

# General Electrical Specification

## Part 4

Electrical Building Installation

Version 4.0



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 3 - 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                                |
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## TABLE OF CONTENTS

|      |                                       |    |
|------|---------------------------------------|----|
| 1    | General.....                          | 1  |
| 1.1  | Basis of design.....                  | 1  |
| 2    | Building services.....                | 1  |
| 2.1  | Power .....                           | 1  |
| 2.2  | Lighting.....                         | 2  |
| 2.3  | Emergency lighting.....               | 2  |
| 3    | General Specifications.....           | 3  |
| 3.1  | Equipment identification .....        | 3  |
| 3.2  | Fixing to the building structure..... | 4  |
| 3.3  | Cable support systems .....           | 6  |
| 3.4  | Conduit.....                          | 7  |
| 3.5  | Trunking .....                        | 8  |
| 3.6  | Cables.....                           | 9  |
| 3.7  | Penetrations and fire stopping .....  | 11 |
| 3.8  | Within walls installation.....        | 11 |
| 3.9  | Above ground installation.....        | 12 |
| 3.10 | Underground installation.....         | 13 |
| 3.11 | Rodent proofing .....                 | 14 |
| 3.12 | Cable entry and termination.....      | 14 |
| 3.13 | Junction boxes/enclosures .....       | 15 |
| 3.14 | Earthquake loading.....               | 15 |
| 3.15 | Earthing.....                         | 15 |

## Definitions

| Term/Acronym | Definition                               |
|--------------|--|
| ABS          | Acrylonitrile butadiene styrene          |
| AS/NZS       | Australian Standard/New Zealand Standard |
| BS EN        | British Standard European Norm           |
| ELV          | Extra low voltage                        |
| HV           | High voltage                             |
| LV           | Low voltage                              |
| PVC          | Polyvinyl chloride                       |
| TPS          | Thermoplastic-sheathed cable             |

## 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 regulations and standards described in parts 1, 2 and 3 of this specification.
- 1.1.3 In the event of conflict of information, the order of precedence will be as follows:
  - (a) New Zealand Electricity Act 1992 & Electricity Amendment Act 2006
  - (b) New Zealand Electricity (Safety) Regulations 2010
  - (c) AS/NZS 3000:2007 - Electrical installations (known as the Australian/New Zealand Wiring Rules)
  - (d) NZ Health and Safety at Work Act 2015
  - (e) NZ Building Act 2004
  - (f) Client General Specification
  - (g) Client Particular Electrical Specification
  - (h) Drawings and schedules
- 1.1.4 The Contractor shall be responsible for any installation design that has not been provided or specified by the Client and seek approval from the Engineer for the design.
- 1.1.5 The Contractor shall comply with the Client's general and site-specific health and safety requirements.

## 2 BUILDING SERVICES

### 2.1 Power

- 2.1.1 The following shall apply to socket outlets:
  - (a) Socket outlets shall comply with AS/NZS 3112 and AS/NZS 3123.
  - (b) The current ratings shown on the drawings refer to the outlet current rating. Refer to the distribution board schedules for circuit protection rating and circuit cable size.
  - (c) PDL 56 series outlets shall be surface mounted unless specified otherwise on the drawings. Provide a suitable mounting block to mount the power outlet.
  - (d) PDL 56 series isolators with remote socket outlets shall be labelled with the specific equipment usage.
  - (e) Where PDL 56 series outlets are to be flush mounted, these shall be complete with flange surrounds and backbox.
  - (f) Unless otherwise specified on the drawings, all outlets mounting heights shall be at 400 mm from floor level.
- 2.1.2 The following shall apply to isolators:
  - (a) PDL 56 series isolators shall be surface mounted unless specified otherwise on the drawings. Provide a suitable mounting block to mount the power outlet

- (b) Where PDL 56 series isolators are to be flush mounted, these shall be complete with flange surrounds and backbox.
- (c) PDL 56 series isolators with remote fixed connections shall be labelled with the specific equipment usage and circuit reference.

## 2.2 Lighting

- 2.2.1 Light fittings shall operate without discernible noise when measured from any point 900 mm from the fitting.
- 2.2.2 All luminaires and equipment shall be securely fixed into position in accordance with NZS 4219. Stainless steel fixings shall be used throughout.
- 2.2.3 Where wiring terminates in enclosed or recessed luminaires or is otherwise exposed to high temperatures, it shall be of the "high temperature" type suitable for the maximum anticipated temperature or alternatively shall have tails made off with heat resistant sleeves.
- 2.2.4 Where fittings are installed into panels the fastenings and cable penetrations shall have neutral cure RTV sealer applied to maintain the fittings IP rating.
- 2.2.5 Provide additional support backing boards to the rear of ceiling tiles where light fittings are mounted to suspended ceilings and fixings cannot be made to the 'T' rail support.
- 2.2.6 The following shall apply to light switches:
  - (a) Light switches shall comply with AS/NZS 3133.
  - (b) Internal office light switches shall be PDL 600 Series white colour.
  - (c) Light switches shall be mounted at door handle height unless specifically stated otherwise on the drawings. PDL 600 series light switches shall be vertical type unless specified otherwise.
  - (d) The Contractor is to confirm all door swings before installing conduits or cables for light switches.
  - (e) Where more than one switch is located at one point on the same subcircuit, group the switches on a common switch plate. Do not fit more than three switches on a switch plate unless a purpose made switching plate is called for. Where more than three switches are in one location, use additional switch plates, complete with a PDL multigang flushbox.
  - (f) Light switches shall have a minimum current rating of 16A inductive or as indicated on the drawings or elsewhere in the Specification.
  - (g) Install adjacent switches on different phases in separate flush boxes clearly marked to indicate the presence of 400V.

## 2.3 Emergency lighting

- 2.3.1 Light switches shall comply with AS/NZS 2293.
- 2.3.2 Emergency signage light fittings where detailed require signage and arrow labelling. These labels shall be provided under these works. Signage labels shall be white with a green background and show a direction arrow where applicable except where shown otherwise.

- 2.3.3 Emergency lighting shall operate in the event of a failure of mains power to any of the egress conventional lighting circuits in the respective floor area.
- 2.3.4 Emergency lighting test controls shall be installed so as to allow for the function testing of the emergency fittings.
- 2.3.5 Each emergency luminaire shall be individually marked and identified by its own unique ID number.
- 2.3.6 A label shall be provided adjacent to every circuit breaker which provides supply to emergency lights. The label should be worded:
- (a) “Warning — Interruption of supply will discharge emergency lighting batteries”.

### 3 GENERAL SPECIFICATIONS

#### 3.1 Equipment identification

- 3.1.1 All equipment where supplied under this Contract, shall be identified with circuit reference and equipment identification labels. All lettering shall be upper case.
- 3.1.2 All traffolyte labels shall be permanently fixed with no fewer than two rust proof fixings and positioned generally above the equipment which they identify. Preferred method is screw fixing. The Contractor may submit an alternative method of fixing to the Engineer for approval.
- 3.1.3 Unless specified otherwise, label-lettering heights, colours, type and sizes shall be as follows:

| Equipment                       | Label size | Label type | Lettering | Background |
|---------------------------------|------------|------------|-----------|------------|
| All warning labels              | 10 mm      | Traffolyte | Red       | White      |
| Main switchboard                | 10 mm      | Traffolyte | Black     | White      |
| Distribution boards             | 10 mm      | Traffolyte | Black     | White      |
| Control boards                  | 10 mm      | Traffolyte | Black     | White      |
| Contactors                      | 5 mm       | Traffolyte | Black     | White      |
| Relays                          | 5 mm       | Traffolyte | Black     | White      |
| Switches                        | 5 mm       | Traffolyte | Black     | White      |
| MCB's                           | 5 mm       | Traffolyte | Black     | White      |
| PDL 56 Series switches/ sockets | 5 mm       | Traffolyte | Black     | White      |
| Sockets                         | 3 mm       | Electronic | Black     | White      |
| PCU's                           | 3 mm       | Electronic | Black     | White      |

## 3.2 Fixing to the building structure

- 3.2.1 In general, the installation shall be installed flush within the wall fabric in areas with plastered finish or within cavities in areas with dry lining or partitions. Installations shall be concealed within ceiling voids or floor voids where these exist.
- 3.2.2 The Contractor shall be responsible for determining all details of finishes from the Architect's Drawings and Specifications.
- 3.2.3 Fixings to the structure shall be in accordance with the following:
- (a) Light fixings to timber shall be by correctly sized wood screws.
  - (b) Screws shall be round head type where plain holes are formed in the fixing and where holes are countersunk.
  - (c) Light fixings to suspended ceiling 'T' rails in the building structure shall be by correctly sized fixture clip droppers. Clip droppers are to be correctly fastened into place as recommended by the clip manufacturer.
  - (d) Lightweight fixings to brick, concrete or other masonry materials shall be by means of correctly sized screws fitted into plastic or metal expanding plugs located in correctly sized holes drilled in the structure.
  - (e) Heavier fixings shall be by expanding metal sleeves fitted with captive tensioning nuts and loose bolt or captive bolt with loose nut. Where loose nuts are used, the bolt shall be cut after tensioning to leave not more than 4 mm and not less than 2 mm of bolt protruding from the nut.
  - (f) Where fixings to steelwork are required, they shall be by the use of metal clamps/hook bolts/or other similar devices where the method of fixing does not require any drilling or cutting of the steelwork. Under no circumstances shall structural steelwork be cut or drilled without the express permission of the Engineer.
  - (g) In all cases, the particular type and size of fixing device used shall be in accordance with the manufacturer's recommendations having regard to the application and the load to be carried by the fixing device. It is the Contractor's responsibility to ensure that all methods of fixings are fit for purpose.
- 3.2.4 The material and finishes of fixings shall be selected from the following tables and shall be dependent upon the working environment.

### Fixings to the building structure – heavy weight fixings

| Equipment to be fixed  | Material   | Environment           | Fixing                                       |
|--|--|-----------------------|--|
| Heavyweight equipment or equipment subject to vibration, shock or heavy handling | Very strong brickwork masonry and dense concrete | Dry                   | Expansion bolts or self drill anchors        |
|  |  | Damp and/or corrosive | Galvanised or cadmium plated expansion bolts |
|  | Normal strength brickwork, masonry and concrete  | Dry                   | Expansion bolts                              |
|  |  | Damp and/or corrosive | Galvanised or cadmium plated expansion bolts |
|  | Poor brickwork, masonry or concrete              | Dry                   | Cement-in sockets or bolts                   |



| Equipment to be fixed   | Material   | Environment          | Fixing   |
|-------------------------|--|----------------------|--|
|                         | in which it is difficult to cut clean fixing holes | wet and/or corrosive | Galvanised or cadmium plated bolts with proprietary caulking anchors   |
|                         | Any material of low strength per unit area         | Any condition        | M.S. brackets and/or plates to spread the load. All brackets to be painted red lead primer and two finishing coats. Bolts to be galvanised, cadmium plated or normal to suit the conditions. |
| Any fixing and/or clips | Structural steelwork                               | Any condition        | Clamps, finish of clamps and bolts etc, to suit the conditions. All brackets to be painted with red lead primer and two finishing coats.   |

#### Fixings to the building structure – light weight fixings

| Equipment to be fixed   | Material  | Environment                | Fixing  |
|---|---|----------------------------|---|
| Lightweight equipment subject to movement excessive vibration shock of heaving handling | Good brickwork, masonry and concrete  | Clean dry                  | Fibre or plastic plugs, steel woodscrews  |
|   |   | Clean damp                 | Plastic plugs, brass woodscrews   |
|   |   | Clean dry high temperature | White bronze plugs steel woodscrews   |
|   |   | Corrosive any temperature  | Proprietary white bronze plugs, cadmium plated steel woodscrews   |
|   | Brickwork and masonry with ragged or irregular holes  | Any condition              | Proprietary plugs compound and woodscrews to suit environment (i.e. dry – steel)<br>Damp – brass corrosive cadmium plated steel |
|   | Good timber blockboard and plywood exceeding 12.5 m thick   | Dry                        | Steel woodscrews  |
|   |   | Damp                       | Brass woodscrews  |
|   | Sheet and cellular material of high strength per unit area (e.g. sheet steel, sheet aluminium, hollow | Any conditions             | Threaded brass/<br>Neoprene inserts, plated gravity plated gravity toggles, plated toggles                                      |

| Equipment to be fixed | Material   | Environment   | Fixing  |
|-----------------------|--|---------------|---|
|                       | concrete blocks, hollow clay blocks, plywood less than 12.5 mm thick chipboard)                                    |               |   |
|                       | Sheet and cellular material of low strength per unit area (e.g. building boards, plaster board, laminated plastic) | Any condition | Plated gravity toggles, plated spring toggles |

### 3.3 Cable support systems

3.3.1 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 manufacturer's 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.

3.3.2 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 be to suit the conditions as follows:
  - (i) Dry - zinc plating, minimum thickness 0.005 mm
  - (ii) Damp - hot dip galvanised
  - (iii) Corrosive - polyvinyl chloride (PVC) coated

3.3.3 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 300mm.
- (c) Covers with 15 degree 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 specified for installations where the ladder is fully utilised, the per metre weight of the ladder and cables is greater than 15 kg.

3.3.4 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 specified for installations where, when the tray is fully utilised, the per meter weight of the tray and cables is greater than 15 kg.

3.3.5 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.

### 3.4 Conduit

3.4.1 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 join 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.
- (e) Conduits shall not be installed such that the conduit forms an undrained "U trap".

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

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

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

3.4.4 All saddles shall be of stainless steel or PVC and of the two-hole fixing type.

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

3.4.6 Terminations into metal enclosures without tapped spouts shall be by means of couplers and smooth bore male bushes.

3.4.7 Bends or other changes of directions may be set on site to suit local conditions.

- 3.4.8 All fittings are to be glued together with PVC cement.
- 3.4.9 Bends in PVC conduit are to be neatly formed using a bending spring, to prevent crushing of the conduit.
- 3.4.10 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.
- 3.4.11 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.
- 3.4.12 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).
- 3.4.13 Conduit types shall conform to AS/NZS 61386.1:2015 and be either:
- (a) Rigid PVC (grey)
  - (b) Galvanised steel
  - (c) Flexible conduit
- 3.4.14 Embedded conduit installations shall meet the following general requirements:
- (a) Cover not less than 40 mm in concrete or 5 mm in plaster.
  - (b) Elbows and tees shall not be used. Install circular junction or adaptable boxed instead.
  - (c) Position all runs as close as possible to the centre of concrete slabs or columns.
  - (d) Brace conduits to prevent movement when concrete is poured.
- 3.4.15 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.
- 3.4.16 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 gasketted with non-perishable material between coupler and box.
  - (f) Entries where possible shall be on the underside of equipment.

### 3.5 Trunking

- 3.5.1 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.

3.5.2 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.

3.5.3 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

3.5.4 Steel trunking installed with the lid down or side-wise, cable retention straps shall be inserted.

3.5.5 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.

3.5.6 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.

## 3.6 Cables

3.6.1 All mains and submains will carry clear identification at time of installation using a proprietary method approved by the Engineer.

3.6.2 Cables shall be of the type and size suitable for the application and comply with manufacturer's general recommendations for installation and current ratings.

3.6.3 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    |

3.6.4 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     |

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

- Stranded conductor type (unless otherwise specified).
- Minimum size 1.5 mm<sup>2</sup> for lighting sub-circuits.
- Minimum size 2.5 mm<sup>2</sup> for power sub-circuits.
- Run parallel with building lines.
- Multi-core control cables shall have white, numbered cores.

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

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

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

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

3.6.9 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 |
| HV         | 300 mm   | 50 mm  | 300 mm    | 300 mm   | 300 mm |

| Cable type | ELV & LV | HV     | Telephone | Co-axial | Piped  |
|------------|----------|--------|-----------|----------|--------|
| 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)

- 3.6.10 Install all sub-circuit wiring in the ceiling space voids on catenary wires. Where thermoplastic-sheathed cable (TPS) is used, clip and protect. The maximum length of unsupported TPS cable shall be 1 m.

### 3.7 Penetrations and fire stopping

- 3.7.1 Provide all penetrations and core slots through the building structure necessary to run all cabling and equipment detailed under this contract.
- 3.7.2 Where practical, penetrations and core slots that have already been undertaken should be utilised, where these require supplemented the Contractor shall liaise with the Engineer to confirm suitability.
- 3.7.3 Do NOT drill or penetrate into prestressed concrete columns, beams or floor ribs.
- 3.7.4 In the case of penetrations through exterior walls, foundations, etc., these shall be sealed to prevent the ingress of moisture and vermin.
- 3.7.5 Penetrations in acoustic partitions shall be sealed in an approved manner.
- 3.7.6 All penetrations through fire rated walls/floors and ceilings shall be sealed over its entire length once all cabling has been installed, by a proprietary sealing method. The completed sealed penetration shall provide a fire rating of not less than the rating of its associated wall/floor.

### 3.8 Within walls installation

- 3.8.1 Wiring in stud partition walls shall be by extension of the system used in the ceiling. Where wiring is routed through metal stud partitions:
- Ensure that there is adequate space to house the cables.
  - Take precautions to prevent damage by holding screws, the ends of other screws protruding into the channel, or sharp edges of holes in the metalwork through which the cable passes.
  - Only accessories of suitable design and construction shall be used and there shall be a minimum clearance of 3 mm between any live terminal or terminal likely to become alive and the metal of the partition.
  - The vertical and horizontal members of the partitions in which the cables are housed or to which accessories are fitted shall be effectively bonded and earthed with a separate earth bonding cable.
  - Drop all wiring to outlets and switches vertically from the ceiling void over. Drill all holes in dwangs for wiring truly vertical to allow the easy drawing in and out of wiring.

- (f) Horizontal cable runs are not permitted.
- 3.8.2 Protect all PVC coated cables installed within polystyrene walls by installing cables in PVC conduit.
- 3.8.3 Protect all PVC coated cables installed within bitumenised building paper walls by ensuring cables are kept away from the building paper.

### 3.9 Above ground installation

- 3.9.1 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.
- 3.9.2 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
- 3.9.3 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.
- 3.9.4 Plant rooms and service areas, install circuit wiring as follows:
  - (a) Where multiple circuits follow a similar route, install wiring in trunking.
  - (b) Install single circuits in conduit.
- 3.9.5 All surface run cables, installed below luminaire level, shall be installed in conduit or cable trunking and subject to the approval of the Engineer.
- 3.9.6 Space utilisation factors within conduits or trunking shall not exceed 35 percent.
- 3.9.7 A clearance of not less than 150 mm from other services or suspended ceiling surface shall be maintained.
- 3.9.8 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.
  - (c) Run the catenary wires parallel to the major axes of the buildings and as required to clear other services and obstructions.
  - (d) Use separate catenary wires for electrical, telephone, and computer services.
  - (e) Maintain a separation of at least 300 mm between a catenary wire carrying computer or telephone services and a parallel catenary wire carrying power or lighting circuits.



- (f) The maximum sag of catenary wires should not exceed 100 mm.
  - (g) Secure cables to the catenary wires with binders at intervals of 500 mm and at changes of direction. The binders shall be coloured to distinguish between services.
- 3.9.9 All cables shall be installed flat and free from twists.
- 3.9.10 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.

### 3.10 Underground installation

3.10.1 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.

3.10.2 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        |                  |

- 3.10.3 Contractor shall report immediately any services exposed or damaged during trenching.
- 3.10.4 Excavations shall be open for the minimum possible time and shall be kept free of water and shored up as necessary.
- 3.10.5 Protection in the form of day and night marking, barricades or covers shall be provided.
- 3.10.6 Grade trench floors evenly and remove all stones.
- 3.10.7 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.
- 3.10.8 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.
- 3.10.9 Trenches under roads, walkways and the like shall be covered with suitable material to allow traffic movement to continue during the installation.
- 3.10.10 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.
- 3.10.11 Backfilling shall not be carried out until the Engineer has inspected the cable installation.
- 3.10.12 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.

3.10.13 Cable end markers shall be fitted in accordance with the latest requirements of NZS 3000.

### 3.11 Rodent proofing

- 3.11.1 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.
- 3.11.2 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.

### 3.12 Cable entry and termination

- 3.12.1 Proprietary cable glands shall be used for "making off" all metal sheathed, armoured, and neutral screened cables.
- 3.12.2 Cable bends shall be followed by a minimum of 50 mm of straight cable before the cable enters a gland where practical.
- 3.12.3 Glands must be appropriate for the cable type and installation conditions.
- 3.12.4 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.
- 3.12.5 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.
- 3.12.6 Soldered joints shall be made with Silfos hard solder for copper conductors.
- 3.12.7 Tinned copper in aluminium to copper joints, or aluminium conductors shall be terminated with bi-metal composite cable lugs.
- 3.12.8 Aluminium surfaces for mechanical jointing shall be prepared and jointed with Utilux No. 4C or equal oxidation inhibiting compound.
- 3.12.9 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.
- 3.12.10 Fully shroud connections and terminals of switchgear.
- 3.12.11 Provide phase identification on all cable cores with a coloured PVC sleeve firmly attached to the core.
- 3.12.12 All wiring shall have crimped termination ferrules of the appropriate type and size.

### 3.13 Junction boxes/enclosures

- 3.13.1 All junction boxes/enclosures installed outdoors must be of either polycarbonate or alloy construction. Acrylonitrile butadiene styrene (ABS) plastic enclosures are not acceptable for outdoor use.
- 3.13.2 Junction boxes/enclosures are to be mounted where they are easily accessible without the use of special equipment (i.e. ladders, unless this is unavoidable).
- 3.13.3 The Contractor shall agree with the Engineer to confirm the final location of junction boxes/enclosures.
- 3.13.4 Any penetration in an electrical enclosure shall be made so that the IP rating of the enclosure is not compromised.
- 3.13.5 The minimum acceptable rating for junction boxes/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.

### 3.14 Earthquake loading

- 3.14.1 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.

### 3.15 Earthing

- 3.15.1 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.
- 3.15.2 All metal cable tray and ladder must be bonded to earth potential throughout its entire length.
- 3.15.3 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. Black heat shrinkable sleeving is to be fitted over the end of the cable where the outer insulation ends and separated conductors emerge. Wrapping copper braided sheath earth conductors in insulation tape instead of heat shrink is not acceptable.