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| Assets Planning and Delivery GroupEngineering |

DESIGN STANDARD DS 26-07

Type Specifications – Electrical

Type Specification for Major Electrical Installations

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| version 2revision 1 |
| NOVEMBER 2021 |

**FOREWORD**

The intent of Design Standards is to specify requirements that assure effective design and delivery of fit for purpose Water Corporation infrastructure assets for best whole-of-life value with least risk to Corporation service standards and safety. Design standards are also intended to promote uniformity of approach by asset designers, drafters and constructors to the design, construction, commissioning and delivery of water infrastructure and to the compatibility of new infrastructure with existing like infrastructure.

Design Standards draw on the asset design, management and field operational experience gained and documented by the Corporation and by the water industry generally over time. They are intended for application by Corporation staff, designers, constructors and land developers to the planning, design, construction and commissioning of Corporation infrastructure including water services provided by land developers for takeover by the Corporation.

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<https://www.legislation.wa.gov.au/legislation/statutes.nsf/law_s4665.html>

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**Head of Engineering**

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REVISION STATUS

The revision status of this standard is shown section by section below.

| **REVISION STATUS** |
| --- |
| **SECT.** | **VER./REV.** | **DATE** | **PAGES REVISED** | **REVISION DESCRIPTION****(Section, Clause, Sub-Clause)** | **RVWD.** | **APRV.** |
| **1** | **1/5** | **30.08.11** | **8, 10** | **1.6, 1.13 revised** | **NJ** | **AK** |
|  | **2/0** | **31.07.15** | **10-11** | **Sections 1.1, 1.5, 1.6 revised** | **NJ** | **MSP** |
|  | **2/1** | **5.11.21** | **10-12** | **Sections 1.6-1.7 revised** | **SWG** | **EdG** |

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| **2** | **2/0** | **31.07.15** | **13-14** | **Section 2 new** | **NJ** | **MSP** |
|  | **2/1** | **5.11.21** | **13-15** | **Sections 2.1-2.5 revised** | **SWG** | **EdG** |

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| **3** | **2/0** | **31.07.15** | **14-16** | **Section 3 new** | **NJ** | **MSP** |
|  | **2/1** | **5.11.21** | **15-16** | **Sections 3.1-3.6 revised** | **SWG** | **EdG** |

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| **4** | **2/0** | **31.07.15** | **17** | **Section 4 new** | **NJ** | **MSP** |
|  |  |  |  |  |  |  |
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| **5** | **1/5** | **30.08.11** | **15** | **5.2 revised** | **NJ** | **AK** |
|  | **2/0** | **31.07.05** | **17-18** | **Section 5 new** | **NJ** | **MSP** |
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| **6** | **2/0** | **31.07.05** | **19** | **Section 6 new** | **NJ** | **MSP** |
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| **7** | **2/0** | **31.07.05** | **19** | **Section 7 new** | **NJ** | **MSP** |
|  | **2/1** | **5.11.21** | **19** | **Section 7.2 revised** | **SWG** | **EdG** |
|  |  |  |  |  |  |  |
| **8** | **1/5** | **30.08.11** | **18** | **8 revised** | **NJ** | **AK** |
|  | **2/0** | **31.07.15** | **20** | **Sec 8.1 revised** | **NJ** | **MSP** |
|  | **2/1** | **5.11.21** | **20** | **Section 8.1 revised** | **SWG** | **EdG** |
|  |  |  |  |  |  |  |
| **10** | **1/5** | **30.08.11** | **20** | **10.1 revised** | **NJ** | **AK** |
|  | **2/0** | **31.07.15** | **21** | **Revised** | **NJ** | **MSP** |
|  |  |  |  |  |  |  |
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| **11** | **1/5** | **30.08.11** | **21** | **11 revised** | **NJ** | **AK** |
|  | **2/0** | **31.07.15** | **21** | **Sec 11.1 revised** | **NJ** | **MSP** |
|  |  |  |  |  |  |  |
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| **13** | **1/5** | **30.08.11** | **23** | **13.3 revised** | **NJ** | **AK** |
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| **15** | **2/0** | **31.07.15** | **23** | **Sec 15.1 revised** | **NJ** | **MSP** |
|  | **2/1** | **5.11.21** | **23** | **Section 15.3 revised** | **SWG** | **EdG** |

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| **16** | **2/0** | **31.07.15** | **23** | **Sec 16 New** | **NJ** | **MSP** |

| **REVISION STATUS HISTORY** |
| --- |
| **VER./****REV.** | **DATE** | **PAGES REVISED** | **REVISION DESCRIPTION****(Section, Clause, Sub-Clause)** | **RVWD.** | **APRV.** |
| **0/0** | **01.08.01** | **All** | **New Edition** | **NHJ** | **AAK** |
| **0/1** | **18.09.01** | **5** | **7.8 general revision** | **NHJ** | **AAK** |
| **0/1** | **18.09.01** | **6** | **7.10.1 general revision** | **NHJ** | **AAK** |
| **0/2** | **19.04.02** | **All** | **7.1-7.13 general revision, Annexure and TTRS included** | **NHJ** | **AAK** |
| **0/3** | **30.10.03** | **3** | **7.2.3 general revision** | **NHJ** | **AAK** |
| **0/3** | **30.10.02** | **7** | **7.12 general revision** | **NHJ** | **AAK** |
| **0/4** | **01.09.03** | **5** | **7.8 general revision** | **NHJ** | **AAK** |
| **0/4** | **01.09.03** | **All** | **Reformatted** | **NHJ** | **AAK** |
| **1/0** | **27.02.04** | **All** | **Sections split, 1.6 general revision** | **NHJ** | **AAK** |
| **1/1** | **30.09.04** | **6** | **1.2.1 revision** | **NHJ** | **AAK** |
| **1/2** | **23.05.05** | **All** | **Paragraphs renumbered** | **NHJ** | **AAK** |
| **1/3** | **30.04.07** | **10** | **3.5 included** | **NHJ** | **AAK** |
| **1/3** | **30.04.07** | **11** | **6 revised** | **NHJ** | **AAK** |
| **1/4** | **02.06.09** | **6** | **1.6 revised** | **NHJ** | **AAK** |
| **1/4** | **02.06.09** | **7** | **1.13 revised** | **NHJ** | **AAK** |
| **1/4** | **02.06.09** | **8** | **2.1 revised** | **NHJ** | **AAK** |
| **1/4** | **02.06.09** | **9** | **3.2, 3.6 revised** | **NHJ** | **AAK** |
| **1/4** | **02.06.09** | **10** | **5.2, 5.3, 6.1, 6.2, 7 revised** | **NHJ** | **AAK** |
| **1/4** | **02.06.09** | **11** | **7 revised** | **NHJ** | **AAK** |
| **1/4** | **02.06.09** | **12** | **13.1, 13.2 revised** | **NHJ** | **AAK** |
| **1/4** | **02.06.09** | **13** | **13.3 revised** | **NHJ** | **AAK** |
| **1/4** | **02.06.09** | **17** | **Annexure revised** | **NHJ** | **AAK** |

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Type Specification for Major Electrical Installations

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# General

## Scope

1. This Specification covers the requirements for the construction and testing of a major electrical installation having a maximum rating of greater than 315kVA or a maximum voltage of greater than 1 kV
2. The scope of the work is described in the Annexure and on the Principal’s drawings listed therein

## Site

The location of and access to the site of the electrical installation shall be as shown in the Annexure.

## Ambient Conditions

The electrical installation shall be rated and suitable for operation under the ambient conditions specified in the Annexure.

## Work by the Principal

The work to be performed by the Principal shall be as specified in the Annexure.

## Information from the Contractor

The Contractor shall provide the following information in respect to the electrical installation within the listed number of days after the receipt of the Principal’s order.

1. Construction programme 14 days
2. Drawings for any switchboards being supplied by the Contractor 28 days
3. Test certificates and associated test results as per approved ITP
4. Set of Principal’s drawings marked up ‘as constructed’ 14 days after commissioning

## Standards

The workmanship, equipment and materials provided in accordance with this Specification shall comply in design, construction, rating and performance with the current relevant Australian Standards and Codes. In their absence, relevant international and other national standards, together with the requirements of competent Authorities having jurisdiction over all or part of the manufacture, installation and operation of the equipment shall be adhered to. Compliance with Regulations shall include all amendments after the date of tender.

Specific reference is made in this specification to the following Australian Standards:

AS 1192 – Electroplated coatings – Nickel and Chromium

AS 1789 – Electroplated zinc coatings for ferrous articles

AS 1897 – Fasteners - Electroplated coatings

AS 2124 – General conditions of contract

AS 2239 – Galvanic (Sacrificial) Anodes for Cathodic Protection

AS 11801:1 – Information technology - Generic cabling for customer premises, Part 1: General requirements

AS 11801:2 – Information technology - Generic cabling for customer premises, Part 2: Office premises.

AS/NZS 2648.1 – Underground marking tape - Non-detectable tape

AS/NZS 3000 – Electrical Installations

AS/NZS 5000:1 – Electric Cables - Polymeric Insulated - For working voltages up to and including 0.6/1 (1.2 kV )

AS/NZS 5000:3 – Electric Cables - Polymeric Insulated - For working voltages up to and including 450/750 V

AS/NZS ISO 9001 – Quality Management Systems – Requirements

The electrical installation shall be constructed and tested in accordance with the requirements of AS/NZS 3000 and with the further requirements of this Specification.

## Supervising Engineer

For work being carried out under a formal contract utilising General Conditions of Contract AS2124, Supervising Engineer shall mean the Contract Superintendent.

In all other instances, Supervising Engineer shall mean the engineer who approved the relevant drawings or an engineer authorised to act on his/her behalf.

## Conformance with the Principal’s Drawings

1. The Works shall be constructed strictly in accordance with the Principal’s drawings and this Specification except where same is varied in writing by the Supervising Engineer. Type or rating or make of equipment shall not be modified unless by written variation from the Supervising Engineer
2. In the event of a discrepancy between the Principal’s drawings and this Specification, the matter shall be referred to the Supervising Engineer for resolution

## Quality Assurance

The electrical installation shall be constructed under a Quality System certified by an Accredited Authority in accordance with AS/NZS ISO 9001 or an approved equivalent.

## Electrical Work

All electrical work shall be performed by appropriately qualified and experienced personnel who shall hold a current electrical worker’s licence to perform such work.

## Settings and Calibration

Equipment settings and calibration shall be as shown on the Principal’s drawings.

## Materials and Workmanship

1. All materials and workmanship shall be in accordance with best industrial practice to the satisfaction of the Supervising Engineer
2. All materials and equipment shall be in a new and previously unused condition unless otherwise stated in the contract specification or approved by the Supervising Engineer

## Switchboard Specifications

1. All switchboards shall comply with the requirements of any relevant switchboard Type Specifications specified in the Annexure or on the Principal’s drawings
2. All Low Voltage switchboards supplied as part of this installation shall comply with the requirements of DS26.9 (Type Specification for LV Switchboards - General Requirements)

## Equipment

The equipment shall be rated for safe, efficient and effective operation under the site conditions and with the relevant electricity supply as stated in the contract specification.

## Mounting Methods

Where the Principal’s drawings do not precisely define the method of mounting equipment, such equipment shall be mounted in accordance with the manufacturer’s instructions and in a manner permitting easy access during testing and maintenance.

# High Voltage Cables

## HV Cables General

The size and type of High Voltage cables shall be as shown on the Principal’s drawings and as specified hereunder.

* 1.

## HV Cables Supplying VCSs

* 1. High Voltage cables carrying R.F. interference voltages (e.g. H.V cables between a HV variable speed controller without input RFI filtering and a screened supply transformer), shall be supplied with copper wire screens on each core
1. The above cables shall be three core cables or single core cables installed in trefoil formation

## HV Cable Joints

In line cable joints shall not be permitted in High Voltage cables unless shown and specified in detail on the Principal’s drawings.

##  HV Cable Terminations

### Manufacturer’s Recommendations

All High Voltage cable terminations shall be made in strict accordance with the manufacturer’s recommendations. Clearances in air shall be maintained at the manufacturer’s recommended level or at the value specified in the relevant Australian Standard, whichever is the greater. Attention shall be taken to ensure that recommended phase to phase and phase to earth clearances for unscreened sections of the cable terminations are maintained.

### Dead-Break Elbow Connections

Dead-break elbow cable terminations on High Voltage screened single core XLPE insulated cables shall be made with approved fully screened, cold fit, dead-break elbow connectors such as Raychem Types RSTI and RSES dead-break elbow connectors (depending on current rating).

### Indoor Air Insulated Terminations

1. High Voltage screened single core XLPE insulated cables within switchboards and air insulated cable boxes shall be terminated with approved heat shrink cable terminations such as Raychem series IXSU-F heat shrink terminations
2. If the spacing between bushings is such that insulating boots are required to be fitted over the bushings, such insulating boots shall be approved cold applied insulating boots of an appropriate voltage rating, e.g. Raychem type RCAB for voltages up to 11 kV

### Pole Top Terminations

1. Pole top terminations on High Voltage single core XLPE cables shall be made with approved outdoor heat shrink terminations, such as Raychem Type OXSU-F heat shrink terminations
2. Incoming supply pole top terminations on “triplex” XLPE cables shall be made with approved outdoor heat shrink terminations and approved mounting brackets, such as Raychem Type OXSU-F heat shrink terminations and Raychem Type EPPA-031 pole top termination brackets

## Earthing of HV Cable Screens

1. The screens on HV cables carrying R.F. interference voltages shall be earthed at both ends
2. The screens on HV cables not carrying R.F. interference voltages shall be earthed as shown on the Principal’s drawings. (Generally such HV cables will be required to be earthed only at one end)

# Low Voltage Cables

## LV Cables General

* 1. The size and type of Low Voltage cables shall be as shown on the Principal’s drawings and as specified hereunder
1. LV cables shall be provided in accordance with the size and type shown on the drawings and with the requirements of AS/NZS 3000

## LV Variable Speed Drive Cables

* 1. Variable speed controller cables shall be symmetrically constructed shielded cables either with three symmetrically placed internal protective earth cores or with a shield rated as the protective earth. Phase conductors, internal protective earth cores and the shield shall be copper
1. If internal protective earth cores are provided, the conductivity of the shield shall be not less than 10% of the conductivity of each phase conductor
2. The combined conductivity of the shield and the internal protective earths (if fitted) shall be not less than, the conductivity of each phase conductor for cables < 16 mm2, and not less than 50% of the conductivity of each phase conductor for cables >16 mm2
3. The cable screen shall consist of either double copper tape screen or a single copper tape screen overlaid with a copper wire screen. Cables with copper braid screens shall not be used for fixed wiring, but shall be used for short lengths of flexible wiring
4. Variable speed controller cables shall be derated for maximum conductor temperature and converter input utilisation factor as shown on the Principal’s drawings

## LV Cable Joints

Mid-run cable connections and straight through LV cable joints shall be avoided wherever practical and in any event shall not be installed without the written approval of the Contract Superintendent.

## Colour Coding for LV Cables

* 1. The preferred colour coding system for Low Voltage cabling between items of equipment is as follows:

Red phase: Red

White phase: White

Blue phase: Blue (bright Blue to AS 2700)

A.C. Neutral: Black

Earth: Green/Yellow

1. The above colour coding system shall be used unless a different system which is consistent with AS 3000 is specified on the Principal’s drawings or has been approved in writing by the Supervising Engineer

## LV Cable Terminations

### Terminals and Lugs

* 1. Cables terminating at stud or screw type terminals shall be fitted with crimp type ring tongue or slotted ring tongue cable lugs
1. Cables terminating at plain tunnel/screw type terminals shall be fitted with wire pin type cable lugs
2. Flexible cables terminating at spring plate clamp type terminals shall be fitted with wire pin type cable lugs
3. Cables terminating at square mouthed terminals shall be fitted with AMP flat blade type terminals
4. Pre‑insulated cable lugs shall be used on all cables smaller than 7/1.04mm
5. Not more than two cables shall be connected to either side of any terminal

### Cable Marking

* 1. Cables, including major earthing cables, shall be identified at each end with clear, indelible and durable labels
	2. Labels shall not be hand‑printed
	3. Major earth cables shall be identified using descriptive text (eg “EARTH MAT”)
	4. All other cables shall be numbered, with numbers as shown on the Drawings

### Crimping

* 1. Cable lugs shall be crimped with the compression tools recommended by the cable lug manufacturer
	2. Where the crimping tools are hand operated they shall be of the type which will not release until full compression is reached
	3. Hexagonal crimping dies shall be used on conductors of' 70 mm2, cross section and above

### LV Cable Glands and Shrouds

* 1. Where cables enter cubicles or panels, they shall be fitted with cable glands
	2. The cable glands shall be fitted in accordance with the manufacturer's recommendations
	3. Cable shrouds shall be fitted over cable glands

### LV Cable Screens

* 1. LV cable screens shall be terminated and earthed concentrically at both ends of the cable
	2. Double copper tape screens on LV cables shall be terminated in glands employing a lead clamping cone
	3. Combined single copper tape and copper wire screens LV cables shall be terminated in armoured cable type cable glands

## LV Cable Entries into Field Equipment

### Above Ground Outdoor Equipment

All field cable entries into outdoor above ground equipment including junction boxes, cubicles and instruments shall be bottom entry so as to minimise the possibility of water ingress.

### Submerged Equipment

* 1. All cable terminations into submerged equipment, including equipment installed in locations subject to flooding, shall be water tight to not less the maximum possible depth submersion
	2. All such cable terminations shall be made strictly in accordance with the equipment manufacturer’s recommendations for submerged equipment

### Buried Equipment

* 1. All cable terminations into buried equipment shall be water tight to the depth of burial plus the depth of possible ground surface submersion in flood situations
	2. All such cable terminations shall be made strictly in accordance with the equipment manufacturer’s recommendations for submerged equipment

# Earthing Unused ELV Cables

* 1. Unused cores in Extra Low Voltage multicore cables (including instrument signal cables) shall be connected to earth at the source and shall be left full length, insulated and taped back at the other end
	2. Wherever practical, source end unused cable cores shall be connected to terminals and these terminals bonded together and connected to earth

# Instrumentation Cables

## Types of Cable

The type of instrumentation cables shall be as shown on the Principal’s drawings and may include:

* 1. copper conductor single twisted pair screened cables
	2. copper conductor multi pair cables with each twisted pair screened as well as an overall screen
	3. copper conductor coaxial cables, and
	4. optical fibre cables

## Colour Coding

(a) The preferred colour coding system for instrumentation cabling between items of equipment is as follows:

Sheath on non intrinsically safe circuit cables: Black

Sheath on intrinsically safe circuit cables: Blue

Unearthed leg cores: White

Earthed leg cores: Black

(b) The above colour coding system shall be used unless a different system is specified on the Principal’s drawings or has been approved in writing by the Supervising Engineer

## Twisted Pair Cables

### Connection

* 1. All control signals shall be transmitted over individual twisted pairs. The use of common return wires shall not be permitted
	2. Multi pair cables shall include not less than 20% spare pairs

### Earthing of Screens

* 1. Unless shown otherwise on the Principal’s drawings, screens on twisted pair cables shall be earthed at the receiving (RTU, PLC or IS barrier) end and insulated at the field instrument end
1. (Where screens cannot be isolated from earth at the instrument end, an isolating amplifier may be required)
2. Individual pair screens shall be earthed at the same point as associated overall screens
3. In the case of cables between a magnetic flow meter head and its associated converter, the cable screens shall be connected as recommended by the manufacturer

## Separation

Unless separately enclosed in steel conduit or cable tray, copper conductor signal cables shall be separated from power cables as follows:

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | *Example* |  |  | **Separation (mm)** |  |  |
| **Class of Signal** |  |  | **1****Sensitive** | **2****Slightly sensitive** | **3****Slightly interfering** | **4****Interfering** |
| **1****Sensitive** | *Low level, analogue, sensors/probes, measuring, Profibus, Ethernet* |  | - | 100 | 500 | 1000 |
| **2****Slightly sensitive** | *Low level digital, low level DC power supplies, control circuits to resistive loads* |  | 100 | - | 200 | 500 |
| **3****Slightly interfering** | *Control circuits with inductive loads, clean AC power supplies, main power supplies 0.6/1kV, ≤400A* |  | 500 | 200 | - | 200 |
| **4****Interfering** | *Switching power supplies, VSD circuits, major LV power circuits,>400A* |  | 1000 | 500 | 200 | - |
| **5** **HV Cable** | *HV cable,(≤33kV),* |  | 1000 | 1000 | 1000 | 1000 |

## Optical Fibre Cables

Optic fibre cables shall be vermin proof via nylon jacketing.

# Cable Markings

(a) All cables, including major earthing cables, shall be identified at each end with clear, indelible and durable labels

(b) Instrumentation cables shall be identified using one sleeve type marker per pair (triad), with both (all) cores passing through the marker

(c) Labels shall not be hand‑printed

(d) All cores of optic fibre cables are to be labelled at both ends

(e) Major earth cables shall be identified using descriptive text (eg “EARTH MAT”)

(f) All other cables shall be numbered, with numbers as shown on the Drawings

# Wiring Systems

## Low Voltage Wiring Systems

* 1. Unless otherwise specified on the Principal's drawings or approved by the Supervising Engineer, all Low Voltage cables shall be installed in UPVC conduit
	2. Single core cables installed as a three‑phase circuit on cable ladder or tray, or buried direct, shall be arranged in trefoil
	3. Underground low voltage cables in UPVC conduit shall be buried to a minimum depth of 500 min, with cable marker tape laid 250 mm above the cable or 50% of the depth of cover above the cable

## High Voltage Wiring Systems

* 1. Unless otherwise specified, underground HV cables shall be direct buried
	2. Trenching for HV cables shall be of uniform depth and shall sufficient so that the depth to the top surface of the installed cables on the bed of sand shall be a minimum of 750 mm
	3. Trenches shall be of sufficient width for chosen mechanical protection to be easily placed. Orange marker tape, in accordance with AS/NZS 2648.1, shall be laid on top of the mechanical protection
	4. Following backfilling of trenches, route markers shall be installed in accordance with clause 9 of this Specification

## Communication Wiring Systems

* 1. Unless otherwise specified on the Principal’s drawings, or approved by the Supervising Engineer, all underground communications cables (including Optic Fibre) shall be installed in UPVC conduit with a minimum diameter of 50 mm
	2. Underground cables in UPVC conduit shall be buried to a minimum depth of 500 mm with cable marker tape laid 300 mm above the cable
	3. Optic fibre conduits require a minimum bend radius as recommended by the manufacturer

# Installation of Conduits, Ducts and Cable Pits

## General

* 1. Unless shown otherwise on the Principal's drawings conduits and ducts shall be installed square to the lines of structures, in a neat and durable manner
	2. Bends shall be of sufficient radius to permit the easy installation of the cable types and numbers shown on the drawings. Changes of direction shall generally be through 90 degrees
	3. All PVC conduit joints shall be cemented with an appropriate adhesive
	4. Duct covers installed within buildings shall be galvanised steel tread plate
	5. Cable pits and conduit entries shall be sealed after cable installation

## Optic Fibre Pits

As a minimum a pit is required every 300m in any city’s CBD, 500m in other urban areas and 1000m in non urban areas.

#  Marking of Underground Cable Routes

## General

1. All underground HV and LV power cable and communication cable (including Optic Fibre) routes shall be marked at all bends and at 25m intervals
2. Route markers shall be either of the concrete block type or of the post type as described below
3. Unless otherwise specified the post type shall be used in locations where it would otherwise be difficult to sight the markers and the concrete block type shall be used elsewhere. Concrete block type markers should be used in trafficable areas and areas not prone to under growth or soil erosion

## Concrete Block Markers

Concrete block markers shall be 300 x 300 x 300mm concrete blocks buried to a depth of 200mm. Stamped on the top surface shall be:-

(i) “HIGH VOLTAGE CABLE” for HV cables or “ELECTRIC CABLES” for LV

 Cables or “COMMUNICATION CABLE” for communications cables;

(ii) the cable depth for HV cables; and

(iii) arrows indicating the approaching and departing cable direction

## Post Markers

Post markers shall be supplied and installed in accordance with drawing 54930-15-01 for HV cables and drawing 54930-14-01 for LV cables.

# Cable Supports

1. Cable supports shall be so arranged and spaced that the cable is held securely in position without appreciable sagging or undue stress
2. Spacing between cable supports shall not be more than 600 mm horizontally or 900 mm vertically
3. PVC fixings and supports shall not be used in locations exposed to direct sunlight
4. Cables shall use existing ducts, trays and ladders where appropriate
5. Outdoor cable trays and ladders shall be installed with covers
6. Indoor cable trays and ladders shall be installed with covers if exposed to the risk of mechanical damage
7. All metallic cable trays, ladders and ducts shall be earthed to the site installation earthing system

# Handling and Care of Cables

## General

1. Cables shall be handled with due care
2. At no time shall a cable be allowed to take up a radius less than the manufacturer’s recommended minimum bending radius. When cable is being laid or being drawn into conduits or ducts, no twists or kinks shall be allowed to occur. Any twisted or kinked cable shall be removed and replaced at the Contractor’s expense
3. Cables shall not be permitted to come into contact with any substances injurious to them, such as grease, oil, petrol or solvents. Only lubricants which are not injurious to cable sheathing may be used, and only when approved by the Supervising Engineer

## Installation of Cable

1. Unless otherwise approved, cable being drawn into place shall be run on sufficient horizontal rollers to ensure that it is kept clear of the ground or other obstructions, and vertical rollers shall be used at points of change of direction
2. Cables shall be pulled into conduits or ducts by means of cable stockings which shall grip the cable serving for not less than 600 mm. Winches used for cable pulling shall have automatic limitation of the pull exerted, which shall not exceed that specified by the manufacturer for the cable and the conditions existing on-site. If the tension required to pull a cable into position exceeds that permitted by the cable manufacturer than a bond-pull shall be applied, using a steel-wire rope to take the pull tension
3. Care shall be taken to avoid damage to the outer sheaths of all cables, particularly those of cables which have protective screens or shields

## Damaged Cable

1. Any damage occurring to a cable including its serving, shall be reported to the Supervising Engineer before work on that particular cable proceeds
2. Cable ends which have been stretched or damaged during installation shall be removed for at least one metre from the point of stretch or damage before termination

# Corrosion Protection

## Miscellaneous

1. All threaded components used, including metal threads, screws and bolts, shall be stainless steel, non-ferrous metal or nickel-chromium electroplated steel to AS1192; or zinc electroplated steel to AS1897 and AS1789, colour yellow iridescent, chromate conversion coating type C
2. All saddles, clamps and miscellaneous fastenings shall be non-ferrous metal, stainless steel, zinc plated steel, nylon or p.v.c. Except where specified otherwise, adhesive fixings shall not be used

## Adjacent Dissimilar Metals

1. Where dissimilar metals are installed adjacent to one another, bimetallic corrosion shall be inhibited by the use of metallic plating or by other methods approved by the Supervising Engineer
2. Screws and washers in contact with aluminium shall be stainless steel or nickel, chromium or yellow iridescent chromated converted zinc plated steel unless otherwise shown on the drawings

# Electrical Bonding and Electrical Earth Potential Grading

If not detailed in the Principal’s project drawings, electrical bonding and electrical earth potential grading at pipe work valve and instrumentation pits shall be carried out in accordance with the requirements of drawing AZ23-3-01

# Earth Electrodes

1. Earth electrodes shall be installed to the depths shown on the Principal’s drawings
2. Earth electrodes shall be either:
	* 1. driven 12 mm diameter copper coated steel rods, or
		2. 35 mm2 bare copper stranded conductors installed in vertical drill holes and backfilled with 50/50 calcium bentonite and gypsum backfill as per Designation B1 in accordance with AS 2239 (Galvanic (Sacrificial) anodes for Cathodic Protection)

# Testing

## Visual Inspection

The Contractor shall carry out a visual check of the installation in accordance with AS/NZS 3000 Clause 8.2 and shall record verification of conformance, item by item, on a checklist in accordance with AS/NZS 3000 Clause 8.2.2.

## Routine Tests

The Contractor shall carry out the following routine tests:

1. Insulation resistance tests of the whole installation, using a 500 volt “megger” for Low Voltage sections and a 5000 volt “megger” for High Voltage sections
2. Earth resistance measurement of each earthing electrode when disconnected from the rest of the earthing system
3. Measurement at each switchboard of the earth resistance of the whole interconnected earthing system
4. Phase sequence test at each switchboard and at all motor terminals
5. Fault loop impedance test at all Low Voltage socket outlets
6. Functional test of all Low Voltage Residual Current Devices

## Optic Fibre Cable Tests

Each optic fibre core shall be tested for length, attenuation and defects using an Optical Time Domain Reflectometer (OTDR) and shall meet the minimum requirements of AS 11801:1 and AS 11801:2.

## Special Tests

The Contractor shall carry out all special tests as listed in the Annexure.

## Test Certificates

The Contractor shall record all test results and shall provide the Principal with a test certificate verifying that all of the required tests have been carried out satisfactorily and showing all test results obtained.

# Commissioning

The electrical installation shall be commissioned under operating conditions in accordance with the programme specified by the Supervising Engineer. The Contractor, and the relevant subcontractor, shall attend the commissioning and provide assistance when necessary.

**Annexure to Specification**

**for**

**Major Electrical Installation**

**A1. Project**

**A2. Site Location**

**A3. Site Access**

**A4. Site Ambient Conditions**

(a) Height above sea level metres

(b) Atmospheric Corrosivity Category (i.e. C3: medium, C4: high, C5: very high,

Cx: extreme)

(c) Maximum Average Monthly Maximum Shade Temperature  oC

(d) Minimum Average Monthly Minimum Shade Temperature oC

(e) Ambient Air Borne Contaminant

**A5. Work by the Principal**

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**A6. Additional Information from the Contractor**

**Annexure to Specification**

**for**

**Major Electrical Installation**

**A7. Principal’s Drawings and Type Specifications**

**A8. Scope of Work**

**A9. Special Testing Required**

|  |
| --- |
| **Type Specification for Major Electrical Installation****Tender Technical Response Schedule** |
| **DS26-07** | **Subject** | **Noted** | **Compliance** | **Comments** |
| **Clause No.** |  |  | **Yes** | **No** |  |
| **1** | **General** |  |  |  |  |
| 1.1 | Scope |  |  |  |   |
| 1.2 | Site |  |  |  |  |
| 1.3 | Ambient Conditions |  |  |  |   |
| 1.4 | Work by the Principal |  |  |  |   |
| 1.5 | Information from the Contractor |  |  |  |   |
| 1.6 | Standards |  |  |  |   |
| 1.7 | Supervising Engineer |  |  |  |   |
| 1.8 | Conformance with the Principal’s Drawings |  |  |  |   |
| 1.9 | Quality Assurance |  |  |  |   |
| 1.10 | Electrical Work |  |  |  |   |
| 1.11 | Settings and Calibration |  |  |  |  |
| 1.12 | Materials and Workmanship |  |  |  |   |
| 1.13 | Relevant Type Specifications |  |  |  | (Attach separate Response Schedules) |
| 1.14 | Equipment |  |  |  |   |
| 1.15 | Mounting Methods |  |  |  |   |
| **2** | **High Voltage Cables** |  |  |  |   |
| 2.1 | HV Cables General |  |  |  |   |
| 2.2 | HV Cables Supplying VSCs  |  |  |  | Single or Three core? |
| 2.3 | HV Cable Joints |  |  |  |  |
| 2.4 | HV Cable Terminations |  |  |  |  |
| 2.4.1 | Manufacturer’s Recommendations |  |  |  |  |
| 2.4.2 | Dead-break Elbow Connections |  |  |  |  |
| 2.4.3 | Indoor Air-Insulated Terminations |  |  |  |  |
| 2.4.4 | Pole Top Terminations |  |  |  |  |
| 2.5 | Earthing of HV Cable Screens |  |  |  |  |
| **3.** | **Low Voltage Cables** |   |  |  |   |
| 3.1 | LV Cables General |  |  |  |   |
| 3.2 | LV Variable Speed Drive Cables |  |  |  |  |
| 3.3 | LV Cable Joints |  |  |  |   |

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| **Type Specification for Major Electrical Installations Tender Technical Response Schedule** |
| **DS26-07** | **Subject** | **Noted** | **Compliance** | **Comments** |
| **Clause No.** |  |  | **Yes** | **No** |  |
| 3.4 | Colour Coding for LV Cables |  |  |  |  |
| 3.5 | LV Cable Terminations |  |  |  |  |
| 3.5.1 | Terminals and Lugs |  |  |  |  |
| 3.5.2 | LV Cable Marking |  |  |  |  |
| 3.5.3 | Crimping |  |  |  |  |
| 3.5.4 | LV Cable Glands and Shrouds |  |  |  |  |
| 3.5.5 | LV Cable Screens |  |  |  |  |
| 3.6 | LV Cable Entries into Field Equipment |  |  |  |  |
| 3.6.1 | Above Ground Outdoor Equipment |  |  |  |  |
| 3.6.2 | Submerged Equipment |  |  |  |  |
| 3.6.3 | Buried Equipment |  |  |  |  |
| **4.** | **Earthing Unused ELV Cables** |  |  |  |  |
| **5.** | **Instrumentation Cables** |  |  |  |  |
| 5.1 | Types of Cables |  |  |  |  |
| 5.2 | Colour Coding |  |  |  |  |
| 5.3 | Twisted Pair Cables |  |  |  |  |
| 5.3.1 | Connection |  |  |  |  |
| 5.3.2 | Earthing of Screens |  |  |  |  |
| 5.4 | Separation |  |  |  |  |
| **6.** | **Cable Marking** |  |  |  |  |
| **7.** | **Wiring Systems** |  |  |  |  |
| 7.1 | Low Voltage Wiring Systems |  |  |  |  |
| 7.2 | High Voltage Wiring Systems |  |  |  |  |
| 7.3 | Communication Wiring Systems |  |  |  |  |
| **8.** | **Installation of Conduits, Ducts & Cable Pits** |  |  |  |  |
| 8.1 | General |  |  |  |  |
| 8.2 | Optic Fibre Pits |  |  |  |  |
| **9.** | **Marking of Underground Cable Routes** |  |  |  |  |
| 9.1 | General |  |  |  |  |
| 9.2 | Concrete Blocks Markers |  |  |  |  |
| 9.3 | Post Markers |  |  |  |  |

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| **Type Specification for Major Electrical Installations Tender Technical Response Schedule** |
| DS26.7 | **Subject** | **Noted** | Compliance | **Comments** |
| **Clause No.** |  |  | **Yes** | **No** |  |
| **10.** | **Cable Supports** |  |  |  |  |
| **11.** | **Handling and Care of Cables** |  |  |  |  |
| 11.1 | General |  |  |  |  |
| 11.2 | Installation of Cable |  |  |  |  |
| 11.3 | Damaged Cable |  |  |  |  |
| **12.** | **Corrosion Protection** |  |  |  |  |
| 12.1 | Miscellaneous |  |  |  |  |
| 12.2 | Adjacent Dissimilar Metals |  |  |  |  |
| **13.** | **Bonding and Potential Grading** |  |  |  |  |
| **14.** | **Earth Electrodes** |  |  |  |  |
| **15.** | **Testing** |  |  |  |  |
| 15.1 | Visual Inspection |  |  |  |  |
| 15.2 | Routine Tests |  |  |  |  |
| 15.3 | Optic Fibre Cable Tests  |  |  |  |  |
| 15.4 | Special Tests |  |  |  |  |
| 15.5 | Test Certificates  |  |  |  |  |
| **16.** | **Commissioning** |  |  |  |  |

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