TESTING & COMMISSIONING PROCEDURE

SUBTRANSMISSION CONTESTABLE WORKS OVERHEAD LINES

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1 PURPOSE

The purpose of this document is to identify generic requirements applicable to the testing & commissioning of new Subtransmission Overhead Power Line systems associated with Essential Energy's network infrastructure.

This procedure applies to all new overhead line installations that are to be connected to Essential Energy's network. The use of this procedure is for Accredited Service Providers, Essential Energy staff and accredited sub-contractors.

The purpose of undertaking overhead line testing is to prove system integrity after installation work is completed and before connection to the Essential Energy Network.

The tests specified within this procedure are minimum requirements. Additional tests or amendments to testing requirements may vary depending upon project/site conditions.

Testing requirements will be negotiated between Essential Energy & the Accredited Service provider after submission, to EE by the ASP, a project specific commissioning program.

2 KEY TERMS & DEFINITIONS

AR means authorised representative. The AR may represent an ASP or EE approved contractor.

ASP means an accredited service provider, being a person or body accredited under part 10 of the Electricity Supply (General) regulation 2001, (NSW).
Accreditation of service providers is administered by the department of Industry & Investment.
A list of ASP's is available on the Industry & Investment website.

ASP3 means a level 3 service provider accredited to carry out design works.

ASP1 means a level 1 service provider accredited to carry out construction works. An ASP1 must have specific accreditation to carry out underground cable installations.

DIP means design information package.

EE means Essential Energy.

HIRAC Hazard Identification, Risk Assessment and Control.

T&C Plan means Testing & Commissioning Plan

QCC means EE appointed Quality Control Coordinator.

3 TESTING & COMMISSIONING

All electricity works shall be designed to be safe for the electrical conditions likely to be experienced during service and the physical environment in which they will operate. EE needs to ensure that appropriate tests have been completed before an installation is commissioned into service for compliance with the design & specifications. This will require close cooperation between the ASP1's construction AR and EE.

EE will appoint a commissioning manager or QCC auditor as EE's representative for coordination purposes.

3a Tests

Before any tests are performed, EE and the AR must agree on the procedures to be used for the tests and any modification to or deletion from this procedure.

EE's QCC auditor shall be notified a minimum of 10 working days prior to the commencement of line installation or any tests to be undertaken.

The AR will be responsible for ensuring that the completed work is QA checked and tested and all records and reports are forwarded to the QCC promptly.

EE's QCC auditor may be present to witness the testing procedures, and only with EE approval shall proceed to test.

Tests must be carried out in the presence of representatives nominated by the AR and EE. The AR must provide the results of tests to EE as requested by EE, within a maximum time period of 10 working days.

All test results shall be documented and submitted to EE including the following detail:

- Testing organisation details.
- Date, time and location of test.
- Description of line tested.
- Description of test equipment used including calibration dates.
- Test procedure.
- Test results.

If tests indicate that corrective works are required to ensure line integrity the AR must then:

- Undertake, at their cost, all rehabilitation, modification or remediation work required to the reasonable satisfaction of EE.
- Report back to EE in writing when all corrective work has been completed and renegotiate a suitable program to recommence tests.

3b Test Equipment.

All test equipment and instrumentation used for testing shall have been calibrated by a NATA Accredited organisation and have a current test sticker affixed. The AR is responsible for ensuring that test equipment and instrumentation is traceable.

4 COMMISSIONING

4a Testing & Commissioning Plan (T&C Plan)

Prior to energising or commissioning any subtransmission overhead line installation a detailed commissioning plan shall be prepared by the ASP1 and submitted to EE for approval.

The T&C Plan shall demonstrate to EE the planning by the ASP1 for the pre-commissioning activities and shall consolidate and reference the QA process installation checks and tests, as well as the tests required before and after completion.

The commissioning plan must include:

- Single line diagram of final installed network.
- Detailed step by step procedure of the activities (checks & tests) with the sequence clearly documented.
- A proposed schedule.
- Supervisor and employees involved including their accreditation & contact details.
- A summary of pre commissioning checks & tests completed and results.
- Written confirmation that all works undertaken by the ASP for the installation meets the required Australian standards, NSW S & I Rules, EE standards and manufacturer's requirements for testing of product, plant, equipment and drawings/specification.
- HIRAC & associated SWMS documentation.

4b Authority for Placing Major Electrical/Plant Equipment into Service (CEPG2047)

CEPG2047 applies to all new Major Electrical Plant/Equipment.
The purpose of procedure CEPG2047 is to ensure that EE's Network Operations department receives written notification that all construction and pre-commissioning checks on major plant/equipment are complete and ready for service.

Prior to final commissioning and energising of the high voltage equipment, direct lines of communication must be established between the ASP's nominated person, for site commissioning and ongoing operations, and the designated EE Systems Operations Centre.

The CEPG2047 written notification shall be completed by the ASP and submitted to EE's QCC auditor for co-ordination with EE's system operations.

4c "As Installed" Detail

On completion of construction and prior to final commissioning of the overhead line installation the ASP is to provide the following "As Installed" detail to EE :

- Route plan including line schedule & profile.
- Structure earthing schedule including measured values.
- Details of other services crossings.
- Test reports and/or test certificates.
- Inspection reports.
- Any modified or additional drawings, information or instructions necessary for the satisfactory completion of the work.

"As Installed" detail shall be provided to EE in electronic form as well as hard copy. Electronic documentation is required in the following formats :

- All documentation - Adobe Acrobat "pdf" .
- Drawings – Microstation "dgn" or compatible.

4d Worksite Hazard Identification, Risk Assessment and Control (HIRAC)

Tests on overhead lines are potentially hazardous to both personnel undertaking the test and the general public in the vicinity.

A Worksite safety management plan shall be prepared for the project and activities, and will be implemented with an accompanying HIRAC.

The HIRAC will be carried out, by the ASP1's authorised person, to determine the precautions that need to be adopted.

The HIRAC procedure & associated SWMS are to be submitted to EE's QCC auditor for review prior to implementation.

5 PRE COMMISSIONING

5a QA Checks

During the installation a system of records shall be maintained which provides objective evidence that requirements have been met, including construction in accordance with applicable standards, construction drawings/plans and specifications.

All records shall be available for audit and review by EE during the installation. The records should provide full traceability of all quality characteristics and activities.

During construction activities QA mechanisms such as check sheets, checklists, inspection & test plans (ITPs) shall be utilised for an EE representative to witness and sign off.

EE's QCC auditor may be present to witness the installation at hold points, as required by EE, and work shall not proceed past a hold point without EE consent.

5b Notice of Completion

On completion of construction works and prior to final commissioning the AR is to submit a notice of completion to EE's QCC auditor.

The completion notice is to include –

- T&C Plan.
- CEPG 2047 written notification.
- "As Installed" Plans and documentation.

A final inspection/audit will be carried out by EE's QCC auditor along with the ASP1's AR.

5c Final Inspection/Audit

The purpose of the final inspection/audit is to ensure the new asset is acceptable to EE for connection to EE's transmission network.
A review will be undertaken of the following –
Vegetation & Environmental Management.
Access.
Construction Quality Assurance including visual inspection of works and sign off of non-conformance issues.

6 PRE COMMISSIONING TESTS

The purpose of pre commissioning tests are to confirm line integrity & compliance with the earthing, EPR & protection studies carried out and approved for the project.

The required pre commissioning tests for subtransmission overhead lines are :

- Structure Earth Resistance Test.
- Phase Continuity Test
- Insulation Resistance Test.
- Earth Current Injection Test.
- OPGW Tests.

6a Structure Earth Resistance Test

After completion of structure installation but prior to the installation of any OHEW/OPGW, the electrical resistance of structure earthing shall be measured by the ASP1. EE's QCC auditor or nominated representative may be present to witness tests. The results shall be supplied to EE's QCC auditor without delay for review.

The ASP1 may be directed by EE to install supplementary earthing where readings exceed the required value. The installation of supplementary earthing shall be in accordance with EE standards and shall be completed prior to the installation of OHEW/OPGW. The supplementary earthing shall be installed so as to comply with the specified electrical resistance of each structure to earth.

6b Phase Continuity Test

A phasing check shall be completed prior to commissioning to ensure that the phases are correctly aligned to synchronise with the network to which the line is to be connected.

6c Insulation Resistance Test

An insulation resistance check ie megger test, shall be completed prior to commissioning to ensure no inadvertent short circuits.

6d Earth Current Injection Test

For shielded lines, earth current injection tests shall be undertaken and the following measurements taken at each support structure –

- Line – Earth Impedance.
- Step & Touch Potential.
- Earth Potential rise.
- Zero Sequence Impedance.

Recorded test measurements are to confirm compliance with the requirements of AS/NZS 7000. Tests shall be performed after the substation earth mats at all ands of the line are fully installed and connected.

6e OPGW Tests

The testing of system components to identify the apparent performance of the optical fibres before and after the responsibility of the component has been transferred between independent parties is essential.

EE advocates that the stringing and splicing activities to be carried out by specialised accredited service providers. It is mandatory that the following testing procedures are implemented between each interface and progressively throughout the works to ensure the separate activities are adequately controlled.

The AR is required to undertake the following tests –

- Drum Test - Upon OPGW receival from either the manufacturer or EE.
- Span Test - After OPGW stringing/installation.
- Splice Test - After OPGW splicing.
- Final Acceptance Test - After OPGW completion.

Each test result shall be uniquely identified for future reference and shall include a record of the environment at time of test and the person performing the test. The attenuation data from the series of tests shall be compared to ensure that there are no problems such as to allow the next step to commence. The manufacturer's factory test report for each drum of OPGW cable shall be made available upon request.

The consolidation and presentation to EE of all optical fibre measurements taken during the course of works shall be in a final installation report within 10 working days of the final acceptance test.

6e.1 OPGW Test Instruments

Either "mini" or "Full Featured" Optical Time Domain Reflectometer (OTDR) instruments, immune to polarisation noise and conforming to the Telcordia/Bellcore Standard GR-196-CORE "Generic Requirements for Optical Time Domain Reflectometer – Type Equipment", are to be used for all OTDR measurements.

The OTDR must be capable of storing the traces on an electronic medium (eg floppy disk or USB stick) for transportation/submission, allow retrieval and reading of traces. All traces are to be stored and submitted in a format compatible OTDR 3.0 emulation software, the preferred trace formats are : Telcordia standard SR4731 Rev 2.0 (SOR extension files) or GR 196 compatible file format.

The OTDR testing is to be carried out at either 1310nm, 1550nm and/or 1625nm wavelengths. The 1625nm OTDR trace is primarily used to identify pressure points, macro bends and imperfections in cable installations.

The OTDR operator must be experienced in the use of high performance OTDR's and shall, have attended an approved TITAB OTDR training course.

6e.2 OPGW Cable & Splice Testing Criteria

The AR shall provide fusion splices with an average attenuation below 0.1dB when measured at 1550nm. Any fusion splice with attenuation above 0.1dB shall be re-spliced and re-tested.

The approved methodology comprises measuring in both directions, using an OTDR, the attenuation of each splice for all fibres. The average of the two readings for each fibre will be accepted as the splice attenuation for each fibre. In addition the end to end attenuation of each fibre in each direction shall be measured using a calibrated light source and light meter.

All measurements shall be made with an accuracy of 0.01dB and shall not be made over sections greater than the capability of the OTDR in use.

Testing of unterminated fibres shall be performed by splicing temporary pigtails to the fibres or by using a Bare Fibre Adapter. A terminated fibre refers to fibres terminated with connectors on patch panels at an ODF and/or at equipment.

6e.3 Drum Test

Upon receipt, by the AR, of the OPGW from either the AR's supplier or EE the AR shall check the cable attenuation and continuity of each drum. The AR shall conduct a one way OTDR test for all optical fibres for all drums from the inside end. The inside end of the cable is accessible for one way

OTDR testing at the nominated wave lengths (1310, 1550 and/or1625nm), without removing the laggings.

Following testing the cable ends shall be resealed with a suitable heat shrink end cap to ensure against moisture or dirt ingress.

The AR shall give EE a minimum of 48hours notice before conducting these tests. If the OPGW is supplied by EE the Drum Test is to be carried out at EE store prior to transport to site.

Any problems or discrepancies encountered shall be immediately reported to EE. The AR shall provide EE with a report of test results within 10 working days of product issue.

6e.4 Span Test

The span test is a two way OTDR test at the nominated wave lengths (1310, 1550 and/or 1625nm).

The span test shall be conducted, by the AR, progressively as each drum is strung and clamped off. Any problems are required to be identified and rectified prior to splicing.

The same test equipment shall be used as for the Drum Test.

The AR shall test the strung OPGW only after all clipping in is complete and in the presence of an EE nominated representative at a time to be mutually agreed upon. The AR shall notify EE at least 48hours in advance of the tests proceeding.

6e.5 Splice Test

The AR shall measure the attenuation, of each splice, in both directions at both 1310nm and 1550nm.

The AR shall submit to EE a Splice Testing Strategy. This strategy is to demonstrate how the AR intends to measure each splice in order to guarantee the average loss per splice was achieved throughout all the splices on the link.

The same test equipment shall be used as for the previous tests undertaken.

6e.5 Final Acceptance Test

The AR shall measure the end to end attenuation of each optical fibre. The same test equipment shall be used as for the previous tests undertaken.

The AR shall submit to EE a Fibre Testing Strategy to guarantee the average loss per splice was achieved throughout the fibre link.

The AR shall present to EE the following data per fibre –

- Attenuation figures for each splice in both directions.
- An OTDR trace for each splice in both directions.
- End to end attenuation figures in both directions.
- OTDR traces for each fibre in both directions.

7 POST COMMISSIONING TESTS

Are placing the transmission line into service the following commissioning tests may be required :

- Radio Frequency Radiation Test.
- Thermal Scan under load.

These tests may be requested by EE to be carried out by the ASP1 at full cost to the ASP1. If required these tests will be requested prior to the end of the construction warrenty period.

7a Radio Frequency Radiation Test

Radio frequency radiation measurements are carried out to ensure that any interference is less than the values specified in AS 2344 “Limits of electromagnetic interference from overhead a.c. power lines and high voltage equipment installations in the frequency range 0.15to 1000MHz”.
Where interference exceeds these values, the sources of interference must be identified and corrective action taken before re-testing.