

Main Roads Technical Standard

MRTS95

Switchboards and Cables

June 09

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Switchboards and Cables

1 INTRODUCTION

This Technical Standard applies to the supply and installation of switchboards and cables for the supply of electrical power to electrical installations including traffic signal installations and Rate 3 road lighting installations.

This Technical Standard does not apply to Rate 1 or Rate 2 road lighting. For Rate 1 and Rate 2 road lighting reference shall be made to the relevant Electricity Entity's Policies, Standards and Specifications.

This Technical Standard shall be read in conjunction with MRTS01 *Introduction to Technical Standards*, MRTS50 *Specific Quality System Requirements* and other Technical Standards as appropriate.

This Technical Standard forms part of the Main Roads Specifications and Technical Standards Manual.

All Electrical Works shall comply with the requirements of the *Electrical Safety Act 2002*.

2 DEFINITION OF TERMS

The terms used in this Standard shall be as defined in Clause 2 of MRTS01 *Introduction to Technical Standards*. Further definitions used in this Standard shall be as defined in Table 2, the *Electrical Safety Act 2002* and AS/NZS 3000.

Table 2 – Definition of Terms

Term	Definition
Act	Electrical Safety Act 2002 and associated Regulations and Codes of Practice.
Administrator	Principal's Representative or Superintendent as defined in Clause 14 of MRTS01.
Electricity Entity	As defined in the Act
Electrical Works	As defined in the Act
Licensed Electrical Contractor	Holder of an Electrical Contractor License under the Act.
Rate 1 Lighting	Public lighting supplied, installed, owned and maintained by the Electricity Entity.
Rate 2 Lighting	Public lighting owned and maintained by the Electricity Entity.
Rate 3 Lighting	Public lighting supplied, installed, owned and maintained by Transport and Main Roads.
URD	Underground Residential Development as defined by the Electricity Entity.

3 REFERENCED DOCUMENTS

3.1 Standards

Table 3.1 lists documents referenced in this Technical Standard.

Table 3.1 – Referenced Documents

Reference	Title
AS 1125	Conductors in insulated electrical cables and flexible cords
AS1158.6	Lighting for roads and public spaces – Luminaires
AS 1795	Sheets and boards for electrical purposes – classification and general requirements.
AS 2700	Colour Standards for general purposes

Reference	Title
AS/NZS 3000	Electrical installations (known as the Australian/New Zealand Wiring Rules)
AS 3560	Electric cables – Cross-linked polyethylene insulated – Aerial bundled – For working voltages up to and including 0.6/1(1.2) kV
AS 3771	Road lighting luminaires with integral control gear
AS/NZS 4695	Fire hazard testing of electrotechnical products
AS 5000.1	Electric cables – Polymeric insulated – For working voltages up to and including 0.6/1(1.2) kV
AS 60529	Degrees of protection provided by enclosures (IP Code)
RPDM	Road Planning and Design Manual Chapter 17
TRUM	Traffic and Road Use Management Section 5-3
TRUM	Traffic and Road Use Management Section 5-4

3.2 Standard Drawings

Table 3.2 lists the Standard Drawings referenced in this document.

Table 3.2 – Referenced Standard Drawings

Drawing Number	Title
1327	Traffic Signals/Road Lighting – Mains Connection
1332	Switchboard Post Mounted
1430	Switchboard Pillar Mounted
1623	Switchboard Typical Layout and Circuit Diagram MEN System
1625	Three Phase Junction Box Wiring Details
1626	Active, Neutral and Earth Bolting Arrangements
1627	Switchboard Top Mounted
1699	Parts List (6 Sheets)

4 QUALITY SYSTEM REQUIREMENTS

4.1 Hold Points, Witness Points and Milestones

General requirements for Hold Points, Witness Points and Milestones are specified in Clause 5.2 of MRTS01 *Introduction to Technical Standards*.

The Hold Points, Witness Points and Milestones applicable to this Standard are summarised in Table 4.1.

Table 4.1 – Hold Points, Witness Points and Milestones

Clause	Hold Point	Witness Point
5	1. Cable testing	
8.2		Cable laying.

4.2 Construction Procedures

Construction procedures which are required to be submitted in accordance with Clause 6 of MRTS50 *Specific Quality System Requirements* are listed in Table 4.2.

Table 4.2 – Construction Procedures

Clause	Procedure
8	Installation of cables
8.5	Cable jointing
9.2	Installation of switchboards and ancillary equipment

5 COMPLIANCE WITH THE ACT AND AS/NZS 3000

The work covered by this Standard shall comply with the requirements of the Act and subordinate legislation and AS/NZS 3000.

The Contractor shall engage a Licensed Electrical Contractor to perform the duties and functions of Electrical Works. This includes the installation of pits and conduits for power and communications cables

The Contractor shall be responsible for carrying out sufficient testing to ensure that materials and installation standards comply with the requirements of this Standard.

The Contractor shall test the cables before connection to the mains as required by the Act in the presence of the Administrator. **Hold Point 1**

The Contractor shall energise each circuit in turn to verify each load is connected to the specified circuit and phase.

6 COMPLIANCE WITH OTHER DOCUMENTATION

For Rate 3 Road Lighting installations, this Standard shall be read in conjunction with referenced documents, Road Planning and Design Manual – Chapter 17 – Lighting, AS/NZS 3000 and TRUM 5-3 and 5-4.

7 MATERIALS

7.1 Standards

Materials supplied and installed under this Standard shall meet the requirements of the relevant Standards listed in Table 3.2, except where varied by this Standard.

7.2 Testing of Cables

Cables shall comply with the requirements of AS 5000.1.

7.3 Electrical Rating

All electrical components shall be suitable for operation on a 240 Volt \pm 6%, 50 Hz \pm 0.1 Hz system. Voltage fluctuations outside these limits may occur under some conditions, such as those due to faults, sudden disconnection of large blocks or lightning strikes.

7.4 Environmental Conditions

Switchboards and cables installed above ground will be installed outdoors and shall be supplied, installed, designed and constructed so as to perform properly in the following conditions –

- a) ambient temperatures from 45°C to - 5°C;
- b) solar radiation intensity of 1000 W/m² with high ultraviolet content;
- c) tropical summer storms with wind gusts exceeding 160 km/h and an annual rainfall in excess of 1500 mm;
- d) extended periods of relative humidity in excess of 90%;
- e) garden sprays and sprinklers set at a height above ground level causing water to be sprayed against or to fall upon a pillar switchboard at angles between 40° below and 60° above the horizontal; and
- f) areas of coastal salt spray and/or industrial pollution with equivalent salt deposit densities in the range 2.0 to 3.0 g/m².

Cables installed under ground shall be supplied, installed, designed and constructed so as to perform properly in the following conditions –

- a) installed directly in PVC conduit at a depth of up to 1200 mm, with cable ends rising up concrete or timber poles and exposed to direct sunlight;
- b) ambient air temperature not exceeding 50°C as determined by a shaded thermometer;
- c) ambient ground temperature not exceeding 40°C;
- d) an altitude not exceeding 500 metres above sea level; and
- e) a humidity of 90% combined with a temperature of 40°C followed by a sudden drop in temperature of up to 10°C.

For aerial cables, the nominated minimum wind speed, normal to the cable is defined to be 0.5 m/s.

7.5 Reliability

The design service life of cables and equipment shall be 25 years under the specified system and environmental conditions.

7.6 Rate 3 Road Lighting

7.6.1 Switchboards

All switchboards shall comply with the requirements of the relevant Standard Drawings, in particular numbers 1623 and 1699.

Steel screws, nuts and other steel parts shall be either stainless steel, galvanised, electroplated or have an equivalent approved protective finish. Brass screws, nuts, etc must be electroplated.

Ferrous materials shall be protected by a suitable non-corrosive coating.

Adjacent electrochemically incompatible materials shall be separated by insulating material.

Wiring between switchboard electrical components shall be 4 mm² (7/0.85) PVC minimum unless shown otherwise.

7.6.2 Switchboard Enclosures

7.6.2.1 Pillar Enclosures

Material used in the construction of the enclosures shall be impact resistant, ultraviolet stabilised, flame retardant in accordance with AS/NZS 4695 (to 750°C) and resistant to scratching, crazing and fading.

The enclosure shall incorporate an injection moulded base and cover each being manufactured from electrically non-conducting materials.

The cover shall be attached to the base by devices which cannot be removed without special tools or by other means which will prevent access by the general public.

The enclosure, when installed in normal service conditions, shall afford at least the degree of protection equal to IP24D to AS 60529 and shall incorporate free flow ventilation by way of openings to minimise condensation of moisture on the internal equipment. IP24D protection must be maintained.

The manufacturer's identification and date of manufacture shall be moulded on both the cover and base in any position other than on the external walls of the base and cover.

The join between the cover and base shall be of such a design so as not to allow condensation and other moisture to drip onto equipment housed in the enclosure.

Equipment panels shall be of high grade non-hygroscopic insulating material and shall be resistant to surface tracking, thermal degradation at 45°C and ageing and shall be of a design and construction in accordance with Sections 1 and 2 of AS 1795, Part 1.

Equipment panels shall meet the requirements of the water absorption test (Clause 3.2), the insulation resistance test (Clause 3.3) and the glow wire test (Clause 3.14) of AS 1795, Part 1.

D-head fixing screws of appropriate number are acceptable for securing the cover to the base.

The base shall support the various types of panels, by means of the slots alone. The base shall support the panels vertically and in a rigid manner.

The panel mounting slots shall meet the following requirements –

- a) for inserting panels, each pair of panel mounting slots shall withstand a downward force of 0.20 kN applied to the panel without breaking or deforming the slots; and
- b) for installing electrical components, each pair of panel mounting slots shall withstand a force of 0.20 kN applied horizontally in both directions at a height of 200 mm vertically above the slots without breaking or deforming the slots.

A minimum of 5 top ventilation holes, between 4 mm and 5 mm in diameter, shall be provided in the pillar cover. To ensure compliance with the requirements of IP24D to AS 60529, the enclosure shall have a suitable attachment barrier or other suitable device installed behind the holes, which complies with the requirements of Clause 3.1 of AS 60529. The base of the cover shall have an indirect entry path to facilitate ventilation.

The pillar installed in the normal service condition shall be capable of supporting a minimum uniformly distributed force of 1.5 kN applied to the top surface of the cover for up to thirty minutes without permanent deformation.

The preferred colour of bases and covers shall be green G14 as defined by AS 2700. Bases manufactured with natural pigments (base colour without additives) will be considered. The colour shall be stable to the ultraviolet effects of sunlight in Queensland.

The weight of each base and each cover shall not exceed 16 kg.

When installed, the pillar base shall have no external ribbing above the ground and all surfaces shall be free of air voids and sharp edges.

Fixing screws, if used, shall be brass or 316 stainless steel with captive washer and shall be secured to the base.

The cover shall have the words “DANGER” and “ELECTRICITY” moulded in raised lettering on the top surface, in letters not less than 25 mm high.

Each enclosure shall be marked with a unique identification in accordance with Standard Drawing number 1430. The identification shall be designed to last the life of the pillar.

The mounting panel inside the pillar shall mount firmly in slots provided in the base of the pillar.

7.6.2.2 Pole Mounted Enclosures

Pole mounted enclosures shall comply with the requirements of Standard Drawing number 1332 or 1627 and have ingress protection rating IP65 to AS60529 when installed.

The enclosure shall be supplied with a mounting plate which securely fixes to the back of the enclosure and an eschuteon plate if so specified.

The enclosure shall be 316 stainless steel with brushed finish.

The enclosure surfaces shall be free of air voids and sharp edges.

The enclosure shall have a hinged door with two locks and a weatherproof seal in accordance with Standard Drawing numbers 1627 and 1332.

Hinges and locking mechanisms shall be stainless steel.

The back plate shall be galvanised.

The enclosure shall have the appropriate holes cut in accordance with the drawings during manufacture.

7.6.3 Photoelectric Control Switches

Photoelectric control switches supplied under this Standard will generally be installed outdoors and may, for all or part of their operating life, be exposed to environmental conditions as detailed in (a) – (d) of Clause 1.5 of AS 1158.6.

The normal service duty cycle will be 12 hours on and 12 hours off.

Photoelectric control switches shall be of a high rating type (1800 VA) for control of the lighting circuits connected to the switchboard. Switches shall be capable of being plugged into a NEMA type base.

Photoelectric control switches shall consume a maximum energy of 2 watts.

Photoelectric control switches shall be fail safe, i.e. the contact shall be “normally closed” in the unenergised condition and any component failure in the control circuit shall cause the switch contact to revert to the normally closed state, energising the lighting circuits controlled by the switchboard.

Photoelectric control switches shall be fitted with a Metal Oxide Varistor (MOV) for lightning and transient/surge protection. The rating of the MOV shall not be less than 160 Joules at 320 V.

The following information shall be indelibly marked on each photoelectric control switch –

- a) manufacturer’s/supplier’s name and identification mark;
- b) country of manufacture;
- c) rated voltage and current; and
- d) model number.

Photoelectric control switches shall switch on at 30 +/- 7.5 lux and shall switch off at a maximum of 30 lux.

For a top mounted switchboard, a microphoto switch shall be mounted in the top of the switchboard as per Standard Drawing number 1627.

For a pillar mounted switchboard, the photoswitch shall be mounted on the top of the post as per Standard Drawing number 1430.

For a back mounted switchboard, the photoswitch shall be mounted on the top of the post as per Standard Drawing number 1332.

7.7 Mains Connection – Traffic Signal Controllers and Rate 3 Road Lighting

Material requirements for the connection of road lighting switchboards and/or traffic signal controllers to the overhead mains supply shall be as shown on Standard Drawing number 1327.

7.8 Underground Cable

PVC and XLPE insulated cables shall comply with the requirements of AS 5000.1.

Unless otherwise specified, conductors shall be stranded circular annealed copper complying with the requirements of AS 1125.

The insulation and sheath for power supply cables shall comply with the requirements stated in Table 7.8-A.

Table 7.8-A – Insulation/Sheath Requirements of Underground Cables

Description	Minimum Grade
6.0 mm ² , 1 core, green/yellow	V-75
2.5 mm ² and 4 mm ² , 2 core, flat	5V-90/V-75
16 mm ² and 25 mm ² , 2 and 4 core	X-90/5V-90

Wiring shall be colour coded as shown in Table 7.8-B.

Table 7.8-B – Cable Colours

Cable Type	Colour
A Phase	Red
B Phase	White
C Phase	Blue
Neutral	Black
Earthing	Green/Yellow
Control & Indication	White with number identified conductors

All power cable sheaths shall be indelibly marked in a contrasting colour with sequential metre marking at one metre intervals. The markings need not start at zero and the starting and finishing metre markings shall be recorded on the drum flange.

To permit identification of cables, the following information shall be printed or embossed on the outer sheath at regular intervals –

- a) manufacturer's name or identifying initials;
- b) year of manufacture;
- c) type of cable; and
- d) metre markings.

7.9 Aerial Cable

Aerial cable shall be stranded compacted circular aluminium cable which complies with the requirements of Clause 2.1 of AS 3560 or hard drawn copper cable which complies with the requirements of Section 2 of AS 1125.

The insulation shall be X-90 grade cross-linked polyethylene (XLPE) and shall be in accordance with the requirements of Clause 2.3 of AS 3560.

Cable sheath insulation shall be black. The pigmentation shall be chosen to afford maximum long term stability under ultraviolet radiation and shall include a minimum content of 2% by weight of carbon black evenly distributed throughout the insulation which shall not be detrimental to the insulation levels.

Individual cores of the cable shall be identified by longitudinal continuous raised ribs as specified in Clause 2.4.2 of AS 3560.

In addition, active cores shall be numbered in Arabic numerals by printing along the core, the numeral matching the number of ribs on the core. The marking shall be legible and durable and shall not degrade the insulation level.

The marking of cable lengths and intervals shall be in accordance with Clause 2.5 of AS 3560.

The cable shall be tested in accordance with Section 3 of AS 3560 except that, in Test 3.d of Table 3.1, the criteria for compliance shall be "no slip greater than 3 mm as measured from a mark scribed on the conductor at the load application end of the insulation".

7.10 Cable Joints

Cable joints shall be carried out within a reopenable joint. Refer to Standard Drawing number 1624 for single phase connections, Standard Drawing number 1625 for three phases connections, Standard Drawing number 1626 for bolting arrangements and TRUM 5-3 for bell joint assembly manual.

8 INSTALLATION OF CABLES

8.1 General

Cables shall be the type shown in the Drawing. Further requirements for detector loops and local termination within poles, outreach arms and mast arms, where not specified below, shall conform to the requirements of MRTS93 *Traffic Signals* and/or MRTS94 *Road Lighting*.

Ends of cable not immediately terminated shall be sealed to prevent the ingress of water.

Cable shall be stored in a safe dry location until required. Cable shall not be stored directly on the ground.

8.2 Underground Cable Laying

Each run of cable shall be formed without intermediate joints. **Witness Point**

Cable shall be drawn in together to avoid twisting and without damage, using approved cable lubricant as required. The Contractor shall replace, at its expense, any cable damaged during installation.

Cables shall lie loose in the ducts free of any kinks. Where two or more cables are laid in a duct they shall not twist or wrap about each other.

Draw ropes shall be replaced in the ducts when the cables are drawn in.

For multicore cable, a minimum of 6 metres of slack cable for each end of each cable shall be coiled in each pit adjacent to controllers, posts, joint-use poles or mast arm columns. A minimum of 2 metres of slack shall be coiled in each intermediate pit.

For traffic signal cable other than multicore cable, a minimum of 2 metres of slack cable for each end of each cable shall be coiled in each pit through which each cable passes.

For road lighting cable, a minimum 2 metres of cable for each end of each cable shall be coiled in each pit through which the cable passes, including terminal pits.

8.3 Aerial Cable

Aerial cable shall only be connected to base plate mounted poles.

Where the initial point of supply for an aerial fed road lighting pole is located on an Electricity Entity pole, that Entity shall be contacted in writing detailing the extent of lighting supplied from that point.

It shall be at the discretion of the Electricity Entity whether a point of supply will be provided at the location shown. Once accepted, the Electricity Entity will provide a pole mounted fuse for connection of the aerial cable.

No work shall to be carried out on an Electricity Entity pole without the prior permission from that Entity.

The aerial cable shall be fitted with strain clamps of the appropriate size at either end which shall be attached to the eyebolts on each pole.

Where 6 mm², twisted 2 core, XLPE, copper aerial cable is used to supply power to a road lighting pole, it may be wired directly in to the terminal block of the luminaire terminal panel.

Where 25 mm², bundled 2 core, XLPE, aluminium aerial cable is used to supply power to a road lighting pole, the active and neutral conductors shall each be fixed to an insulating piercing connector, 6 – 35 mm² / 4 – 35 mm², external to pole. A 6 mm², twisted 2 core, XLPE, copper cable shall then run from the connectors to the terminal block of the luminaire terminal panel.

When a series of road lighting poles are to be supplied with power in turn by aerial cable, the cable type shall be 25 mm², bundled 2 core, XLPE, aluminium. The active and neutral conductors shall each pass through an insulation piercing connector, 25 – 95 mm² / 6 – 35 mm², at each pole. A 6 mm², twisted 2 core, XLPE, copper cable shall then be run from the connectors to the terminal block of the luminaire terminal panel. Where the continuous 25 mm² cable is likely to wear against the pole it shall be protected by spiral wrap insulation.

8.4 Terminations

Terminal connections shall be as shown in the Drawing.

Cable in road lighting outreach arms shall be terminated to the road lighting termination panel in the pole and to the luminaire when installed.

For traffic signal installations, all unused cores in multicore cables shall be terminated at spare terminals at traffic signal posts, joint use poles and mast arms.

8.5 Jointing

Cable shall be terminated neatly with the conductors stripped for the minimum length necessary to correctly join the conductors.

Cable joints shall be in accordance with TRUM 5-3 and Standard Drawing number 1624 for single phase installations and Standard Drawing number 1625 for three phase installations.

The spigot of the junction box and the cable shall be roughened and the cable entry to the joint shall be sealed against moisture ingress.

Heatshrink sleeves shall be applied with the arrow pointing towards the junction box base. The spigot shall be roughened using sand paper or equivalent method to obtain a key in the surface prior to the installation of the heatshrink sleeve. The surface of the spigot and cable shall be inspected for cleanliness and cleaned if necessary before installation of the heatshrink sleeve.

Unused entry ports in junction boxes shall be sealed with mastic if entry port knockouts have been damaged or removed.

9 INSTALLATION OF SWITCHBOARDS

9.1 General

The electricity supply should be provided by the local Electricity Entity.

Where the Contractor is required to provide installation to a mains connection box on the power pole it shall be installed as shown on Standard Drawing number 1327.

All components and ancillaries shall be securely fixed in place and the fixing devices used shall be compatible with the materials to be joined.

9.2 Switchboards and Ancillary Equipment

Photoelectric control switches shall face south.

Installation of pole mounted switchboards shall be in accordance with Standard Drawing number 1332.

Pillar mounted switchboards shall be installed as shown on Standard Drawing number 1430.

All exposed duct entries shall be sealed with a silicone sealant to prevent the ingress of water and condensation within the switchboard enclosure.

Switchboards shall be earthed using the MEN system as described in AS/NZS 3000. This shall be achieved by running an earth cable from the neutral link to an earth stake located in the nearest pit or, in the case of the switchboard being mounted in an electricity supply pillar, the stake may be located in the base of the pillar.

The cable from the earth stake to the neutral link shall be continuous and not broken and re-joined. Stripping of insulation to effect other connections is permitted.

10 APPLICATION FOR POWER SUPPLY

No work shall be carried out on an Electricity Entity pole without the prior permission of that Entity.

The Contractor is responsible for organising the supply of power to a site that does not have a point of supply. This includes –

- a) to make application for supply of electricity to the Electricity Entity with a copy being sent to the Administrator;
- b) to carry out the installation work as per Standard Drawing number 1327;
- c) to submit "Ready for connection" form to the Electricity Entity;
- d) to submit to the Electricity Entity a disconnection notice when the supply is no longer required;
- e) to submit to the Electricity Entity a schedule of loading or change of load;
- f) to supply and install service pole (if required); and
- g) organise test and inspections and submit to Transport and Main Roads the record of tests.

It is the responsibility of the Contractor to provide the mains connection box, located approximately 4 metres from the base of the power pole, and all conduit and wiring from the switchboard to the mains connection box.

The Electricity Entity will then connect the overhead supply to the mains connection box.

11 TESTING

The Contractor is responsible for carrying out sufficient testing to ensure that materials and construction standards comply with this Standard and the requirements of the Act. Tests shall include the mandatory tests detailed in AS/NZS 3000 and earth fault loop impedance tests.

In addition to copies of the Contractor's completed test sheets as part of its QA procedures, the Contractor shall also provide a completed Certificate of Test and Compliance, a Record of Inspection and Tests, and accurate as-constructed drawings.

12 REMOVAL OF CABLE

Where shown in the Drawing or where such cable is no longer required for lighting and power, existing underground or aerial cable shall be removed. The Contractor shall terminate any remaining cable safely, removing fuses or circuits if appropriate. The Contractor shall record the date each of the circuits is removed.

Cable not required for reuse shall be disposed of by the Contractor.

13 REUSE OF CABLE

Following its removal, existing underground or aerial cable may be reused only if it is first inspected and tested and is shown to conform with the requirements of this Standard.

Any existing joints and tags shall be removed.

Where traffic signals and road lighting cable is reused, it shall be installed in accordance with the requirements of this Standard.