Distribution Commissioning Manual

Contents

Contents **1**
Brief description **9**
Related policies 9
Introduction 9
Scope 9
Completion 9
Responsibilities 9
Labelling of apparatus (Distribution Equipment Labelling Standard) 10
Training and competence 10
1. Overhead lines **11**
1.1 HV overhead powerlines – DCF 1.1 11
1.1.1. Equipment pre-handover status 11
1.1.2. Pre-commissioning checks 11
1.1.3. Commissioning of the equipment (Energisation) 11
1.1.4. Handover of responsibility 12
1.2 Low Voltage (LV) overhead lines – DCF 1.2 12
1.2.1. Equipment pre-handover status 12
1.2.2. Pre-commissioning checks 12
1.2.3. Commissioning of the equipment (energisation) 12
1.2.4. Handover and Responsibility 12
1.3 Low voltage aerial bundled conductor (LV ABC) – DCF 1.3 13
1.3.1. Equipment pre-handover status 13
1.3.2. Pre-commissioning checks 13
1.3.3. Test criteria 13
1.3.4. Commissioning of the equipment (Energisation) 13
1.3.5. Handover of Responsibility 14
1.4 HV ABC and Hendrix spacer cable – DCF 1.4 14
1.4.1. Equipment pre-handover status 14
1.4.2. Pre-commissioning checks 14
1.4.3. Test criteria 14
1.4.4. Commissioning of the equipment (Energisation) 15

1.4.5. Handover of responsibility 15
2. Underground cable 15
2.1 HV XLPE cable – DCF 2.1 15
2.1.1. Equipment pre-handover status 15
2.1.2. Responsible persons 16
2.1.3. Pre-commissioning checks 16
2.1.4. Test criteria 16
2.1.5. Insulation resistance test (post–VLF test) 17
2.1.6. Handover of responsibility 18
2.2 HV mixed cable – DCF 2.2 18
2.2.1. Equipment pre-handover status 18
2.2.2. Responsible persons 18
2.2.3. Pre-commissioning checks (visual inspection and safety checks) 18
2.2.4. Test criteria 19
2.2.5. Handover of responsibility 20
2.3 HV paper-insulated belted cable – DCF 2.3 21
2.3.1. Equipment pre-handover status 21
2.3.2. Responsible persons 21
2.3.3. Test criteria 21
2.3.4. Commissioning of the equipment 22
2.3.5. Handover of responsibility 23
2.4 HV paper-insulated screened cable – DCF 2.4 23
2.4.1. Equipment pre-handover status 23
2.4.2. Responsible persons 23
2.4.3. Pre-commissioning checks 23
2.4.4. Test criteria 24
2.4.5. Commissioning of the equipment 24
2.4.6. Handover of responsibility 24
2.5 LV XLPE cable – DCF 2.5 25
2.5.1. Equipment pre-handover status 25
2.5.2. Responsible persons 26
2.5.3. Pre-commissioning checks 26
2.5.4. Test criteria 26
2.5.5. Commissioning of the equipment 27
2.6 LV cable with/without pillars – DCF 2.6 27
2.6.1. Equipment pre-handover status 27

2.6.2. Responsible persons 28
2.6.3. Pre-commissioning checks 28
2.6.4. Test criteria 28
2.6.5. Reconnect N-E connections: 29
2.6.6. Handover 29
2.6.7. Commissioning of the equipment 29
2.7 Steel standard streetlights (Double Insulated (DI)) – DCF 2.7 30
2.7.1. Equipment pre-handover status 30
2.7.2. Pre-commissioning visual inspection and safety checks 30
2.7.3. Multiple streetlight circuit 30
2.7.4. Test criteria 30
2.7.5. Commissioning of the equipment 32
2.7.6. Handover of responsibility 32
2.8 SPUDS single-phase to three-phase pillar – DCF 2.8 32
2.8.1. Equipment pre-handover status 32
2.8.2. Pre-commissioning visual inspection and safety checks 32
2.8.3. Test criteria 33
2.8.4. Handover of responsibility 33
2.9 Pole to pillar/Pit – DCF 2.9 33
2.9.1. Responsible persons 33
2.9.2. Equipment pre-handover status 34
2.9.3. Pre-commissioning checks 34
2.9.4. Test criteria 34
2.9.5. Commissioning of the equipment 35
2.9.6. Handover of responsibility 35
2.10 Streetlights underground supply cable repair – DCF 2.10 35
2.10.1. Task details 35
2.10.2. Pre-repair 36
2.10.3. Supply cable insulation resistance (IR) tests 36
2.10.4. Supply Polarity tests 36
2.10.5. Handover and responsibility 37
2.11 Steel Standard Columns (Class 1) – DCF 2.11 37
2.11.1. Task details 37
2.11.2. Visual inspection 37
2.11.3. Insulation resistance (IR) tests 38
2.11.4. Handover of responsibility 39

2.12 Standalone Power System (SPS) LV Cable - DCF 2.12 39
2.12.1. Equipment pre-handover status 39
2.12.2. Responsible persons 39
2.12.3. Required Commissioning Equipment 39
2.12.4. Test criteria 39
Part 1 – Network Service/Supply cable 40
2.12.5. Isolation 40
2.12.6. Continuity and phasing test 40
2.12.7. Insulation resistance test 40
2.12.8. Visual Inspection and Safety Check 40
2.12.9. Critical checks before energising. 40
2.12.10. Commissioning of the equipment SPS Unit. 40
2.12.11. De-energise Uni-Pillar 40
Part 2: Consumer connection to uni-pillar 41
2.12.12. Handover 41
2.12.13. Isolation 41
2.12.14. Continuity 41
2.12.15. Insulation Resistance Test 41
2.12.16. Visual Inspection 41
2.12.17. Connect consumer main into the uni-pillar. 41
2.12.18. Critical checks before energising 41
2.12.19. Commissioning 41
2.12.20. SCT Details & Final Sign Off 41
2.13 UMSx steel standard (Class II assembly) – DCF 2.13 41
2.13.1. Equipment pre-handover status 41
2.13.2. Pre-commissioning visual inspection and safety checks 42
2.13.3. Test criteria 42
2.13.4. Re-energise the streetlight standard. 42
2.13.5. Power supply functionality and Polarity 42
2.13.6. Handover 43
2.14 UMSx wooden distribution pole – DCF 2.14 43
2.14.1. Equipment pre-handover status 43
2.14.2. Pre-commissioning visual inspection and safety checks 43
2.14.3. Test criteria 43
2.14.4. Handover 44
3. Distribution transformers 44

3.1 MPS distribution transformer – DCF 3.1 45
3.1.1. Decommissioning checks 45
3.1.2. Pre-connection checks 45
3.1.3. Insulation resistance test 45
3.1.4. Installation 45
3.1.5. Commissioning of the equipment 46
3.1.6. Handover of responsibility 47
3.2 Non-MPS distribution transformer DCF – 3.2 47
3.2.1. Decommissioning checks 47
3.2.2. Pre connection checks 47
3.2.3. Insulation resistance test 47
3.2.4. Installation and construction 48
3.2.5. MCCB settings 49
3.2.6. Commissioning of the equipment 49
3.2.7. Handover of responsibility 50
3.3 Single-phase transformer (pole-mounted/pad-mounted) – DCF 3.3 50
3.3.1. Pre connection checks 50
3.3.2. Installation and construction 50
3.3.3. Energisation of the Transformer - Voltage test 51
3.3.4. Handover of responsibility 52
3.4 Three-phase transformer (pole-mounted) – DCF 3.4 52
3.4.1. Decommissioning checks 52
3.4.2. Pre-connection checks 52
3.4.3. Installation and construction 53
3.4.4. Energising the transformer 53
3.4.5. Connecting the Transformer to the network 54
3.4.6. Handover of responsibility 54
3.5 SWER isolation transformer (pole-mounted) – DCF 3.5 54
3.5.1. Pre connection checks 54
3.5.2. Installation and construction 55
3.5.3. Commissioning of the equipment 55
3.5.4. Handover of responsibility 55
3.6 SWER isolation transformer (ground mounted) – DCF 3.6 55
3.6.1. Pre connection checks 56
3.6.2. Installation and construction 56
3.6.3. Commissioning of the equipment 57

3.6.4. Handover of responsibility 57
3.7 Three phase pole mounted shunt reactor - Commissioning – DCF 3.7 57
3.7.1. Pre-connection checks 57
3.7.2. Test criteria 58
3.7.3. Commissioning of the equipment 58
3.7.4. Handover of responsibility 58
4. Distribution equipment 59
4.1 HV Earthing system resistance testing – DCF 4.1 59
4.1.1. Responsible persons 59
4.1.2. Test equipment 59
4.1.3. Instructions 59
4.1.4. Test criteria 59
4.1.5. Acceptable results 62
4.1.6. Handover of responsibility 62
4.2 Nu-Lec load break switch/sectionaliser – DCF 4.2 62
4.2.1. Equipment pre-handover status 62
4.2.2. Pre-commissioning checks 63
4.2.3. Test criteria 63
4.2.4. Commissioning of the equipment and energisation 63
4.2.5. Operations and communications (controller) 64
4.2.6. Handover of responsibility 64
4.3 Nu-Lec pole-mounted automatic control recloser – DCF 4.3 64
4.3.1. Equipment pre-handover status 64
4.3.2. Installation and Pre-commissioning checks 65
4.3.3. Test criteria 65
4.3.4. Commissioning of the equipment 65
4.3.5. Operations and communications (controller) 66
4.3.6. Handover of responsibility 66
4.4 Pole-top switch – DCF 4.4 66
4.4.1. Equipment pre-handover status 66
4.4.2. Pre-commissioning checks 66
4.4.3. Commissioning of the equipment 67
4.4.4. Handover of responsibility 67
4.5 Pole-mounted capacitor bank – DCF 4.5 67
4.5.1. Equipment pre-handover status 68
4.5.2. Pre-commissioning checks 68

4.5.3. Commissioning of the equipment 68
4.5.4. Controller setting and testing. 68
4.5.5. Handover of responsibility 69
4.6 HV Single-phase underground rural supply fuse switch – DCF 4.6 69
4.6.1. Equipment pre-handover status 69
4.6.2. Pre-commissioning checks 69
4.6.3. Test criteria 69
4.6.4. Handover of responsibility 70
4.7 Voltage regulator (Closed-delta connection) – DCF 4.7 70
4.7.1. Equipment pre-handover status 70
4.7.2. Pre-commissioning checks 70
4.7.3. Test criteria 70
4.7.4. Control setting and testing 71
4.7.5. Handover of responsibility 72
4.8 Voltage regulator (Star connection) – DCF 4.8 72
4.8.1. Equipment pre-handover status 72
4.8.2. Pre-commissioning checks 72
4.8.3. Test criteria 73
4.8.4. Control setting and testing 73
4.8.5. Handover of responsibility 74
4.9 HV ring main switchgear – DCF 4.9 74
4.9.1. Equipment pre-handover status 74
4.9.2. Test criteria 74
4.9.3. Pre-commissioning checks 75
4.9.4. Extensible metering unit 76
4.9.5. Commissioning of the equipment 76
4.9.6. Handover of responsibility 76
4.10 PENDA or LV kiosk – DCF 4.10 76
4.10.1. Responsible persons 76
4.10.2. Equipment pre-handover status 77
4.10.3. Test criteria 77
4.10.4. LV underground cables 77
4.10.5. Pre-commissioning checks 77
4.10.6. Commissioning of the equipment 78
4.10.7. Handover of responsibility 78
4.11 NOJA pole-mounted switchgear – DCF 4.11 78

4.11.1. Equipment pre-handover status 78
4.11.2. Test criteria 79
4.11.3. Pre-commissioning checks 79
4.11.4. Control setting and testing 80
4.11.5. Handover of responsibility 80
5. Deviations 80
6. Dictionary 81
7. References 83
8. Related documents 84
9. Review 86
10. Content owner 86
11. Content approver 86
12. Approval history 86
Appendix 1: Distribution equipment commissioning scope, qualification and training requirements table 88

Brief description

This manual is intended for use when undertaking testing and commissioning activities of electrical apparatus on Western Power's distribution network. It is recognised that equipment procured by Western Power changes over time, therefore this manual does not aim to identify and document individual equipment requirements.

Related policies

This manual is made under and supports the *Safety, Health and Environment Management Standard (EDM 32254910)*.

Introduction

This manual provides notes for the completion of the various *Distribution Commissioning Forms* (DCF).

The testing and commissioning of an electrical apparatus must verify continuity, insulation, polarity, turn ratios, calibration, adjustments, protective devices and relay settings, motor rotation, run-in operation and functional activity of all electrical equipment, devices and controls.

Commissioning work must be performed in accordance with the *Electrical System Safety Rules (ESSR) (EDM 41392645)* where applicable, and current procedures, work instructions, DCFs and WRAPs.

Any switching performed in association with commissioning must be carried out under an approved switching program.

Scope

This manual applies to:

1. Workers
2. all activities involving distribution commissioning including, but not limited to:
    - performing tests (voltage, phasing, final tests, etc.)
    - switching.

Completion

The Distribution Commissioning forms are Word documents and can be submitted electronically or printed. Once the form is completed and signed off, it must be returned to the relevant project file/work pack. If paper printed, the work pack/project file along with any hardcopy records must be scanned, with the AO *OM020-F - Operational Maintenance - Scanning Cover Sheet (EDM 59566678)* and retained in EDM where they are to be archived according to current document management standard practice. If electronically collected on Field Mobility Services (FMS) or Power On Mobile (POM) forms, they are archived in the Networks Data Warehouse Work (NDWW) tables.

Responsibilities

The **Head of SEQT** is responsible for:

- ensuring the maintenance and periodic review of this guide and the associated Distribution Commissioning Forms.

Asset Operations Formal Leaders are responsible for:

- ensuring that Workers performing the installation, testing and commissioning of apparatus on Western Power's network have the necessary training, skills, experience, competencies and qualifications to perform the commissioning task
- ensuring that the person responsible for commissioning signs the commissioning form before energisation
- ensuring that the switching operators hold current and updated switching authorisation approved by Western Power when performing switching operations.

Workers are responsible for:

- maintaining any competence and authorisation required to perform the commissioning tests
- ensuring that test instruments used for commissioning are within test and calibration date
- ensuring that safe work methods are used
- recording the test results on the commissioning form(s) and attaching fully completed forms to the job package
- ensuring that where incorrect test results are recorded, corrective actions are taken.

Labelling of apparatus (Distribution Equipment Labelling Standard)

The fixing of permanent labels and safety signs is the responsibility of the equipment installer. However, the commissioning officer must identify and confirm the presence and correctness of all labels and safety signs fitted to distribution equipment.

No equipment should be commissioned and placed into service without fixed permanent labels and safety signs installed. All signage and labelling must be attached to apparatus in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005)*.

The maintenance of labels and safety signs is the responsibility of the maintenance inspector; however, the switching operator must identify and confirm the presence and correctness of all labels and safety signs fitted to distribution equipment or structures at the time of switch operation.

All underground consumer mains must be labelled at the point of supply (see *Section 3.4 (Labelling)* in the *WA Electrical Requirements (WAER))*.

Training and competence

Workers required to perform testing and commissioning activities on distribution equipment must have completed the Distribution testing and commissioning course (provided at PTS) or equivalent unit of competence covered under Certificate III qualifications.

Workers who have not performed commissioning work within the previous 12 months should be re-familiarised with the hazards associated with commissioning work, key documentation, commissioning forms and business processes.

Developers must refer to the *Underground Distribution Scheme Manual (UDSM) (EDM 23169833)* for additional information on requirements for the tasks that they can perform.

The table and notes in *Appendix 1: Distribution equipment commissioning scope, qualification and training requirements table* provide guidance on the training/qualification requirements for performing commissioning work.

1. Overhead lines

The intent of this section is to provide the commissioning requirements for overhead conductors and cables. This section contains details of the following installation types:

- High voltage (HV) overhead powerlines
- Low voltage (LV) overhead lines
- LV aerial bundled conductor (ABC)
- HV ABC and Hendrix spacer cable.

Where down earths are provided for system earthing or earth wire is installed, earthing tests must be performed at each earthing point, refer to *Section 4.1 – HV Earthing system resistance testing DCF 4.1* in this manual and record the results on *DCF 4.1 Earthing system resistance testing (all equipment) (EDM 21631145)* before energising. The completed earthing test forms must accompany the project documentation.

1.1 HV overhead powerlines – DCF 1.1

This DCF covers the testing and commissioning of new or replacement HV overhead powerlines (three phase and single phase).

1.1.1. Equipment pre-handover status

HV overhead conductors must be installed in accordance with the applicable guidelines in *Distribution Construction Standards Handbook* HB01 and applicable design drawings.

1.1.2. Pre-commissioning checks

The following checklist must be completed prior to any commissioning activities:

1. Check the handover certificate (where applicable).
2. Check that all apparatus is correctly labelled.
3. Check and ensure that the SPIDAWeb pick IDs or pole numbers for each item are in accordance with the as-constructed drawings. Record details on the commissioning form.
4. Check and record the work package number.
5. Conductor Tension Test details.
6. Compare the results with the design tension or applicable conductor sag and tension tables to ensure that the conductor was tensioned correctly.
7. Ensure all earth points have acceptable test results and record them on the earth testing commissioning form. The *DCF 4.1 Earthing system resistance testing (all equipment) (EDM 21631145*) must be attached to the commissioning form.
8. The person responsible for commissioning must check the earthing points, ensuring that the connections and inspection pit are correctly installed as per the appropriate construction standard.

1.1.3. Commissioning of the equipment (Energisation)

1. Energise the line in accordance with Network Operations and the switching program.
2. Phase out under Network Operations switching program across open points.
3. Confirm with Network Operations all equipment is in its final circuit condition and all normally open points are set to their designated position.
4. Ensure all equipment is protected from unauthorised access and locked where applicable.
5. Ensure the work area is left tidy with no hazards to the public.

1.1.4. Handover of responsibility

- Hand over responsibility to the network operating authority.
- Return the relevant documents to the project file as a record of the commissioning/handover certificate.

1.2 Low Voltage (LV) overhead lines – DCF 1.2

This DCF covers the testing and commissioning of new or replacement LV bare overhead lines (three phase and single phase).

1.2.1. Equipment pre-handover status

An LV overhead conductor must be installed in accordance with the applicable guidelines in *Distribution Construction Standards Handbook* HB01 and applicable design drawings.

1.2.2. Pre-commissioning checks

1. Check the handover certificate (where applicable).
2. Check that all apparatus is correctly labelled.
3. Check and ensure that the SPIDAWeb pick IDs or pole numbers for each item are in accordance with the as-constructed drawings.
4. Check that all line taps are correctly placed and secure.
5. Check that the neutral and phase conductor arrangement is correct.
6. Conductor Tension Test details.

Compare the results with the design tension or appropriate conductor sag and tension tables to ensure that the conductor was tensioned correctly.

1.2.3. Commissioning of the equipment (energisation)

1. Energise the line in accordance with Network Operations and the switching program.
2. Conduct a service connection test on all installations where the service connections have been disturbed.
3. If the LV network is to be interconnected with another LV network(s), phase out at the normally open point(s); otherwise phase out as required. Ensure that all the inter-connectable points are phased out.
4. Where new LV disconnectors have been installed, they must be phased out and checked.
5. Ensure all equipment is in a final circuit state and all normally open points are set to their designated position.
6. Ensure all equipment is protected from unauthorised access and locked where applicable.
7. Ensure the work area is left tidy with no hazards to the public.

1.2.4. Handover and Responsibility

- Hand over responsibility to the network operating authority.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

1.3 Low voltage aerial bundled conductor (LV ABC) – DCF 1.3

This DCF covers the testing and commissioning of new or replacement LV ABC.

1.3.1. Equipment pre-handover status

LV ABC must be installed in accordance with the appropriate guidelines in *Distribution Construction Standards Handbook* HB01 and applicable design drawings.

1.3.2. Pre-commissioning checks

1. Check the handover certificate (where applicable).
2. Check that all apparatus is correctly labelled.
3. Check and ensure that the SPIDAWeb pick IDs or pole numbers for each item are in accordance with the as-constructed drawings.
4. Check that all line taps and Insulation piercing connectors (IPCs) are correctly placed and secure.
5. Conductor Tension Test details.

1.3.3. Test criteria

Continuity test

Use a resistor box (2 MΩ, 7 MΩ and 11 MΩ) in conjunction with a 500V insulation resistance tester to identify the cable end and phases. The test results depend on the resistor box used.

Insulation resistance test

1. Ensure all Workers not engaged in performing this task have vacated the test area and are outside the safety barriers.
2. Inform safety observers (where present) that testing is about to commence.
3. Remove any safety earth or earth switches on the cable to be tested prior to testing.
4. Use a 500V insulation resistance tester (DO NOT exceed 500V for this test) for a minimum of 1 minute (refer to the commissioning form for the sequence of tests).
5. Values greater than 100 MΩ for new cables and greater than 10 MΩ for aged cables are acceptable.
6. Ensure that capacitive charge in the cable is discharged and replace safety earth leads that were on the cable prior to testing.

1.3.4. Commissioning of the equipment (Energisation)

1. Energise the line in accordance with Network Operations and the switching program.
2. Conduct a service connection test on all installations where the service connections have been disturbed.
3. If the LV network is to be interconnected with another LV network(s), phase out at the normally open point(s); otherwise phase out as required.
4. Where new LV disconnectors have been installed, they must be phased out and checked.
5. Ensure all equipment is in a final circuit condition and all normally open points are set to their designated position.
6. Ensure all equipment is protected from unauthorised access and locked where applicable.
7. Ensure the work area is left tidy with no hazards to the public.

1.3.5. Handover of Responsibility

- Hand over responsibility to the network operating authority.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

1.4 HV ABC and Hendrix spacer cable – DCF 1.4

This DCF covers the testing and commissioning of new or replacement HV ABC and Hendrix spacer cable.

1.4.1. Equipment pre-handover status

HV ABC and Hendrix spacer cables must be installed in accordance with the appropriate guidelines in *Distribution Construction Standards Handbook* HB01, the *HV ABC and Hendrix spacer cables manuals* and applicable design drawings.

1.4.2. Pre-commissioning checks

The following is a checklist to be completed prior to any commissioning activities:

1. Check the handover certificate (where applicable).
2. Check that all apparatus is correctly labelled.
3. Check and ensure that the SPIDAWeb pick IDs or pole numbers for each item are in accordance with the as-constructed drawings.
4. Check that all line taps are correctly placed and secure.
5. Check that the neutral and phase conductor arrangement is correct.
6. Conductor Tension details.

1.4.3. Test criteria

Continuity test

Use a resistor box (2 MΩ, 7 MΩ and 11 MΩ) in conjunction with a 500V insulation resistance tester (DO NOT exceed 500V for this test) to identify the cable end and phases. Record the test results (MΩ) for each phase to screen.

Insulation resistance test

1. Inform safety observers (where present) that testing is about to commence.
2. Ensure all Workers not engaged in performing this task have vacated the test area and are outside the safety barriers.
3. Remove any safety earth or earth switches on the cable to be tested prior to testing.
4. Use a 5kV insulation resistance tester for a minimum of 1 minute (refer to the commissioning form for the sequence of tests).
5. Values greater than 10,000 MΩ for new cables and greater than 100 MΩ for aged cables are acceptable.
6. Ensure that capacitive charge in the cable is discharged and replace safety earth leads that were on the cable prior to testing.

Note: Testing of the apparatus is detailed in *DCF 4.1 Earthing system resistance testing (all equipment) (EDM 21631145)*.

1.4.4. Commissioning of the equipment (Energisation)

1. Energise the line in accordance with Network Operations and the switching program.
2. Phase out under Network Operations switching program across the normally open point(s), if applicable.
3. Ensure all equipment is in a final circuit condition and all normally open points are set to their designated position.
4. Ensure all equipment is protected from unauthorised access and locked where applicable.
5. Ensure the work area is left tidy with no hazards to the public.

1.4.5. Handover of responsibility

- Hand over responsibility to the network operating authority.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

2. Underground cable

The intention of this section is to provide the commissioning requirements for underground equipment. This section currently contains details for the following installations:

- HV cross-linked polyethylene (XLPE) cable
- HV mixed cable
- HV paper-insulated belted cable
- HV paper-insulated screened cable
- LV cross-linked polyethylene (XLPE) cable
- LV cables with/without pillars
- Steel standard streetlights
- Single-phase underground distribution system (SPUDS) single-phase to three-phase pillar
- Pole to pillar
- Streetlights underground supply cable repair

2.1 HV XLPE cable – DCF 2.1

This DCF covers the testing and commissioning of new or replacement HV XLPE cable.

HV XLPE cables, including cable joints and terminations, must be tested following installation, alteration, repair or jointing (including under fault situations) to confirm that the insulation levels and integrity of the cable system are within acceptable values.

HV XLPE cables must not be tested with a HV DC cable tester (high potential (hipot)), as it may cause damage to the cable.

2.1.1. Equipment pre-handover status

The cable must be installed, terminated and jointed in accordance with the appropriate guidelines in the *Distribution Underground Cable Installation Manual (EDM 34011711)*, work instructions and applicable design drawings.

The number of in-line joints must be recorded as this will determine whether VLF testing is required on (<250m) transformer cables. Refer to the HV testing document *Very Low Frequency (VLF-0.1 Hz) Voltage testing of High Voltage cables (EDM 21404211)* if required.

The installer must affix permanent labels stating the destination of all cables in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005).*

Insulation, continuity, and phasing tests must be carried out and the results recorded.

On completion, the installer must issue cable testing schedules and a handover certificate to the operating authority.

2.1.2. Responsible persons

The project manager or officer in charge is responsible for ensuring that testing is in accordance with this instruction.

The testing officer is responsible for carrying out tests in accordance with this instruction and recording all test results and explanatory comments where relevant.

2.1.3. Pre-commissioning checks

The following checklist must be completed prior to any commissioning activities:

1. Check the cable handover certificate (where applicable).

   Note: In most cases a combined handover certificate is issued for the transformer and cables.
2. Check the HV XLPE cable testing schedule.
3. Check that permanent labels indicating the cable destination have been attached to the cable ends
4. Check that the HV screens are all solidly and separately bolted to the HV earth bar.
5. Verify on site that the equipment has been installed correctly and is suitable for service according to the as constructed drawing.
6. Perform a detailed and thorough check of all assets.
7. If the cable ends are to be left disconnected, follow the requirements in the *Laying, pulling and bedding cables work instruction (EDM 41855257)*.

2.1.4. Test criteria

Visual inspection and safety check

1. The following test equipment is required for the tests outlined in this instruction:
   - 500V insulation resistance tester
   - 5kV insulation resistance tester
   - Resistor box
   - 0.01–1.0 Hz very low frequency (VLF) tester for a test voltage up to 60kV.
2. Ensure surge arresters are not connected when testing a pole cable termination (if applicable).
3. HV XLPE cable MUST NOT be tested using DC hipot test equipment. HV tests may only be conducted using a 5kV insulation resistance meter or an approved VLF test set.
4. All HV XLPE cables must be tested as follows:
   - For transformer cables ≤ 250 metres and without in-line joints, conduct an end-to-end phasing test, an insulation resistance test and a sheath integrity test.
   - For transformer cables >250 metres and/or with in-line joints, conduct an end-to-end phasing test, an insulation resistance test, a sheath integrity test, a VLF test and an insulation resistance test (post–VLF test).
   - For feeder cables, conduct an end-to-end phasing test, an insulation resistance test, a sheath integrity test, a VLF test and an insulation resistance test (post–VLF test).

End-to-end phasing test

Use a resistor box (2 MΩ, 7 MΩ and 11 MΩ) in conjunction with a 500V insulation resistance tester to identify the cable end and phases. Record the test results (MΩ) of each phase to screen.

Insulation resistance test

Test the insulation resistance using a 5kV insulation resistance tester between each phase conductor and its corresponding cable screen. Record the measured resistance (MΩ/GΩ). The insulation resistance test results should be for a period of 1 to 10 minutes (subject to the length of the cable) or until the reading is stable. Values greater than 10,000 MΩ are acceptable.

Sheath integrity test

Test the sheath integrity using a 5kV insulation resistance tester between screen and earth. Record the measured values. Values greater than 1,000 MΩ for new cables and 100 MΩ for old cables are acceptable.

The insulation resistance test results should be for a period of 1 to 10 minutes (subject to the length of the cable) or until the reading is stable. The test is carried out using a 5kV insulation resistance tester between each cable screen to earth. Record the measured resistance (MΩ/GΩ).

Note: If the insulation resistance test is <1,000 MΩ for new cables and <100 MΩ for old cables, notify appropriate authorities (e.g., the project manager) for further testing and repair; otherwise proceed.

VLF test

Using a VLF tester, test between conductors to screens (which must be earthed) for 60 minutes at a voltage of 3 VN in the frequency range of 0.01–1.0 Hz (subject to the length of the cable). The result is acceptable if no breakdown occurs.

System voltage	V_N	Test voltage 3 V_N (kV)	
		Peak	RMS
6.6kV	3.8kV	12.0	9.0
11kV	6.35kV	19.0	14.0
22kV	12.7kV	38.0	27.0
33kV	19.1kV	57.0	41.0

Note:

- For maintenance of cables the test voltage is to be reduced to 80% for existing cable and to 60% for ageing cable (greater than 30 years of service).
- Repetitive VLF testing of a cable should be avoided.

2.1.5. Insulation resistance test (post–VLF test)

After the VLF test, carry out an insulation resistance test using a 5kV insulation resistance tester between phase to phase and earth. The insulation resistance test results should be for a period of 1 to 10 minutes (subject to the length of the cable) or until the reading is stable. Values greater than 10,000 MΩ are acceptable. Record the measured values.

Note: Testing of the apparatus is detailed in *DCF 2.1 High voltage XLPE cable (EDM 21540116).*

2.1.6. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility for the completion of the form.
- The testing officer, cable jointer or construction project manager and the person responsible for commissioning must sign off on the testing schedule.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

2.2 HV mixed cable – DCF 2.2

This DCF covers the testing and commissioning of HV mixed cable. Mixed cable refers to different types of cable (made of different insulation materials and construction methods) that are jointed together.

All HV cables, including cable joints and terminations, must be tested following installation, alteration or repair to confirm the insulation levels and integrity of the cable system.

2.2.1. Equipment pre-handover status

The cable must be installed, terminated and jointed in accordance with the appropriate guidelines in the *Distribution Underground Cable Installation Manual (EDM 34011711)*, work instructions and applicable design drawings.

The installer must affix permanent labels stating the destination of all cables in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005)*.

On completion, the installer must issue cable testing schedules and a handover certificate to the operating authority.

2.2.2. Responsible persons

The project manager or officer in charge is responsible for testing in accordance with this instruction.

The testing officer is responsible for testing in accordance with this instruction and recording all test results and explanatory comments where relevant.

2.2.3. Pre-commissioning checks (visual inspection and safety checks)

The following checklist to be completed prior to any commissioning activities:

1. Check the cable handover certificate (where applicable).

   Note: In most cases a combined handover certificate is issued for the transformer and cables.
2. Verify (on site) that equipment has been installed correctly and is suitable for service as per the as-constructed drawing.
3. Check that permanent labels indicating the cable destination have been attached to the cable ends.
4. Carry out a detailed and thorough check of all assets.
5. If the cable ends are to be left disconnected, follow the requirements in the *Laying, pulling and bedding cables work instruction (EDM 41855257)*.

The jointing of different types of cables in a circuit imposes limitations on permissible commissioning tests.

2.2.4. Test criteria

The following test equipment is required for the tests outlined in this instruction:

- 500V insulation resistance tester
- 5kV insulation resistance tester
- Resistor box.

Note: HV DC testing (Hi-Pot) must not be carried out on XLPE cables.

1. Test the cable:
   - after installation and before it is put into service
   - after alteration, repair or jointing and before it is put back into service
2. Paper-insulated cables may be of belted or screened construction.
3. All paper-insulated cables connected to system voltages greater than 11kV are screened construction. (Belted cables are not manufactured for system voltages greater than 11kV.)
4. Whenever possible, test individual cable sections of a mixed cable circuit before the cables are joined.

Mixed XLPE and paper-insulated cables

HV circuits comprising mixed cables must be tested.

Mixed cable imposes limitations on permissible commissioning tests.

Circuits comprising two or more cables of differing insulation material and construction which are jointed must be subjected to the following tests:

End-to-end phasing test

Use a resistor box (2 MΩ, 7 MΩ and 11 MΩ) in conjunction with a 500V insulation resistance tester to identify the cable end and phases. Record the test results (MΩ) of each phase to screen.

Insulation resistance test

Test the insulation resistance using a 5kV insulation resistance tester between conductor to conductor and conductors to earth. Record the measured resistance (MΩ/GΩ). The insulation resistance test results should be for a period of 1 to 10 minutes (subject to the length of the cable) or until the reading is stable. Values greater than 200 MΩ for XLPE-PILC belted, and greater than 500 MΩ for XLPE-PILC screened are acceptable.

VLF test

Using a VLF tester, test between conductors to screens (which must be earthed) for 60 minutes at a voltage of 3 V_N at a frequency range of 0.01–1.0 Hz (subject to the length of the cable). The results are acceptable if no breakdown occurs. Refer to the HV testing document *Very Low Frequency (VLF-0.1 Hz) Voltage testing of High Voltage cables (EDM 21404211)* if required.

System voltage	V_N	Test voltage 3 V_N (kV)	
		Peak	RMS
6.6kV	3.8kV	12.0	9.0
11kV	6.35kV	19.0	14.0
22kV	12.7kV	38.0	27.0
33kV	19.1kV	57.0	41.0

Note: For maintenance of cables the test voltage is to be reduced to 80% for existing cable and to 60% for ageing cable (greater than 30 years of service).

Note: Repetitive VLF testing of a cable should be avoided.

Insulation resistance test (post–VLF test)

1. After the VLF test, use a 5kV insulation resistance tester:
   - Test the insulation resistance between conductor and screen.
   - Test the insulation resistance between phase to phase and earth
2. The insulation resistance test should be for a period of 1 to 10 minutes (subject to the length of the cable) or until the reading is stable.
3. Record the measured values. Values greater than 200 MΩ for XLPE-PILC belted, and greater than 500 MΩ for XLPE-PILC screened are acceptable.

   Note: Testing of the apparatus is detailed in the *DCF2.2 High voltage mixed cable (EDM 21535022).*

2.2.5. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility for the completion of the form.
- The testing officer, cable jointer or construction project manager and the person responsible for commissioning must sign off on the testing schedule.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

2.3 HV paper-insulated belted cable – DCF 2.3

This DCF covers the testing and commissioning of new or replacement HV paper-insulated screened cable.

All HV paper-insulated cables, including cable joints and terminations, must be tested after installation, alteration or repair to confirm the insulation levels and integrity of the cable system.

Refer to the HV testing document *Testing of High Voltage Paper Insulated (Belted) Cables (EDM 21965356)* if required.

2.3.1. Equipment pre-handover status

The cable must be installed, terminated and jointed in accordance with the appropriate guidelines in the *Distribution Underground Cable Installation Manual (EDM 34011711),* work instructions and applicable design drawings.

Permanent labels must be attached to all cables in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005)*.

On completion, the installer must issue cable testing schedules and a handover certificate to the operating authority.

2.3.2. Responsible persons

- The project manager or officer in charge is responsible for testing in accordance with this instruction.
- The tester officer is responsible for carrying out tests in accordance with this instruction and recording all test results and explanatory comments where relevant.
- Pre-commissioning checks

The following test equipment is required for the tests outlined in this instruction:

- 500V insulation resistance tester
- 5kV insulation resistance tester
- Resistor box
- single-output (DC negative) hipot tester for a test voltage of up to 60kV
- positive/negative output DC hipot tester for a test voltage of up to 27kV.

Paper-insulated cables may be of belted or screened construction.

All paper-insulated cables connected to system voltages greater than 11kV are of screened construction. (Belted cables are not manufactured for system voltages greater than 11kV.)

Test the cable:

- after installation and before it is put into service
- after alteration, repair or jointing and before it is put back into service.

2.3.3. Test criteria

Faults mainly occur in these cables from core to earth because each core is continuously wrapped in metal foil (the screen). The only exception is at the cable terminations, where the foil is cut back. This creates a small risk of a core-to-core fault at this location.

End-to-end phasing test

Use a resistor box (2 MΩ, 7 MΩ and 11 MΩ) in conjunction with a 500V insulation resistance tester to identify the cable end and phases. Record the test results (MΩ) of each phase to screen.

Insulation resistance test

The insulation resistance is tested using a 5kV insulation resistance tester connected conductor to conductor and between conductors to sheath. Record the measured values.

Test the insulation resistance using a 5kV insulation resistance tester between conductor to conductor and conductors to earth. Record the measured resistance (MΩ). The insulation resistance test results should be for a period of 1 to 10 minutes (subject to the length of the cable) or until the reading is stable. Values greater than 200 MΩ are acceptable.

Hipot test

- In accordance with the cable-designated voltage or system voltage, apply the recommended test DC voltage for 15 minutes between all conductors connected together and the sheath (R+W+B to sheath). The cable sheath is earthed. The test is acceptable if no breakdown occurs.
- In accordance with the cable-designated voltage or system voltage, apply the test DC voltage for 15 minutes R to W+B and W to B+R. The cable sheath is earthed. The test is acceptable if no breakdown occurs.
- Phase to earth (lead and armour together). A single-output (negative) tester or a positive and negative output tester may be used for an all-conductors-to-sheath hipot test. The conductors must be connected to the negative output. Bond all phase conductors and connect them to the negative output hipot test set. Apply DC HV according to the cable-designated voltage or system voltage, whichever is lesser, for 15 minutes. (Refer to the table below.)
- A cable tester with positive and negative outputs MUST be used for phase-to-phase hipot testing. A cable tester with a single-terminal (negative) HV output must not be used for core-to-core testing. This test must be performed exclusively using a positive and negative hipot tester. Both the lead sheath and armour should be earthed for this test. Apply DC HV according to the cable-designated voltage for 15 minutes as per the following table.

Cable-designated or system voltage (kV)	Test DC voltage [(1)] applied for 15 minutes	
	Between all conductors-to-sheath belted cables (kV)	Between conductor-to-conductor belted cables (kV)
3.8/6.6	12.0	16.0
6.35/11	**20.0**	**27.0**

Test voltage (belted cables) after repair or cut in.

Note: (1) The test DC voltage is based on Table B3 of *AS/NZS 1026:2004* (r2017) with an applied derating factor of 0.8. This factor accommodates the service ageing of cables.

Note: Testing of the apparatus is detailed in the Distribution Commissioning Form.

2.3.4. Commissioning of the equipment

1. On completion of items 1-7 transfer control to the person responsible for commissioning
2. Phase out under the Network Operator switching schedules across the normally open point, and any other open points if applicable.
3. Commissioning persons must ensure that all checks are completed, and the test results comply with minimum standards
4. Check that permanent labels indicating the cable destination have been attached to the cable ends
5. The testing officer, cable jointer or construction project manager and the person responsible for commissioning must sign off on the testing schedule

2.3.5. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

2.4 HV paper-insulated screened cable – DCF 2.4

This DCF covers the testing and commissioning of new or replacement HV paper-insulated screened cable.

This DCF must be followed for all HV paper-insulated screened cable installations in the distribution network. All HV paper-insulated cables, including cable joints and terminations, must be tested following installation, alteration or repair to confirm the insulation levels and integrity of the cable system.

Refer to the HV testing document *Testing of High Voltage Paper Insulated (Belted) Cables (EDM 21965356)* if required.

2.4.1. Equipment pre-handover status

The cable must be installed, terminated and jointed in accordance with the appropriate guidelines in the *Distribution Underground Cable Installation Manual (EDM 34011711)*, work instructions and applicable design drawings.

The installer must affix permanent labels to all cables in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005).*

On completion, the installer must issue cable testing schedules and a handover certificate to the operating authority.

2.4.2. Responsible persons

The project manager or officer in charge is responsible for testing in accordance with this instruction.

The tester officer is responsible for carrying out tests in accordance with this instruction and recording all test results and explanatory comments where relevant.

2.4.3. Pre-commissioning checks

The following test equipment is required for the tests outlined in this instruction:

- 500V insulation resistance tester
- 5kV insulation resistance tester
- Resistor box
- single-output (DC negative) hipot tester for a test voltage of up to 60kV
- positive/negative output DC hipot tester for a test voltage of up to 27kV.

Paper-insulated cables may be of belted or screened construction. All paper-insulated cables connected to system voltages greater than 11kV are of screened construction. (Belted cables are not manufactured for system voltages greater than 11kV.)

Test the cable:

- after installation and before it is put into service
- after alteration, repair or jointing and before it is put back into service.

2.4.4. Test criteria

Faults mainly occur in these cables from core to earth because each core is continuously wrapped in metal foil (the screen). The only exception to this is at the cable terminations, where the foil is cut back. This creates a small risk of a core-to-core fault at this location.

End-to-end phasing test

Use a resistor box (2 MΩ, 7 MΩ and 11 MΩ) in conjunction with a 500V insulation resistance tester to identify the cable end and phases. Record the test results (MΩ) of each phase to screen.

Insulation resistance test

The insulation resistance is tested using a 5kV insulation resistance tester connected conductor to conductor and between conductors to sheath. Record the measured values.

Test the insulation resistance using a 5kV insulation resistance tester between conductor to conductor and conductors to earth. Record the measured resistance (MΩ). The insulation resistance test results should be for a period of 1 to 10 minutes (subject to the length of the cable) or until the reading is stable. Values greater than 200 MΩ are acceptable.

Hipot test

A single-output (negative) tester must be used for all conductors to screen hipot tests. Conductors must be connected to the negative output.

In accordance with the cable-designated voltage or system voltage, whichever is the lesser, apply the recommended test DC voltage for 15 minutes R to W+B+E. The conductor screens and metallic cable sheath are earthed. The test is acceptable if no breakdown occurs.

Cable-designated or system voltage (kV)	Test DC voltage applied for 15 minutes between conductors and earth	
	New cables (kV)	Service-aged cables (kV)
6.35/11	25.0	20.0
12.7/22	50.0	40.0
19/33	**75.0**	**60.0**

Note: The test DC voltage is based on Table B3 of *AS/NZS 1026:2004 (R2017)* with a derating factor of 0.8 for service-aged cables older than 3 years.

Note: Testing of the apparatus is detailed in the Distribution Commissioning Form.

2.4.5. Commissioning of the equipment

1. On completion of items 1-7 transfer control to the person responsible for commissioning.
2. Commissioning persons must ensure that all checks are completed, and the test results comply with minimum standards.
3. Check that permanent labels indicating the cable destination have been attached to the cable ends.

2.4.6. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility for the completion of the form.

- The testing officer, cable jointer or construction project manager and the person responsible for commissioning must sign off on the testing schedule.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

2.5 LV XLPE cable – DCF 2.5

This DCF covers the testing and commissioning of new or replacement LV XLPE cable.

All LV cables, including cable joints and terminations (pillar, frames), must be tested following installation, alteration, and repair or jointing to confirm the insulation levels and integrity of the cable system.

Great care must be taken to ensure that no customers will be affected by the application of test voltages, especially under 'brownfield' conditions.

2.5.1. Equipment pre-handover status

The cable must be installed, terminated and jointed in accordance with the appropriate guidelines in the *Distribution Underground Cable Installation Manual (EDM 34011711)*, work instructions and applicable design drawings.

The installer must attach permanent labels stating the destination of all cables in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005)*.

On completion, the installer must issue cable testing schedules and a handover certificate to the operating authority.

2.5.2. Responsible persons

- The project manager or officer in charge must be responsible for the performance of testing in accordance with this instruction.
- The testing officer must be responsible for carrying out tests in accordance with this instruction and recording all test results and additional comments where relevant.

2.5.3. Pre-commissioning checks

The following test equipment is required for the tests outlined in this instruction:

- 500V insulation resistance tester
- 1kV insulation resistance tester
- Resistor box

Test the cable:

- after installation and before it is put into service
- after alteration, repair or jointing and before it is put back into service.

2.5.4. Test criteria

Test to confirm the end-to-end phasing, the insulation resistance, and the sheath integrity on each circuit as follows:

- Cables are terminated with N-E links left disconnected.
- The readings for each test must be recorded on the Low Voltage XLPE Cable Distribution Commissioning Work Instruction Form.

End-to-end phasing test

End-to-end testing means that the through-joint or tee-joint is between the test points.

Use a resistor box (2 MΩ, 7 MΩ and 11 MΩ) in conjunction with a 500V insulation resistance tester to identify the cable end and phases, and to confirm active(s) to neutral polarity.

Ensure that where a section of cable has been added or a joint has been performed that this is the part of the circuit being tested.

Record the test results (MΩ) between each phase and the neutral screen.

Insulation resistance test

Use an insulation resistance tester to test at 1kV (DO NOT exceed 1kV for this test) for 1 minute between each of the phase conductors, and the phase conductors to neutral. Record the insulation resistance values. Values greater than 10 MΩ for new cable and greater than 1 MΩ for existing cables are acceptable.

Ensure all persons are clear of the circuit before testing.

Discharge the cable after testing.

Cables not Energised within two weeks must be insulation tested again just before energisation.

Sheath integrity test (new sections of cable only)

This test is intended to prove the cable sheath is free from damage which could allow water ingress to the neutral screen.

Test the sheath integrity between the neutral screen and an independent earth reference point. Use an insulation resistance tester at 1kV for 1 minute. Record the value.

A value greater than 10 MΩ for new cable should be achieved. If not, notify the appropriate authorities for further testing or repair; otherwise proceed.

Reconnect N-E links:

1. Reinstate the cable neutral at the supply end first.
2. Check for voltage at the pillar end between the cable neutral and the earth (must be <6V).
3. Connect the cable neutral to the neutral bar in the pillar

Handover

On completion of the above tests, the Testing officer/cable jointer/project manager transfers control to the person responsible for commissioning.

2.5.5. Commissioning of the equipment

1. If the cable circuit is not commissioned (Energised) within two weeks of testing, insulation testing must be repeated.
2. Check that permanent labels indicating the cable destination have been attached to the cable ends.
3. Follow an approved LV switching program to energise the cable circuit.
4. If the LV network is to be interconnected with another LV network, phase out at the normally open point(s); otherwise phase out as required.
5. Commissioning persons must ensure that all checks are completed, and the test results comply with minimum standards.
    - Ensure the work area is left tidy with no hazards to the public.
    - Hand over responsibility for the completion of the form.
    - The testing officer, cable jointer or construction project manager and the person responsible for commissioning must sign off on the testing schedule.
    - Return the relevant form to the project file as a record of the commissioning/handover certificate.

2.6 LV cable with/without pillars – DCF 2.6

This DCF covers the testing and commissioning of new or replacement LV XLPE cable with or without pillars.

All LV cables, including cable joints and terminations (pillar, frames), must be tested following installation, alteration or repair (including under fault situations) to confirm the insulation levels and integrity of the cable system.

Great care must be taken to ensure that no customers will be affected by the application of test voltages, especially under ‘brownfield’ conditions.

2.6.1. Equipment pre-handover status

For an existing cable that is being replaced:

- A phase sequence test must be performed and recorded before the ‘old’ cable is de-energised and disconnected.
- The phase sequence for the new cable must match the replaced cable.

The new/replacement cable must be installed, terminated and jointed in accordance with the appropriate guidelines in the *Distribution Underground Cable Installation Manual (EDM 34011711)*, work instructions and applicable design drawings.

The installer must attach permanent labels stating the destination of all cables.

On completion, the installer must issue cable testing schedules and a handover certificate to the operating authority.

2.6.2. Responsible persons

- The project manager or officer in charge is responsible for the performance of testing in accordance with this instruction.
- The testing officer is responsible for carrying out tests in accordance with this instruction and recording all test results and additional comments where relevant.

2.6.3. Pre-commissioning checks

The following test equipment is required for the tests outlined in this instruction:

- 500V insulation resistance tester
- 1kV insulation resistance tester
- Resistor box.

Test the cable:

- after installation and before it is put into service
- after alteration, repair or jointing and before it is put back into service

2.6.4. Test criteria

Testing must be carried out on each identified circuit as follows:

After all cables are terminated and N-E connections are disconnected/open, test the end-to-end phasing, the insulation resistance and the sheath integrity.

The readings for each test must be recorded on the Low Voltage Cable With/Without Pillars Distribution Commissioning Form.

At the completion of each cable section and prior to the connection of any N-E connections installations, test the insulation resistance of each conductor and the sheath integrity for new cable only.

Continuity and phasing test

Use a resistor box (2 MΩ, 7 MΩ and 11 MΩ) in conjunction with a 500V insulation resistance tester to identify the cable end and phases. Record the test results (MΩ) of each phase to screen.

This test verifies the continuity of the circuit. If using Western Power equipment, connect the four-lead resistor boxes at the beginning of the cable.

Example: Connect the resistor box at the transformer end and test using a 500V insulation resistance tester at the pillars.

Correct resistance values should be measured and recorded between R-N, W-N, B-N, respectively.

Insulation resistance test

This test may not be practical for existing cables because of connected services.

Use a 1kV insulation resistance tester (DO NOT exceed 1000V for this test) for 1 minute between conductor to conductor and conductor to neutral.

Record the values obtained.

Values greater than 10 MΩ for new cable and 1 MΩ for existing cables are acceptable.

Ensure all persons are clear of the circuit before testing.

Discharge the cable after testing.

Sheath integrity test (new sections of cable only)

This test is intended to prove the cable sheath is free from damage which could allow water ingress to the neutral screen.

Ensure that cable N-E connections are disconnected for this test.

Test the sheath integrity between the neutral screen and an independent earth reference point. Use an insulation resistance tester at 1kV for 1 minute. Record the value.

A value greater than 10 MΩ for new cable should be achieved. If not, notify the appropriate authorities for further testing or repair; otherwise proceed.

2.6.5. Reconnect N-E connections:

1. Reinstate the cable neutral at the transformer end.
2. Check for voltage at the pillar end between the cable neutral and the earth (must be <6V).
3. Connect the cable neutral to the neutral bar in the pillar.

2.6.6. Handover

- On completion of the above tests, the testing officer/cable jointer/project manager transfers control to the person responsible for commissioning.

2.6.7. Commissioning of the equipment

1. All cables must be correctly connected, labelled, protected against mechanical damage, and saddled.
2. Feeder pillars, mini-pillars and LV connection points should be fitted with locks, where necessary. They must be checked for public security.
3. If the cable circuit is not commissioned (Energised) within two weeks of testing, insulation testing must be repeated.
4. Each phase must be Energised in turn from the remote end and checked at each pillar for correct phasing. Record the voltages.
5. Confirm phase-phase voltages and record
6. Confirm correct phase sequence
7. Phase out across open points at the feeder pillars, mini-pillars and LV connection points, because cross-phasing is likely to occur at these points.
8. For any interconnection point, cables are identified by labels showing their first points of isolation from that source. Correct labelling is essential to identify the circuit.

   Note: Phase out before closing the LV open point.
9. Conduct a service connection test on all installations where the service connections have been disturbed.

Ensure the work area is left tidy with no hazards to the public.

The testing officer, cable jointer or construction project manager and the person responsible for commissioning must sign off on the DCF.

Return the relevant form to the project file as a record of the commissioning/handover certificate.

2.7 Steel standard streetlights (Double Insulated (DI)) – DCF 2.7

This DCF covers the electrical testing and commissioning of supply cables, cutouts, internal wiring and luminaires of double insulated streetlight assemblies mounted on steel standards. The testing ensures correct electrical installation, and that the steel standards do not become energised.

Where the luminaire or cutout is replaced, the complete installation must be upgraded to 'Double insulated':

- New luminaires (Class II) are provided with twin-core cable, no earth; connect active and neutral in the cutout (Ref DCSH R26-7 series).
- Luminaire – double insulated (DI) with TPS (See DCSH MM13-R26-3)
  - Cutout – Separate neutral/earth (SNE), neutral and earth NOT connected together.
  - TPS earthwire – parked in open/blank terminals at the luminaire and at the cutout.
- Luminaire (old single insulated) with TPS (See DCSH MM13-26-2)
  - Cutout – Separate neutral/earth (SNE), neutral and earth bonded together.
  - TPS earthwire – parked in earth terminals at the luminaire and at the cutout.

2.7.1. Equipment pre-handover status

Steel standard streetlights must be installed in accordance with the following as applicable:

- *Distribution Construction Standards Handbook Part 8 - Street lighting (drawings S08 – S12).*
- *Distribution Construction Standards Handbook Part 2 – Reference (drawings R26 series and R27).*

2.7.2. Pre-commissioning visual inspection and safety checks

The following checklist must be completed prior to any commissioning activities:

1. Check the handover certificate (where applicable).
2. Record the address, work package number, instrument serial number and instrument calibration date.
3. Verify that all equipment has been installed correctly and is suitable for service.
4. Check that there are no cables exposed to the public and backfill if required.
5. Check that a cable identification tag is attached to the supply cable directly below the cutout indicating the pic id of the supply source (e.g., upstream streetlight column or pillar).

2.7.3. Multiple streetlight circuit

Follow the testing sequence on the DCF, completing all the tests on each streetlight before moving to the next. Start at the streetlight closest to the point of supply.

2.7.4. Test criteria

Luminaire TPS cable insulation test

At the cutout 'load' terminals

- Ensure that testing can be safely performed.

- Using an insulation tester (set to 500V), test the active and neutral wires for one second (1 sec) respectively to the metal bracket (earth) inside the steel column. (A-E, N-E 1sec@500V).
- Values exceeding 1MΩ are acceptable.

DO NOT test active to neutral. This could damage electronic circuits in the luminaire.

Supply cable

Isolating and testing the supply cable is not necessary for work on the load side of the cutout, e.g., luminaire head replacement. Select N/A at the drop-down boxes provided.

Insulation resistance test

Note: This insulation test is not required for brownfield pole replacement when the supply cable is in service and is not damaged.

- At the cutout 'line' terminals:
  - Use a 500V insulation resistance tester and test between active to neutral and active to independent earth.
  - Values must be greater than 1MΩ.

Double insulated streetlight installations do not have a MEN connection.

Polarity test

- At the cutout 'line' terminals
- Use a voltmeter between active to line neutral, active to independent earth, and line neutral to independent earth.
- For testing purposes, use an effective earthed reference point spaced a minimum of 2 meters from any electrically conductive object in the ground.
- Active to Line Neutral test values must be between 216–253 V.
- Active to independent earth test values must be 216–253 V.
- Line neutral to independent earth test values must be < 6 V.

Loop impedance

- Prove the neutral connections have been correctly made by using an impedance meter at the cutout 'line' terminals.
- test for and record the loop impedance of the active/neutral loop back towards the supply.
- loop impedance must be < 6.6 ZΩ.

Final touch potential test

- Connect the voltmeter to any exposed metal on the streetlight standard and the independent earth.
- Energise the luminaire by replacing the cutout fuse holder, and simultaneously check for a rise in voltage (the lamp illuminates briefly when the cutout is plugged in, and this is when the 'load' circuit is Energised end to end).
- Record the voltage between the steel standard and the independent earth (must be < 6V). For a voltage of 6V or more, fault-finding must be initiated.

2.7.5. Commissioning of the equipment

1. All cables must be correctly connected, labelled, protected against mechanical damage, and saddled.
2. Feeder pillars, mini-pillars and LV connection points should be fitted with locks, where necessary, and checked for public security.

   Note: If energisation occurs more than two weeks after these commissioning tests, conduct a final insulation resistance test to ensure the cable is safe to energise.
3. Ensure the work area is left tidy with no hazards to the public.

2.7.6. Handover of responsibility

- Certify all steps have been completed and transfer control to the network operating authority.
- The testing officer, cable jointer or construction project manager and the person responsible for commissioning must sign off on the testing schedule.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

2.8 SPUDS single-phase to three-phase pillar – DCF 2.8

This DCF covers the testing and commissioning of a SPUDS single-phase pillar that has been converted to a standard three-phase pillar.

2.8.1. Equipment pre-handover status

The converted three-phase pillar must be installed in accordance with the guidelines in *Distribution Construction Standards Handbook Part 05 (U)* and applicable design drawings.

2.8.2. Pre-commissioning visual inspection and safety checks

The following checklist must be completed prior to any commissioning activities:

1. Check the handover certificate (where applicable).
2. Record the address, work package number and location of the pillar.
3. Check that all affected customer SPDs have been removed and their load neutral disconnected.
4. Disconnect all customer supplies at the affected pillars – confirm that their cables are correctly labelled per section 3.4 of the WA Electrical Requirements (2023), underground consumer mains must be labelled at the point of supply. Refer to the *Distribution Equipment Labelling Standard (EDM 25433005)*.
5. Ensure the circuit supply point has been isolated and tagged.
6. Check that the streetlight or UMS circuit (if present) is correctly installed as per the works package requirements and *Distribution Construction Standards Handbook* HB01 and that there are no signs of damage.
7. Check at the circuit supply source that the cable is reconfigured to 3-phase, and that redundant bridging has been removed.
8. Check at each pillar that the cable cores are correctly positioned, and that redundant bridging has been removed.
9. Compare the existing outgoing service connection with the required service connection in the work package.
10. Ensure that the work conforms to the work package in preparation for any load balancing that may be required.

2.8.3. Test criteria

Insulation and core separation test

Use a 1kV insulation resistance tester (DO NOT exceed 1000V for this test).

Confirm the integrity of the cable insulation, and that the cores are separated (all bridging removed).

Values greater than 10 MΩ for new cable and 1 MΩ for existing cables are acceptable.

Energising

After energising according to the LV switching program, check and record:

- Phase rotation
- Line, phase and neutral voltages

Use a voltmeter to measure the voltage across the incoming supply terminals at the mini-pillar. Expected values between phases should be 376–440V; phase to neutral should be 216–253 V.

Customer connection

Reconnect customer cables

Perform a service connection test at each customer installation.

Phasing out

Phase out across open points at the feeder pillars, mini-pillars and LV connection points because cross-phasing is likely to occur at these points.

Note: Commissioning to be carried out in accordance with section 3.8 of the WA Electrical Requirements, label all underground mains of consumers at the point of supply.

2.8.4. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Certify all items have been completed and transfer control to the network operating authority.
- The testing officer, cable jointer or construction project manager and the person responsible for commissioning must sign off on the testing schedule.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

2.9 Pole to pillar/Pit – DCF 2.9

This DCF covers the testing and commissioning requirements for reconnecting or new LV cable between the overhead network and a pillar/pit in the Western Power distribution network.

2.9.1. Responsible persons

The project manager or person responsible for must ensure that testing is carried out in accordance with this instruction.

The person responsible for commissioning must confirm all the tests listed in this instruction have been performed satisfactorily and must record all test results and additional comments where relevant.

Where reasonably practicable, to prevent single phasing, affected customers SPDs should be open circuited before commencing the commissioning/re-energising process.

Where reasonably practicable, SPDs should be removed to prevent reconnection of significant load. Great care must be taken to ensure their replacement on completion of works.

Certain checks must be performed at the pole-top by the linesman and confirmed on the form as completed; it is not necessary to record the results unless out of range; these include:

- proving the aerial mains, A-N voltages.
- checks for no voltage before connecting the cable cores to the aerial mains.

2.9.2. Equipment pre-handover status

For an existing pillar, a phase sequence test must be performed and recorded before the pole-to-pillar cable is disconnected from the aerial conductors.

The *Distribution Construction Standards Handbook (DCSH) – Part 05 (U)* and applicable design drawings should be used for guidance on cable connection in the pillar/pit.

The neutral and each core of the cable must be identified and positioned ready for connection at the pole top.

Where there is more than one cable connected at the pole-top, each cable must be clearly labelled at both ends for future identification.

2.9.3. Pre-commissioning checks

Record the required information on the commissioning form prior to any commissioning activities:

1. Record the address, work package number and location of the pillar/pit.
2. Ensure that customer installations will not be Energised until after all the commissioning tests have been completed with the required results.
3. Ensure that the cable neutral core and the aerial neutral have been correctly identified.
4. Check the correct alignment of the service cable and conduit to the pole.
5. Check all electrical connections at the pillar/pit are completed and tight.
6. Make sure the work conforms to the work package in preparation for any load balancing that may be required.

2.9.4. Test criteria

Test instruments must be approved and within their calibration date.

Often a high impedance voltmeter will indicate stray or ‘ghost’ voltages on the unconnected phase(s) when one phase is Energised. To get a true reading use:

- a low-impedance voltmeter, or
- a stray-voltage eliminator, or
- connect a load tester across the test points to dissipate stray voltage.

Before connecting the cable in the pillar/pit, perform the following tests in accordance with the Distribution Commissioning Form (DCF2.9)

1. Insulation resistance tests.
2. Sheath test.
3. Polarity test per phase.
4. Phase rotation test.

2.9.5. Commissioning of the equipment

If the neutral voltage at Step 3 is greater than 6V, disconnect the cable neutral from the neutral bar in the pillar/pit and investigate.

1. Confirm aerial mains voltages. (May be omitted for aerial bundled conductor)
2. Ensure no volts between the cable core and the aerial main conductor before connecting.
3. Touch the cable neutral core to the aerial neutral while confirming voltage at the pillar/pit N-E <6V.
4. After proving, connect the cable neutral to the aerial neutral and reconfirm N-E voltage <6V
5. Confirm A-N voltage is still <6V and reconnect the earth conductor to the neutral terminal block.
6. Connect the active cores in turn, confirming voltage at the pillar/pit after each connection is made, A-N voltage ±240V.
7. Record the final voltages at the pillar/pit.
8. Confirm phase rotation. For a cable replacement or upgrade, the phase rotation must be the same as before the original cable was de-energised.
9. On completion of commissioning, at least one service connection test (SCT) must be performed at a customer's premises that is fed from the pillar/pit.
10. If any service connections were disconnected and reconnected in the pillar/pit, service connection testing must be performed on those services to prove loop impedance and correct polarity before the meter load neutral is reconnected and the service restored.

The person responsible for commissioning must sign off on the testing schedule and include their name and Basic Network Authority (BNA) number.

2.9.6. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility to the network operating authority.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

2.10 Streetlights underground supply cable repair – DCF 2.10

Streetlights underground supply cable repair form (EDM 47073329) is for recording test results after repairs to streetlight underground supplies.

The DCF is:

- For using the approved kit for jointing and repair of the various types of cable used to supply streetlights
- For use when:
  - replacing a single pole in a multiple pole streetlight circuit (e.g., after car v pole)
  - replacing a tee-off joint
  - replacing the cable from the tee-off to the pole
  - repairing the underground supply cable (through joint).

2.10.1. Task details

Provide the following information as required on the form:

- Supply pillar Pick Id.
- Repair location address.

- Pick Ids of adjacent poles if the repair is between two poles, or single pole Pick Id if working on the tee-off or cut-out, including car v pole.
- Supply cable details.

  Note: Instruments must have a current calibration certificate.

Workers are advised that when testing the supply loop impedance (line active-line neutral), a result above 1 ohm will indicate a ‘‘failure’’ when the Metrel SCT instrument is used. This is because the Metrel is calibrated for Service connection testing. Record the actual impedance and use this to determine the maximum fuse rating as provided in the commissioning form.

A cable identification tag must be attached to the directly below the cutout indicating the pic id of the supply source.

2.10.2. Pre-repair

- Remove the supply fuse for the streetlight circuit and apply a ‘Do not operate’ danger tag at the point of supply.
- Establish an independent earth at least 2m away from the steel streetlight column. Test between the column and the independent earth using a low-impedance voltmeter to check for touch potential. Record the voltage, this must be less than six volts.
- Access the cutout and remove the cover. Test for de-energised on the supply side.
- Check that the cut-out has been correctly wired for the type of luminaire. Refer to the *Distribution Construction Standards Handbook* (DCSH) diagrams MM13; S08; S09; S10; S11; S12; R26; R27.
- Determine the nature and extent of the repair.

On completion of supply cable repair perform the following tests at the first downstream cut-out from the repair, or at the teed-off cut-out (for tee-off repair).

2.10.3. Supply cable insulation resistance (IR) tests

- Remove all the cut-out covers in the streetlight circuit to ensure that the PE cells will not be subject to IR test voltages.
- Test the insulation resistance of the supply cable: Active to Neutral, and Active to the steel pole only. Test at 500V and record the results (> 1MΩ).
- Failed tests must be investigated and repaired before continuing.

2.10.4. Supply Polarity tests

- Energise the circuit and perform a touch potential test between the steel pole and the independent earth.
- Record the supply voltages at the first downstream streetlight column from the repair.
- Loop impedance must be recorded – refer to the table at the end of the form for the maximum allowable impedances for the supply fuse rating. i.e., for a 16A fuse the impedance must be less than 3.19ZΩ.
- Failed tests must be investigated and repaired before continuing.
- Establish an MEN at the cutout if required i.e., for Class 1 luminaires. Refer to the *Distribution Construction Standards Handbook* (DCSH) diagrams MM13; S08; S09; S10; S11; S12; R26; R27.
- After closing the inspection cover, perform a final touch potential test between the steel pole and the independent earth. Record the voltage.

2.10.5. Handover and responsibility

- Ensure that all metal inspection covers are replaced, and the work area is tidy with no hazards to the public.
- Hand over responsibility to the network operating authority.
- Attach an 'ASCON' drawing to the test form on completion of works – this can be drawn on a separate sheet or amended on a hard copy of the SPIDA-drawing. This must include details of the repair and data corrections for errors (missing cable, abandoned cable, missing poles, etc) relating to the circuit being worked on.

2.11 Steel Standard Columns (Class 1) – DCF 2.11

This form covers the electrical testing and commissioning of the supply cable, cut-out, and internal wiring for AMI or Small cell single insulated (Class I) assemblies mounted on steel standards. This form can be used for steel streetlight standards fitted with both Class II luminaires and AMI or Small cell (Class I) assemblies.

The DCF is:

- applicable to Workers who have attended *AMI install communication device* training
- for use in commissioning standalone columns with only AMI/Small cell assemblies fitted
- for use in commissioning streetlight columns with Class II luminaires and AMI/Small cell assemblies fitted.

2.11.1. Task details

Provide the following information as required on the form:

- Supply pillar Pick Id.
- Installation location address.

  Note: Instruments must have a current calibration certificate

2.11.2. Visual inspection

- Establish an independent earth (IE) > 2m from the steel column.
- Use a low-impedance voltmeter to check for touch potential between IE and the column and record the voltage, this must be less than six volts.
- Ensure that the supply fuse at the pit/pillar has been removed, the supply cable is de-energised, and cannot be inadvertently re-energised.
- Confirm the following at the pillar or pit (refer to DCSH series U08; U09; U23; U30):
  - the protective earth (PE) is connected to the neutral bar or terminal block and is effectively (not directly) connected to the earth spear
  - the cable neutral screen is taped and covered with black heat shrink
  - the cable active core is made off into the fitted fuse or fed through a floating floodseal fuse.
- Check that the cut-out has been correctly wired. Refer to the DCSH applicable diagrams (Ref R45-SL in the *Network guideline – Telstra equipment installed on Western Power poles – (EDM 47982725).*
- Note the additional requirement of the protective earth (PE) wire that runs back to the supply pit/pillar
- A cable identification tag must be attached to the directly below the cutout indicating the pic id of the supply source.

2.11.3. Insulation resistance (IR) tests

Luminaire (if applicable) and AMI or Small Cell cable insulation test

DO NOT test active to neutral. This could damage electronic circuits in the luminaire or AMI or Small Cell assemblies.

At the cutout 'load' terminals:

- ensure that testing can be safely performed
- if there are two neutrals, they may be tested simultaneously
- using an insulation tester (set to 500V), test the active and neutral wires respectively to the metal bracket (earth) inside the steel column. (A-E, N-E 1sec@500V).
- values exceeding 1MΩ are acceptable.

Supply cable insulation resistance test

At the cutout 'line' terminals:

- Use a 500V insulation resistance tester and test between:
  - active to neutral (>1MΩ) and
  - active to independent earth (>1MΩ).
- Test between IE and PE (0MΩ).

Commissioning of the equipment

1. If energisation occurs more than two weeks after these commissioning tests, conduct a final insulation resistance test to ensure the cable is safe to energise.
2. Before energising, all cables must be correctly connected and labelled and protected against mechanical damage.
3. Pillars and pits must and checked for public security.

Supply polarity test

After energising the cable, test at the cutout 'line' terminals:

- Use the independent earth (IE) as a reference for testing purposes.
- Use a low impedance voltmeter and test between active to line neutral, active to IE, and line neutral to IE.
- Active to Line Neutral test value must be between 216–253V.
- Active to IE test value must be 216–253V.
- Line neutral to IE test value must be < 6V.

Supply loop impedance

- Record the loop impedance of the active/neutral loop back towards the supply.
- Record the loop impedance of the active/PE loop.
- Loop impedances must be < 1Ω.

Final touch potential test

- Connect the voltmeter to any exposed metal on the streetlight standard and the independent earth.
- Record the voltage between the steel standard and the independent earth (must be < 6V). For a voltage of 6V or more, fault-finding must be initiated.

2.11.4. Handover of responsibility

- Certify all steps have been completed.
- The testing officer, cable jointer or construction project manager and the person responsible for commissioning must sign off on the testing schedule.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.
- Ensure the work area is left tidy with no hazards to the public.

2.12 Standalone Power System (SPS) LV Cable - DCF 2.12

- This DCF covers SPS testing and commissioning of new or replacement LV XLPE cable with or without pillars.
- All LV cables, including cable joints and terminations (pillar, frames), must be tested following installation, alteration or repair (including under fault situations) to confirm the insulation levels and integrity of the cable system.
- Great care must be taken to ensure that no customers will be affected by the application of test voltages.

2.12.1. Equipment pre-handover status

For an existing cable that is being replaced:

- A phase sequence test must be performed and recorded before the 'old' cable is de-energised and disconnected.
- The phase sequence for the new cable must match the replaced cable.
- The new/replacement cable must be installed, terminated and jointed in accordance with the appropriate guidelines in the *Distribution Underground Cable Installation Manual (EDM 34011711)*, work instructions and applicable design *drawings.*

2.12.2. Responsible persons

The SPS Technician or Contractor is responsible for carrying out tests in accordance with this instruction and recording all test results and additional comments where relevant.

2.12.3. Required Commissioning Equipment

The following test equipment is required for the tests outlined in this instruction:

- 500V insulation resistance tester
- 1kV insulation resistance tester
- Independent earth stake and lead.

Test the cable:

- after installation and before it is put into service
- after alteration, repair or jointing and before it is put back into service.

2.12.4. Test criteria

The readings for each test must be recorded on the *SPS DISTRIBUTION COMMISSIONING FORM (DCF) 2.12 Low Voltage Cable with/without pillars EDM 63904808.*

Part 1 – Network Service/Supply cable

2.12.5. Isolation

- De-energize potential sources of supply to the uni-pillar, isolate and airgap, lockout and tag out.
- Ensure consumers installation is electrically separated from pillar.
- Test for dead before commencing work or if change of task occurs. Level 2 PPE is required until proven de-energised.

2.12.6. Continuity and phasing test

- Ensure that the test instruments are working and within calibration date. Complete tests as required in Section 4 - Continuity and Phasing Test.

2.12.7. Insulation resistance test

- Complete Test as per Section 5 - Insulation resistance Test.
- Record system voltages to the relevant phase configuration, (single phase, split phase or three phase). Strike through non-applicable phase configuration.

2.12.8. Visual Inspection and Safety Check

- Complete Checklist as per Section 6.

  Note:

  1. SPS pillars do not have an earth stake.
  2. Escalate any failed results to relevant parties and if re-commissioning is required; commissioning must be re-initiated and new forms completed.

2.12.9. Critical checks before energising.

- Complete Critical Checks as per Section 7.

2.12.10. Commissioning of the equipment SPS Unit.

- Complete Commissioning Checks as per Section 8.
- If the cable circuit is not commissioned (Energised) within two weeks of testing, insulation testing must be repeated.
- Record system voltages to the relevant phase configuration, (single phase, split phase or three phase). Strike through non-applicable phase configuration.

2.12.11. De-energise Uni-Pillar

Complete Section 9. Ensure all internal covers are in place and the cabling is in a safe state.

If the consumer mains are not to be commissioned on the same day, the supply cable (SPS – pillar) must be de-energised with info tag affixed to the customer connection circuit breaker at the SPS AC distribution board.

Note: If Part 2 is not completed within 2 weeks of original test dates they must be completed again in full.

Part 2: Consumer connection to uni-pillar

2.12.12. Handover

On completion of the cable testing procedure, transfer control to the person responsible for energisation

Complete Section 1. Relevant parties' sign.

2.12.13. Isolation

Section 2: Confirm by testing that the uni-pillar is isolated from all sources of supply, and the customer's installation is disconnected from the pillar.

2.12.14. Continuity

Confirm end-to-end continuity of the consumer (mains) cable as per Section 3.

2.12.15. Insulation Resistance Test

- Complete Insulation Resistance Test as per Section 4.
- Record the insulation resistance test results on the Commissioning form. Strike through where not applicable.

2.12.16. Visual Inspection

Perform a visual safety check of the meter panel. Ensure that the Load actives and Load neutral are disconnected at the meter, and the SPD fuses are removed. Visual Checklist as per Section 5.

2.12.17. Connect consumer main into the uni-pillar.

Connect the consumer main into uni-pillar. Complete the checklist as per Section 6.

2.12.18. Critical checks before energising

Complete Critical Checks as per Section 7.

2.12.19. Commissioning

Use the Service connection test form to complete final commissioning as per Section 8.

2.12.20. SCT Details & Final Sign Off

Complete SCT details & final sign off as per section 9.

2.13 UMSx steel standard (Class II assembly) – DCF 2.13

This DCF covers the electrical testing and commissioning of UMSx 48VDC point of supply (POS) installation on a steel streetlight standard. This DCF can be used for new UMSx installations and fault repairs. The testing ensures correct electrical installation, and that the steel streetlight standards do not become energised.

2.13.1. Equipment pre-handover status

UMSx must be installed in accordance with:

- Distribution Construction Standards Handbook – UMSx (drawing N310 – 1)

2.13.2. Pre-commissioning visual inspection and safety checks

- Establish an independent earth (IE) > 2m from the steel standard.
- Use a low-impedance voltmeter to check for touch potential between IE and the column and record the voltage, this must be less than six volts.
- Check that the cut-out has been correctly wired and asset has been configured for a Class II installation.
- Visually check cabling and power supply are free from cracks, cuts, and abrasions. All cables must be correctly connected, labelled, protected against mechanical damage.

2.13.3. Test criteria

UMSx AC cable - Supply side insulation test

At the cutout 'load' terminals:

- ensure that testing can be safely performed
- test the Active and Neutral wires individually to Earth using an insulation tester set to 500V. Apply the test between each conductor and the metal steel standard for one second (A-E, N-E for 1 sec @ 500V). The measured values must be above 1 MΩ.
- only values exceeding 1 MΩ are acceptable.

DO NOT test Active to Neutral, as this could damage components within electronic power supply.

UMSx DC cable - Load side insulation test

This test is to be completed at the UMSx 48v Point of Supply on the steel standard. Ensure that testing can be safely performed:

- Connect the DC plug to the Point of Supply (POS). Ensure that the two tails of the DC plug are not touching each other or any other conductive surfaces.
- Test the Positive (+) and Negative (-) wires individually to earth using an insulation tester set to 250V. Apply the test between each conductor and the metal steel standard for one second (P-E, N-E for 1 sec @ 250V).
- Only values exceeding 0.5 MΩ are acceptable.
- Remove the DC plug after test

DO NOT test Positive to Negative, as this could damage components within electronic power supply.

2.13.4. Re-energise the streetlight standard.

- Connect the voltmeter between any exposed metal on the steel standard and the independent earth. Check touch potential between IE and the column is less than six volts.
- Whilst reinserting the cutout, simultaneously check for a rise in voltage (the lamp illuminates briefly when the cutout is plugged in, and this is when the 'load' circuit is energised end to end).
- Record fuse rating within cut-out fuse link cover.
- Record the voltage between the steel standard and the independent earth (must be < 6V). For a voltage of 6V or more, fault-finding must be initiated.

2.13.5. Power supply functionality and Polarity

Ensure that testing can be safely performed as voltage is present at the DC supply output.

- Set the multimeter to the DC volt measurement; observe the correct polarity when using the test probes (Positive and Negative).
- Connect the DC plug to the POS, ensuring the tails of the DC plug are not touching each other or any other conductive surfaces.
- Connect the positive (+) lead of the multimeter to the positive (+) tail of the DC plug and the negative lead to the negative (-) tail.
- Record the voltage reading displayed on the multimeter(+48V).

2.13.6. Handover

- Ensure metal inspection cover has been replaced, and the work area is left tidy with no hazards to the public.
- The completed form must be returned to the project file/work pack.

2.14 UMSx wooden distribution pole – DCF 2.14

This DCF covers the electrical testing and commissioning of UMSx 48VDC point of supply (POS) installation on a wooden distribution pole. This DCF can be used for new UMSx installations and fault repairs. The testing ensures correct electrical installation, and safe work practices.

2.14.1. Equipment pre-handover status

UMSx must be installed in accordance with:

- Distribution Construction Standards Handbook - UMSx (drawings N310-1 Rev A).

2.14.2. Pre-commissioning visual inspection and safety checks

The following checklist must be completed prior to any commissioning activities:

- Ensure mains cabling and the surrounds are secure and there is no danger or faults around the distribution pole.
- Check all cables must be correctly connected, labelled, protected against mechanical damage, and saddled.
- Visually check UMSx cabling, and power supply are free from cracks, cuts, and abrasions.
- Ensure all MAD zone installation requirements have been met.

Note: Refer to the Distribution Construction Standards Handbook (DCSH) reference drawing N310 – 1 for MAD zone clearances and installation requirements.

2.14.3. Test criteria

Test voltage and energise installation.

Connect the service cables to the mains overhead lines. Ensure to use the correct safety equipment to complete the task.

- Ensure that testing can be safely performed.
- Confirm that the correct connections (polarity) have been made through visual inspection of the service cable.
- Remove the fuse holder from the Flowline fuse box.
- Connect one of the leads from the multimeter to the line side of the fuse holder and the other to the neutral terminal.
- Record the voltage reading displayed on the multimeter.

- Record fuse rating and install the fuse into holder into flowline fuse box.
- Confirm neutral tag has been applied to identify neutral conductor.

Power supply functionality and Polarity

Ensure that testing can be safely performed as voltage is present at the DC supply output.

- Set the multimeter to the DC volt measurement; observe the correct polarity when using the test probes (Positive and Negative).
- Connect the DC plug to the POS, ensuring the tails of the DC plug are not touching each other or any other conductive surfaces.
- Connect the positive (+) lead of the multimeter to the positive (+) tail of the DC plug and the negative lead to the negative (-) tail.
- Record the voltage reading displayed on the multimeter (+48V).
- Remove the DC plug on completion of testing.

2.14.4. Handover

- Ensure the work area is left tidy with no hazards to the public.
- The completed form must be returned to the project file/work pack.

3. Distribution transformers

This section provides details of commissioning requirements for distribution transformers, and contains details of:

- modular package substation (MPS) transformer
- non-MPS transformer
- single-phase transformer (pole-mounted/pad-mounted)
- three-phase pole-mounted transformer
- single-wire earth return (SWER) isolation transformer (pole-mounted)
- SWER isolation transformer (ground-mounted).

Equipment pre-handover status

Distribution transformers

Distribution transformers must be installed in accordance with the guidelines in the *Distribution Construction Standards Handbook* and applicable design drawings.

Underground cables

1. The cable links between the HV ring main switchgear, the transformer and the LV switchgear must be installed, terminated and jointed in accordance with the appropriate standards and guidelines as documented in the *Distribution Underground Cable Installation Manual (EDM 34011711)*.
2. As minimum, the installer must attach temporary labels to all relevant network equipment such as transformers and switch fuse units, stating the destinations of all cables.
3. Insulation and phasing tests must be carried out and the results recorded.
4. On completion, the installer must issue HV and LV cable testing schedules and a handover certificate to the operating authority.

Earthing

Before energising, an Earthing system resistance test must be performed to ensure that the earthing arrangement meets requirements. *DCF 4.1 Earthing system resistance testing (all equipment) (EDM 21631145)* must be submitted with the project documentation.

3.1 MPS distribution transformer – DCF 3.1

This DCF covers the testing and commissioning of new or replacement MPS distribution transformers up to 750kVA before energisation. The testing should verify that the equipment:

- has not been damaged in transit
- has been installed in the network correctly
- operates to specification and is suitable for service.

3.1.1. Decommissioning checks

Use *DCF 3.1 MPS Distribution transformer – Decommissioning (EDM 29854219).*

Decommissioning checks must be completed on existing transformers before they are replaced. These checks are essential for ensuring that the connections on the new transformer are the same as the previous transformer.

3.1.2. Pre-connection checks

Record the details of the apparatus location, pick id etc. and complete the *DCF 3.1 MPS Distribution transformer – Commissioning (EDM 44077625)* form as follows:

- Record the Manufacturer serial number.

3.1.3. Insulation resistance test

Use a 2.5kV and 1kV insulation resistance tester for 1 minute to test the insulation resistance on the HV and LV transformer winding, respectively.

The insulation resistance values are acceptable if greater than 1 GΩ at 2.5kV for HV winding and greater than 100 MΩ at 1kV for LV winding.

3.1.4. Installation

Installation of the MPS must follow the work package and comply with any/all environmental considerations such as placement in a public area, access, screens.

The following checklist must be completed prior to commencement of any commissioning activities:

1. Verify (on site) that the equipment has been installed correctly according to the *Distribution Substation Plant Manual (EDM 49988881)* (Refer to drawings DSPM-4-02) and is suitable for service.
2. Check that the transformer tap is at the position as per network planning or the previously installed transformer.
3. Check the transformer handover certificate where applicable.
4. Check the cable handover certificate where applicable.

   Note: In most cases, a combined handover certificate is issued for the transformer and cables.
5. If the cable is to be laid by the customer, then before responsibility is handed over to Western Power for the jointing conduct a pre-acceptance test (insulation resistance test) to determine the state of the cable.
6. Check that the earthing grid is installed as required in the *Distribution Substation Manual.*

7. Check all earthing connections to the transformer.
8. Check the earthing test results meet requirements. (Refer to the earth resistance testing. *DCF 4.1 Earthing system resistance testing (all equipment) (EDM 21631145)* to be attached to project documentation).
9. Check the HV and LV cable testing schedule.
10. Check that the SPIDAWeb pick ID numbers for each item are in accordance with the as-constructed drawings.
11. Check and record the address/pole number and work package number.
12. Check the integrity of the transformer tank and assembly for oil leaks.
13. Check new MPS transformer installations, to make sure that all phase and earth/neutral connections are securely bolted.
14. For MPS transformer changeovers that occur, once the new transformer is installed and while the kiosk is still removed visually and physically check that all phase connections have been reconnected to the correct bushings. Once a team member has completed this step, a second team member must complete this step again to confirm connections.
15. Check and record the address/pole number and work package number.
16. Prepare permanent cable destination labels in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005)*.

3.1.5. Commissioning of the equipment

Energise - No load:

1. Prepare a commissioning program to energise the equipment in accordance with the DCF and the switching program.
2. Verify that the temporary cable destination and transformer labels are correct.
3. Carry out the commissioning program as per the switching program number.
4. Measure the no-load secondary voltage of the transformer to ensure that it meets the voltage requirements at the supply side of the LV disconnector to ensure correct voltages at customer points of supply (POS).

   These voltages may be slightly elevated to compensate for downstream volt-drop.
5. Check that the phase rotation is correct.

   Note: The commissioning program for the transformer may be incorporated into the commissioning program for the ring main switchgear.
6. Check and record the final no-load voltage on each phase of the LV of the transformer.

LV Phase-out test

A phase-out test is conducted under approved switching schedules on ALL points of the LV network where the potential of the Energised transformer can be matched with the potential of another Energised transformer. This test is conducted to ensure interconnections of transformers are made or can be made for operational purposes.

If the LV conductors are Energised from an interconnected transformer, conduct a phase-out test at the new transformer's LV disconnector.

If the LV conductors are not Energised and for sole use, conduct the phase-out as required.

Energise - On load:

1. Energise the transformer according to the approved switching program.
2. Connect the load according to the approved LV switching schedule.
3. Check and record the LV line and phase voltages.
4. Confirm all POS voltages are within required limits: 390–440 V_{line}, and 226–254 V_{phase}.
5. Check and record the final tap position of the transformer.
6. Replace the temporary cable destination and transformer labels with permanent labels on the transformer in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005)*.
7. Conduct a service connection test on all installations where the service connections have been disturbed. Attach completed SCT forms to project documentation.

3.1.6. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility to the network operating authority.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

3.2 Non-MPS distribution transformer DCF – 3.2

This DCF covers the testing and commissioning of new or replacement non-MPS distribution transformers up to 1,000kVA before energisation. The testing should verify that the equipment:

- has not been damaged in transit
- has been installed in the network correctly
- operates to specification and is suitable for service.

3.2.1. Decommissioning checks

Use *DCF 3.2 Non-MPS Distribution transformer – Decommissioning (EDM 44074468)*.

Complete the decommissioning checks on existing transformers before replacing them. These checks are essential for ensuring that the connections on the new transformer are the same as those on the previous transformer.

3.2.2. Pre connection checks

Record the details of the apparatus location, pick id etc. and complete the *DCF 3.2 Non-MPS Distribution transformer – Commissioning (EDM 24981587)* form as follows:

1. Check and record the address/pole number and work package number.
2. Record the Manufacturer serial number.
3. Check that the SPIDAWeb pick ID numbers for each item are in accordance with the as-constructed drawings.

3.2.3. Insulation resistance test

Use a 2.5kV and 1kV insulation resistance tester for 1 minute to test the insulation resistance on the HV and LV transformer winding, respectively.

The insulation resistance values are acceptable if greater than 1 GΩ at 2.5kV for HV winding and greater than 100 MΩ at 1kV for LV winding.

3.2.4. Installation and construction

The following checklist must be completed prior to any commissioning activities:

1. Verify (on site) that the equipment has been installed correctly according to the *Distribution Substation Plant Manual* and is suitable for service.
2. Check that the transformer tap is at the position per network planning or the previously installed transformer.
3. Check the integrity of the transformer tank and assembly for oil leaks.
4. Check the transformer handover certificate (where applicable).
5. Check that the earthing grid is installed as required in the Distribution Design Catalogue (HU 59 – 61) as applicable.
6. Check all earthing connections to the transformer.
7. Check the earthing test results meet requirements. (Refer to the earth resistance testing. *DCF 4.1 Earthing system resistance testing (all equipment) (EDM 21631145)* to be attached to project documentation).
8. Check the HV and LV cable testing schedule.
9. Check the cable handover certificate (where applicable).

   Note: In most cases a combined handover certificate is issued for the transformer and cables.
10. For a customer cable, a pre-acceptance test (insulation resistance test) must be performed, and the results recorded, before connection.
11. For new non-MPS transformer installations, visually check that all phase and earth/neutral connections are securely bolted.
12. For non-MPS transformer changeovers that occur, once the new transformer is installed and while the kiosk is still removed, visually and physically check that all phase connections have been reconnected to the correct bushings. Once a team member has completed this step, a second team member must complete this step again to confirm connections.
13. Prepare permanent cable destination labels in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005)*.
14. Check that unused bushings are fitted with proper bushing inserts and are correctly capped.

    Note: Do not confuse with caps fitted from factory since these are not rated.
15. Check that drain wires are connected to all HV elbow connectors and connected to the cable screen. This ensures the elbows are safe to touch.
16. Check that the HV screens are all solidly and separately bolted to the HV earth bar.
17. Check that all elbow connectors are fitted with correct bailing assemblies and are secure.
18. Check that the neutrals are reconnected, and that earth and the N-E connections are reconnected.
19. If the transformer is for the sole use of a single customer and has multiple LV single-core cables on each phase, check that none of the cores have been inadvertently crossed between phases; otherwise, a short circuit of the transformer will occur when energised.
20. Check that there are no cables exposed to the public and backfill if required.
21. Check the site for erosion around the transformer. If so, then backfill with blue metal or crushed limestone.
22. Open all LV fuse ways, including the transformer disconnector.
23. Check that all LV neutral connections are connected to the LV neutral bar, not the earth bar.

3.2.5. MCCB settings

Refer to the *Distribution customer connection requirements (DCCR) document (EDM 48688244) section 8.2 Arrangement drawings (DCCR 1-00-5 and DCCR 1-00-6).* Confirm that the correct MCCB setting has been applied. If settings are incorrect, adjust the MCCB to suit.

A photo of the MCCB with the applied settings must be submitted with the completed commissioning form.

3.2.6. Commissioning of the equipment

The commissioning program for the transformer may be incorporated into the commissioning program for the HV ring main switchgear.

Energise - No Load

1. Prepare a commissioning program to energise the equipment in accordance with the switching program.
2. Verify that the temporary Cable destination and Transformer labels are correct.
3. Ensure that all fuse ways including the transformer disconnector are open.
4. Carry out the commissioning program as per the switching program number.
5. **Ensure that the MCCB lock out device is removed and safely stowed away when then MCCB is in the "ON" position.**
6. Measure the no-load secondary voltage of the transformer to ensure that it meets the voltage requirements to ensure correct voltages at customer points of supply (POS).

   These voltages may be slightly elevated to compensate for downstream volt-drop.
7. Check that the phase sequence is correct.
8. If the LV cables are energised from an interconnected transformer, conduct the phase-out test at the new transformer's LV disconnector. This test must be performed to ensure that transformers can be paralleled.

LV Phase-out test

A phase-out test is conducted under Network Operations switching schedules on ALL points of the LV network where the potential of the Energised transformer can be matched with the potential of another Energised transformer. This test is conducted to ensure interconnections of transformers are made or can be made for operational purposes.

If the LV conductors are not Energised and for sole use, conduct the phase-out as required.

Energise – On load.

1. Confirm any/all short circuiting is removed from the LV cables.
2. Connect the load as per the LV switching schedule and ensure that the transformer is not interconnected with any other transformers.
3. Check and record the load voltage on each phase of the LV of the transformer. 390–440 V_{line}, and 226–253 V_{phase}.
4. Replace the temporary Cable destination and Transformer labels with permanent labelling in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005).*
5. The switching program should also ensure that the network is returned to the normal operating configuration. i.e., all disconnectors are returned to their normal position (normally open or normally closed).
6. Conduct a service connection test on all installations where the service connections have been disturbed.

3.2.7. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility to the operating authority.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

3.3 Single-phase transformer (pole-mounted/pad-mounted) – DCF 3.3

This DCF covers the testing and commissioning of new or replacement single-phase pole-mounted or pad-mounted transformers up to 50kVA before energisation. The testing should verify that the equipment:

- has not been damaged in transit
- has been installed in the network correctly
- is suitable for service and operates to specification.

3.3.1. Pre connection checks

Record the details of the apparatus location, pick id etc. and complete the form as follows:

- Record the Manufacturer serial number.

Insulation test for Single-bushing transformer:

There are two types of single HV bushing transformer (SWER) configurations.

1. HV bushing (SW) and a tank earth stud only i.e., no external ER bushing (old ABB transformers): The one end (SW) of the HV winding is brought out through the large external bushing and the other is bolted to the inside of the transformer tank. This winding cannot be isolated from the tank and therefore cannot be 'insulation tested'.
2. HV bushing (SW) and a small external earth return bushing marked ER (new Tyree or ETEL transformers): The one end (SW) of the HV winding is brought out through the large external bushing and the other/neutral end is brought out through the ER bushing and bonded to the transformer tank by an earth link. In this case the HV winding can be 'insulation tested' by disconnecting the link between the small (ER) bushing and the tank. The earth link must be reconnected after testing is completed.
    - For the HV bushings, use 2.5kV insulation resistance tester for 1 minute.
    - For the HV-LV and LV-LV tests, use 1kV insulation resistance tester for 1 minute.
    - Ensure that the transformer and the MEN/N-E connections are disconnected.

Prove the end-to-end continuity of the windings by using the insulation tester set to 1kV or its lowest voltage setting and check: SW-ER or A8-A1, and a1-a2 and a3 -a4. All results must indicate continuity (0 Ω).

3.3.2. Installation and construction

The following checklist must be completed prior to any commissioning activities:

1. Check on site and verify that the equipment has been installed correctly according to the *Distribution Construction Standards Handbook* (DCSH) and is suitable for service.
2. Check that the transformer tap is at the position as per network planning or the previously installed transformer.
3. Check the transformer handover certificate (where applicable).
4. Check the cable handover certificate (if applicable).

   Note: In most cases a combined handover certificate is issued for the transformer and cables.

5. If the cable is to be laid by the customer, then before responsibility is handed over to Western Power for the jointing conduct a pre-acceptance test (insulation resistance test) to determine the state of the cable.
6. Check that the earthing grid is installed as required in the *Distribution Substation Manual* (if applicable).
7. Check all earthing connections to the transformer.
8. Check the earthing testing schedule, if applicable (*DCF 4.1 Earthing system resistance testing (all equipment) (EDM 21631145)*).
9. Check the HV cable testing schedule (if applicable).
10. Check the LV cable testing schedule (if applicable).
11. Check that the SPIDAWeb pick ID numbers for each item are in accordance with the as-constructed drawings.
12. Check there are no cracked bushings (HV and LV).
13. Check that all LV connections are correct – including polarity.
14. Check that HV insulated leads are being used (LV ABC).
15. Check that there is a dropout fuse element as per the fuse chart.
16. Ensure that all signage (including HV danger sign) and operational labelling is in place and complies with the *Distribution Equipment Labelling Standard (EDM 25433005).*
17. Open all fuse ways, LV disconnectors.
18. Check and record the address/pole number, SPIDAWeb pick ID number and work package number.
19. Prepare permanent cable destination labels in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005)* (if applicable).
20. For pad-mounted transformers in car parks, ensure protective bollards are installed around the pad-mounted transformer.

3.3.3. Energisation of the Transformer - Voltage test

This test must be carried according to an approved switching program.

The commissioning program for the transformer may be incorporated into the commissioning program for HV switchgear (pad-mounted).

When energising a transformer with or without a load, measure the voltage at the secondary/LV side.

Energise - No Load

Note: Testing of the apparatus is detailed in the Distribution Commissioning Form.

1. Ensure that the transformer and the MEN/N-E connections are re-connected.
2. Verify that the connections to the LV mains are correct.
3. Ensure that all fuse ways including the transformer disconnector are open.
4. Prepare a commissioning program to energise the equipment in accordance with the switching program. Record the switching program number on the commissioning form.
5. Carry out the commissioning as per the switching program.
6. Measure the no-load secondary voltage of the transformer to ensure correct voltages at customer points of supply (POS).

   These voltages may be slightly elevated to compensate for downstream volt-drop.
7. Phase out (confirm polarity) across open LV disconnectors if available.

Energise - On Load

1. Confirm no short circuits on the LV circuits.
2. Energise the LV mains as per the switching program and ensure that the transformer is not interconnected with any other transformers.
3. Check and record the load voltage at LV of the transformer.
4. When erecting a new or replacement transformer, check the voltage at an existing LV point, if possible. Phase out (confirm polarity) across open LV disconnectors if available.
5. Replace the temporary cable destination and transformer labels with permanent labels on the transformer in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005).*
6. Conduct a service connection test on all installations where the service connections have been disturbed.

3.3.4. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility to the operating authority.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

3.4 Three-phase transformer (pole-mounted) – DCF 3.4

This DCF covers the testing and commissioning of new or replacement three-phase pole-mounted transformers up to 315kVA before energisation. The testing should verify that the equipment:

- has not been damaged in transit
- has been installed in the network correctly
- operates to specification and is suitable for service.

3.4.1. Decommissioning checks

Complete the decommissioning checks on existing transformers before replacing them. These checks are essential for ensuring that the connections on the new transformer are the same as those on the previous transformer.

3.4.2. Pre-connection checks

Record the details of the apparatus location, pick id etc. and complete the form as follows:

- Record the Manufacturer serial number
- Check the earthing testing schedule, if applicable (*DCF 4.1 Earthing system resistance testing (all equipment) (EDM 21631145*)).

Insulation resistance test

Use a 2.5kV and 1kV insulation resistance tester for 1 minute to test the insulation resistance on the transformer winding.

The insulation resistance values are acceptable if greater than 1000 MΩ at 2.5kV for HV winding and greater than 100 MΩ at 1kV for LV winding.

Note: Testing of the apparatus is detailed in the Distribution Commissioning Form 3.4.

3.4.3. Installation and construction

The following checklist must be completed prior to any commissioning activities:

1. Verify (on site) that the equipment has been installed correctly according to the *Distribution Construction Standards Handbook* (DCSH) and is suitable for service.
2. Check that the transformer tap is at the position as per network planning or the previously installed transformer.
3. Check the transformer handover certificate (where applicable).
4. Check the cable handover certificate (if applicable).

   Note: In most cases a combined handover certificate is issued for the transformer and cables. If the cable is to be laid by the customer, then before responsibility is handed over to Western Power for the jointing conduct a pre-acceptance test (insulation resistance test) to determine the state of the cable.
5. Check all earthing connections to the transformer.
6. Check the HV cable testing schedule (if applicable).
7. Check the LV cable testing schedule (if applicable).
8. Check that the SPIDAWeb pick ID numbers for each item are in accordance with the as-constructed drawings.
9. Check and record the address/pole number, SPIDAWeb pick ID number and work package number.
10. Prepare permanent labels in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005)*.

3.4.4. Energising the transformer

Voltage test (no load)

This test must be carried out as per the switching program.

When energising a transformer without a load:

- ensure the red to neutral, white to neutral and blue to neutral test results are within the acceptable range (226 V to 254 V).
- ensure the red to white, white to blue and blue to red test results are within the acceptable range (390 V to 440V).
- Confirm correct LV Phase rotation – verify against decommissioning form if applicable.

Phase-out test

A phase-out test is conducted under Network Operations switching schedules on all points of the LV network where the potential of the new transformer can be matched with the potential of another transformer. This test is conducted to ensure that transformers can be paralleled for operational purposes.

If the LV conductors are energised from an interconnected transformer, conduct the phase-out test at the new transformer's LV disconnector or fuse box.

If the LV conductors are for sole use, conduct the phase-out as required.

When erecting a new or reconstructed LV apparatus, conform to the Western Power practices for the construction of distribution overhead lines. Phase out at an existing LV point, if possible. Phase out any newly fitted LV disconnectors and check them for sound operation.

3.4.5. Connecting the Transformer to the network

1. Prepare a commissioning program to energise the equipment in accordance the switching program.
2. Carry out the commissioning as per the switching program.
3. Verify that the connections to the LV mains are correct.
4. Measure the no-load secondary voltage of the transformer to ensure that it meets the statutory voltage requirements at the supply side of the LV disconnector or downstream of the disturbed connection.
5. Connect the load as per the switching program.
6. Check and record the LV load voltage on each phase of the transformer. At customer POS 226 to 254 V_{Phase}, 390 to 440V_{Line}.
7. Check that the phase rotation and synchronisation are correct.
8. Check and record the final tap position of the transformer.
9. Replace the temporary cable destination and transformer labels with permanent labels on the transformer in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005)*.
10. Conduct a service connection test on all installations where the service connections have been disturbed.

3.4.6. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility to the network operating authority.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

3.5 SWER isolation transformer (pole-mounted) – DCF 3.5

This DCF covers the testing and commissioning of new or replacement SWER isolation transformers up to 200kVA before energisation. The testing should verify that the equipment:

- has not been damaged in transit
- has been installed in the network correctly
- operates to specification and is suitable for service.

3.5.1. Pre connection checks

Record the details of the apparatus location, pick id etc. and complete the form as follows:

- Record the Manufacturer serial number

Insulation resistance

Ensure earth return (ER) links and bushings have been disconnected.

Use the table in the commissioning form and test according to the transformer type (stock number) and terminal configurations. The Western Power stock numbers can be found on the transformer nameplate. Testing ensures:

- primary and secondary winding are insulated from each other
- windings are insulated from the tank.

1. Perform insulation tests as described using an insulation resistance tester capable of delivering 2.5kV for at least one minute.
2. Prove winding continuity end-to-end at a lower voltage. Continuity tests are ‘touch tests’ and do not need to be proven for a minute.

3.5.2. Installation and construction

The following checklist must be completed prior to any commissioning activities:

1. Verify (on site) that the equipment has been installed correctly according to the *Distribution Construction Standards Handbook* (DCSH) and is suitable for service.
2. Check all earthing connections to the transformer.
3. Check the earthing testing schedule, if applicable (*DCF 4.1 Earthing system resistance testing (all equipment) (EDM 21631145)*).
4. Check that the ER links and bushings have been correctly reconnected.
5. Check that the transformer tap is at the position as per network planning or the transformer that is being replaced.
6. Check the transformer handover certificate (where applicable).
7. Check the HV cable testing schedule (if applicable).
8. Check that the SPIDAWeb pick ID numbers for each item are in accordance with the as-constructed drawings.
9. Check and record the address/pole number, SPIDAWeb pick ID number and work package number.
10. Prepare permanent labels in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005)* (if applicable).

3.5.3. Commissioning of the equipment

1. Prepare a commissioning program to energise the equipment in accordance with the switching program.
2. Check that the HV fuses are correct rating.
3. Carry out the commissioning as per the switching program. Record the switching program number on the commissioning form.
4. Check for abnormal noise.
5. Confirm voltage (HV) on the secondary side of the isolation transformer (use a non-contact device such as a Modiwark).
6. Confirm and record the low voltage (LV) value at an existing LV point fed from the transformer (240V).

3.5.4. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility to the operating authority.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

3.6 SWER isolation transformer (ground mounted) – DCF 3.6

This DCF covers the testing and commissioning of new or replacement ground mounted SWER isolation transformers up to 315kVA. The testing should verify that the equipment:

- has not been damaged in transit
- has been installed in the network correctly
- operates to specification and is suitable for service.

The transformer has 3 pairs of primary bushings (A-A, B-B, C-C) for in-out cable connections, only two are connected via the transformer primary winding. The B-B bushings (Tyree) or C-C bushings (ABB) are only for ‘parking’ the middle cores of the cable and are not connected to the winding. Refer to the transformer name-plate to establish which bushings are in use.

3.6.1. Pre connection checks

Record the details of the apparatus location, pick id etc. and complete the form as follows:

- Record the Manufacturer serial number.

Transformer tests

Ensure that the transformer and the earth return (ER) connections are disconnected.

Confirm the continuity of the primary winding and the secondary winding separately:

- For ABB transformers (stock code XT0191), the continuity test value must be zero between bushings 'A' and bushings 'B'.
- For Tyree transformers (stock code XT0226), the continuity test value must be zero between bushing 'A' and bushing 'C'.
- For both ABB and Tyree transformers, bushing SW to bushing ER. The continuity test value must be zero.

Use a 2.5kV insulation resistance tester for 1 minute at the following connections:

- For both ABB and Tyree transformers, bushing 'A' to the tank (>1000 MΩ).
- For both ABB and Tyree transformers, bushing 'A' to the SW1 connection (>1000 MΩ).
- For ABB transformers, test bushing 'C' to the tank, and to bushing 'A' (both >1000 MΩ).
- For Tyree transformers, test bushing 'B' to the tank, and to bushing 'A' (both >1000 MΩ).

3.6.2. Installation and construction

The following checklist must be completed prior to any commissioning activities:

1. Verify that the equipment has been installed correctly according to the *Distribution Construction Standards Handbook (DCSH)* and is suitable for service.
2. Check that the earthing grid is installed as required in the *Distribution Substation Manual.*
3. Check all earthing connections to the transformer.
4. Check the earthing testing schedule (*DCF 4.1 Earthing system resistance testing (all equipment) (EDM 21631145)*).
5. Ensure that the transformer and the ER connections are re-connected.
6. Check the HV cable testing schedule.
7. Check the cable handover certificate (where applicable).
8. Check that the transformer tap is at the position as per network planning or the previously installed transformer.
9. Check the transformer handover certificate (where applicable).

   Note: In most cases a combined handover certificate is issued for the transformer and cables.
10. If the customer installs the cable, a pre-acceptance test (insulation resistance test) must be conducted before responsibility is handed over to Western Power for connection.
11. Check that the SPIDAWeb pick ID numbers for each item are in accordance with the as-constructed drawings.
12. Check and record the address/pole number and work package number.
13. Prepare permanent cable destination labels in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005).*

3.6.3. Commissioning of the equipment

The commissioning program for the transformer may be incorporated into the commissioning program for the ring main switchgear.

1. Replace the temporary cable destination and transformer labels with permanent labels in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005).*
2. Prepare a commissioning program to energise the equipment in accordance with the DCM and the switching program.
3. Check that the HV fuses are correct.
4. Carry out the commissioning as per the switching program.
5. Check for abnormal noise.

When erecting a new or reconstructed HV apparatus, check the voltage at an existing LV (240V) point, if possible, in accordance with NETWORK OPERATIONS instructions. Phase out any newly fitted LV sections.

3.6.4. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility to the network operating authority.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

3.7 Three phase pole mounted shunt reactor - Commissioning – DCF 3.7

This commissioning instruction covers the testing and commissioning of a new or replacement Three phase pole mounted shunt reactor. The testing proves as far as reasonably practicable that the equipment:

- has not been damaged in transit
- has been installed in the network correctly
- operates to specification and is suitable for service.

3.7.1. Pre-connection checks

Record the details of the Reactor on the commissioning form *Three phase pole mounted shunt reactor - Commissioning – DCF 3.7*, location, pick id etc. and complete the form as follows:

- Record the Manufacturer serial number.
- Verify (on site) that the equipment has been installed correctly according to the *Distribution Construction Standards Handbook (DCSH) drawing H34 (EDM 24538359)* and is suitable for service.
- Check:
  - correct voltage rating
  - bushings not cracked
  - general condition of tank
  - no oil leaks
  - correct oil level if visible.
- Check the reactor handover certificate where applicable.
- Check the down earth is connected to the reactor tank.
- Check the earthing test results meet requirements. (Refer to the earth resistance testing. *DCF 4.1 Earthing system resistance testing (all equipment) (EDM 21631145)* to be attached to project documentation).

3.7.2. Test criteria

Before connecting the reactor perform the following tests:

Windings insulation resistance test

1. Bridge the RWBN bushing terminals together for this test – ensure that the bridging conductors are clear of the reactor tank.
2. Use a 2.5kV insulation resistance tester for 1 minute to test the insulation resistance between the windings and the reactor tank.
3. The insulation resistance value is acceptable if greater than 1000 MΩ (≥1 GΩ) at 2.5kV.
4. Record the test results on the commissioning form.
5. The bridging must be removed on completion of the test.

Continuity test

Perform a continuity (beep) test from each phase bushing terminal to the neutral bushing terminal. These should all give a positive result. Note that testing between the phase bushing terminals might not give a positive result due to high winding resistance (two in series) and/or high inductance.

Connection

1. On completion of IR and continuity tests check to make sure that all three phase connections are fixed securely to the phase bushing terminals.
2. Confirm that the Neutral bushing is NOT connected.
3. Check that the SPIDAWeb pick ID numbers are in accordance with the as-constructed drawings.
4. Check and record the address/pole number and work package number.
5. Check and record the address/pole number and work package number.
6. Apply labelling in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005)*.

3.7.3. Commissioning of the equipment

1. Check the HV fuse rating (10A - Stock code GF1565).
2. Prepare a commissioning program to energise the equipment in accordance with the DCF and the switching program.
3. Carry out the commissioning program as per the switching program number.
4. Conduct a service connection test on all installations where the service connections have been disturbed. Attach completed SCT forms to project documentation.

3.7.4. Handover of responsibility

- Ensure the work area is left tidy, with no hazards to the public.
- Hand over responsibility to the network operating authority.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

4. Distribution equipment

The intention of this section is to provide details of commissioning requirements for distribution equipment. This section currently contains details of:

- Earth testing
- Nu-Lec load break switch/sectionaliser
- Nu-Lec pole-mounted automatic recloser
- Pole-top switch
- Pole-mounted capacitor bank
- Single-phase underground rural supply fuse switch
- Voltage regulator (closed Delta connection)
- Voltage regulator (Star connection)
- HV ring main switchgear
- LV kiosk.

4.1 HV Earthing system resistance testing – DCF 4.1

This DCF covers testing of the earth resistance of electrodes or earths for HV systems (e.g., RMU) or combined HV-LV earthing systems (e.g., transformers).

Workers must refer to the *FAQ on earthing standards (EDM 28984244*) for further information on required test results, and details on earthing installation and configurations.

Where required, refer to the *Maintaining and replacing down earth assemblies work instruction (EDM 41862205).*

Good earthing systems are essential for the protection of Workers from electrical shock and the protection of electrical equipment from dangerous overvoltage and excess current. Certain network configurations rely on good earthing as circuit requirement.

4.1.1. Responsible persons

The project manager or officer in charge is responsible for testing in accordance with this instruction.

The tester in charge is responsible for carrying out tests in accordance with this instruction and recording all test results and comments where relevant.

4.1.2. Test equipment

The following test equipment is required for the tests outlined in this instruction:

- a ground resistance tester.

4.1.3. Instructions

For combined HV and LV earthing systems (e.g., transformers), measure resistance to earth of the completed system with all earth connections and neutral-earth connections in place. Record the results.

4.1.4. Test criteria

Earthing system resistance test (fall of potential method)

The earth connections of the earthing systems must be located, installed and maintained so that the resistance to earth must not exceed the expected values as specified:

- Disconnected Earth Electrode for overhead apparatus (ref DCSH): i.e., Transformer tank and LV neutral; Cable termination; PTS; Switchgear – less than 30 Ω.
- Disconnected Earth Electrode: Underground system (ground mounted equipment) (each electrode) i.e., Pad-mounted transformer (each electrode); RMU – less than 10 Ω.
- Connected Earth Electrode: Combined HV-LV earthing system (e.g., transformers) – less than 1 Ω.

The resistance specified in HV and LV systems must be achieved independently of any connections between the neutral conductor and earth at other points within the electrical installation.

This test involves two test instrument electrodes (electrode 2 and electrode 3).

If the depth of electrode 1 is d, then the test probe P (electrode 3) of the tester must be placed at a minimum of 2 x d from the earth electrode 1 and the C probe (electrode 2) must be minimum 3.2 x d from the earth electrode 1(in that ratio where P is 62% of the distance between the earth electrode and C probe). This ensures an accurate earth resistance measurement. Otherwise, the measurement would result in higher resistance readings due to summation of the zones of influence of the earth electrode and the C probe. (See *Table 4.1 - Straight line probe spacing*).

In the case that the electrode under test (electrode 1) is unknown, install the electrode 2 at 50 metres away, and electrode 3 at 31 metres (around 62% of the distance between electrodes 1 and 2) in a straight line.

This test is repeated by moving the electrode 3 three metres forwards, and then three metres backwards from its initial position and in straight line. See diagram 1 below.

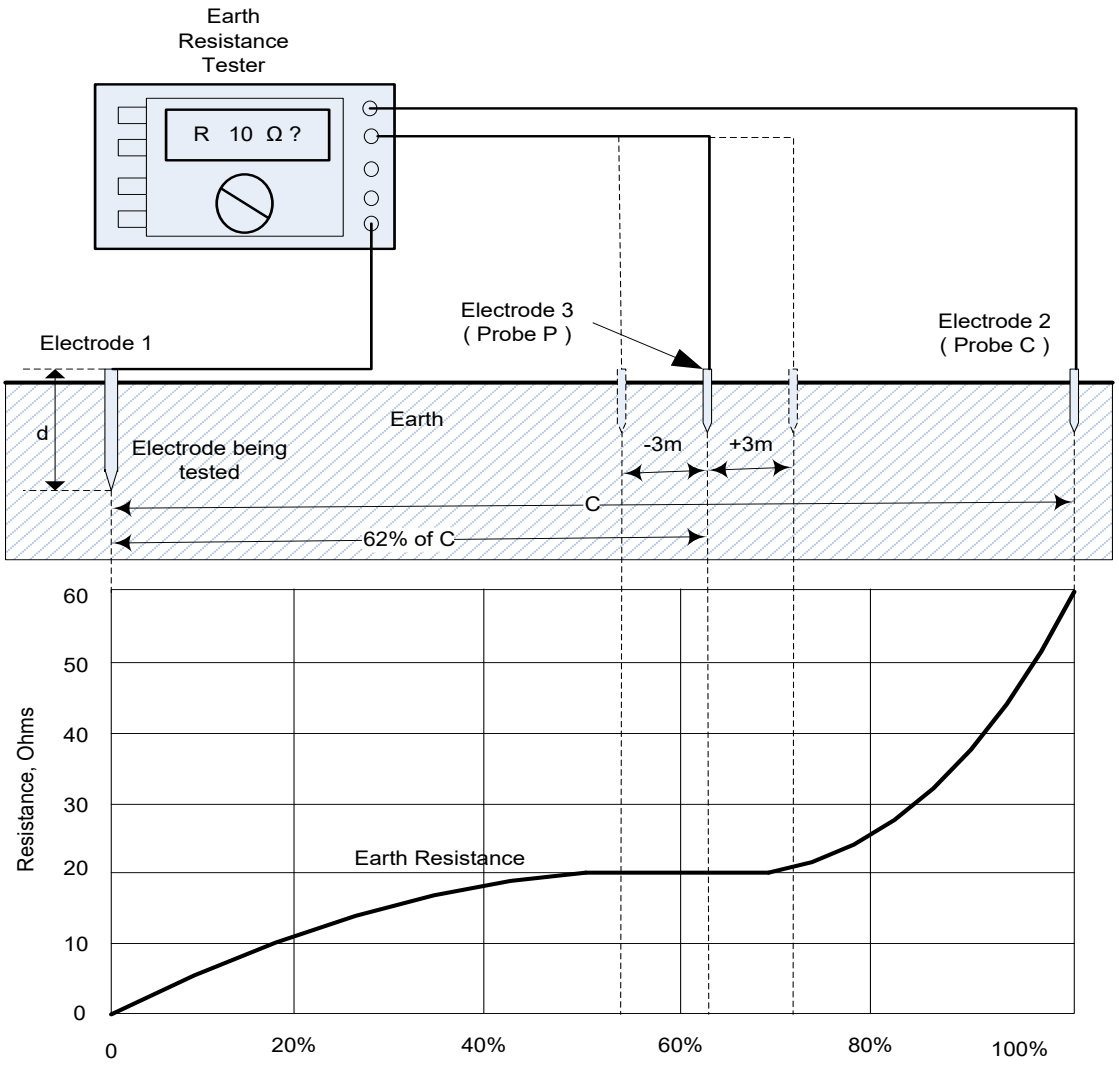

Diagram 1
Percentage of the distance from Electrode 1 to Electrode 2

ELECTRODE DEPTH (d)	Test Lead lengths from Earth Electrode	
	Potential Probe (P)	Current Probe (C)
<15m	30m	50m
15 - 30m	60m	100m
30 - 45m	90m	150m
45 - 60m	120m	190m
60 - 75m	150m	240m
75 - 100m	200m	320m

Table 4.1 - Straight line probe spacing (Western Power Network)

The final test result is the average of the three test results, to be recorded in the Distribution Commissioning Form 4.1.

4.1.5. Acceptable results

Apparatus	Test result
Disconnected Earth Electrode for overhead apparatus (ref DCSH): i.e., Transformer tank and LV neutral; Cable termination; PTS; Switchgear.	Less than 30 Ω
Disconnected Earth Electrode: Underground system (ground mounted equipment) (each electrode) i.e., Pad-mounted transformer (each electrode); RMU.	Less than 10 Ω
Connected Earth Electrode: Combined HV-LV earthing system (e.g., transformers).	Less than 1 Ω

4.1.6. Handover of responsibility

- The person responsible for testing must sign off on the Commissioning form.
- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility to the network operating authority.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

4.2 Nu-Lec load break switch/sectionaliser – DCF 4.2

This DCF covers the testing and commissioning of a new or replacement Nu-Lec load break switch (LBS)/sectionaliser before energisation. Use this instruction in conjunction with the *Electrical System Safety Rules, Western Power Switchgear Instruction Manual*, work instructions and the switchgear manufacturer's operating and commissioning manual.

The switch mechanism can be operated by either a manual hookstick or an electric motor. The switching contacts are driven by an over-centre spring mechanism to ensure that the operating speed is always constant, independently of the speed of the operator.

4.2.1. Equipment pre-handover status

A Nu-Lec load break switch/sectionaliser must be installed in accordance with the appropriate guidelines in *Distribution Construction Standards Handbook* H-60, 61, 63 and applicable design drawings.

Workers must check:

- correct spacing of the bolt holes in the pole for the breaker support bracket
- that when attaching the breaker assembly to the pole, the support bracket for the breaker is properly located so that the bolts are at the top of the slotted holes
- the bolts have been properly tightened
- double check by second crew member

Before energising, an Earthing system resistance test (DCF 4.1) must be performed to ensure that the earthing arrangement meets requirements. The completed Earthing system resistance test form must be submitted with the project documentation.

4.2.2. Pre-commissioning checks

1. Before proceeding, check that the correct rating switch has been installed:
   - RL27 for 11 & 22 kV - stock code GS6016
   - RL38 for 33 kV - stock code GS0131
2. Check the handover certificate (where applicable).
3. Check that the SPIDAWeb pick ID/pole numbers for each item are in accordance with the as-constructed drawings.
4. Confirm correct earthing values. (<30Ω)
5. Check that the antenna is aligned to the correct bearing (applicable radio comms only) and installed correctly (with elements vertical and drain hole down). Antenna pole brackets with open slotted fixing holes are not permitted.

4.2.3. Test criteria

Insulation resistance test

Test the insulation resistance using a 5kV insulation resistance tester between each phase conductor and the load break switch tank. Record the measured resistance (MΩ). The insulation resistance test results should be taken after 1 minute of testing. Values greater than 100 MΩ are acceptable. Check the indicator position.

Continuity test

With the unit in the closed (ON) position, use an insulation resistance tester to verify the continuity of each phase (line to load) circuit. Check that the indicator shows the ON position.

Control cabinet

Check that the antenna surge diverter is fitted at the base of the control box.

4.2.4. Commissioning of the equipment and energisation

1. Ensure that the apparatus is properly labelled in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005).*
2. Carry out the commissioning program in accordance with the switching program.
3. Conduct a phase-out test under network operations switching schedules if the conductors on both sides of the switch are Energised from different feeders. Use appropriate high voltage phasing devices to ensure that phases on the left side of the switch are in phase with those on the right side of the switch.

4. Leave the switch in the OFF position if the control, alarm and communications settings have not yet been applied.
5. The recloser must be tagged “Out of service” until final application of settings and communications checks are performed.

Polarity test

Energise the 240V supply to the control cabinet and conduct a polarity test.

For testing purposes, use an independent earth >2 meters from any electrically conductive object embedded in the ground.

Lock the control unit using approved (NMK2) padlock. NK6 padlocks must not be used.

4.2.5. Operations and communications (controller)

After energising the switch and auxiliary supply, responsibility for final application of settings and communications checks are performed by Asset Operations/Operation Maintenance (Primary Response).

Pole-top control cubicle

The pole-top control cubicle (PTCC) controller works intimately with the on-board electronics of the RL-Series switch. Key electrical characteristics of the switch are stored in the on-board electronics. Thus, any PTCC controller can be connected to any RL-Series switch, and the controller immediately reads the on-board memory and recognises the switch, adapting to suit the characteristics of the switch.

4.2.6. Handover of responsibility

- Ensure that the alarm and controls are set to the required parameters.
- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility to network operating authority.

Return the relevant form to the project file as a record of the commissioning/handover certificate.

4.3 Nu-Lec pole-mounted automatic control recloser – DCF 4.3

This DCF covers the testing and commissioning of new or replacement Nu-Lec pole-mounted automatic reclosers before energisation. Use this instruction in conjunction with the *Electrical System Safety Rules,* work instructions *Western Power Switchgear Instruction Manual* and the switchgear manufacturer’s operating and commissioning manual.

4.3.1. Equipment pre-handover status

A Nu-Lec pole-mounted automatic recloser must be installed in accordance with the appropriate guidelines in *Distribution Construction Handbook (EDM 24538359)* and applicable design drawings.

Workers must check:

- correct spacing of the bolt holes in the pole for the breaker support bracket
- that when attaching the breaker assembly to the pole, the support bracket for the breaker is properly located so that the bolts are at the top of the slotted holes
- the bolts have been properly tightened
- double check by second crew member.

Before energising, an Earthing system resistance test (DCF 4.1) must be performed to ensure that the earthing arrangement meets requirements. The completed Earthing system resistance test form must be submitted with the project documentation.

4.3.2. Installation and Pre-commissioning checks

The following checklist must be completed, and results recorded on the Commissioning form prior to any commissioning activities:

1. Check the handover certificate (where applicable).
2. Check that the SPIDAWeb pick ID and pole numbers for each item are in accordance with the as-constructed drawings.
3. Consult the Nu-Lec pole-mounted automatic recloser manufacturer's operating and commissioning instruction manual to identify any special items that are required to be checked or examined before the equipment is placed in service.
4. Ensure that the apparatus is properly labelled in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005)*.
5. Confirm correct earthing values.
6. Check that all the connections (including the recloser and control cabinet) are properly connected and bonded to earth.
7. Check the recloser for damage, tank, bushings, cracks in boots and excessive dirt.
8. For relocated reclosers, all the HV boots must be removed, cleaned, and repacked with silicon grease. Ensure the boots are fully filled with silicon grease and that no air gaps or moisture are present.
9. Ensure the bushing palms and the lugs are fitted and are tightened correctly.
10. Check that all the HV lightning arresters have bird caps fitted and are tightened correctly.
11. Check the maximum separation between the down earth and the recloser umbilical cable.
12. Check that the pole is labelled correctly.
13. Ensure the 240V white thermal plastic sheath is continuous up to the circuit breaker and stripped minimally to terminate the active and neutral conductors. Install or run the 240V thermal plastic sheath cable behind the gear tray (without a conduit). The earth in the thermal plastic sheath cable can be cut as it need not be connected.
14. Check that the antenna surge diverter is fitted at the base of the control box.
15. Check that the antenna is aligned to the correct bearing (applicable radio comms only) and installed correctly (with elements vertical and drain hole down). Antenna pole brackets with open slotted fixing holes are not permitted.

4.3.3. Test criteria

Insulation resistance test

Use a 5kV insulation resistance tester and take the resistance values after 1 minute of testing. Test the recloser in the OFF (open contact) position. Operate the manual trip lever if required.

Test and record the insulation resistance values.

Note: Testing of the apparatus is detailed in the Distribution Commissioning Form 4.3.

4.3.4. Commissioning of the equipment

1. Ensure that the apparatus is properly labelled in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005)*.
2. Carry out the commissioning program in accordance with the switching program.
3. Conduct a phase-out test under network operations switching schedules if the conductors on both sides of the switch are energised from different feeders. Use appropriate high voltage phasing devices to ensure that phases on the left side of the switch are in phase with those on the right side of the switch.

4. Leave the recloser in the OFF position if the control, alarm and communications settings have not yet been applied.
5. The recloser must be tagged “Out of service” until final application of settings and communications checks are performed.

Polarity test

Energise the 240V supply to the control cabinet and conduct a polarity test.

For testing purposes, use an independent earth >2 meters from any electrically conductive object embedded in the ground.

Lock the control unit using approved (NMK2) padlock. NK6 padlocks must not be used.

4.3.5. Operations and communications (controller)

After energising the switch and auxiliary supply, responsibility for final application of settings and communications checks are performed by Asset Operations/Operation Maintenance (Primary Response).

4.3.6. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility to Network Operations Authority.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

4.4 Pole-top switch – DCF 4.4

This DCF covers the testing and commissioning of new and replacement pole-top switches before energisation.

If a transformer and LV switchgear are to be commissioned at the same time as the pole-top switch, refer to the instructions for commissioning these items of equipment and include the appropriate switching operations in the switching program.

4.4.1. Equipment pre-handover status

Pole-top switches must be installed in accordance with the appropriate guidelines in *Distribution Construction Standards Handbook HB01* and applicable design drawings.

Before energising, an Earthing system resistance test (DCF 4.1) must be performed to ensure that the earthing arrangement meets requirements. The completed Earthing system resistance test form must be submitted with the project documentation.

4.4.2. Pre-commissioning checks

The following steps are to be carried out with the switch de-energised. Refer to the *Distribution Construction Standards Handbook* (H12) and notes for construction details.

1. Check the handover certificate (where applicable).
2. Check that the SPIDAWeb pick ID numbers for each item are in accordance with the as-constructed drawing.
3. Ensure that the apparatus is properly labelled in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005).*
4. Install the earth electrode (maximum 30 Ω).
5. Check that the switch body is earthed to the earthing stud on top of the pole (if using a concrete pole).

6. Check the mechanical operation of the switch and adjust as necessary for smooth operation. Check that all contacts are seated correctly in the closed position.
7. Check that all contacts make and break simultaneously.
8. Ensure that the operating rod has PVC covering where it passes bare LV.

For ground-level operating handle:

1. Ensure that the switch body, switch handle and earth mat are properly earthed and secured.
2. Check the insulated earthing cable used to connect the switch body to the operating mechanism at the base of the pole (if using a wood pole) or connect the operating mechanism to the earth stud at the base of the pole using insulated wire (if using a concrete pole).
3. Check that the switch handle has a flexible bonding connection to the operating mechanism—do not rely on hinge/pivot points to provide adequate bonding.
4. Check that the operating mechanism has a bonding connection to the earth mat and a separate connection to the earth stakes.
5. Check the earthing at the base of the pole (and grease if required). Check that the earth mat is at the correct position for operator safety when operating the switch handle. The earth mat should be above ground, not buried.
6. Fit a Distribution Switching padlock and ensure that the switch handle is lockable in both open and closed positions.

   Note: An NK6 padlock must not be used.

4.4.3. Commissioning of the equipment

1. Carry out the commissioning in accordance the switching program.
2. Conduct a phase-out test under Network Operations switching schedules if the conductors on both sides of the switch are Energised from different feeders. Use appropriate phasing devices to ensure that phases on the left side of the switch are in phase with those on the right side of the switch.
3. Ensure all equipment is in its final circuit condition and that all normally open points are set to their designated position.
4. Ensure all equipment is locked, labelled and protected from unauthorised access.
5. Record the switching program number.
6. Replace the temporary labels with permanent labels.

4.4.4. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility to the operating authority.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

4.5 Pole-mounted capacitor bank – DCF 4.5

This DCF covers the testing and commissioning of new and replacement pole-mounted capacitor banks before energisation. The testing should verify that the equipment:

- has not been damaged in transit
- has been installed in the network correctly
- operates to specification and is suitable for service.

If a transformer is to be commissioned at the same time as a pole-top capacitor bank, refer also to the applicable transformer commissioning form.

4.5.1. Equipment pre-handover status

Capacitor banks must be installed in accordance with the appropriate guidelines in *Distribution Construction Standards Handbook HB01* and applicable design drawings.

Before energising, an Earthing system resistance test (DCF 4.1) must be performed to ensure that the earthing arrangement meets requirements. The completed Earthing system resistance test form must be submitted with the project documentation.

4.5.2. Pre-commissioning checks

The following checklist must be completed prior to any commissioning activities:

1. Check the capacitor bank handover certificate (where applicable).
2. Check that the SPIDAWeb updater has generated the SPIDAWeb pick ID numbers for each item in accordance with the as-constructed drawings.
3. Record the address, work package number and SPIDAWeb pick ID.
4. Ensure that the apparatus is properly labelled in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005).*
5. Check that the construction complies with the distribution construction standards.
6. Check that all the earth connections (including capacitor and control) are properly connected and bonded to earth.
7. Consult the pole-top capacitor bank manufacturer's operating and commissioning instruction manual to identify any special items that are required to be checked or examined before the equipment is placed in service.
8. Record the capacitor bank serial number, rating and stock code number in the data sheet.
9. Go to the site and verify that the equipment has been installed correctly and is suitable for service.
10. Check that the capacitors have been correctly installed and that the electrical connections have been re-tightened.
11. Install dropout fuses according to the design requirements. DO NOT ENERGISE. All dropout fuses and capacitor bank switches must be open.
12. Check that the operating arm on the vacuum switches is OFF (i.e., the switches are in the down position).
13. Lock control unit doors with two Western Power approved padlocks.
14. Ensure that the control settings are configured to the desired set parameters. (Refer to the Distribution Commissioning Form for the control setting and testing.)

4.5.3. Commissioning of the equipment

4.5.4. Controller setting and testing.

Final application of settings and communications checks are performed by Asset Operations/Operation Maintenance (Primary Response). These steps are provided in the Commissioning form (DCF 4.5).

1. Confirm the HV drop-out fuses and capacitor bank switches are open
2. Ensure the feeder reclosers are set to MANUAL during the energisation period.
3. Where automation is provided, ensure that the Supervisory Control and Data Acquisition (SCADA) is set to manual.
4. Ensure all switches operate correctly.
5. Supervisory Control and Data Acquisition (SCADA) labelling and operation is true and correct.

6. Ensure all equipment is in its final circuit condition and all normally open points are set to their designated position.
7. Connect the 240V supply and conduct a polarity test at the controller to ensure its safe operation.
8. For testing purposes, use an independent earth point > 2 meters from any electrically conductive object embedded in the ground.
9. Check that the controller settings have been correctly applied.
10. Check all control functionality using the instruction on the Commissioning form (DCF 4.5).
11. Ensure all equipment is locked, labelled and protected from unauthorised entry.

4.5.5. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility to the network operating authority.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

4.6 HV Single-phase underground rural supply fuse switch – DCF 4.6

This DCF covers the testing and commissioning of new or replacement single-phase underground rural supply fuse switches before energisation. The testing should verify that the equipment:

- has not been damaged in transit
- has been installed in the network correctly
- operates to specification and is suitable for service.

4.6.1. Equipment pre-handover status

A single-phase underground rural supply fuse switch must be installed in accordance with the appropriate guidelines in *Distribution Construction Standards Handbook* HB01 and applicable design drawings.

Before energising, an Earthing system resistance test (DCF 4.1) must be performed to ensure that the earthing arrangement meets requirements. The completed Earthing system resistance test form must be submitted with the project documentation.

4.6.2. Pre-commissioning checks

The following checklist must be completed prior to any commissioning activities:

1. Check the handover certificate (where applicable).
2. Check that the SPIDAWeb pick ID/pole numbers for each item are in accordance with the as-constructed drawings.
3. Record the address, work package number and SPIDAWeb pick ID.
4. Ensure that the apparatus is properly labelled in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005).*

4.6.3. Test criteria

Installation check

1. Refer to manufacturer's instruction and install a switch with blades and contacts de-energised and operate for a function test.
2. Contacts must be in alignment.
3. Contacts must seat fully after 'close' operation.
4. Complete construction checks.

Insulation resistance test

With the unit in the OFF position, use a 5kV insulation resistance tester for 1 minute. Values greater than 5000 MΩ are acceptable.

Energisation

- Confirm correct fuse rating.
- Check switching program for energisation method – must use a remote switch for first energisation.
- Ensure the switch is in the correct position (ON or OFF).
- Fit a Perspex cover and lock the unit door with a Distribution Switching padlock.

4.6.4. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility to the network operating authority.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

4.7 Voltage regulator (Closed-delta connection) – DCF 4.7

This DCF covers the testing and commissioning of new or replacement Closed-delta connected voltage regulators before energisation.

4.7.1. Equipment pre-handover status

Voltage regulators (with a Closed-delta connection) must be installed in accordance with *the Distribution Construction Standards Handbook* applicable design drawings series (H-33).

4.7.2. Pre-commissioning checks

Before energising, an Earthing system resistance test (DCF 4.1) must be performed to ensure that the earthing arrangement meets requirements. The completed Earthing system resistance test form must be submitted with the project documentation. Earthing test result must be <30Ω.

When configured in an offset arrangement, the earths between the poles must be connected (DCSH H33-4).

The following checklist must be completed prior to any commissioning activities:

1. Check the handover certificate (where applicable).
2. Confirm the correct earthing arrangement and tests (DCF 4.1).
3. Check that the SPIDAWeb pick ID and pole numbers for each item are in accordance with the as-constructed drawings.
4. Record the address, work package number and SPIDAWeb pick ID.
5. Ensure that the apparatus is properly labelled in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005).*
6. Ensure that the control settings are configured to the desired parameters.

4.7.3. Test criteria

Insulation resistance test

Use a 5kV insulation resistance tester and measure the resistance value after 1 minute of testing (R >1 GΩ).

Note: Testing of the apparatus is detailed in the Distribution Commissioning Form.

4.7.4. Control setting and testing

Responsibility for final application of settings and checks are performed by Asset Operations/Operation Maintenance (Primary Response).

1. To ensure that the voltage regulators function properly and automatically, test each voltage regulator control as follows:
    a. With the regulator bypass switch in a closed position and the S, L and SL switches in an open position, turn off the power switch and the control switch inside the control box, if available. Check and ensure that the potential switch (V1 and V6, if fitted, for Cooper; DS1 for GE) is in the closed position. Close the current transformer bypass (C switch for Cooper; DS2 for GE). This is to ensure that the control does not respond abruptly when Energised.
    b. With the L switch left in the open position, close the S and SL switch in order to energise the internal potential transformer to supply the control. Phase out if necessary.
    c. Turn the power switch to INTERNAL and the control switch to MANUAL in order to enable the control. Operate the RAISE/LOWER button and observe if the regulator responds to the controls. A sound from the internal motor together with the clicking of the taps should be heard whenever the regulator changes tap. The tap position indicator together with the display in the control should indicate the same tap position and also indicate the change in tap during this operation. This test is to ensure that the tap changer responds to the control.
    d. Return the tap changer to the neutral tap position by operating the RAISE/LOWER button. This can be verified by checking the tap position indicator and ensuring that the neutral lamp/LED lights up.
    e. Upload the settings to the control.
    f. Measure the voltages at the voltmeter terminals or meter out and check that the measured voltage matches that of the voltage displayed in the panel. This is to ensure that the voltage display is correct.
    g. Put the display into the band centre (Depress 1, SET voltage for Cooper; press the UP or DOWN and ENTER button for GE). Set the control to MANUAL, then operate the RAISE button enough steps to put the voltage out of bandwidth. Set the control switch to AUTO and wait for the 30 second time delay. The control should cause the regulator to step down to the top bandwidth. This test is to ensure that the regulator automatically works when the voltage is above the bandwidth.
    h. Repeat the previous step, this time lowering the voltage below the bandwidth, by operating the LOWER button, to test if the regulator automatically works when the voltage is below the bandwidth.
    i. Set the voltage regulator to neutral by setting the control to MANUAL and operating the RAISE/LOWER button as required and ensuring that the neutral lamp/LED lights up. Initially set the regulator control current transformer (CT)/voltage transformer (VT) configuration to Delta Lead for Cooper units or +30° for GE units. This is to prepare the voltage regulator for commissioning.
2. With all voltage regulator controls set to neutral and at manual operation, carry out the switching program by closing all the L switches and opening the regulator bypass; then open the current transformer bypass (C switch for Cooper; DS2 for GE).
3. After 30 seconds, compare the power factor reading on the control display with Network Operations' power factor reading of the feeder of the installed voltage regulator. If checking the power factor reading with Network Operations is not possible, check that the power factor reading on the control display is within acceptable limits (0.50 to 0.99). If the power factor reading is similar to Network Operations' power factor reading or is within acceptable limits (if it could not be verified with Network

Operations), set the control to AUTO and proceed to the handover of responsibility. The units have been successfully commissioned.

4. If the power factor reading is not similar to Network Operations' power factor reading or is not within acceptable limits, set the regulator control CT/VT configuration to Delta Lag for Cooper units or -30° (+330°) for GE units. After 30 seconds, recheck Network Operations' power factor reading of the feeder and compare it with the power factor reading on the control display or recheck that the power factor reading on the control display is within acceptable limits. If the power factor reading is similar to Network Operations' power factor reading or is within acceptable limits, set the control to AUTO and proceed to the handover of responsibility. The units have been successfully commissioned.
5. If the power factor reading is still dissimilar to Network Operations' or is not within acceptable limits, DO NOT commission the units. Leave the regulators in the neutral tap position and manual operations, close all regulator bypass switches, open L, SL and S in that order, and report the problem to your formal leader for further investigation with the supplier or manufacturer.

4.7.5. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility to the network operating authority.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

4.8 Voltage regulator (Star connection) – DCF 4.8

This DCF covers the testing and commissioning of new or replacement Star connected voltage regulators before energisation.

4.8.1. Equipment pre-handover status

A voltage regulator must be installed in accordance with *the Distribution Construction Standards Handbook (Part 4 – HV Overhead)* applicable design drawings series (H-33).

4.8.2. Pre-commissioning checks

Before energising, an Earthing system resistance test must be performed to ensure that the earthing arrangement meets requirements. The completed Earthing system resistance test form (DCF 4.1) must be submitted with the project documentation. Earthing test result must be <30Ω.

When configured in an offset arrangement, the earths between the poles must be connected (DCSH H33-4).

The following checklist must be completed prior to any commissioning activities:

1. Check the handover certificate (where applicable).
2. Confirm the correct earthing arrangement and tests (DCF 4.1).
3. Check that the SPIDAWeb pick ID and pole numbers for each item are in accordance with the as-constructed drawings.
4. Record the address, work package number and SPIDAWeb pick ID.
5. Ensure that the apparatus is properly labelled in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005).*
6. Ensure that the control settings are configured to the desired parameters.

4.8.3. Test criteria

Insulation resistance test

Use a 5kV insulation resistance tester and measure the resistance after 1 minute of testing (R >1 MΩ).

Note: Testing of the apparatus is detailed in the Distribution Commissioning Form.

4.8.4. Control setting and testing

Responsibility for final application of settings and checks are performed by Asset Operations/Operation Maintenance (Primary Response).

1. To ensure that the voltage regulators function properly and automatically, test each voltage regulator control as follows:
    a. With the regulator bypass switch in a closed position and the S and L switch in an open position, turn off the power switch and the control switch inside the control box, if available. Ensure that the potential switch (V1 and V6, if fitted, for Cooper; or DS1 for GE) are in the closed position. Close the current transformer bypass (C switch for Cooper; DS2 for GE). This ensures that the control does not respond abruptly when Energised.
    b. With the L switch left in the open position, close the S switch in order to energise the internal potential transformer to supply the control. Phase out if necessary.
    c. Turn the power switch to INTERNAL and the control switch to MANUAL in order to enable the control. Operate the RAISE/LOWER button and observe if the regulator responds to the controls. A sound from the internal motor together with the clicking of the taps should be heard whenever the regulator changes tap. The tap position indicator together with the display in the control should indicate the same tap position and also indicate the change in tap during this operation. This test ensures that the tap changer responds to the control.
    d. Return the tap changer to the neutral tap position by operating the RAISE/LOWER button. This can be verified by checking the tap position indicator and ensuring that the neutral lamp/LED lights up.
    e. Upload the settings to the control.
    f. Measure the voltages at the voltmeter terminals or meter out and check that the measured voltage matches that of the voltage displayed in the panel. This ensures that the voltage display is correct.
    g. Put the display into band centre (Depress 1, SET VOLTAGE for Cooper; press the UP or DOWN and ENTER button for GE). Set the control to MANUAL, then operate the RAISE button enough steps to put the voltage out of bandwidth. Set the control switch to AUTO and wait for the 30 second time delay. The control should cause the regulator to step down to the top bandwidth. This test ensures that the regulator works automatically when the voltage is above the bandwidth.
    h. Repeat the previous step, this time lowering the voltage below the bandwidth, by operating the LOWER button, to test if the regulator works automatically when the voltage is below the bandwidth.
    i. Set the voltage regulator to neutral by setting the control to MANUAL and operating the RAISE/LOWER button as required and ensuring that the neutral lamp/LED lights up. This prepares the voltage regulator for commissioning.
2. Carry out the switching program by closing the L switch and opening the regulator bypass switches.
3. Open the current transformer shorting links (C for Cooper and DS2 for GE). Set the control to AUTO and proceed to the handover of responsibility. The voltage regulator has been successfully commissioned.

4.8.5. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility to the operating authority.
- Return the relevant form to the project file as a record of the commissioning/handover certificate**.**

4.9 HV ring main switchgear – DCF 4.9

This DCF covers the testing and commissioning of new or replacement HV ring main switchgear. The testing should verify that the equipment:

- has not been damaged in transit
- has been installed in the network correctly.

If a transformer and LV switchgear are to be commissioned at the same time as the ring main switchgear, refer to the instructions for commissioning these items of equipment as well as the appropriate switching operations in the switching program.

4.9.1. Equipment pre-handover status

HV ring main switchgear

The ring main switchgear must be installed in accordance with the appropriate Manufacturers guidelines, the *Distribution Substation Manual* and applicable design drawings.

Extensible sections must assembled and tested in accordance with the Manufacturer's instructions.

HV underground cables

The cables must be installed, terminated and jointed in accordance with the appropriate standards and guidelines and as detailed in the *Distribution Underground Cable Installation Manual (EDM 34011711)*.

As a minimum, the installer must affix temporary labels to all switches stating the destinations of all cables (more permanent labels may be fitted at this time).

Sheath and insulation tests must be carried out and the results recorded. On completion, the installer must issue a HV cable testing schedule and a handover certificate to the project manager. The equipment as-constructed drawings must be prepared and issued prior to the project manager accepting and signing off on the handover certificate.

Earthing

Before energising, an Earthing system resistance test must be performed to ensure that the earthing arrangement meets requirements. The completed Earthing system resistance test form (DCF 4.1) must be submitted with the project documentation. Earthing test result must be ≤10Ω.

4.9.2. Test criteria

Insulation resistance test

The purpose of this test is to verify the integrity of the busbar with respect to earth.

Before connecting any cable, use a 5kV insulation resistance tester for 1 minute and record the value. The insulation resistance test value must be greater than 5,000 MΩ/5 GΩ.

Continuity test

The purpose of this test is to verify the connection between the same phase.

Test between all bushings of the same phase using a 1kV insulation resistance tester to verify continuity (R = 0 MΩ).

Open all circuit switches and close all earthing switches. Connect an insulation resistance tester between all bushings of the same phase and earth bar to verify continuity.

Note: Testing of the apparatus is detailed in the Distribution Commissioning Form.

4.9.3. Pre-commissioning checks

The following checklist must be completed prior to any commissioning activities:

1. Check the handover certificate (where applicable).

   Note: This should include the switchgear and connecting cable.
2. Check the HV switchgear testing schedules as appropriate.

   Note: Non-extensible switchgear does not require additional on-site testing.
3. Check the HV cable testing schedule.
4. Check the earthing tests have been performed (DCF 4.1) and acceptable results (≤10 Ω) achieved.
5. Check that the SPIDAWeb pick ID numbers for each item of equipment are in accordance with the as-constructed drawings.
6. Ensure that the apparatus is properly labelled in accordance with *the Distribution Equipment Labelling Standard (EDM 25433005)* if not already completed.
7. Operate all switch mechanisms to confirm proper functioning. Test the earth switches. Test all interlock mechanisms to confirm correct functioning and test the interlock mechanism's inhibit function for any improper operational actions.
8. Consult the switchgear manufacturers operating and commissioning instruction manual to identify any items that must be checked before the equipment is placed in service.

   Note: Before proceeding, ensure cables on either side of the HV switchgear and either side of ring main unit are de-energised and earthed at the remote ends and disconnected.
9. Where appropriate, check the gas leakage indication gauge to verify that the switchgear is at service pressure.
10. If a switch disconnector or fuse switch is spare and does not have a cable connected, then check that it is selected to the earth position and that it is appropriately tagged. Spare units must always be set to the earth position.
11. Clean away any dust which may have blown onto the unit during the installation activities.
12. Check that all HV cable terminations are secure and that the correct bailing assemblies are used.
13. Check that any unused bushings are correctly capped with rated parts and bailing fitted.
14. Check that drain wires are fitted to all HV elbow connectors and connected to a cable screen.

    Note: This ensures the elbows are safe to touch.
15. Check that the HV cable screens are all solidly and separately connected and bolted to the HV earth bar.
16. Ensure that the switch disconnectors are in the OFF position and that the fuse switches are off and in the EARTH position.
17. Connect the HV cables (still isolated and earthed at the remote ends).
18. If the ring main unit is in a kiosk, check that the kiosk body is earthed correctly, including the kiosk doors.

19. Ensure all Workers engaged in performing this task have vacated the test area and are outside the safety barriers.
20. Install high rupturing capacity fuses according to the design and ensure that the striker pin faces the striker bar.

    Note: Clean the inside of the fuse compartment of all visible dirt.
21. Switch the transformer fuse switch back to the OFF position.

4.9.4. Extensible metering unit

Where a metering unit is either part of the initial installation, or added later; the metering officer must:

1. Check the test certificate
2. Confirm the correct ratings
3. Complete and document the commissioning process

4.9.5. Commissioning of the equipment

1. Carry out the commissioning program according to the DCF 4.9 and the switching program.
2. Phase out the HV ring main switchgear in accordance with the Network Operations switching program.
3. Ensure that all equipment is in its final circuit conditions as per the switching program.
4. Ensure that all equipment is locked, and secure from unauthorised entry.

4.9.6. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility to the network operating authority.
- The testing officer; cable jointer; construction project manager or the person responsible for commissioning must sign off on the testing schedule.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

4.10 PENDA or LV kiosk – DCF 4.10

This DCF provides guidelines for the commissioning of an LV kiosk. The testing should verify that the equipment:

- has not been damaged in transit
- has been installed in the network correctly.

Use the instruction in conjunction with the Electrical System Safety Rules and the Work Instructions.

If a transformer and LV switchgear are to be commissioned at the same time as the ring main switchgear, refer to the instructions for commissioning these items of equipment as well as the appropriate switching operations in the switching program.

This instruction is required to be followed for all LV switchgear that is to be connected to Western Power's Southwest Interconnected System (SWIS) distribution network.

4.10.1. Responsible persons

The project manager or officer in charge is responsible for ensuring that testing is in accordance with this instruction.

The tester in charge is responsible for carrying out all necessary inspections and tests to verify that the LV switchgear is suitable for operational service in accordance with this instruction and for recording all test results and additional comments where relevant.

The following test and checks must be carried out on new installations of LV kiosks. This is the minimum testing requirement before energisation.

4.10.2. Equipment pre-handover status

LV kiosk

The LV kiosk must be installed in accordance with the appropriate guidelines in the *Distribution Construction Standards Handbook* and applicable design drawings.

On completion, the installer must issue a handover certificate to the project manager.

Earthing

An earth test (DCF 4.1) is not required to be submitted for LV only sites, e.g., PENDA 1.1.

For combined HV-LV installations, an Earthing system resistance test must be performed to ensure that the earthing arrangement meets requirements. The completed Earthing system resistance test form (DCF 4.1) must be submitted with the project documentation.

4.10.3. Test criteria

Insulation resistance test

Remove the transformer links and verify that the busbars are de-energised before carrying out this test.

Use a 1kV insulation resistance tester (never use 5kV insulation tester for this test) between busbars and busbars to neutral.

Test and record the insulation resistance values measured using an insulation resistance tester connected as shown in the DCF 4.10:

- Measured values of 10 MΩ or greater are acceptable.
- If energisation does not follow immediately after commissioning, the insulation resistance test must be repeated, and the values must be measured prior to energisation.

Note: Testing of the apparatus is detailed in the *Distribution Commissioning Form (DCF 4.10).*

4.10.4. LV underground cables

The cables must be installed, terminated and jointed in accordance with the appropriate standards and guidelines as detailed in the *Underground Cable Installation Manual (EDM 34011711).*

As minimum, the installer must affix temporary labels to all relevant network equipment such as fuse disconnector units stating the destinations of all cables.

Insulation, continuity and phase-out tests must be carried out and the results recorded.

On completion, the installer must issue an LV cable testing schedule, an LV continuity and phasing schedule, an earthing test schedule and a handover certificate to the project manager.

4.10.5. Pre-commissioning checks

The following checklist must be completed prior to any commissioning activities:

1. Check the handover certificate (where applicable).

   Note: This should include the cables and switchgear.

2. Check the LV cable testing schedules.
3. Check the earthing tests have been performed (DCF 4.1) and acceptable results (≤10 Ω) achieved.

4. Confirm that the neutral to earth link has been properly connected.
5. Check that the SPIDAWeb pick ID numbers for each item are in accordance with the as-constructed drawings.
6. Ensure that the apparatus is properly labelled in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005).*
7. If a fuse disconnector is spare and does not have a cable connected, then check that it is appropriately tagged.
8. Ensure that all conditions mentioned in the distribution transformer pre-commissioning requirements are met.
9. Check that the enclosure is satisfactory for the environment at the location of installation.
10. Check that the electrical equipment complies with relevant designs and drawings.
11. Check that the voltage rating of electrical equipment is suitable for the nominal supply voltage.
12. Check that each item of electrical equipment is suitable for the design current loadings and current protection devices.
13. Check that barriers or screens are in place to prevent inadvertent contact with bare conductors.
14. Check that minimum clearances are maintained.
15. Check the mechanical operation of all switches, fuse holders and fuse ways.
16. Check that all electrical equipment is labelled and identified in accordance with relevant drawings.

4.10.6. Commissioning of the equipment

1. Carry out the commissioning in accordance with the DCF and the switching program, and check voltages.
2. If the LV network is to be interconnected with another LV network, phase out at the normally open point; otherwise, phase out as required.

4.10.7. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility to the operating authority.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.
- The testing officer; cable jointer; construction project manager or the person responsible for commissioning must sign off on the testing schedule.

4.11 NOJA pole-mounted switchgear – DCF 4.11

This DCF covers the testing and commissioning of new or replacement NOJA pole-mounted reclosers/load-break switches before energisation.

4.11.1. Equipment pre-handover status

NOJA pole-mounted switchgear must be installed in accordance with the appropriate guidelines in *Distribution Construction Handbook - Part 4 (EDM 24538359)* and applicable design drawings.

Before energising, an Earthing system resistance test (DCF 4.1) must be performed to ensure that the earthing arrangement meets requirements. The completed Earthing system resistance test form must be submitted with the project documentation.

4.11.2. Test criteria

Insulation resistance test

Use a 5kV insulation resistance tester and take the resistance values after 1 minute of testing. Test the switchgear in the OFF (open contact) position. Operate the manual trip lever if required.

Test and record the insulation resistance values.

Note: Testing of the apparatus is detailed in the *Distribution Commissioning Form 4.11 (EDM 24538359).*

Polarity test

Energise the control box and conduct a polarity test on the 240V supply.

For testing purposes, use an effective earthed reference point spaced more than two metres from any electrically conductive object embedded in the ground.

4.11.3. Pre-commissioning checks

The following checklist must be completed prior to any commissioning activities:

1. Check the handover certificate (where applicable).
2. Check that the SPIDAWeb pick ID and pole numbers for each item are in accordance with the as-constructed drawings.
3. Ensure that the apparatus is properly labelled in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005)*.
4. Check the earthing testing schedule. (Refer to the heading earth testing.)
5. Consult the manufacturer's operating and commissioning instruction manual to identify any special items that are required to be checked or examined before the equipment is placed in service.
6. Check the maximum separation between the down earth and the recloser umbilical cable.
7. Check that the pole is labelled correctly.
8. Ensure the 240V white thermal plastic sheath is continuous up to the circuit breaker and stripped minimally to terminate the active and neutral conductors. Install or run the 240V thermal plastic sheath cable behind the gear tray (without a conduit). The earth in the thermal plastic sheath cable can be cut as it need not be connected.
9. Check that the antenna surge diverter is fitted at the base of the control box.
10. Check that the antenna is aligned to the correct bearing (applicable radio comms only) and installed correctly (with elements vertical and drain hole down). Antenna pole brackets with open slotted fixing holes are not permitted.

Commissioning of the equipment

Ensure that the switch is in the correct position (open or closed) as outlined in the switching program or network configuration.

Energise the switchgear as outlined in the switching program and network configuration.

Phase out the HV under direction of the switching program.

Confirm availability and correct polarity of the 240V supply to the switchgear controller.

4.11.4. Control setting and testing

Responsibility for final application of settings and checks are performed by Asset Operations/Operation Maintenance (Primary Response). Complete the relevant section of DCF 4.11.

- Ensure the correct controller firmware is used.
- Ensure that all the indications from the controller are normal.
- Ensure all the required settings have been installed.
- Enable/connect the communication device (radio, etc.).
- Check that all the alarms and controls tested to Network Operations indicate a successful communication.
- Phase fault, earth fault and sensitive earth fault detection settings have been recorded by the network controller.
- Ensure the analogues (I, V, kW & kVAR) have been recorded by the network controller.
- Check remote (Network Operations) operation.
- Remove the 'Out of Service' warning tag from the padlock on the front of the control cabinet.

4.11.5. Handover of responsibility

- Ensure the work area is left tidy with no hazards to the public.
- Hand over responsibility to Network Operations.
- Return the relevant form to the project file as a record of the commissioning/handover certificate.

5. Deviations

The content of this procedure/guideline summarises the minimum legislative/compliance requirements to provide safe systems of work and cannot provide details to cover all operational scenarios.

When deviation from this procedure/guideline is required to be managed at site, the following applies:

- Deviation(s) must be recorded in the WRAP. The documented deviation controls must be equivalent to, or better (greater) than the existing control(s) for the tasks to be performed. Deviation controls must be communicated to all impacted workers.
- Site coordinator/person in charge of site must review/sign off the deviation in the WRAP prior to works commencing.
- The duration of deviation must not be longer than one shift.
- The deviation must not contravene any existing regulation or any legislation.

If a recurring deviation to this procedure/guideline is required, the following applies:

- Deviation must be justified through a risk assessment and approved by the relevant Head of Function in consultation with the SEQT Head of Function (see *Work Health and Safety (WHS) General Risk Assessment Tool (EDM 53756142)*).
- The deviation must not contravene any existing regulation or any legislation.
- The risk assessment must demonstrate that the deviation controls are equivalent to, or better (greater) than, the existing control(s) for the tasks to be performed.
- The risk assessment and controls must be documented and communicated to all impacted workers.
- The duration of the deviation must be clearly indicated on the HoF approval.

- A record of approval by the Head of Function and the consultation with SEQT HoF must be retained for audit purposes. Copy of this record must be provided to SEQTMS@westernpower.com.au for inclusion into the consultation register.

If a permanent deviation is required for a specific group/area, please contact the Safety, Health and Environment Management System Team via SEQTMS@westernpower.com.au.

6. Dictionary

Defined terms appear in this document as capitalised.

Defined term	Meaning
ABC	Aerial bundled conductor.
Accountable	The staff member ultimately answerable for the correct and thorough completion of the objective or communication, and the one who delegates the work to those responsible. For example, an *Accountable* officer approves work that the responsible officer provides.
Active or phase conductor	Any conductor that is maintained at a difference of potential from the neutral or earthed conductor (also known as phase, line, red, white, blue, live).
As-constructed drawing	A design drawing that has been modified or altered due to changes to the construction and should be prepared by a qualified surveyor showing the cable routes and must be verified and signed by the person in charge of the work.
Authorised person	A competent person with the delegated authority to perform the duty on behalf of Western Power. See Appendix 1 for the specific training requirements that persons responsible for commissioning must meet in order to be authorised to commission distribution equipment.
Cable	Insulated multi-strand wiring (with or without fillings, reinforcements or protective coverings) designed for underground electrical installations.
Commissioning	Activities carried out in order to ensure that new and existing equipment is safely and accurately connected to the network and, once in service, operates as intended. Activities include inspections to verify installation, commissioning tests and post-energisation tests/checks.
Commissioning authority	The group which conducts pre-commissioning and final commissioning activities and controls access to plant and equipment (which cannot be energised by normal switching) during the commissioning stage.
Commissioning notice	Issue of this notice signifies that all commissioning tests have been completed and that a site and items of a plant are accepted by the operating authority for service. The notice may contain a list of outstanding items.
Construction authority	The group responsible for construction and installation of plant and equipment. The construction authority controls access to plant and equipment which cannot be energised by normal switching during the construction stage.
Continuity test	A test to determine whether electrical current will flow continuously between two points. A test to determine whether two points are electrically connected.

Defined term	Meaning
Control authority	The representative authority responsible for the control of the apparatus. Typically, this includes: • Construction authority • Commissioning authority • Operating authority (Network Operations which is responsible for the transmission and distribution network).
DCF	Distribution commissioning form
De-energised	The electrical supply to electrical apparatus has been switched off. The electrical supply has been de-energised but not necessarily isolated, tested and earthed.
Discharged (electrically)	Conductors which have been connected to earth so as to remove any stored electrical energy.
Disconnected	The status of apparatus that has been separated from the system by the removal of jumpers or sections of conductors/cables such that the apparatus cannot be re-energised through normal switching operations (sometimes referred to as 'non-connectable'). For example, an opened electrical connection, as in the case of open MEN links/N-E connections, and open earthing leads from earth electrodes.
Earth	The conductive mass of the earth, the electric potential of which, at any point, is conventionally taken as zero.
Electrical Access Permit (EAP)	Western Power's standard form that authorises access to, and work on, electrical apparatus which has been made safe by isolating and earthing.
Electrical Systems Safety Rules (ESSR)	The intention of the ESSR is to provide Western Power with a standard set of procedures and rules that govern the network.
Energised	With reference to electrical apparatus, means that a voltage exists between apparatus and earth.
Equipotential mat	A conducting device at ground level, connected electrically to equipment to avoid differences of step and touch potential through the body of a person.
Handover certificate	Used when responsibility for control of one or more items of plant, or an entire site, is transferred from one group to another.
High voltage (HV)	A voltage of 1,000V AC or 1,500V DC or greater.
Independent earth	An effective earthed reference point used for testing purposes.
Insulated	Separated from adjoining conducting material by a non-conducting substance which provides adequate resistance to the passage current, or to disruptive discharges through or over the surface of the substance at the operating voltage and mitigates the danger of shock or injurious leakage of current.
Insulated Conductor	A conductor covered by a type of insulation that prevents the danger of electric shock.
Issuing officer	An authorised person who is responsible for issuing permits. This task is generally handled by the switching operator.
Low Voltage (LV)	A voltage less than 1,000V AC or 1,500V DC.
MEN links/N-E connections	Multiple earthed neutral system of earthing as defined in AS/NZS 3000 or Neutral Earth connections.
Phase rotation	The sequence in which phases rotate relative to each other.

Defined term	Meaning
Phasing out	Identification of active conductors of the same phase (having no significant angular displacement i.e., red phase to red phase).
Responsible	The individual who is assigned the duty for completing an activity. Responsibility can be shared. The degree of responsibility is determined by the accountable person.
Ring main unit (RMU)	One or a combination of ring main switches and/or switch fuses used to control and operate HV underground systems.
Ruling span	The ruling span (or equivalent span) is defined as that span which behaves identically to the tension in every span of a series of suspension span under the same loading tension. The value of the ruling span is found in the design drawings of the respective line.
Safety observer	A competent person assigned by the person in charge and whose sole function is to observe and warn against unsafe approach to live electrical apparatus or unsafe conditions.
SPIDAWeb	A geographical information system (GIS) that allows users to view the electrical distribution network in relation to physical geographical location in Western Australia. Users can view and analyse network assets using spatial information.
Switching	The operation of circuit breakers, isolators, disconnectors, fuses or other methods of making or breaking an electrical circuit and/or the application and removal of programmed earths.
Switching authority	An authority that has been issued an approval to give approval to perform switching operations.
Switching operator	A person authorised by the operating authority to carry out switching operations within the limits of their authorisation.
Test voltage	The voltage which must be applied to the specified equipment for the purpose of periodic electrical testing.
VLF	Very low frequency
Worker	Under the WHS legislation a worker is a person who carries out work in any capacity for a person conducting a business (PCBU) or undertaking, including any of the following: • an employee • a contractor or subcontractor • an employee of a contractor or subcontractor • an employee of a labour hire company who has been assigned to work in the person's business or undertaking • an outworker • an apprentice or trainee • a student gaining work experience • a volunteer – except a person volunteering with a wholly 'volunteer association' with no employees (whether incorporated or not).
XLPE	Cross-linked polyethylene

7. References

- *WA Electrical Requirements (WAER) 2023*
- *AS/NZS 1026:2004 (R2017) - Electrical Cables – Impregnated Paper Insulated – Working voltages up to and including 33kV*

- *AS/NZS 1429.1:2006 (R2017) - Electric Cables – Polymeric Insulated – for working voltages 1.9/3.3 (3.6) kV up to and including 19/33 (36) kV).*
- *AS 2067:2016 Substations and HV Installations Exceeding 1kV AC.*
- *AS/NZS 3000:2018 - Electrical Installations (known as the Australian/New Zealand Wiring Rules)*
- *AS 3017:2022 Electrical installations – Verification by inspection and testing*
- *AS 4741:2010 Testing of connections to low voltage networks*
- *AS/NZS 4961:2003(R2017) - Electric Cables – Polymeric Insulated – For distribution and service applications.*
- *AS IEC 60038:2022 Standard voltages*
- *AS 62271.1:2019 High-voltage switchgear and control gear – Common specifications for alternating current switchgear and controlgear (IEC 62271-1:2017, MOD)*

8. Related documents

Title	EDM reference
AO OM020-F - Operational Maintenance - Scanning Cover Sheet Operational Maintenance - Scanning Cover Sheet	59566678
Distribution Commissioning Forms and Manual - Consultation Register	44074778
Distribution Construction Standards Handbook Part 1 – General	23953024
Distribution Construction Standards Handbook Part 10 – Conductor Tensioning Table	30842672
Distribution Construction Standards Handbook Part 2 – Reference	23919924
Distribution Construction Standards Handbook Part 3 – High Voltage Underground	21335403
Distribution Construction Standards Handbook Part 4 – High Voltage Overhead	24538359
Distribution Construction Standards Handbook Part 5 – Low Voltage Underground	24608615
Distribution Construction Standards Handbook Part 6 – Low Voltage Overhead	24611458
Distribution Construction Standards Handbook Part 7 – Low Voltage Aerial Bundled Cable	24612566
Distribution Construction Standards Handbook Part 8 – Street Lighting	24236319
Distribution Construction Standards Handbook Part 9 – Maintenance Manual	25343954
Distribution Equipment Labelling Standard	25433005
Earthing system resistance testing (all equipment) (DCF 4.1)	21631145
Electrical System Safety Rules (ESSR)	41392645
FAQ on earthing standards	28984244
High voltage aerial bundled conductor and Hendrix spacer cable (DCF 1.4)	23994096
High voltage mixed cable (DCF 2.2)	21535022
High voltage overhead powerlines (DCF 1.1)	21584553
High voltage ring main switchgear (DCF 4.9)	21611007
High voltage single-phase underground rural supply fuse switch (DCF 4.6)	21823418
High voltage XLPE cable (DCF 2.1)	21540116
HV paper-insulated belted cable (DCF 2.3)	21944117

Title	EDM reference
HV paper-insulated screened cable (DCF 2.4)	21951092
Laying, pulling and bedding cables work instruction	41855257
Low voltage aerial bundled conductor (DCF 1.3)	21583726
Low voltage cable with/without pillars (DCF 2.6)	21635344
Low voltage kiosk (DCF 4.10)	21613761
Low voltage overhead lines (DCF 1.2)	22138998
Low voltage XLPE cable (DCF 2.5)	21536808
Maintaining and replacing down earth assemblies work instruction	41862205
MPS distribution transformer – Commissioning (DCF 3.1)	24253324
MPS distribution transformer – Decommissioning (DCF 3.1)	29854219
NOJA pole-mounted automatic control recloser (DCF 4.11)	32271371
Non-MPS distribution transformer – Commissioning (DCF 3.2)	24981587
Non-MPS distribution transformer – Decommissioning (DCF 3.2)	29855006
Nu-lec load break switch/sectionaliser (DCF 4.2)	21734095
Nu-lec pole-mounted automatic control recloser (DCF 4.3)	21543658
Pole to Pillar (DCF 2.9)	34034804
Pole-mounted capacitor bank (DCF 4.5)	21638217
Pole-top switch (DCF 4.4)	21640904
Safety, Health and Environment Management Standard	32254910
Single-phase transformer (pole-mounted/pad mounted) (DCF 3.3)	23932817
SPS Low Voltage Cable without pillars. (DCF 2.12)	68351610
SPUDS single –phase to three-phase pillar (DCF 2.8)	27007034
Steel standard column (Class 1 assemblies) (DCF 2.11)	50580780
Steel standard streetlights (DCF 2.7)	33981562
Streetlights underground supply cable repair (DCF 2.10)	47073329
SWER isolation transformer (ground mounted) (DCF 3.6)	25344754
SWER isolation transformer (pole mounted) (DCF 3.5)	24293616
Testing of High Voltage Paper Insulated (Belted) Cables	21965356
Three-phase pole-mounted Shunt Reactor (DCF 3.7)	60606300
Three-phase pole-mounted transformer – Commissioning (DCF 3.4)	24238157
Three-phase pole-mounted transformer – Decommissioning (DCF 3.4)	30562085
UMSx wooden distribution pole (DCF 2.14)	68057878
UMSx steel standard (class II assembly) (DCF 2.13)	68058740
Underground Cable Installation Manual	34011711

Title	EDM reference
Underground Distribution Scheme Manual (UDSM)	23169833
Very Low Frequency (VLF-0.1 Hz) Voltage testing of High Voltage cables	21404211
Voltage regulator (closed Delta connection) (DCF 4.7)	22105433
Voltage regulator (Star connection) (DCF 4.8)	24601112

9. Review

This manual will be reviewed and evaluated by the content owner at least once in every three-year period taking into account the purpose of the manual and the outcome of the compliance review.

10. Content owner

Full name	Role title	Business unit
Sue Nesci	Assurance Manager	SEQT

11. Content approver

Full name	Role title	Business unit
Andy Shaw	Head of Function	SEQT

12. Approval history

Version	Approved by	Date of approval	Notes
1.0	WPDT Manager	02/2016	NOJA mounted automatic control recloser
2.0	SEQT HoF	05/2017	3.1 - MPS distribution transformer – Commissioning: Reviewed 3.2 - Non-MPS distribution transformer – Commissioning: Reviewed 3.3 - Single-phase transformer (pole-mounted/pad-mounted): Reviewed 4.2 - Nu-Lec load break switch/sectionaliser: Reviewed Pictures of the test forms have been removed Labelling requirements referenced to revised standard
3.0	SEQT HoF	06/2017	2.7 – Steel standard streetlights – additional IR test 2.9 – Pole to pillar – elimination of stray/ghost voltages
4.0	SEQT HoF	11/2017	2.10 – Streetlights underground supply cable repair
5.0	SEQT Assurance Manager	04/2019	Review of entire document and Appendix 1
6.0	SEQT Assurance Manager	01/2020	2.5 - Low voltage XLPE cable – DCF 2.6 - Low voltage cable with/without pillars – DCF Amended to remove sheath tests for brownfield 2.11 - Steel standard column (Class 1 assemblies) – DCF added

Version	Approved by	Date of approval	Notes
7.0	Safety, Environment, Quality and Training HoF Andy Shaw	27/05/2024	SHEMS periodic review. Added: • DCF 3.7 - Three-phase pole-mounted Shunt Reactor. • DCF 2.12 - Low Voltage Cable without pillars (SPS). • DCF 2.13 - UMSx steel standard (class II assembly). • DCF 2.14 - UMSx - Wood Pole. Terminology updated to reflect WHS Act and SHEMS changes. Added deviations and consultation register

Appendix 1: Distribution equipment commissioning scope, qualification and training requirements table

			Developer Jointer	Developer Electrician (Cert III)	Network Dist. Linesperson (Cert III)	Network Electrician (Cert III)	Network Dist. Joiner (Cert III)	Automation equipment commissioning officer – Network Invest. & others	Tester In Charge	Cable test section	LV switching operator	HV switching operator
Required additional course work		Distribution testing and commissioning[5]			✓	✓	✓	✓	✓	✓	✓	✓
		LV overhead and underground network switching									✓	✓
		HV overhead and underground switching										✓
		Schneider reclosers and load break switches						✓				
Distribution Commissioning Form	1.1	HV overhead powerlines			Install and test[2]							Energise and commission
	1.2	LV overhead lines			Install and test[2]						Energise and Commission	
	1.3	LV ABC			Install and test[2]						Energise and Commission	
	1.4	HV ABC and Hendrix spacer cable			Install and test[2]							Energise and commission
	2.1	HV XLPE cable	UDSM[1]	UDSM[1]			Joint and test[5]		Test	VLF		Energise and commission
	2.2	HV mixed cable	UDSM[1]	UDSM[1]			Joint and test[5]		Test	VLF		Energise and commission
	2.3	HV paper insulated belted cable					Joint and test[5]		Test	Hipot		Energise and commission
	2.4	HV paper insulated screened cable					Joint and test[5]		Test	Hipot		Energise and commission
	2.5	LV XLPE cable	UDSM[1]	UDSM[1]		Connect and test	Joint and test[5]				Energise and Commission	
	2.6	LV cable with/without pillars	UDSM[1]	UDSM[1]		Connect and test	Joint test and commission[5]				Energise and Commission	
	2.7	Steel standard streetlights	UDSM[1]	UDSM[1]	Install test and commission[2]	Connect and test	Joint test and commission[5]				Energise and Commission	
	2.8	SPUDS single-phase to three-phase	UDSM[1]	UDSM[1]		Install and test	Joint and test[5]				Energise and Commission	
	2.9	Pole to pillar			Install test and commission[2,3,7]	Install test and commission [6,]	Joint test and commission[5]				Energise and Commission	
	2.10	Streetlights underground supply cable repair			Install test and commission[2,3]		Joint test and commission[5]				Energise and Commission	
	2.11	Steel Standard Columns (Class 1)	UDSM[1]	UDSM[1]	Install test and commission[2]	Connect and test	Joint test and commission[5]				Energise and Commission	
	3.1	MPS distribution transformer	UDSM[1]	UDSM[1]		Install and test	Joint and test[5]					Energise and commission
	3.2	Non-MPS distribution transformer	UDSM[1]	UDSM[1]		Install and test	Joint and test[5]					Energise and commission

			Developer Jointer	Developer Electrician (Cert III)	Network Dist. Linesperson (Cert III)	Network Electrician (Cert III)	Network Dist. Joiner (Cert III)	Automation equipment commissioning officer – Network Invest. & others	Tester In Charge	Cable test section	LV switching operator	HV switching operator
	3.3	Single phase transformer (pole/pad mounted)	UDSM[1]	UDSM[1]	Install and test[2]	Install and test	Joint and test[5]					Energise and commission
	3.4	Three phase transformer (pole mounted)			Install and test[2]	Connect and test						Energise and commission
	3.5	SWER isolation transformer (pole mounted)			Install and test[2]	Connect and test						Energise and commission
	3.6	SWER isolation transformer (ground mounted)	UDSM[1]	UDSM[1]		Install and test						Energise and commission
	4.1	Earth testing	UDSM[1]	UDSM[1]	Test[2]	Test	Test	Test	Test	Test	Test	Test
	4.2	Nu-Lec load break switch/sectionaliser			Install and test[2]	Install and test		Install and test				Energise and commission
	4.3	Nu-Lec pole mounted automatic control recloser			Install and test[2]	Install and test		Install and test				Energise and commission
	4.4	Pole top switch			Install and test[2]							Energise and commission
	4.5	Pole mounted capacitor bank			Install and test[2]	Install and test		Install and test				Energise and commission
	4.6	HV single phase underground rural supply fuse switch				Install and test						Energise and commission
	4.7	Voltage regulator (closed Delta connection)				Install and test		Install and test				Energise and commission
	4.8	Voltage regulator (Star connection)				Install and test		Install and test				Energise and commission
	4.9	HV ring main switchgear	UDSM[1]	UDSM[1]		Install and test	Install and test					Energise and commission
	4.10	LV kiosk	UDSM[1]	UDSM[1]			Install and test				Energise and Commission	
	4.11	NOJA pole mounted automatic control recloser			Install and test[2]			Install and test				Energise and commission

* See notes:

1. Refer to Underground Distribution Scheme Manual (UDSM), Table 12 Test Work Instruction Schedule or Qualification Matrix 6.2.7.4, for the tasks that Developers can perform.
2. Dx Linespersons can only perform continuity, insulation and phase-to-phase tests on lines and pole mounted equipment and pole to pillar cables.
3. Workers commissioning this work must hold a current authorisation for pole to pillar work.
4. Dx Jointers can only perform insulation, core to core and continuity tests on cables.
5. Distribution Commissioning testing course or equivalent unit of competence covered under cert III qualifications
6. Deenergised connection at pillar end: Authorisation XPTP
7. Energised connection at line end Authorisation: XPTP and XLLCM; De-energised connection at line end: Authorisation XPTP