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| Assets Planning and Delivery GroupEngineering |

DESIGN STANDARD DS 26-44

Type Specification – Electrical

Type Specification for Minor Electrical Installations

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| version 1revision 1 |
| March 2023 |

**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.

Nothing in this Design Standard diminishes the responsibility of designers and constructors for applying the requirements of the Western Australia's Work Health and Safety (General) Regulations 2022 to the delivery of Corporation assets. Information on these statutory requirements may be viewed at the following web site location:

[Overview of Western Australia’s Work Health and Safety (General) Regulations 2022 (dmirs.wa.gov.au)](https://www.dmirs.wa.gov.au/sites/default/files/atoms/files/overview_general_regulations.pdf)

Enquiries relating to the technical content of a Design Standard should be directed to the Senior Principal Engineer, Electrical, Engineering. Future Design Standard changes, if any, will be issued to registered Design Standard users as and when published.

Head of Engineering

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REVISION STATUS

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

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DESIGN STANDARD DS 26-44

Type Specification – Electrical

Type Specification for minor Electrical Installations

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# General

## Scope

1. This Specification covers the requirements for the construction and testing of a minor electrical installation having a maximum rating of not more than 315 kVA and a maximum voltage of not 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 the 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 a specified in the Annexure.

## Information to be Provided by 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 Certificate 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 Electroplated coatings on threaded components (metric coarse series)

AS 2239 Galvanic (Sacrificial) Anodes for Cathodic Protection

AS/NZS 3000 Electrical Installations

AS 11801.1 Information technology - Generic cabling for customer premises - General requirements

AS 11801.2 Information technology - Generic cabling for customer premises - Office premises

AS/NZS 5000.1 Electric Cables – polymeric insulated – for working voltages up to and including 02.6/1 (1.2 kV)

AS/NZS 5000.2 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 further requirements of this Specification.

## Supervising Engineer

The 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 to be 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 license to perform such work.

## Setting 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 DS 26-09 Type Specification for Low Voltage 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.

## Transport Protection

All materials and equipment shall be packed to prevent damage from moisture and handling during transport to site.

## Authority Notification

The Contractor shall provide sufficient notice to the relevant authority for the connection of electrical power supply and telecommunications service to the site.

## As Constructed Drawings

The Contractor shall provide as constructed information on all drawings and submit these to the Supervising Engineer. These drawings shall be clean hard copies of the Principal’s drawings marked up neatly and completely in red ink to indicate any variations to the Principal’s drawings.

# Cables

## Cable Size & Type

1. Cables shall be provided in accordance with the size and type shown on the drawings and with the requirements of AS/NZS 3000
2. Unless specified otherwise, cables shall incorporate multi-stranded conductors and V75, 0.6/1 kV insulation to AS/NZS 5000.1. For multi-core cable up to 6 mm2, the voltage rating will be 450/750V to AS/NZS 5000.2 due to market availability
3. Optic fibre cables shall be vermin proof via nylon jacketing

## Cable Joints

Mid‑run cable connections and straight through 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

The preferred colour coding system for cabling between items of equipment is as hereunder. This system shall be used unless a different colour coding system which is consistent with AS 3000 has been specified on the Principal's drawings or in associated switchboard standard specifications or has been approved by the Supervising Engineer.

1. 240V/415V Cables

Red Phase : Red

White Phase : White

Blue Phase : Blue (bright Blue to AS2700)

AC Neutral : Black

Earth : Green/Yellow

1. Instrumentation Cables

Sheath : Black

Cores : White (unearthed leg)

 : Black (earthed leg)

# 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
2. Cables terminating at plain tunnel/screw type terminals shall be fitted with wire pin type cable lugs
3. Flexible cables terminating at spring plate clamp type terminals shall be fitted with wire pin type cable lugs
4. Cables terminating at square mouthed terminals shall be fitted with AMP flat blade type terminals
5. Pre‑insulated cable lugs shall be used on all cables smaller than 7/1.04mm
6. 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. Instrumentation cables shall be identified using one sleeve type marker per pair (triad), with both (all) cores passing through the marker
3. Labels shall not be hand‑printed
4. All cores of optic fibre cables are to be labelled at both ends
5. Major earth cables shall be identified using descriptive text (eg “MAIN EARTH”)
6. 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

## 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

## Field Cable Entries

### 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

## Optic Fibre Cables

1. Termination of Optic Fibre cables is to be to SCA pigtails using a Fusion Splice connection Fibre Optic Breakout Tray (with SCA adaptors), with a minimum of 12 connectors
2. Optic Fibre Patch Leads shall be terminated at each end with SC Duplex connectors

# Cable Earthing

## Earthing Unused ELV Cable Cores

1. Unused cores in Extra Low Voltage multicore 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 Cable Screens

1. Unless shown otherwise on the Drawings, instrumentation cable screens shall be earthed at the central panel and isolated from earth at the instrument
2. Where screens cannot be isolated from earth at the instrument end, the matter shall be referred to the Supervising Engineer to determine whether an isolating amplifier should be fitted
3. In the case of cables between a magnetic flow meter head and converter, the screens shall be connected as recommended by the manufacturer

# 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 with a minimum diameter of 80 mm
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 mm, with cable marker tape laid 250 mm above the cable or 50% of the depth of cover above the cable

## 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 & Cable Pits

## General

(a) 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

(b) 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

(c) All PVC conduit joints shall be cemented with an appropriate adhesive

(d) Cable pits and conduit entries shall be sealed after cable installation

## Optic Fibre Pits

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

# Marking of Underground Cable Routes

## General

(a) All underground LV power and communication cable (including Optic Fibre) routes shall be marked at all bends and at 25m intervals

(b) Route markers shall be either of the concrete block type or of the post type as described below

(c) 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 in areas not prone to undergrowth or soil erosion

## Concrete Block Markers

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

 (i) "ELECTRIC CABLES" for LV cables or “COMMUNICATION CABLE” for communication cables

 (ii) The cable depth for all cables

 (iii) Arrows indicating the approaching and departing cable direction

## Post Markers

Post markers shall be supplied and installed in accordance with drawing KA76-001-006-01 for LV cables.

# Cable Supports

(a) Cable supports shall be so arranged and spaced that the cable is held securely in position without appreciable sagging or undue stress

(b) Spacing between cable supports shall not be more than 600 mm horizontally or 900 mm vertically

(c) PVC fixings and supports shall not be used in locations exposed to direct sunlight

(d) Cables shall use existing ducts, trays and ladders where appropriate

(e) Outdoor cable trays and ladders shall be installed with covers

(f) Indoor cable trays and ladders shall be installed with covers if exposed to the risk of mechanical damage

(g) All metallic cable trays, ladders and ducts shall be earthed to the site installation earthing system

# Handling and Care of Cables

## General

(a) Cables shall be handled with due care

(b) 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 no twists or kinks shall be allowed to occur. Any twisted or kinked cable shall be removed and replaced at the Contractor's expense

(c) 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

(d) Cables shall be kept capped during installation, and shall be recapped at both exposed ends immediately after cutting

# Corrosion Protection

## Miscellaneous

1. All threaded components, including metal threads, screws and bolts, used shall be stainless steel; or non­ferrous metal; or nickel‑chromium electroplated steel to AS 1192; or zinc electroplated steel to AS 1897 and AS 1789, 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 AZ23‑003‑001-01. Electrical bonding of all metallic civil infrastructure (ground slab re-bar, columns, etc.) shall be carried out and connected to the main earth bar of the installation.

# Earth Electrodes

1. Earth electrodes shall be installed to the depths shown on the Principal's drawings
2. Earth electrodes shall be either:
3. Driven 12 mm diameter copper coated steel rods, or
4. 35 mm2 bare hard drawn copper stranded conductors installed in vertical drill holes and backfilled with 50/50 calcium bentonite and gypsum backfill as per Designation B I in accordance with AS 2239 [Galvanic (Sacrificial) Anodes for Catholic 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 check list in accordance with AS/NZS 3000 Clause 8.2.2.

## Routine Tests

The Contractor shall carry tests of the installation in accordance with AS/NZS 3000 Clause 8.3 and shall record verification of conformance. The following additional routine tests shall be undertaken:

1. Insulation resistance tests of the whole installation using a 500 volt "megger" for Low 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
7. Operational test of all instrumentation and control systems

## 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.

## 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**

**Electrical Installation**

**A1. Project**

**A2. Site Location**

**A3. Site Ambient Conditions**

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

Maximum Average Monthly Maximum Shade Temperature °C

Minimum Average Monthly Minimum Shade Temperature °C

Ambient Air Borne Contaminants

**A4. Work by the Principal**

**A5. Additional Information from the Contractor**

Annexure to Specification

**For**

**Electrical Installation**

**A.6 Principal’s Drawings and Type Specifications**

**A7. Scope of Work**

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| --- |
| **Type Specification for Minor Electrical InstallationsTender Technical Response Schedule** |
| **DS26.44** | **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 Principal’s Drawings |  |  |  |  |
| **1.9** | Quality Assurance |  |  |  |  |
| **1.10** | Electrical Work |  |  |  |  |
| **1.11** | Settings and Calibration |  |  |  |  |
| **1.12** | Materials and Workmanship |  |  |  |  |
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