Distribution Commissioning Manual

Contents

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 & Environment Standard (EDM 32254910).*

Introduction

This manual provides information related to the various Distribution Commissioning Forms (DCF).

The testing and commissioning of an electrical apparatus shall 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), Work Instructions, DCFs and any other applicable documents by suitably trained and authorised personnel.

On commissioning, all signage and labelling must be affixed to apparatus in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005).*

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

All commissioning work is to be carried out in accordance with an approved switching program.

Appendix 1 details the specific training requirements persons responsible for commissioning must meet, to be authorised to commission distribution equipment.

Scope

This Manual applies to:

(i) employees
(ii) contractors, section 2
(iii) all specified activities and processes including, performing tests (voltage, phasing, final tests, etc.) and switching, undertaken in connection with Western Powers business activities and operations.

The Distribution Commissioning forms are fillable PDF 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, the work pack/project file must be scanned with the scanning cover sheet *(EDM 34132644)*. The electronic copy of the completed work pack/project file must be retained within EDM along with the electronic FMS forms, any hard copy records must be archived.

Responsibilities

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

(i) ensuring the maintenance and review of this guide and the associated DCF.

The **Asset Operations formal leader** is responsible for ensuring that:

(i) persons 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.

(ii) the person responsible for commissioning signs the commissioning form before energisation.

(iii) the switching operators hold current and updated switching authorisation approved by Western Power when performing switching operations.

The **SHE Management Systems Team** is responsible for:

(i) updating the contents of this document

(ii) ensuring alignment with the associated DCF

(iii) consulting with subject matter experts to ensure the accuracy of the information contained within this Manual.

Training and Competence

Network Personnel required to perform testing and commissioning activities on distribution equipment must have completed the Distribution Commissioning testing course or equivalent unit of competence covered under cert III qualifications.

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

Developers must refer to the *Underground Distribution Scheme Manual* (UDSM), Table 12 Test Work Instruction Schedule or Qualification Matrix 6.2.7.4, for the tasks that they can perform.

The table and notes in Appendix 1 provide guidance on the training/qualification requirements for performing commissioning work.

1. Overhead lines

The intention of this section is to provide details of the commissioning requirements of 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.

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).

Equipment pre-handover status

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

Where down earths are provided for system earthing or earth wire installed, earthing tests must be performed at each earthing point, and results recorded on DCF 4.1 before energising. The completed earthing test forms must accompany the project documentation.

Pre-commissioning checks

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

1. Check the handover certificate (where applicable).
2. 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.
3. Check and record the work package number.
4. Conductor Tension Test details
5. Compare the results with the design tension or applicable conductor sag and tension tables to ensure that the conductor was tensioned correctly.
6. Ensure all earth points have acceptable test results and record them on the earth testing commissioning form. The earth testing commissioning forms must be attached to the commissioning form.
7. 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.

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 NOC all equipment is in its final circuit condition and all normally open points are set to their designated position.
4. Ensure all equipment is locked, labelled and protected from unauthorised access.
5. Ensure the work area is left tidy with no hazards to the public.

Handover of responsibility

1. Hand over responsibility to the network operating authority.
2. 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).

Equipment pre-handover status

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

Where applicable (e.g. transformers) earthing tests must be performed at each earthing point, and the test results recorded on DCF 4.1 before energising. The completed earthing test forms must accompany the project documentation.

Pre-commissioning checks

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

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 condition and all normally open points are set to their designated position.
6. If applicable, ensure all equipment is locked, labelled and protected from unauthorised access.
7. Ensure the work area is left tidy with no hazards to the public.

Handover and Responsibility

1. Hand over responsibility to the network operating authority.
2. 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.

Equipment pre-handover status

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

Where applicable (e.g. transformers) earthing tests must be performed at each earthing point, and the test results recorded on DCF 4.1 before energising. The completed earthing test forms must accompany the project documentation.

Pre-commissioning checks

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

Test criteria

Continuity test

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

Insulation resistance test

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

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. If applicable, ensure all equipment is locked, labelled and protected from unauthorised access.
7. Ensure the work area is left tidy with no hazards to the public.

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.

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.

Where down earths are provided for system earthing or earth wire installed, earthing tests must be performed at each earthing point, and the test results recorded on DCF 4.1 before energising. The completed earthing test forms must accompany the project documentation.

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 and ensure that the SPIDAWeb pick IDs or pole numbers for each item are in accordance with the as-constructed drawings.
3. Check that all line taps are correctly placed and secure.
4. Check that the neutral and phase conductor arrangement is correct.
5. Conductor Tension details.

Test criteria

Continuity test

Use a resistor box (2 MΩ, 7 MΩ and 11 MΩ) in conjunction with a 500 V 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. Use a 5 kV insulation resistance tester for a minimum of 1 minute.
2. Values greater than 10,000 MΩ for new cables and greater than 100 MΩ for aged cables are acceptable.
3. Discharge the cable with shorting leads and safety earth leads on the cable prior to testing.
4. Inform safety observers (where present) that testing is about to commence.
5. Ensure all personnel engaged in performing this task have vacated the test area and are outside the safety barriers.
6. Remove any safety earth or earth switches on the cable to be tested prior to testing.

Note: Testing of the apparatus is detailed in the Distribution Commissioning Form (DCF1.4)

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. If applicable, ensure all equipment is locked, labelled and protected from unauthorised access.
5. Ensure the work area is left tidy with no hazards to the public.

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 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.

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.

References

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.

Transmission substation maintenance services: transmission testing services for HV cables (EDM 21404211).

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*, 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.

The installer must affix permanent labels to all relevant network equipment such as transformers, switch fuse units and RMUs, 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.

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.

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 permanent cable destination labels in accordance with *Distribution Equipment Labelling Standard (EDM 25433005).*
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 as per 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 work instruction *Laying, pulling and bedding cables (EDM 41855257).*

Test criteria

Visual inspection and safety check

1. The following test equipment is required for the tests outlined in this instruction:
    - 500 V insulation resistance tester
    - 5 kV insulation resistance tester
    - Resistor box
    - 0.01–1.0 Hz very low frequency (VLF) tester for a test voltage up to 60 kV.
2. Ensure surge arresters are disconnected for testing from 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 5 kV 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 500 V 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 5 kV 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 5 kV 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 5 kV 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 (CPM) 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 V_N 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
6.6 kV	3.8 kV	12.0	9.0
11 kV	6.35 kV	19.0	14.0
22 kV	12.7 kV	38.0	27.0
33 kV	19.1 kV	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)

After the VLF test, carry out an insulation resistance test using a 5 kV 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 the *Distribution Commissioning Form (DCF2.1).*

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.

References

AS/NZS 1026–2004 (R2017): Electrical Cables – Impregnated Paper Insulated – Working voltages up to and including 33 kV.

AS 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.

EDM 21404211: Transmission substation maintenance services: transmission testing services (for HV cables).

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*, Work Instructions and applicable design drawings.

The installer must affix permanent labels to all relevant network equipment such as transformers and switch fuse units and RMUs, 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.

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.

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. Carry out a detailed and thorough check of all assets.
4. If the cable ends are to be left disconnected, follow the requirements in the Work Instruction *Laying, pulling and bedding cables (EDM 41855257).*

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

Test criteria

1. The following test equipment is required for the tests outlined in this instruction:
   - 500 V insulation resistance tester
   - 5 kV insulation resistance tester
   - Resistor box

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

2. 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
3. Paper-insulated cables may be of belted or screened construction.
4. All paper-insulated cables connected to system voltages greater than 11 kV are of screened construction. (Belted cables are not manufactured for system voltages greater than 11 kV.)
5. 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 500 V 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 5 kV 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.

System voltage	V_N	Test voltage 3 V_N (kV)	
		Peak	RMS
6.6 kV	3.8 kV	12.0	9.0
11 kV	6.35 kV	19.0	14.0
22 kV	12.7 kV	38.0	27.0
33 kV	19.1 kV	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 5 kV insulation resistance tester:
2. Test the insulation resistance between conductor and screen.
3. Test the insulation resistance between phase to phase and earth
4. 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.
5. 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 *Distribution Commissioning Form (DCF2.2).*

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 following installation, alteration or repair to confirm the insulation levels and integrity of the cable system.

References

AS/NZS 1026–2004 (R2017): Electrical Cables – Impregnated Paper Insulated – For working voltages up to and including 19/33 (36) kV.

EDM 21965356 Testing of High Voltage Paper Insulated Cables

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*, Work Instructions and applicable design drawings.

The installer must affix permanent labels to all relevant network equipment such as transformers and switch fuse units and RMUs, 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.

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:

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

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

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

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.

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 500 V 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 5 kV insulation resistance tester connected conductor to conductor and between conductors to sheath. Record the measured values.

Test the insulation resistance using a 5 kV 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 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.

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

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.

References

AS/NZS 1026–2004 (2017): Electric Cables – Impregnated Paper Insulated – Working voltages up to 19/33 (36) kV.

EDM 21965356: Testing of High Voltage Paper Screened Cables.

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*, Work Instructions and applicable design drawings.

The installer must affix permanent labels to all relevant network equipment such as transformers, switch fuse units and RMUs, 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.

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:

- 500 V insulation resistance tester
- 5 kV insulation resistance tester

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

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

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.

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 500 V 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 5 kV insulation resistance tester connected conductor to conductor and between conductors to sheath. Record the measured values.

Test the insulation resistance using a 5 kV 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.

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.

Handover of responsibility

1. Ensure the work area is left tidy with no hazards to the public.
2. Hand over responsibility for the completion of the form.
3. The testing officer, cable jointer or construction project manager and the person responsible for commissioning must sign off on the testing schedule.
4. 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.

References

AS/NZS 4961–2003 (R2017): Electric Cables – Polymeric Insulated – For distribution and service applications.

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*, Work Instructions and applicable design drawings.

The installer must affix permanent labels to all relevant network equipment such as transformers and switch fuse units, 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.

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.

Pre-commissioning checks

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

- 500 V insulation resistance tester

- 1 kV 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.

Test criteria

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

- After all cables are terminated and all MEN links and N-E connections are disconnected or 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 XLPE Cable Distribution Commissioning Work Instruction Form.
- At the completion of each cable section and prior to the connection of any MEN links and N-E connections installations, test the insulation resistance of each conductor and the sheath integrity.

End-to-end phasing test

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

Insulation resistance test

Use a 1 kV insulation resistance tester (DO NOT exceed 1000V for this test) for 1 minute between conductor to conductor and conductor to neutral. Values greater than 10 MΩ for new cable and 1 MΩ for existing cables are acceptable. This test may not be practical for existing cables because of connected services.

Test and record the insulation resistance values. Measured value of 10 MΩ or greater is acceptable at the point of handover of a clean circuit from the construction authority (cable installer) to the commissioning authority. If energisation does not follow immediately after commissioning prior to energisation (assuming that sufficient time has lapsed between the handover and the energisation period), the insulation resistance test must be repeated, and measured values of not less than 1 MΩ (to *AS/NZS 3000 Rule 6.3.3.3.2*) must be obtained.

Sheath integrity test

With all earth leads MEN links/N-E connections disconnected, test the sheath integrity using an insulation resistance tester connected neutral screen (to earth. For testing purposes, use an effective earthed reference point spaced more than 2 meters from any electrically conductive object embedded in the ground. Record the value. Measured values of 10 MΩ or greater for new cables and >1 MΩ for existing cables are acceptable.

This test confirms the integrity of the cable sheath. Damaged or punctured sheaths allow moisture to enter the cable. Use a 1 kV insulation resistance tester for 1 minute with all the neutral connections disconnected within the circuit of the cable being tested.

If the sheath integrity is <10 MΩ for new cable and <1 MΩ for existing cable, then notify the appropriate authorities for further testing or repair; otherwise proceed.

Reinstatement of Connections
Conduct a final insulation resistance test between all phases and the neutral/earth on all LV circuits before energising them for the first time. If energisation does not follow immediately after two weeks of the commissioning tests, conduct a final insulation resistance to ensure that the circuit is safe to be energised.

Commissioning of the equipment

1. On completion of items 1-6 transfer control to the person responsible for commissioning
2. 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.
3. Commissioning persons must ensure that all checks are completed, and the test results comply with minimum standards.

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.

2.6 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.

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*, Work Instructions and applicable design drawings.

The installer must affix permanent labels to all relevant network equipment such as transformers and switch fuse units, 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.

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.

Pre-commissioning checks

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

- 500 V insulation resistance tester
- 1 kV 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

Test criteria

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

After all cables are terminated and all MEN links 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 MEN links and N-E connections installations, test the insulation resistance of each conductor and the sheath integrity.

Continuity and phasing test

Use a resistor box (2 MΩ, 7 MΩ and 11 MΩ) in conjunction with a 500 V 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: At the transformer's LV connection point, between phases and neutral, carry out the testing using a 500 V insulation resistance tester at the pillars.

Correct resistance values should be measured between R-N, W-N, B-N, respectively. A value of more than 10 MΩ should be measured between N-E.

Insulation resistance test

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

Actual values must be recorded.

Values greater than 10 MΩ for new cable and 1 MΩ for existing cables are acceptable. This test may not be practical for existing cables because of connected services.

Ensure all persons are clear of the circuit before testing. Test and record the insulation resistance values measured using an insulation resistance tester. Measured value of 10 MΩ or greater is acceptable at the

point of handover of a clean circuit from the construction authority (cable installer) to the commissioning authority.

Sheath integrity test

With all MEN links and N-E connections disconnected, test the sheath integrity using an insulation resistance tester connected neutral screen (Nscr) to earth. For testing purposes, use an effective earthed reference point spaced more than 2 meters from any electrically conductive object embedded in the ground. Measure and record values. Measured values of 10 MΩ or greater for new cables and >1 MΩ for existing cables are acceptable.

This test confirms the integrity of the cable sheath. Damaged or punctured sheaths allow moisture to enter the cable. Use a 1 kV insulation resistance tester for 1 minute with all the neutral connections disconnected within the circuit of the cable being tested.

If the sheath integrity is <10 MΩ for new cable and <1 MΩ for existing cable, notify appropriate authorities for further testing or repair; otherwise proceed.

Note: If initial energisation does not follow within two weeks of insulation and sheath testing, the tests must be repeated, and measured values of not less than 1 MΩ (to *AS/NZS 3000 Rule 6.3.3.3.2*) must be obtained.

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. Phase out at the feeder pillars, mini-pillars and LV connection points, because cross-phasing is likely to occur at these points.
4. Before energising a new LV cable, conduct an insulation resistance test to make sure that the cable is in sound condition.
   Note: When conducting an insulation resistance test, remove customer meter fuses in order to obtain a correct reading. If this is not done, the voltage coil of the customer's meter gives a false reading. Operators should earth out cores between tests and on completion of testing.
5. 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.
6. Each phase must be energised in turn from remote end and checked at each pillar for correct phasing. Record the voltages and phase sequence and phase out.

   Note: Phase out before closing the LV open point.
7. Conduct a service connection test on all installations where the service connections have been disturbed.
8. Ensure the work area is left tidy with no hazards to the public.

Handover of responsibility

- Certify sections 1-8 are completed and transfer control to the person responsible for commissioning.
- 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.

2.7 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 completed installation is required to be upgraded to 'Double insulated':

- Luminaire – double insulated
- Cutout - Separate neutral/earth (SNE), neutral and earth NOT connected
- TPS earthwire – parked in open/blank terminals at the luminaire and at the cutout

References

- AS 3000 – Wiring rules
- AS 3017 – Electrical installations – Verification guidelines
- AS 4741 – Testing of connections to low voltage networks
- AS 60038 - 2012 Standard voltages

Equipment pre-handover status

Steel standard streetlights must be installed in accordance with:

- Distribution Construction Standards Handbook Part 8 - Street lighting (drawings S08 – S12) and
- Distribution Construction Standards Handbook Part 2 – Reference (drawings R26-3 and R26-6).

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.

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.

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 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.

Supply 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.

Supply 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.

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.

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.

References

Australian Standard AS 60038 - 2012 Standard voltages

Equipment pre-handover status

The converted three-phase pillar must be installed in accordance with the appropriate guidelines in Distribution Construction Standards Handbook HB01 and applicable design drawings.

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.
5. Ensure the circuit supply point has been isolated and tagged.
6. Check that the streetlight 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.

Test criteria

Insulation and core separation test

Use a 1 kV 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:

- Phase rotation
- Line, phase and neutral voltages

Customer cables must now be connected, and a service connection test performed at each customer installation.

Phasing out

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

Phase out 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.

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 – DCF 2.9

This DCF covers the testing and commissioning of all replacements or new installations of LV cable, from the pole of an existing overhead distribution system to a pillar in the Western Power distribution network.

References

Australian Standard AS 60038—2012 Standard voltages

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.

Certain checks must be performed at the pole-top by the linesman and confirmed as done on the form – 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.

Equipment pre-handover status

For an existing pillar where the pole-to-pillar cable 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.

Pole to pillar must be installed in accordance with the appropriate guidelines in *Distribution Construction Standards Handbook (DCSH) – Part 5 Low Voltage Underground* and all applicable design drawings.

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

Test criteria

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, utilise;

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

Perform the following tests in accordance with the Distribution Commissioning Form (DCF2.9)

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

5. Phase rotation test. For a cable replacement or upgrade, the phase rotation must be the same as before the original cable was de-energised.

Commissioning of the equipment

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. Confirm and connect the cable neutral core to the aerial neutral. Confirm voltage N-E <6V.
4. Connect the remaining active cores, confirming voltage at the pillar after each connection s made.
5. Reconnect the earth conductor to the neutral terminal block.
6. Record the final voltages at the pillar.
7. Confirm phase rotation.
8. If any service connections were present in the pillar, service connection testing must be performed 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 NAC number.

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

This DCF form (EDM 47073329) is for recording test results after repairs to streetlight underground supplies. The form is a fillable PDF form and can be:

- Filled and saved in a different location
- Filled and then printed
- Printed and then filled by hand.

The DCF is:

- Applicable to employees and contractors
- 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 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)

References

- AS 3000 – Wiring rules
- AS 3017 – Electrical installations – Verification guidelines
- AS 4741 – Testing of connections to low voltage networks

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
- Instruments must have a current calibration certificate

Personnel are advised that when testing the fault loop impedance (line active-line neutral), a result above 1 ohm will indicate a 'fail' 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.

Pre-repair

- Use a low-impedance voltmeter to check for touch potential and record the voltage, this must be less than six volts
- 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

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

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.

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.

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 appropriate 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*.
2. As minimum, the installer must affix 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. The completed Earthing system resistance test form (DCF 4.1) 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 750 kVA 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

Decommissioning checks

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.

Pre-commissioning checks

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

1. Verify (on site) that the equipment has been installed correctly 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 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).*

Test criteria

Insulation resistance test

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

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

The LV frame insulation tests should be greater than 100 MΩ at 1 kV

Note: Testing of the apparatus is detailed in the *Distribution Commissioning Form (DCF 3.1)*

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 energised from an interconnected transformer, conduct a phase-out test at the new transformer's LV disconnector or fuse box.
- If the LV conductors are not energised and for sole use, conduct the phase-out as required.

Commissioning of the equipment

1. Prepare a commissioning program to energise the equipment in accordance with the DCF and the switching program.
2. Conduct insulation and phasing tests and record the results.
3. Verify that the temporary cable destination and transformer labels are correct.
4. Carry out the commissioning program as per the switching program number.
5. 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.
6. 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.

7. Check and record the final no-load voltage on each phase of the LV of the transformer.
8. Check and record the load voltage on each phase of the LV of the transformer.
9. Connect the load as per the switching program.

10. Measure the secondary voltage with load.
11. Check and record the final tap position of the transformer.
12. Replace the temporary cable destination and transformer labels with permanent labels on the transformer in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005).*
13. Conduct a service connection test on all installations where the service connections have been disturbed. Attach completed SCT forms to project documentation.

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 1,000 kVA 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.

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.

Pre-commissioning checks

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

1. Go to the site and verify that the equipment has been installed correctly 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 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. For new non-MPS transformer installations, visually check that all phase and earth/neutral connections are securely bolted.
14. 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.
15. Prepare permanent cable destination labels in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005).*
16. 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.

17. 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.
18. Check that the HV screens are all solidly and separately bolted to the HV earth bar.
19. Check that all elbow connectors are fitted with correct bailing assemblies and are secure.
20. Check that the neutrals are reconnected, and that earth and the MEN/N-E connections are reconnected.
21. 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 occurs when the equipment is energised.
22. Check that there are no cables exposed to the public and backfill if required.
23. Check the site for erosion around the transformer. If so, then backfill with blue metal or crushed limestone.
24. Open all LV fuse ways, including the transformer disconnector.
25. Check that all LV neutral connections are connected to the LV neutral bar, not the earth bar.
26. Check that the transformer is set to the correct HV tap setting.

Test criteria

Insulation resistance test

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

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

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 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 not energised and for sole use, conduct the phase-out as required

Commissioning of the equipment

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 statutory voltage requirements.
5. Check that the phase sequence is correct.

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

6. Check and record the final no-load voltage on each phase of the LV of the transformer.
7. Check and record the load voltage on each phase of the LV of the transformer.
8. Check and record the final tap position of the transformer.
9. Connect the load as per the switching program and ensure that the transformer is not interconnected with any other downstream.
10. Replace the temporary cable destination and transformer labels with permanent labels on the transformer in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005)*.
11. Conduct a service connection test on all installations where the service connections have been disturbed.

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/pad-mounted) transformers up to 50 kVA 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.

Pre-commissioning checks

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

1. Go to the site and verify that the equipment has been installed correctly 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)).
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.
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 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 bollards are installed around the pad-mounted transformer.

Test criteria

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 (no external ER bushing): 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: 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 2.5 kV insulation resistance tester for 1 minute.
    - For the HV-LV and LV-LV tests, use 1 kV insulation resistance tester for 1 minute.
    - Ensure that the transformer and the MEN/N-E connections are disconnected

Energisation of the Transformer - Voltage test

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

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

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

Commissioning of the equipment

1. Ensure that the transformer and the MEN/N-E connections are re-connected
2. Prepare a commissioning program to energise the equipment in accordance with the switching program.
3. Carry out the commissioning as per the switching program.
4. Verify that the connections to the LV mains are correct.
5. Measure the no-load and load secondary voltage of the transformer to ensure that it meets the statutory voltage requirements.

Note: The commissioning program for the transformer may be incorporated into the commissioning program for the ring main switchgear (pad-mounted).

6. Check and record the load voltage at LV of the transformer.
7. Connect the load as per the switching program.
8. Check and record the final tap position of the transformer.
9. When erecting a new or reconstructed LV apparatus, check the voltage at an existing LV point, if possible, in accordance with NETWORK OPERATIONS instructions. Phase out any newly fitted LV disconnectors and check them for sound operation.
10. Replace the temporary cable destination and transformer labels with permanent labels on the transformer in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005*).
11. Conduct a service connection test on all installations where the service connections have been disturbed.

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 315 kVA 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.

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.

Pre-commissioning checks

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

1. Verify (on site) that the equipment has been installed correctly 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 earthing testing schedule, if applicable (DCF 4.1 - Earthing system resistance testing (all equipment)).
7. Check the HV cable testing schedule (if applicable).
8. Check the LV cable testing schedule (if applicable).
9. Check that the SPIDAWeb pick ID numbers for each item are in accordance with the as-constructed drawings.
10. Check and record the address/pole number, SPIDAWeb pick ID number and work package number.
11. Prepare permanent labels in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005).*

Test criteria

Insulation resistance test

Use a 2.5 kV and 1 kV 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 2.5 kV for HV winding and greater than 100 MΩ at 1 kV for LV winding.

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

Voltage test

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

When energising a transformer with and without a load:

- ensure the red to neutral, white to neutral and blue to neutral test results are within the acceptable range (216 V to 253 V).
- ensure the red to white, white to blue and blue to red test results are within the acceptable range (376 V to 440 V).

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 energised from an interconnected transformer, conduct the phase-out test at the new transformer's LV dis-connector or fuse box.
- If the LV conductors are not energised and 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.

Commissioning of the equipment

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. Conduct a service connection test on all installations where the service connections have been disturbed.
7. Check that the phase rotation and synchronisation are correct.
8. Check and record the final tap position of the transformer.
9. Check and record the load voltage on each phase of the LV of the transformer.

10. Replace the temporary cable destination and transformer labels with permanent labels on the transformer in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005*).

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 200 kVA 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.

Pre-commissioning checks

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

1. Verify (on site) that the equipment has been installed correctly 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 all earthing connections to the transformer.
7. Check the earthing testing schedule, if applicable (DCF 4.1 - Earthing system resistance testing (all equipment)).
8. Check the HV cable testing schedule (if applicable).
9. Check that the SPIDAWeb pick ID numbers for each item are in accordance with the as-constructed drawings.
10. Check and record the address/pole number, SPIDAWeb pick ID number and work package number.
11. Prepare permanent cable destination labels in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005)* (if applicable).

Test criteria

1. Perform insulation tests as described in the DCF using an insulation resistance tester capable of delivering 2.5 kV for at least a minute.
2. Continuity tests are 'touch tests' and do not need to be proven for a minute.

Commissioning of the equipment

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 switching program.
3. Check that the HV fuses are correct.
4. Carry out the commissioning as per the switching program.
5. When erecting a new or reconstructed LV apparatus, check the voltage at an existing LV point, if possible, in accordance with NETWORK OPERATIONS instructions. Phase out any newly fitted LV disconnectors and check them for sound operation.
6. Check for abnormal noise.
7. Measure and record the voltage reading of the transformer at the control of the single-phase recloser (if available).

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

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 315 kVA 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.

Pre-commissioning checks

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

1. Go to the site and verify that the equipment has been installed correctly 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 testing schedule (DCF 4.1 - Earthing system resistance testing (all equipment)).
9. Check the HV 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. Prepare permanent cable destination labels in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005).*

Test criteria

Transformer tests

Although the transformer has 3 bushings, only two are connected via the transformer primary winding. The 3rd bushing is there only for 'parking' the 3rd core of the cable and is not connected to the winding. Refer to the transformer name-plate to establish which bushings are in use.

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

- Ensure that the transformer and the MEN/N-E connections are disconnected
- Insulation resistance test values greater than 1000 MΩ for 2.5 kV are acceptable.
- The continuity test value must be zero.

Commissioning of the equipment

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

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

7. When erecting a new or reconstructed LV apparatus, check the voltage at an existing LV point, if possible, in accordance with NETWORK OPERATIONS instructions. Phase out any newly fitted LV disconnectors and check them for sound operation.

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 Earthing system resistance testing – DCF 4.1

This DCF covers testing of the earth resistance of electrodes or earth systems.

Good earthing systems are essential for the protection of personnel from electrical shock and the protection of electrical equipment from dangerous overvoltage and excess current.

References

- *Maintaining and replacing down earth assemblies work instruction (EDM 41862205)*
- *AS 2067 Substations and HV Installations Exceeding 1 kV AC.*
- *Electrical System Safety Rules.*
- *Distribution Design Catalogue.*
- *Distribution Substation Manual*.

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.

Test equipment

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

- a ground resistance tester.

Instructions

For combined earthing systems, measure resistance to earth of the completed system with all earth connections and neutral-earth connections in place. Record the results.

For separate earthing systems, measure the resistance to earth of the HV earthing system and the LV system independently and separately. The measurements must be made independently of any connection between the neutral conductor and earth elsewhere within the electrical installation. Record the results.

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 in the *Distribution Commissioning Form (DCF) 4.1.*

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.

Resistance to earth – combined earthing system

The combined earthing system must have a resistance to earth not greater than 1Ω.

A resistance of 1 Ω may be achieved by connection to electrode systems, metallic cable sheaths or LV neutrals, provided that when any such connection is temporarily removed for test or maintenance purposes the resistance of the remaining earthing connections does not exceed 30 Ω.

A resistance to earth value greater than 1 Ω may be appropriate where step and touch potentials are satisfactory.

Note: Testing of the apparatus is detailed in the Distribution Commissioning Form 4.1.

Handover of responsibility

- The person responsible for testing must sign off on the testing schedule and include appropriate registration and licence numbers where applicable.
- 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, Work Instructions and the switchgear manufacturer's operating and commissioning manual.

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 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.

Pre-commissioning checks

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. Check the earthing testing schedule. (Refer to the earth testing).
4. 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.

Test criteria

Insulation resistance test

Test the insulation resistance using a 5 kV 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

Use an insulation resistance tester to verify the continuity of the circuit. Check the indicator position.

Polarity test

Use a voltmeter or multi-tester on the 240 V supply to verify the correct supply to the controls and its safe operation.

For testing purposes, use an earth reference point spaced at least 2 meters from any other electrically conductive object embedded in the ground.

Operations and communications (controller)

Pole-top control cubicle

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. The mechanism can be driven by either a manual hookstick or an electric motor.

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.

Control cabinet

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

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 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.

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.

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.

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.

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 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.
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 240 V 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 240 V 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.

Test criteria

Insulation resistance test

Use a 5 kV 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.

Polarity test

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

For testing purposes, use an earth reference point spaced at least 2 meters from any electrically conductive object embedded in the ground.

Commissioning of the equipment

1. Before closing an automatic control recloser on the distribution network, phase out the HV.
2. Ensure that the alarms and controls are set to the specified requirements.
3. Lock the control units using two approved (NMK2) padlocks. NK6 padlocks must not be used.

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.

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.

Pre-commissioning checks

The following steps are to be carried out with the switch de-energised.

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. Ensure that the switch body, switch handle and earth mat are properly earthed and secured.
7. 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).
8. 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.
9. Check that the operating mechanism has a bonding connection to the earth mat and a separate connection to the earth stakes.
10. 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.
11. 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.
12. Ensure that the proper signage and labelling has been applied in accordance with the *Distribution Equipment Labelling Standard (EDM 25433005)*.
13. Fit a Distribution Switching (WPC) padlock and ensure that the switch handle is lockable in both open and closed positions.

    Note: An NK6 padlock must not be used.

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.

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.

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.

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. Check that the settings of the protection circuits are correct.
14. Lock control unit doors with two Western Power approved padlocks.
15. Ensure that the control settings are configured to the desired set parameters. (Refer to the Distribution Commissioning Form for the control setting and testing.)

Commissioning of the equipment

1. Ensure the feeder reclosers are set to MANUAL during the energisation period.
2. Ensure all switches operate correctly.
3. Where automation is provided, ensure that the SCADA labelling and operation is true and correct.
4. Ensure all equipment is in its final circuit condition and all normally open points are set to their designated position.
5. Conduct a polarity test on the controller supply using a voltmeter or multimeter to verify its safe operation.
6. For testing purposes, use an effective earthed reference point spaced more than 2 meters from any electrically conductive object embedded in the ground.
7. Ensure all equipment is locked, labelled and protected from unauthorised entry.

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

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.

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)*

Test criteria

Installation check

1. Install a switch with blades and contacts de-energised and operate for a function test
2. 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

- Ensure the switch it in the correct position (ON or OFF)
- Fit a Perspex cover and lock the unit door with a Distribution Switching (WPC) padlock

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.

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 (H-33).

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.

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.

Test criteria

Insulation resistance test

Use a 5 kV 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.

Commissioning of the equipment

1. To ensure that the voltage regulators function properly and automatically, test each voltage regulator control as follows:
    - 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.
    - 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.
    - 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.

- 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.
- Upload the settings to the control.
- 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.
- 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.
- 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.
- 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.

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.

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 (H-33).

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.

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.

Test criteria

Insulation resistance test

Use a 5 kV 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.

Commissioning of the equipment

1. To ensure that the voltage regulators function properly and automatically, test each voltage regulator control as follows:
    - 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.

- 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.
- 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.
- 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.
- Upload the settings to the control.
- 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.
- 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.
- 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.
- 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.

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.

Related information

Australian Standard AS 2067–2012: Substations and High Voltage Installations Exceeding 1 kV AC. Published by Standards Australia.

AS 62271.1–2012: High Voltage Switchgear and Control Gear – Common Specifications.

Equipment pre-handover status

HV ring main switchgear

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

Where extensible switchgear has been assembled on site to form a composite type switchboard, then, prior to terminating the cables, the installer must test it to A*ustralian Standards AS 2067 - 2012 and AS 62271.1–2012*.

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*.

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.

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. 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 disconnected.
8. Where appropriate, check the gas leakage indication gauge to verify that the switchgear has sufficient service pressure.
9. 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.
10. Clean away any dust which may have blown onto the unit during the installation activities.
11. Check that all HV cable terminations are secure and that the correct bailing assemblies are used.
12. Check that any unused bushings are correctly capped with rated parts and bailing fitted.
13. 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.
14. Check that the HV cable screens are all solidly and separately connected and bolted to the HV earth bar.
15. Ensure that the switch disconnectors are in the OFF position and that the fuse switches are off and in the EARTH position.
16. If the ring main unit is in a kiosk, check that the kiosk body is earthed correctly, including the kiosk doors.
17. Ensure all personnel engaged in performing this task have vacated the test area and are outside the safety barriers.
18. 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.
19. Switch the transformer fuse switch back to the OFF position.

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 5 kV 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 1 kV insulation resistance tester to verify continuity (R = 0 MΩ).

Close all earthing switches and open all load-carrying 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.

Commissioning of the equipment

1. Carry out the commissioning program according to the DCF and the switching program.
2. Operate all switch mechanisms for 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.

Note: Interlocks have only been tested to confirm that an operational action is allowed when such an action is permissible. The interlock mechanism must also be tested to confirm that an operational action is positively prevented when that action should never occur.

3. Phase out the HV ring main switchgear in accordance with the Network Operations switching program.

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 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 SWIS distribution network.

References

Australian Standard AS 3000–2007: Electrical Installations (known as the Australian/New Zealand Wiring Rules).

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.

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

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.

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.

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 for protection against indirect contact by way of arrangements, barriers or screens.
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.

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

Test criteria

Insulation resistance test

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

Use a 1 kV insulation resistance tester (never use 5 kV 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 follows:

- 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)*

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.

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.

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.

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.

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.

Commissioning of the equipment

1. Before closing the switchgear (ON) on the distribution network, phase out the HV.
2. Ensure that the alarms and controls are set to the specified requirements.

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. Dictionary

Words in the first column of the following table are defined terms and have the corresponding meaning shown in the second column of the table. 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.

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)
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.
CPM	Construction Project Manager
Energised	With reference to electrical apparatus, means that a voltage exists between apparatus and earth.
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.
eNAR	Electronic Network Access request. Formal request to Network Operations to access the transmission and distribution network. It is also the primary tool used for customer interruption management
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
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.
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
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.
EWL	Electrical Workers Licence

Defined term	Meaning
EWP	Elevating platform
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
Hipot	High potential
High voltage (HV)	A voltage of 1,000 V AC or 1,500 V 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 1,000 V AC or 1,500 V DC.
MEN links/N-E connections	Multiple earthed neutral system of earthing as defined in AS/NZS 3000 or Neutral Earth connections.
MPS	Modular package substation
NAC	Network Authority Card
NOP	Normally open point
Phase rotation	The sequence in which phases rotate relative to each other
Phasing out	Identification of active conductors of the same phase (having no significant angular displacement i.e. red phase to red phase).
PTCC	Pole-top Control cubicle
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.

Defined term	Meaning
Sanction to test (STT)	Western Power's standard form authorising the testing of electrical apparatus
SCADA	Supervisory Control and Data Acquisition
SPUDS	Single-phase underground distribution system
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.
SWER	Single-wire earth return
SWIS	South West Interconnected System
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
XLPE	Cross-linked polyethylene

6. Content owner

Name & Surname	Business Unit
Stephanie Applegate	SEQTMS Team Leader

7. Accountabilities

Head of SEQT	Accountable for the development, maintenance and publishing of this Manual in-line with the requirements of Western Power's SHE Management System and, so far as reasonably practicable influencing compliance with the arrangements prescribed by the details within this Manual

8. 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.

9. References

AS/NZS 1026–2004 (R2017): Electrical Cables – Impregnated Paper Insulated – Working voltages up to and including 33 kV

AS/NZS 4961–2003(R2017): Electric Cables – Polymeric Insulated – For distribution and service applications.

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/NZS 3000–2018: Electrical Installations (known as the Australian/New Zealand Wiring Rules)

AS 62271.1 -2012 High-voltage switchgear and control gear – Common specifications

AS 60038 - 2012 Standard voltages

AS 2067 – 2016 Substations and HV Installations Exceeding 1 kV AC.

AS 4741 – 2010 Testing of connections to low voltage networks

AS 3017 – 2007 Electrical installations – Verification guidelines

10. Related documents

Document Name	EDM reference
Very Low Frequency Voltage testing of High Voltage cables	21404211
Testing of High Voltage Paper Insulated Cables	21965356
Distribution equipment labelling standard	25433005
Laying, pulling and bedding cables	41855257
Distribution Construction Standards Handbook Part 1 – General	23953024
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 Construction Standards Handbook Part 10 – Conductor Tensioning Table	30842672
Distribution Underground Cable Installation Manual	34011711

Document Name	EDM reference
High voltage overhead powerlines (DCF 1.1)	21584553
Low voltage overhead lines (DCF 1.2)	22138998
Low voltage aerial bundled conductor (DCF 1.3)	21583726
High voltage aerial bundled conductor and Hendrix spacer cable (DCF 1.4)	23994096
High voltage XLPE cable (DCF 2.1)	21540116
High voltage mixed cable (DCF 2.2)	21535022
HV paper-insulated belted cable (DCF 2.3)	21944117
HV paper-insulated screened cable (DCF 2.4)	21951092
Low voltage XLPE cable (DCF 2.5)	21536808
Low voltage cable with/without pillars (DCF 2.6)	21635344
Steel standard streetlights (DCF 2.7)	33981562
SPUDS single –phase to three-phase pillar (DCF 2.8)	27007034
Pole to Pillar (DCF 2.9)	34034804
Streetlights underground supply cable repair (2.10)	47073329
MPS distribution transformer – Commissioning (DCF 3.1)	24253324
MPS distribution transformer – Decommissioning (DCF 3.1)	29854219
Non-MPS distribution transformer – Commissioning (DCF 3.2)	24981587
Non-MPS distribution transformer – Decommissioning (DCF 3.2)	29855006
Single-phase transformer (pole-mounted/pad mounted) (DCF 3.3)	23932817
Three-phase pole-mounted transformer – Commissioning (DCF 3.4)	24238157
Three-phase pole-mounted transformer – Decommissioning (DCF 3.4)	30562085
SWER isolation transformer (pole mounted) (DCF 3.5)	24293616
SWER isolation transformer (ground mounted) (DCF 3.6)	25344754
Earthing system resistance testing (all equipment) (DCF 4.1)	21631145
Nu-lec load break switch/sectionaliser (DCF 4.2)	21734095
Nu-lec pole-mounted automatic control recloser (DCF 4.3)	21543658
Pole-top switch (DCF 4.4)	21640904

Document Name	EDM reference
Pole-mounted capacitor bank (DCF 4.5)	21638217
High voltage single-phase underground rural supply fuse switch (DCF 4.6)	21823418
Voltage regulator (closed Delta connection) (DCF 4.7)	22105433
Voltage regulator (Star connection) (DCF 4.8)	24601112
High voltage ring main switchgear (DCF 4.9)	21611007
Low voltage kiosk (DCF 4.10)	21613761
NOJA pole-mounted automatic control recloser (DCF 4.11)	32271371
Scanning Cover Sheet – Operational Maintenance	34132644

11. Approval history

Version	Approved by (job title)	Date of approval	Notes
1.	WPDT Manager	Feb 2016	NOJA mounted automatic control recloser
2.	SEQT HoF	May 2017	3.1 - MPS distribution transformer – Commissioning: Reviewe 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.	SEQT HoF	June 2017	2.7 – Steel standard streetlights – additional IR test 2.9 – Pole to pillar – elimination of stray/ghost voltages
4.	SEQT HoF	Nov 2017	2.10 – Streetlights underground supply cable repair
5.	SEQT Assurance Manager	April 2019	Review of entire document and Appendix 1

12. Content Approver

Name and Surname	Signature
Gordon East	

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]		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	
	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
	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

			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
	3.6	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

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. Personnel commissioning this work must have completed PTS 149 and hold 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