



Part of Energy Queensland

Ergon Energy Corporation Limited

Specification for UDC Electrical Testing

RSC10

Abstract: Electrical Testing for Underground Distribution Construction (UDC)

Specification for UDC Electrical Testing



Contents

1. Purpose and Scope.....	4
2. References.....	4
2.1 Ergon Energy controlled documents	4
2.2 Other sources	4
3. Definitions, Acronyms, and Abbreviations	5
3.1 Definitions	5
3.2 Acronyms and Abbreviations	6
4. Security.....	6
5. Safety, Environmental and Ergonomic Considerations	6
6. Acts, Regulations, and Requirements.....	6
6.1 Laws and Authorisations	6
6.2 Safety Management System	6
6.3 Other authorities	6
7. Pre-Start Meeting	6
8. Audits.....	6
8.1 During Testing.....	6
8.2 Final Audit.....	7
8.3 Re-Audits	7
9. Electrical Testing	7
9.1 Generally.....	7
9.2 Safety Requirements	7
9.3 Low Voltage Electrical Testing	7
9.4 Low Voltage Visual and Mechanical Test	8
9.5 Low Voltage Cable Continuity Test	8
9.6 Low Voltage Cable Insulation Resistance Test	8
9.7 High Voltage Cable Testing	8
9.8 Cable Sheath Integrity Test (IR Test) Prior to Application of Joints and Terminations	8
9.9 Cable Sheath Integrity Test (IR Test) After Application of Joints and Terminations	9
9.10 Verify Phasing and Cable Continuity and Prepare Cable for Testing	9

Specification for UDC Electrical Testing



9.11 Pre High Voltage test - Insulation Test.....	9
10. Certificate of Completion	10
10.1 Developer Design and Construct Works	10
11. Faults Found During Audits	10
12. Work Verification.....	10
13. Tools and Equipment.....	11
14. Records.....	11
Appendix A: Certificate of Completion – Electrical Testing.....	12
Appendix B: Certificate of Test - Low Voltage Cable Continuity and Insulation Resistance Test	13
Appendix C: Certificate of Test - High Voltage Cable.....	14
Appendix D: Certificate of Test - Public Lighting.....	16
PROJECT NAME:	16
LOCATION:	16
AS CONSTRUCTION PLAN NO:	16

1. Purpose and Scope

This Specification details Ergon Energy's requirements for electrical testing to be undertaken by the Developer under the conditions of Developer Design and Construct Works associated with installation works in Underground Distribution Construction (UDC) Developments.

All work shall be in accordance with the Construction Issue Plan, this specification and referenced documents.

The Contractor shall provide all tools and equipment required to correctly carry out work to Ergon Energy's Construction Standard.

2. References

2.1 Ergon Energy controlled documents

This specification shall be read in conjunction with the Ergon Energy documents listed below and if conflict is found to exist between various parts of this specification & the listed documents, priority shall be given in the following order:

RSC06. UDC Main Specification,

RSC08. UDC Electrical Works specification

RSC14 Project Management specification

Construction Issue Plan

Lighting Construction Manual

Underground Construction Manual

Any specification and construction manual referenced in this specification may be accessed through the Ergon Energy website: www.ergon.com.au

2.2 Other sources

This specification shall be read in conjunction with the following Standards:

AS/NZS 1429.1- Electric Cables – Polymeric insulated,

AS/NZS 3017- Electrical Installations - Testing and inspection guidelines

AS/NZS 4836 – Safe Working on low voltage Electrical Installations

3. Definitions, Acronyms, and Abbreviations

3.1 Definitions

3.1.1 As Constructed Plan: The Construction Issue Plan to which approved variations and other required information during the course of construction has been added.

3.1.2 Aged cables: Cables that have been energised for (1) one year or more.

3.1.3 Audits: Checking for compliance with the applicable Ergon Energy specifications and drawings, *Electrical Safety Act 2002* (Qld) and *Electrical Safety Regulation 2002* (Qld).

3.1.4 Authorisation/s: An approval, consent, permits, clearance, licence or other preconditions required under Law of from an authority in relation to the Project.

3.1.5 Certificate of Completion - Electrical Testing: A certificate from the Site Manager advising that all tests to be undertaken by the Contractor, have been completed in accordance with Ergon Energy's requirements.

3.1.6 Construction Issue Plan: A Construction Plan or plans as defined in RSC08, UDC Electrical Works specification.

3.1.7 Construction Standard: The standard of construction required by Ergon Energy. This is the standard of construction that ensures a quality of supply acceptable to Ergon Energy's customers, continuity of supply and the least long-term cost to Ergon Energy. It shall be to the satisfaction of the Liaison Person. Construction carried out by the Developer's Contractors shall meet this standard.

3.1.8 Contractor: A company or person (including a subcontractor engaged by the contractor) approved by Ergon Energy and selected by the Developer to undertake electrical works associated with the Project.

3.1.9 Designer: A company or person approved by Ergon Energy and selected by the Developer to design and oversee material procurement associated with the electrical reticulation of the project. The Designer is required to resolve issues that may be encountered during construction and considered to impact on their design.

3.1.10 Developer: Any person or company which enters into an agreement with Ergon Energy for the electrical reticulation works.

3.1.11 Development: Works within an area which the Developer has entered into an agreement with Ergon Energy for the electrical reticulation works.

3.1.12 Laws: Includes legally binding law, legislation, statute, acts, ordinances, regulations, by-laws, orders, awards and proclamations that are enacted, issued or promulgated by the State of Queensland or any relevant local authority.

3.1.13 Liaison Person: The Ergon Energy officer who may carry out from time to time audits of materials procured, construction and testing of the electrical works undertaken for the Developer for compliance to Ergon Energy's materials and construction specifications.

3.1.14 Project: All electrical works to be undertaken and includes upgrading of the Ergon Energy distribution system and extension if/as necessary to provide supply to the Development.

3.1.15 Project Manager: A company or person approved by Ergon Energy, selected by the Developer and nominated in the Network Extension Agreement to facilitate, manage and coordinate electrical works for the project.

3.1.16 Site Manager: The Contractor's site representative with authority to deal directly with the Project Manager as required for completion of the Project. The Site Manager is also required to have authority to submit and sign the Certificate of Completion – Electrical Testing, accompanying Certificates of Test and Commissioning Forms.

3.2 Acronyms and Abbreviations

HV High Voltage

LV Low Voltage

UDC Underground Distribution Construction

4. Security

The Developer has responsibility for all issues of site security within an area which the Developer has entered into an agreement with Ergon Energy.

5. Safety, Environmental and Ergonomic Considerations

Refer Clause 6.

6. Acts, Regulations, and Requirements

6.1 Laws and Authorisations

The Developer must comply with all Laws and relevant Authorisations.

6.2 Safety Management System

The Contractor must have documented and implemented a safety management system that complies with all current statutory requirements.

6.3 Other authorities

The Developer must comply with specific requirements of other authorities and utilities.

7. Pre-Start Meeting

Prior to the commencement of the testing work a meeting may be required, at Ergon Energy's discretion, between the Project Manager, Contractor, Liaison Person and if considered necessary, other contractors and representatives of other relevant authorities. Meeting details shall be provided by the Liaison Person and, unless advised otherwise, the meeting shall be held in conjunction with the pre-start site meeting for civil works.

8. Audits

8.1 During Testing

The Project Manager shall notify the Liaison Person to arrange site Audits that shall normally be arranged within two (2) working days of the request being received. Where significant travel is

Specification for UDC Electrical Testing

required from the relevant Ergon Energy Depot additional notice is required as agreed with the Liaison Person.

Audits shall be requested at the following stages:

- **LV Electrical Testing** - prior to commencement of testing.
- **HV Electrical Testing** - prior to commencement of testing.

Should the Project Manager not notify the Liaison Person to arrange site Audits at the above mentioned stages of work the Liaison Person may require the tests to be repeated as is deemed necessary to make a satisfactory Audit.

8.2 Final Audit

On completion of the electrical works and testing Ergon Energy shall carry out a detailed Audit to ensure compliance with the *Electrical Safety Act 2002* (Qld) and *Electrical Safety Regulation 2002* (Qld) and with Ergon Energy's specification and drawings. This Audit does not excuse the Developer from faults found at a later time.

The As Constructed Plan showing all changes and the test certificates shall be returned to the Liaison Person prior to the final Audit.

8.3 Re-Audits

Re-Audits shall be carried out to ensure that faults, if any, have been rectified. Ergon Energy shall apply a charge for each re-Audit or necessary re-testing.

9. Electrical Testing

9.1 Generally

Appendices in this specification shall be completed in full and accompany the Certificate of Completion – Electrical Testing:

- Certificate of Test, Appendix B
- Certificate of Test, Appendix C
- Certificate of Test, Appendix D

9.2 Safety Requirements

As the voltages used in the tests are potentially hazardous appropriate safety measures must be employed and a risk assessment conducted to ensure the safety of the personnel involved in the testing process is not compromised.

9.3 Low Voltage Electrical Testing

Pre-commissioning electrical testing of the works shall be carried out by the Contractor in accordance with the relevant Australian Standards, in particular AS/NZS 3017- "Electrical Installations - Testing and inspection guidelines". In the event of tests being incorrectly performed, or test data being incorrect, Ergon Energy reserves the right to reject the work so affected within the defects liability period. Affected work shall be replaced, repaired or re-done, to the required Construction Standard and re-tested under the supervision of the Liaison Person.

The Project Manager shall notify the Liaison Person of the date for LV testing in accordance with Clause 8. The Liaison Person shall advise if tests are to be witnessed. If so requested, the proposed test methods and details of the proposed test instruments shall be submitted for approval prior to any electrical testing.

All testing shall be performed after the completion of electrical installation, placement of bedding material and trench backfilling etc. Any queries should be directed to the Liaison Person. The Contractor shall record test results on the Certificates of Test (refer Appendix B, C and D).

9.4 Low Voltage Visual and Mechanical Test

Confirm by sample at a minimum of each sixth pillar that cable terminations are tight and phase colours correct.

9.5 Low Voltage Cable Continuity Test

Continuity tests shall be carried out on the LV circuits from the ends of each branch or open point to the origin of the circuit.

Each continuity test shall be carried out with a suitable low reading ohm meter or wheatstone bridge to measure the loop resistance from the test point to the circuit origin and back. Continuity test instruments shall have a resolution of 0.01 ohm.

Connect the phase conductors and neutral together at the circuit origin. At the remote ends of the circuit check the resistance between each phase and neutral. The difference between readings shall be less than 10%. Failure of this test requires that each connection between the remote end and the circuit origin be checked and rectified if necessary. Remedial work shall be at no cost to Ergon Energy.

9.6 Low Voltage Cable Insulation Resistance Test

Connect the phases, neutral and earth as tabulated in the Certificate of Test (refer Appendix B and D) and inject 1.0kV DC until a steady value is achieved. The minimum allowable insulation resistance for new cables is 100M Ω (minimum allowable resistance prior to energisation for aged cables is 1M Ω). Discharge the cable upon completion of testing.

9.7 High Voltage Cable Testing

The following pre-commissioning electrical testing of the works shall be carried out by the Contractor. The Project Manager shall notify the Liaison Person the dates for HV testing, in accordance with Clause 8. The Liaison Person shall advise if tests are to be witnessed. If so requested, the proposed test methods and details of the proposed test instruments shall be submitted for approval prior to any electrical testing. The Contractor shall record test results on the Certificate of Test (refer Appendix C).

It is preferred that a remote switching device is used to energise any new HV cables for the first time. Where practicable, the earth fault protection operating time of the cable's protection system may be reduced during the initial cable energisation – refer the Liaison Person.

9.8 Cable Sheath Integrity Test (IR Test) Prior to Application of Joints and Terminations

This test must be carried out after the installation of the cable, but prior to the application of joints or terminations. This test checks for sheath damage.

Isolate the outermost metallic layer at both ends and measure the insulation resistance between the outermost metallic layer and earth at 1000V DC. Record megger readings, cable identification and the cable temperature. The measured value should be greater than the specified value in the table below for XLPE and paper lead cables. For PVC sheathed cables the acceptance value is 1M Ω . If the cable has two insulated metallic layers (the cable screen and double brass tape termite protection) then the insulation between these layers must be tested also.

Specification for UDC Electrical Testing

Distance	250m	500m	1000m	2000m
Cable size	MΩ	MΩ	MΩ	MΩ
11kV or less				
400mm ²	500	250	125	62
185-240mm ²	300	150	75	37
35mm ²	500	250	125	62
22kV or higher				
185-630mm ²	500	250	125	62
35mm ²	400	200	100	50

The insulation resistance shall be recorded 1 minute after application of the voltage.

No breakdown of the insulation shall occur.

Earth screen for at least 5 minutes after the test.

Where the prescribed values cannot be achieved contact the Liaison Person for direction.

9.9 Cable Sheath Integrity Test (IR Test) After Application of Joints and Terminations

Repeat the test specified in Clause 9.8 after completion of the joints and terminations. This testing is to be completed by the Contractor.

Where the prescribed values cannot be achieved contact the Liaison Person for direction.

9.10 Verify Phasing and Cable Continuity and Prepare Cable for Testing

Ensure that cable cores are isolated at both ends, surge diverters and any voltage transformers are disconnected, and the cable screen wires are connected to earth.

Confirm cable phase identification by belling or using a diode box.

9.11 Pre High Voltage test - Insulation Test

Prior to the HV test (if required) the cable shall be tested for insulation resistance (IR). A voltage of 5000V DC shall be used for cables of rated voltage 11kV and 10000V DC shall be used for cables of rated voltage 22kV except that for aged cables a voltage of 5000V DC shall be used. For cables of rated voltage 6.6kV and below a voltage of 1000V DC shall be applied.

Measure the insulation resistance A to B+C+E, B to A+C+E and C to A+B+E at the voltages described above. Record megger results as before. The measured values should be greater than the specified values in the table below.

Distance	250m	500m	1000m	2000m
Cable size	GΩ	GΩ	GΩ	GΩ
11kV or less				

Specification for UDC Electrical Testing

400mm ²	20	10	5	2.5
185-240mm ²	20	10	5	2.5
35mm ²	40	20	10	5
22kV or higher				
630mm ²	20	10	5	2.5
185mm ²	35	17	9	4
35mm ²	60	30	15	7.5

The insulation resistance shall be recorded 1 (one) minute, 2 (two) minutes and 5 (five) minutes after application of the voltage.

It may take longer than 5 minutes on very long cables for the resistance value to stabilise.

In this case a final reading is taken at 10 minutes and the measurement terminated.

No breakdown of the insulation shall occur.

Earth cable conductors for at least 5 minutes after the test.

Where the prescribed values cannot be achieved contact the Liaison Person for direction.

10. Certificate of Completion

10.1 Developer Design and Construct Works

The Certificate of Completion - Electrical Testing, Appendix A shall be provided by the Project Manager stating all works to be undertaken by the Developer have been carried out in accordance with this specification and Ergon Energy's requirements. The Project Manager shall also ensure the Certificate of Electrical Test in Appendix B, C and D (as applicable) are completed to the satisfaction of the Liaison Person and be submitted with the Certificate of Completion - Electrical Works.

11. Faults Found During Audits

Subsequent to Ergon Energy accepting the Certificate of Completion - Electrical Testing and associated documents the Developer and Contractor shall consider the installation as live & shall not have access.

Faults found during the defects liability period shall be rectified by Ergon Energy and all costs shall be recovered from the Developer.

12. Work Verification

The Contractor is responsible for supervision of construction and compliance with the specification and Construction Issue Plan, however Ergon Energy may also undertake Audits as deemed necessary.

Specification for UDC Electrical Testing

13. Tools and Equipment

Tools and equipment shall be fit for purpose to safely undertake all necessary tasks and comply with all requirements under Law, as well as electricity supply industry requirements.

14. Records

All forms are available on the Ergon Energy website: www.ergon.com.au and shall be completed in full prior to the Certificate of Completion - Electrical Works being issued.

Specification for UDC Electrical Testing



Appendix A: Certificate of Completion – Electrical Testing

PROJECT NAME:

PROJECT No:

LOCATION:

AS CONSTRUCTED PLAN NO:

I/We.....
being the Contractor for the above Project, hereby certify that electrical testing as follows has been completed:

- a. Low Voltage and High Voltage testing has been completed in accordance with the specification.
- b. "Certificate of Test", Appendix B, Appendix C and Appendix D (as applicable) have been completed as applicable and attached.
- c. All tools and equipment used for testing the works have been removed and the works are ready for commissioning.

Dated thisday of20

(Site Manager to Sign)

Attachments: Certificate of Test, Appendix B
Certificate of Test, Appendix C
Certificate of Test, Appendix D

CIRCULATION
Project File

RSC10

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Specification for UDC Electrical Testing

Appendix B: Certificate of Test - Low Voltage Cable Continuity and Insulation Resistance Test

PROJECT NAME:

PROJECT No:

LOCATION:

AS CONSTRUCTED PLAN No:

Core Continuity

Instrument Number:

(Reading in Ohms)

CABLE FROM	TO	A-N	B-N	C-N	A-B	B-C	C-A

Insulation Resistance

Instrument Number:

Test Voltage: 1000Volt Megger Test

(Readings in Megohms)

CABLE FROM	TO	A - B+C+N+E	B - A+C+N+E	C - A+B+N+E	N - A+B+C+E

.....
(Site Manager to Print)

.....
(Site Manager to Sign)

Date...../...../.....

Specification for UDC Electrical Testing

Sheet 1 of 2

Appendix C: Certificate of Test - High Voltage Cable

PROJECT NAME:

PROJECT No:

LOCATION:

AS CONSTRUCTED PLAN No:

A. GENERAL INFORMATION AND DATA

Location	Circuit
Make/Type	Voltage
Size	Route Length

B. PREREQUISITES

Ensure the following steps have been carried out.

1. Cable to be tested properly identified.
2. Warning signs and barriers installed.
3. Correct test probes and instruments installed.
4. Staff briefed on safety requirements. (Wear insulating gloves for megger test and HV test.)

C. TESTING

1. CABLE BELLING

Phase identification as per Line Diagram complete Yes ☐ No ☐

2. SHEATH INTEGRITY TEST (1000V Megger) Instrument Number: _____

Test prior to installation of joints and terminations

CABLE FROM	TO	Calculated value (M-Ohm)	MEASURED VALUE (M-OHM)

Test after installation of joints and terminations Instrument Number: _____

CABLE FROM	TO	Calculated value (M-Ohm)	MEASURED VALUE (M-OHM)

Specification for UDC Electrical Testing

Sheet 2 of 2

Appendix C Continued

3. INSULATION TEST

Test prior to joints and terminations Refer Clause 9.11 Test Voltage

Instrument Number: _____

Cable From	To	Calculated value (M-Ohm)	Measured Value (G-Ohm)		
			A to B+C+E	B to A+C+E	C to A+B+E

Test after joints and terminations Refer Clause 9.11 Test Voltage

Instrument Number: _____

Cable From	To	Calculated value (M-Ohm)	Measured Value (G-Ohm)		
			A to B+C+E	B to A+C+E	C to A+B+E

----- Date:-----/-----/-----
(Site Manager to Print) (Site Manager to Sign)

Specification for UDC Electrical Testing



Appendix D: Certificate of Test - Public Lighting

PROJECT NAME:

PROJECT No:

LOCATION:

AS CONSTRUCTION PLAN NO:

Instrument Number:

INSULATION RESISTANCES 1000Volt DC Megger Test				
CIRCUIT		Phase/ Neutral INSULATION RESISTANCE (100M Ω MIN.)		
FROM	TO LIGHT			

(Site Manager to Print)

(Site Manager to Sign)

Date.-----/-----/-----