoor use.
- 2.12.2 Junction boxes and enclosures are to be mounted where they are easily accessible without the use of special equipment (i.e. ladders, unless this is unavoidable).
- 2.12.3 The Contractor shall agree with the Engineer to confirm the final location of junction boxes and enclosures.
- 2.12.4 Any penetration in an electrical enclosure shall be made so that the Internet Protocol (IP) rating of the enclosure is not compromised.
- 2.12.5 The minimum acceptable rating for junction boxes and enclosures is:
- (a) IP22 in office or clean and dry pumping station type environment.
  - (b) IP54 for indoor and damp environment.
  - (c) IP56 for outdoor and spray environment.

## 2.13 Earthquake loading

- 2.13.1 The installation shall be able to resist earthquake induced loads where working stresses shall not be exceeded by:
- (a) A horizontal load acting in the most adverse direction, assumed to act at the centre or mass, equal to the weight of the equipment multiplied by a factor of 1.5.
  - (b) A vertical load acting in the most adverse direction, assumed to act at the centre of mass, equal to the weight of the equipment multiplied by a factor of 1.5. The vertical load is in addition to the weight of the equipment and can act at the same time as the earthquake induced horizontal load.

## 2.14 Earthing

- 2.14.1 The Contractor is responsible to ensure that all electrical installations (new or modified) meet the requirements of the latest version on AS/NZS 3000:2007.
- 2.14.2 All metal cable tray and ladder must be bonded to earth potential throughout its entire length.
- 2.14.3 Power cables provided with a copper braided sheath for the purpose of earthing shall have green heat shrinkable sleeving installed over the copper braided sheath where it is formed into a separate conductor.
- (a) Black heat shrinkable sleeving is to be fitted over the end of the cable where the outer insulation ends, and separated conductors emerge.
  - (b) Wrapping copper braided sheath earth conductors in insulation tape instead of heat shrink is not acceptable.

- 2.14.4 Screened instrument cables shall have the screen earthed at one end only to prevent 'earth loop' currents.
- (a) The screen shall be earthed at the end at which the circuit is powered.
  - (b) Instrument earthing shall be installed separate to the general earthing system.
  - (c) Additional precautions shall be taken when cabling is in close proximity to radio transmitters.
- 2.14.5 Foil screened cables are to be earthed by terminating the bare earth conductor under the foil, the foil may be trimmed back. Green and black heat shrink sleeving is to be applied as per power cable terminations.

### 3 DOCUMENTATION

#### 3.1 Installation Contractor requirements

- 3.1.1 The Contractor shall supply accurate and clear documentation including drawings and operation and maintenance manuals in accordance with the Client's standards.
- 3.1.2 Before site work can commence, as a minimum, the following documents shall be supplied and approved:
- (a) General Site Layout drawing (Status – Draft)
  - (b) Cable sizing calculation (if necessary) (Status – Draft)
  - (c) Health & Safety Plan (Status – Draft)
- 3.1.3 The Engineer will witness cable tests in part or whole and the Contractor shall provide the following documents:
- (a) Insulation test results (Status – As installed)
  - (b) Continuity test results (Status – As installed)
- 3.1.4 Before the Client will accept hand-over of the site, the Contractor shall provide the following documents:
- (a) Certificate of compliance (Status – As Installed)
  - (b) 'As-built' drawings for site (Status – As Installed)