Standard

Testing, Commissioning and Training

Record Number R246497

Version 3.0, September 2020

Tasmanian Networks Pty Ltd (ABN 24 167 357 299)

Authorisations

Action	Name and title	Date
Prepared by	Anthony Januba, Senior Asset Strategy Engineer	25/08/2020
Reviewed by	Stewart Collins, Senior Asset Strategy Engineer Andrew Strikis, Senior Asset Strategy Engineer Satendra Bhola, Principal Asset Engineer Santosh Dakal, Substations Engineer	09/09/2020 28/08/2020 09/09/2020 31/08/2020
Authorised by	Robert Smith, Substations Asset Strategy Team Leader	13/09/2020
Review cycle	30 months	

Responsibilities

This document is the responsibility of the Substations Asset Strategy Team, Tasmanian Networks Pty Ltd, ABN 24 167 357 299 (hereafter referred to as "TasNetworks").

Please contact the Substations Asset Strategy Team Leader with any queries or suggestions.

- Implementation All TasNetworks staff and contractors.
- Compliance All group managers.

Minimum Requirements

The requirements set out in TasNetworks' documents are minimum requirements that must be complied with by TasNetworks staff, contractors, and other consultants.

The end user is expected to implement any practices which may not be stated but which can be reasonably regarded as good practices relevant to the objective of this document.

© Tasmanian Networks Pty Ltd 2014

Record of revisions

Section number	Details
Whole document	Formatting changed extensively
1.4	Added more clarity for deviation from this standard
1.5	Added cyber security and IEC 61850 standards and guides. Updated reference numbers for documents now stored in the Zone. Removed referenced documents that are not stored in the Zone.
3	Added information about IEC 61850 sites
5	Added information about IEC 61850 sites
9	Added information about IEC 61850 sites
9.4	Updated testing guide references. Added cyber security requirements

Table of contents

List of tables 5

1 General 6
- 1.1 Purpose 6
- 1.2 Scope 6
- 1.3 Objective 6
- 1.4 Precedence 6
- 1.5 References 7

2 General requirements 7

3 General inspection and testing requirements 7

4 Inspection and test plan 8
- 4.1 Testing schedule 9

5 Type testing 9

6 Routine testing 9

7 Factory acceptance testing 10

8 Site tests 10

9 Specific equipment tests 11
- 9.1 Power transformer tests 11
- 9.2 Metering installation tests 12
- 9.3 Civil infrastructure inspection and tests 12
- 9.4 Secondary equipment testing 12
- 9.5 HV shunt capacitor bank tests 12

10 Other requirements for testing 13
- 10.1 Testing personnel requirements 13
- 10.2 Site safety requirements 13
- 10.3 Testing sequence 13
- 10.4 Material testing requirements 14
- 10.5 Testing equipment 14

11 Test reports 15
- 11.1 Test result sheets 15
- 11.2 Preliminary test report 16
- 11.3 Final test report 16

11.4 Test results....16
12 TasNetworks' role during testing....17
13 Commissioning requirements....17
13.1 Commissioning Manager....17
13.2 Commissioning documentation and timing....18
13.2.1 Commissioning documentation....18
13.2.2 Commissioning documentation time line....18
14 Commissioning program requirements....20
15 Switching program....21
16 Energisation of plant....21
17 Remedial work....21
18 Outstanding items....22
19 Training program....22
19.1 Components of the training....22
19.2 Content....23
19.3 Assessment....23
20 Information to be provided with offer....23
21 Deliverables....23
22 Hold points....24

List of tables

Table 1 Deadlines for commissioning documentation....18

1 General

1.1 Purpose

To define the requirements for any testing and commissioning of assets and training associated with the assets, under the responsibility of TasNetworks.

1.2 Scope

This standard applies to testing, commissioning and training of all assets or part of assets, under the responsibility of TasNetworks.

This standard is to be applied to new installations as well as redevelopment of part or all of existing installations.

1.3 Objective

TasNetworks requires design, construction, installation and commissioning of equipment and services as covered in this standard to ensure:

(a) that relevant Australian legal requirements are met;

(b) that the requirements of the Tasmanian Electricity Code and National Electricity Rules are met;

(c) personnel and public safety;

(d) safety of TasNetworks' assets;

(e) ease in operation and maintenance;

(f) reliability and continuity of the AC supply;

(g) minimum disruption to the AC supply following a fault;

(h) the requirements of TasNetworks' business plan are met; and

(i) the exposure of TasNetworks' business risk is minimised.

1.4 Precedence

Any apparent conflict between the requirements of this standard and the law, mandatory requirements, industry standards, project specifications, non-statutory standards or guidelines, and any other associated documents should be brought to the immediate attention of TasNetworks for resolution and no action must be taken that might result in a breach of law or a mandatory standard.

Where there may be a conflict between the requirements of this standard and any:

(a) law, mandatory requirement or industry standard, then that law or statutory requirements will prevail over this standard;

(b) non-mandatory standard, or guideline, then this standard will prevail over that standard or guideline; or

(c) project specification, then a deviation must be specifically requested and approved in writing by TasNetworks' Substations Asset Strategy Team Leader.

Approval for a deviation to this standard may only be accorded if it does not reduce the quality of workmanship, pose a safety risk to personnel or equipment and does not deviate from the intent of this standard.

1.5 References

The following documents have been used in the preparation of this standard and have been referenced to provide further information.

Contractor Management Procedure (R1247724)

General Substation Requirements Standard (R522687)

Secondary Equipment Testing Standard (R244782)

Substations Civil Design and Construction Standard (R590634)

IEC 61850 Protection and Automation Standard (R1606300)

IEC 61850 Testing Guide (R1682658)

Technology Asset and Change Management Standard (R1400111)

Security Event Logging and Monitoring Standards (R1313426)

Testing, Commissioning and Training Schedule (R246524)

2 General requirements

Project specific requirements for the Testing, Commissioning and Training will be listed in the project specification.

3 General inspection and testing requirements

The following general inspection and testing requirements must be met:

(a) All components, plant and materials must be subject to inspection by TasNetworks.

(b) All components, plant and materials must be tested in accordance with relevant applicable Australian and International standards. Where tests are optional in the standards, it will be considered that these tests are required by TasNetworks, unless otherwise requested by the Contractor and agreed in writing by TasNetworks before the award of Contract.

(c) Unless otherwise specified in the project specification all works associated with inspection and testing will be by the Contractor.

(d) Where there is no Australian Standard covering a particular equipment or system, the testing must conform to the requirements of International Standards (IEC and IEEE).

(e) Where there is no Australian or International Standard covering particular equipment, it must be stated in the contract offer. Such equipment will be used only if there is no substitute equipment that is tested in accordance with Australian and International Standards. The testing procedures for such equipment must be proposed in the contract offer and will need review and approval of TasNetworks after the award of contract. If no proposal is submitted with the contract offer, the Contractor will need to nominate such tests after the award of contract and TasNetworks can nominate additional tests which are considered necessary to demonstrate the performance of the plant or equipment, the cost of these tests will be deemed to be included in the contract price and will be borne by the Contractor. It is important to note that the Tasmanian Electricity Code and the National Electricity Rules requires TasNetworks (as a Network Service Provider) to only use equipment that has been tested in accordance with Australian or International standards.

(f) Where testing is conducted and deficiencies are found with subsequent corrections or where plant or a section of plant is modified or reworked in any way including re-connection of small wiring and

software modifications, all tests must be repeated on the complete plant. This requirement applies for all stages of testing, manufacturing, factory acceptance, pre-commissioning and commissioning.

(g) At sites where IEC 61850 process and/or station bus is implemented, specific testing, commissioning and training requirements shall be in accordance with this standard, the TasNetworks IEC 61850 Protection and Automation standard, and TasNetworks IEC 61850 Testing Guide.

4 Inspection and test plan

The following requirements for inspection and test plans must be met:

(a) The Inspection and Test Plan (**ITP**) must set out details of inspections and tests to be performed on primary and secondary plant.

(b) An ITP must be produced for each project. Unless otherwise stated in the project specification, the ITP must be produced at a minimum of three levels:

(i) for each specific asset category;

(ii) for each sub-activity or stage of a project; and

(iii) for the complete project or system.

(c) The ITP may be broken down to further levels depending upon the complexity of the project.

(d) The ITP must:

(i) describe the sequence and nature of all special, type, routine, factory acceptance, site acceptance, installation, commissioning and energisation tests;

(ii) detail the procedures that will be used to ensure the quality of the asset and the system;

(iii) detail the procedures that will be used to measure the quality of the asset and system;

(iv) detail the measurements to be used to evaluate the deliverability of the asset to Contractual requirements;

(v) consider and include the requirements of Australian and International Standards;

(vi) consider and include the requirements of the National Electricity Rules; and

(vii) include the requirements of TasNetworks project specifications and associated standards.

(e) A list of the minimum requirements of the inspection and tests for each type of equipment is outlined in TasNetworks' individual standards and this standard. It serves as a guide to show the minimum requirements that the Contractor must fulfil in the Contract. It is not a comprehensive list nor does it exclude any other tests that are deemed to be necessary to prove the equipment or plant prior to putting into services.

(f) A draft ITP must be submitted to TasNetworks within 60 days of the award of the Contract or 60 days before the inspection and testing is scheduled to commence, whichever is earlier. ITP's will be reviewed for acceptance by TasNetworks. After considering the comments from TasNetworks, the final ITP must be submitted to TasNetworks at least 15 days from the date of TasNetworks' comments or 30 days before commencing any tests, whichever is earlier.

(g) Once the ITP has been accepted, no inspections or tests will be waived except upon the instruction of TasNetworks in writing.

4.1 Testing schedule

A detailed testing schedule must be prepared for each element on the ITP and provided to TasNetworks. Confirmation on the elements of the testing schedule must be provided to TasNetworks as required in this standard.

5 Type testing

The following considerations must be met for type testing:

(a) Type tests are intended to prove the soundness of manufacture and design of the equipment and its suitability for operation under the conditions detailed in the project specification. Type tests must be performed at the manufacturer's works before delivery. A certified test report, detailing the results of such tests along with the procedures followed, must be provided to TasNetworks.

(b) Type tests must have been passed by all equipment in accordance with the requirements of the specific TasNetworks standard and applicable Australian and International Standards.

(c) These tests must have been applied to equipment of identical design to that offered, or on equipment of a design which does not differ from that offered in any way which might influence the properties to be checked by the type test.

(d) Where such tests have already been performed, copies of type test reports that qualify for the exemption from conducting these tests must be provided at the time of offer.

(e) Where it is found that the type test reports provided do not conform to the requirements of the standard or the equipment delivered is not of a similar design to the one used for type test, the equipment may be rejected by TasNetworks in accordance with the contract.

(f) Where type tests on specific equipment are conducted, as a part of the project, TasNetworks will witness such tests. Invitation to witness such tests must be in accordance with requirements as stated in this standard.

(g) Type tests for conformance with the IEC 61850 standards will be specified in TasNetworks' IEC 61850 Testing Guide and IEC 61850 Protection and Automation standard.

6 Routine testing

The following considerations apply to routine tests:

(a) The routine tests must be conducted on components of equipment and the complete system to prove quality of design and manufacture, and conformance with the relevant performance requirements of the applicable standards. Routine testing must be performed at the Contractor's works before delivery of equipment to site.

(b) Routine tests must be conducted as a minimum in two levels stated below, however splitting of routine tests into separate phases for individual components of the system is not acceptable. The levels of the routine test must include:

  (i) routine tests of each component; and

  (ii) routine tests of the complete system.

(c) Routine tests must be conducted in accordance with the requirements of this standard and applicable Australian and International (IEC and IEEE) Standards.

(d) Routine test plans including testing equipment to be used, applicable parameters (voltage, current, duration etc.) must be submitted to TasNetworks prior conducting routine test.

(e) Routine test results must be submitted to TasNetworks for approval. Routine tests will be considered as completed only after TasNetworks approves the test results.

(f) Routine test results must be approved by TasNetworks before commencement of the factory acceptance testing.

7 Factory acceptance testing

The following considerations apply to factory acceptance tests (FAT):

(a) FAT must be performed for each item of equipment as detailed in the TasNetworks approved ITP. In addition to the requirement of the project specification and TasNetworks standards, FAT must include all routine tests as per applicable Australian and International Standards.

(b) Invitation to witness testing must be provided to TasNetworks at least 30 days in advance and TasNetworks will respond with testing requirements within 15 days of commencement of FAT.

(c) TasNetworks will witness the FAT unless explicitly advised otherwise.

(d) The Contractor is responsible for creation of detailed isolation and test procedures for all routine tests conducted and must demonstrate the effectiveness of these procedures to TasNetworks during FAT witnessing.

(e) FAT must essentially include all electrical, mechanical, environmental and other performance tests in accordance with applicable Australian and International (IEC and IEEE) standards.

(f) FAT results must be approved by TasNetworks before dispatch of equipment to site.

(g) All non-conformances identified during FAT must be lodged in a non-conformance register and must be resolved prior to dispatching the equipment to site or prior to commencing site testing.

8 Site tests

The following considerations apply for site tests:

(a) The Contractor will be responsible for the quality assurance of the installation.

(b) The Contractor will be responsible for the submission of all equipment, including the material supplied and works done by a sub-contractor for site inspection and tests.

(c) Site tests must include pre-commissioning and commissioning tests. “Pre-commissioning tests” means testing prior to energisation. “Commissioning tests” means testing performed during the energisation process and after the equipment has been energised and put on load.

(d) Site tests must be conducted to determine whether the construction work, assembly and installation has been carried out in accordance with the design. Site tests must also prove compliance with the specified requirements in terms of the functions, characteristics, capacity and performance of the equipment and plant under working conditions. These tests must be conducted independently of any tests which may have already been carried out at the Contractor’s works. Specifically, the tests must verify that:

    (i) the equipment has not been damaged during transit;

    (ii) the plant has been installed in accordance with the design;

    (iii) the plant has been installed with good workmanship;

    (iv) the plant will perform in accordance with the design;

    (v) the design will enable the plant to function as intended;

    (vi) any defects or non-compliances recorded from FAT have been rectified; and

(i) the plant can be energised and put into service safely.

(e) During the course of erection, TasNetworks must have full access for inspection of the progress of the work and checking workmanship and accuracy as may be required.

(f) Sufficient inspection and testing must be performed to prove that all plant and equipment:

(i) has been installed correctly;

(ii) will operate with the designed characteristics in accordance with the intended design, the relevant drawings and specifications; and

(iii) is fit for commercial operation prior to handing over to TasNetworks.

(g) The Contractor will be responsible for the performance and completion of the site testing, however the following requirements will apply:

(i) TasNetworks must witness site tests. The Contractor must send an invitation to TasNetworks to witness site tests at least 14 days in advance.

(ii) TasNetworks reserves the right to request a repeat of a test or part thereof or an extension of a test if TasNetworks has any doubt about the method of testing or the result of a test.

(iii) TasNetworks reserves the right to include other tests as considered necessary.

(iv) TasNetworks will reject any tests that are not witnessed by TasNetworks, unless a prior agreement has been made for such tests to be performed without a TasNetworks witness.

(h) No inspection or passing of the work, plant, any item of equipment or materials and tests, will relieve the Contractor of any liability to complete the work in accordance with the Contract or relieve the Contractor from any guarantees, nor will it prejudice the right of TasNetworks to reject the equipment if it does not function properly or perform as intended on commissioning of the whole plant.

(i) At any stage when the substation equipment is declared by TasNetworks to be alive, due to its proximity to live equipment or connection, despite that it may still have no physical connection, all installation work and tests will be subject to the Power System Safety Rules (**PSSR**) and procedures for working on or near energised equipment.

(j) An infrared scan must be conducted on all primary circuits and capacitor banks to identify hot joints/spots while the equipment is conducting normal load current.

The costs of all tests and inspections, including the supply of testing equipment, are deemed to be included in the Contract Price.

9 Specific equipment tests

In addition to the requirements of this standard, TasNetworks' equipment specific standards contain tests that must be carried out.

At sites where IEC 61850 process and/or station bus is implemented, specific testing must be carried out in accordance with the TasNetworks IEC 61850 Testing Guide.

9.1 Power transformer tests

Any inspections and testing requirements of network or supply transformer installations can be found in the Network Transformer and Supply Transformer standards.

9.2 Metering installation tests

Where a Metering Installation is included in the project, on-site commissioning tests shall be carried out by TasNetworks' Metering Provider (MP). Notification must therefore be given to TasNetworks' MP six weeks in advance of the scheduled date for commissioning.

The MP will provide TasNetworks with final Metering Registration sheets, including the commissioning test results, within 2 working days of their completion.

Further information can be sought from TasNetworks' Metering Standard.

9.3 Civil infrastructure inspection and tests

Any inspections or testing requirements of substation civil infrastructure can be found in the Substations Civil Design and Construction standard.

9.4 Secondary equipment testing

TasNetworks have a dedicated Secondary Equipment Testing standard and a suite of testing guides for the various protection schemes in-service across the network. These testing guides shall be supplied to the Contractor, on request, by the TasNetworks' project manager, which are listed as follows:

- Protection Testing General Requirements Guide (R213844)
- Transmission Line Protection Testing Guide (R211562)
- Transformer Protection Testing Guide (R211565)
- Busbar Protection Testing Guide (R211566)
- Feeder Protection Testing Guide (R211567)
- Capacitor Bank Protection Testing Guide (R211569)

At sites where IEC 61850 process and/or station bus is implemented, specific testing must be carried out in accordance with the TasNetworks IEC 61850 Testing Guide.

During and after any secondary equipment testing, the following software controls and monitoring features are to be checked or implemented:

(a) Change the device default password.

(b) Disable or remove unused interfaces.

(c) Disable built-in or default user accounts.

(d) If possible, record:

  (i) what activity was performed (e.g. setting changes on protection relay);

  (ii) who performed the activity (e.g. engineer or operator); and

  (iii) when the activity was performed (e.g. time and date).

9.5 HV shunt capacitor bank tests

Any inspections and testing requirements of HV shunt capacitor bank installations can be found in the HV Shunt Capacitor Bank standards.

10 Other requirements for testing

10.1 Testing personnel requirements

The following requirements must be met for testing personnel:

(a) It is imperative that the persons performing the testing and supervising the testing have an intimate knowledge of the design and complete contractual requirements. It is a requirement that these persons have also been involved in similar electrical installations and commissioning.

(b) A competent and experienced test engineer appointed by the Contractor must lead the site testing.

(c) Details of the proposed Lead Testing Engineer including qualification and experience on similar projects must be submitted at the time of offer.

(d) No change of Lead Test Engineer will be permitted without the request and approval from TasNetworks in writing. All such requests must be accompanied by the reasons for this change.

(e) The Lead Test Engineer must be accompanied with relevant staff that are aware of all designs and ensure that the testing is conducted in a manner so as to confirm that the installed works comply with the requirements of the design and TasNetworks' project specifications.

10.2 Site safety requirements

All safety measures and precautions must be taken during testing on TasNetworks sites.

Testing in an energised substation or on equipment deemed to be live must comply with the PSSR.

10.3 Testing sequence

To ensure testing follows an efficient and effective procedure in a logical sequence and to ensure that all necessary tests as per Testing, Commissioning and Training Schedule are completed, the sequence of testing must follow that stated in documented methodology and procedures. The following considerations must be met:

(a) The pre-commissioning testing sequence order must be:

  (i) Insulation check on control and auxiliary cables on the drum prior to installation.

  (ii) Insulation check on control and auxiliary cables after installation completed but prior to termination.

  (iii) Functional, characteristics and insulation check on individual equipment e.g. circuit breaker, current transformer, and relay.

  (iv) Main circuit and contact resistance on completion of the installation of the assembly.

  (v) HV power frequency test on the complete assembly.

  (vi) Functional check on the complete assembly.

  (vii) Functional check of the complete protection and control scheme e.g. protection and both remote and local control and alarm systems. This must include point to point checks of the scheme with the NOCS.

  (viii) Earthing system test.

(b) Testing to be performed on the Protection and Control system include the following as a minimum:

  (i) Visual inspection of correctness of installation and quality of workmanship in accordance with design documentation.

(ii) Insulation check and proving of wiring to schematic and wiring drawings (point to point checks and termination tightness).

(iii) Connection to permanent auxiliary AC and DC supplies.

(iv) Secondary injection at test isolation links, verifying accuracy of the relays / instrumentation.

(v) Primary injection to prove the correct installation of all instrument transformers.

(vi) Demonstration that all RTU I/O are functional.

(vii) Demonstration that all local alarms are functional.

(viii) Functional tests of inter-connected systems, for example, auto-reclose, voltage regulation and sensitive earth fault control, over-current and earth fault blocking to transformer protection, etc.

(ix) Functional tests at extremes of the operating power supply voltage.

(x) Prove all local and remote switchgear control and interlocking functions.

(xi) Prove correct operation of the screen based control system.

(xii) Verification of accuracy of documentation and marking up of drawings (including variances found during inspection and testing).

(xiii) Burden checks on CTs and VTs.

(c) At the appropriate stages, site tests may be carried out on an individual item of equipment to determine whether its characteristics and performance remain intact. However, the functional test of the whole plant, or a functionally independent section of the plant, must not be carried out unless all the erection and installation associated with it have been completed. The schedule and sequence of all the on-site tests must be submitted to TasNetworks for review.

(d) Phasing check of all High Voltage (HV) and Extra High Voltage (EHV) connections is required. For the HV switchgear the phasing check must be performed with suitably rated phasing sticks at the HV cable and/or busbar spouts.

(e) An on-load test of all equipment must be performed on completion of energisation.

10.4 Material testing requirements

The following requirements must be met for materials testing:

(a) Test pieces must be provided as required by TasNetworks to enable assessment of the quality of the material supplied under the Contract.

(b) Test pieces for material tests, must be prepared and supplied and all costs associated with the test will be borne by the Contractor.

(c) If a test piece fails to comply with the requirements of the specification for the material in question, TasNetworks may reject the whole of the material represented by that test piece. The Contractor's designers and metallurgist will be consulted before any material is rejected.

(d) All plant and equipment under FAT must be assembled in the same conditions and configuration as to be erected on site for normal operation.

10.5 Testing equipment

The following considerations must be met for testing equipment:

(a) Test equipment, materials, instruments, consumables, labour, tools and any other equipment or resource, necessary to carry out full testing of all plant and equipment must be supplied.

(b) Procedures and facilities used in the testing must be of a standard and accredited to an approved testing authority.

(c) The measurement equipment must have been calibrated at least once a year at an accredited measurement laboratory and a valid certificate must be available for inspection at the test location before commencing any tests.

(d) The latest calibration curves must be made available on request by TasNetworks.

(e) Each piece of test equipment will be assigned a unique designation. The specification of each test equipment used and a full record of the last test date of the testing equipment must be recorded on the test record sheet. The type and designation of the test equipment must be recorded on the test result sheets.

(f) Each item of measurement equipment must have attached a visible record identifying the equipment and showing the last calibration date and calibration reference.

(g) Prior to commencement of any testing, the calibration of all test equipment must be checked against standard instruments. A record of such checks, duly certified by the Contractor, may be reviewed by TasNetworks. If, at any time during testing, doubt exists as to the accuracy of a piece of test equipment, calibration tests must be repeated at the request of TasNetworks. Where tests have been conducted and it is established that the test equipment used for testing was not fit for purpose all tests will need to be repeated and all costs associated with such repetition will be borne by the Contractor.

(h) Where the equipment being tested can interface with other existing equipment such as protection or other control schemes, isolations must be confirmed so that false triggering of the existing schemes is avoided.

(i) Where testing will trigger alarms either locally or remotely in NOCS, prior arrangements must be made to account for these false alarms. Arrangements include prior notification to TasNetworks' operating staff and temporary suppression of these alarms.

11 Test reports

All test reports must be forwarded to TasNetworks for approval. The tests will be considered as completed, only after an approval of test results by TasNetworks in writing.

11.1 Test result sheets

The following requirements must be met for test result sheets:

(a) In addition to the daily submitting and reporting to TasNetworks of the testing schedules and reports as specified, copies of the complete test result sheets of a complete assembly of plant or scheme must be submitted for review to TasNetworks, for example, a complete HV transformer incomer panel or the EHV busbar protection etc. The sheets must be submitted within 24 hours upon completion of the testing and before energisation of the equipment or the scheme.

(b) The Test Result Sheets must provide a means of recording all tests carried out and their corresponding results.

(c) On completion of the testing and commissioning of the works, a comprehensive test result report must be submitted together with an official letter signed by the Commissioning Manager confirming that the plant is fit to be energised and put into commercial operation. The test result report must record, on each sheet, the:

    (i) location - i.e. substation name;

    (ii) circuit;

(iii) manufacturer's name;

(iv) equipment type;

(v) equipment serial number;

(vi) test equipment number;

(vii) date of test;

(viii) weather conditions, e.g. ambient temperature and humidity, etc.;

(ix) test results;

(x) testing personnel's name and signature and date;

(xi) Contractor verifier's signature and date;

(xii) Commissioning Manager approval signature and date;

(xiii) remedial work sheets; and

(xiv) outstanding work items and minor defects, which do not affect the proper functioning of the plant.

(d) Test result sheets must be designed such that results for each piece of equipment on one particular circuit or section of the equipment (e.g. Current Transformers, Voltage Transformers and Circuit Breakers) can be filed together.

(e) Test result sheets must be submitted electronically for each asset.

11.2 Preliminary test report

The following requirements must be met for preliminary test reports:

(a) A preliminary test report including copies of draft test results must be presented to TasNetworks immediately after completion of each test. TasNetworks must be provided with a draft test result copy as soon as a part test is completed.

(b) All test results and test reports must be provided to TasNetworks.

(c) In addition, the report must also detail a summary of problems and defects found during testing and a list of any outstanding work items that require completion.

11.3 Final test report

The following requirements must be met for final test reports:

(a) Within four weeks of completion of the tests, a final Test Report, including any documented or electronic test plans, must be submitted to TasNetworks.

(b) The final report of all routine, type and special tests must form part of the final operation and maintenance manuals.

(c) The Test Report will consist of the completed Test Result Sheets and Remedial Work Sheets.

(d) In addition, the report must also detail a summary of problems and defects found during testing and a list of any outstanding work items that require completion.

11.4 Test results

The following considerations must be met for test results:

(a) Where a unit is damaged during testing, it is at the discretion of TasNetworks to accept a repaired unit or a completely new unit.

(b) All reports of damage of equipment during testing must be forwarded to TasNetworks for consideration. These reports must be complete with information on the serial number, type, model number and the function of the damaged unit or system. This requirement applies to all conditions irrespective of the presence of TasNetworks witness personnel.

(c) Where non-conformance is found during a test and modifications are required, it is under TasNetworks' discretion to allow:

(i) continuation of testing;

(ii) repeat part testing; or

(iii) repeat complete testing.

(d) Should any equipment or part of equipment fail under test to give the required performance, further tests which are considered necessary by TasNetworks must be carried out and the whole cost of the repeated tests will be borne by the Contractor. This applies equally to tests carried out at sub-contractors works.

12 TasNetworks' role during testing

Amongst other roles that TasNetworks needs to perform under various project specifications and TasNetworks standards, the following specific requirements apply for TasNetworks' role during Testing. Note that the roles listed below are not exhaustive and are indicative: (Other roles of TasNetworks during testing are listed in other sections of this standard).

(a) TasNetworks will witness all tests unless specifically agreed in writing. All such agreements will be specific to a particular testing phase for particular equipment.

(b) Invitation to witness factory testing must be provided to TasNetworks at least 30 days in advance. For site tests the invitation to witness site tests may be provided 14 days in advance. A final confirmed date must be given at least 7 days in advance.

(c) Inspecting and witnessing by TasNetworks will in no way relieve the Contractor of the responsibility for quality assurance, correctness, guarantees, compliance with the project specifications, relevant standards, and delivery commitments. Nor will it prejudice TasNetworks' right to reject the plant if it does not comply with the requirements of the project specifications, or if its characteristics and performance do not meet the intended design or will not be safe to operate after erection.

(d) TasNetworks has the right to request tests to be repeated or further tests to be performed, if TasNetworks is not satisfied with the testing method or the results.

13 Commissioning requirements

"Commissioning" means the process from the first pre-commissioning testing to the last commissioning testing after which the equipment is declared to be safe and fit for commercial operation.

13.1 Commissioning Manager

A suitably qualified and experienced Commissioning Manager must be appointed.

Details of the proposed Commissioning Manager including qualifications and experience on similar projects must be submitted with the Contract. No change of Commissioning Manager will be permitted without the written consent of TasNetworks.

It will be the Commissioning Manager's responsibility to:

(a) understand and enforce Workplace Occupational Health and Safety policies, procedures and systems;

(b) understand and enforce the Power System Safety Rules;

(c) develop the Inspection and Test Plan;

(d) develop the Commissioning Program;

(e) liaise with TasNetworks for agreement of the Commissioning Program and other documentation to meet the National Electricity Rules;

(f) co-ordinate and secure the services of an Issuing Officer;

(g) implement the Commissioning Program;

(h) ensure the safe execution of all testing and commissioning activities;

(i) liaise with and demonstrate to TasNetworks' satisfaction, the testing of each item of equipment and commissioning of the whole plant on a daily basis;

(j) allocate competent and appropriately trained resources;

(k) supervise and co-ordinate all testing and commissioning activities on site;

(l) co-ordinate the commissioning activity, including the operational requirements, ensuring that at all times, all parties are completely aware of the activity in progress; and

(m) report and submit to TasNetworks a copy of the schedules, test result sheets and reports of the tests completed on that day, and maintain an outstanding work register.

13.2 Commissioning documentation and timing

13.2.1 Commissioning documentation

For the guidance of the Contractor, TasNetworks will provide the format for, and examples of, the various documents that form the minimum requirement for outage planning and commissioning. These documents will be provided to the Contractor after the award of the Contract.

13.2.2 Commissioning documentation time line

In addition to the requirements as specified in various TasNetworks standards, requirements of project specifications and the requirements from the National Electricity Rules, the minimum requirements listed below must be complied with. Each of the documents listed in Table 1 must be submitted to TasNetworks by the specified deadline.

Table 1 Deadlines for commissioning documentation

Days from Energisation	**Documentation Required and Action (for each stage of energisation)**
105	• Preliminary Commissioning Program (refer requirements from Commissioning program mentioned in this standard)
	15 business days from the receipt and acceptance of documentation as above • Commissioning program acceptance and commissioning date agreement by TasNetworks and the Australian Energy Market Operator (AEMO)

90	• Major Equipment Schedule • Power Circuit One Line Diagram • Metering and Protection One Line Diagrams • Operational Earthing Drawing • General Arrangement Drawings • Draft RTU Scan Lists and screen amendments (for NOCS) • Draft Protection Setting Coordination Report and associated calculations • Confirm delivery of communication circuits with TasNetworks Telecommunications Services
	20 business days from the receipt and acceptance of documentation as above • TasNetworks to provide Contractor and AEMO with any comments on Protection Settings Coordination Report
42	• Submit requests for transmission system outages and distribution system outages, as required, for commissioning • Notification to TasNetworks' metering provider of metering requirements
40	Contractor to submit training program to TasNetworks for review and approval
28	• Final RTU Scan Lists • Final Protection Setting Coordination report and calculations
14	Network Operations to submit proposed switching plan. TasNetworks Project Manager to forward the switching plan to the Contractor
07	• TasNetworks on behalf of the Contractor to confirm to AEMO that the switching plan is achievable • Risk Management Plan, Risk Assessment and Mitigation Plan in place • Emergency Response Plan in place • Final Commissioning Program (refer requirements from Commissioning program mentioned in this standard)
01	• Completed and signed pre-commissioning ITP • Completed as built red-line drawings • Test Results Report
00	• Pre-energisation ○ Certificate of Asset Acceptance & Operational Control ○ Certificate of Conformance • Post energisation ○ Commissioned protection settings ○ A copy of the marked up installation drawings

14 Commissioning program requirements

The following requirements must be met for the Commissioning Program:

(a) At least three and a half months before commencing the site pre-commissioning testing a Commissioning Program with detailed schedules must be submitted for review by TasNetworks.

(b) The Commissioning Program must include:

(i) all the details of the ITP into a form that shows the sequence and duration of proposed activities together with a plan for energisation. The actual sequence must follow that specified in the program; and

(ii) the details of the numbers of commissioning staff required to achieve the program.

(c) The Commissioning Program will be reviewed and is subject to approval by TasNetworks.

(d) All documents in accordance with the NER Chapter 5 for inspection and testing (5.7) and commissioning (5.8) including a schedule of parameter settings and a commissioning program for energisation must be prepared.

(e) TasNetworks, being the Network Service Provider, is required to submit the above mentioned documents to AEMO not less than 3 months prior to commencement of commissioning. Therefore the above mentioned documentation must be completed and submitted to TasNetworks three and half months prior to commencement of commissioning for TasNetworks' review.

(f) The Commissioning Program is a formal document and must carry a specific document number as per the General Substation Requirements standard. As a minimum the outline of the commissioning program must include:

(i) an overview giving:

- proposed changes;
- impact on the power system;
- brief protection philosophy;
- brief metering philosophy; and
- brief control philosophy;

(ii) general instructions;

(iii) special instructions;

(iv) reference documents (Final Commissioning Program);

(v) equipment rating details (Asset Management Information System information);

(vi) site testing, specifically:

- pre-commissioning test requirements; and
- post-commissioning test requirements;

(vii) risk analysis and risk mitigation strategy;

(viii) contingency assessment and planning;

(ix) switching sequence plans; and

(x) contact details list.

15 Switching program

On receipt and acceptance of the Contractor's Commissioning Program, a Switching Plan will be produced by the relevant TasNetworks operating staff to facilitate the implementation of the Commissioning Program to put into service the plant or equipment;

The switching requirements must be jointly reviewed with TasNetworks' operating staff to ascertain their practicality on Power System operation;

Where revision of the Switching Program necessitates a change to the Commissioning Program, the Contractor must revise accordingly until a practical Commissioning Program is agreed and accepted by all parties concerned; and

Switching will only be granted after agreement is reached between the Contractor, TasNetworks and TasNetworks' operating staff on the Switching Program.

16 Energisation of plant

Prior to energising the new equipment or plant the following requirements must be met:

(a) The plant must be energised in strict accordance with the Switching Program. It is the Contractor's responsibility to ensure that the plant is ready and safe to be energised and put into commercial operation.

(b) Assistance must be provided in the process of switching operations as required by TasNetworks and TasNetworks' operating staff. The energisation procedure must strictly comply with the regulations and instructions specified by AEMO and/or TasNetworks.

(c) The commissioning tests, as stated in the Commissioning Program, must be performed. Typical tests must include, but not be limited to, phasing check at primary and/or secondary equipment, measurement of secondary on-load currents and voltages to verify:

    (i) the correct functioning of all instrumentation;

    (ii) correct quantities being measured by the protection equipment; and

    (iii) stable operation of protection schemes.

(d) The plant or equipment must be deemed to be acceptable for commercial operation on production of the satisfactory commissioning test results.

17 Remedial work

The following considerations must be met for all remedial work:

(a) Once construction work is complete and it has been handed over for testing, no further construction work is permitted to take place.

(b) If, as a result of inspection or testing, remedial construction work is necessary then testing on that particular section of work must cease until remedial work is complete. All relevant tests on that section of work must then be repeated.

(c) All remedial work and associated repeat testing will be at the expense of the Contractor. All remedial work must be reported in a Remedial Work Sheet and presented to TasNetworks for certification that the defect is rectified.

(d) The report must contain:

    (i) the date that the defect was recognised;

(ii) the item of plant affected;

(iii) the test during which the defect was noticed;

(iv) the nature of the defect;

(v) the remedial action which was taken; and

(vi) the date that the remedial action was complete.

(e) The Remedial Work Sheet must be signed by the Contractor and approved by TasNetworks.

18 Outstanding items

All items that require additional work to be carried out after acceptance of the plant must be listed on the Certificate of Asset Acceptance & Operational Control at each energisation stage and the Certificate of Practical Completion. This list must be agreed between the Contractor and TasNetworks at the time of submission. Responsibility for each item will be assigned and the items will not be deemed to be completed until the parties agree that it has been completed satisfactorily. A further Certificate of Practical Completion must be issued and signed to signify that outstanding items have been completed.

19 Training program

The training program for the new plant or equipment must meet the following requirements:

(a) After pre-commissioning, but prior to energisation, all new equipment and systems must be made available for 10 working days for the purpose of inspections and training.

(b) A training program must be prepared for operating and engineering personnel involved in the operation and maintenance of TasNetworks' substations up to a maximum of 20 participants unless specified in the project specification.

(c) The detailed training program, including module content, training objectives and assessment methods must be submitted to TasNetworks' Operational Training Coordinator for approval at least eight weeks prior to commencement of commissioning of the new plant.

(d) A one to five day course of instruction and practical work must be designed and delivered. The training course must be built around the Operation and Maintenance Manuals for the equipment and must include training for modifying the Substation Control System and operation of the system. It is envisaged that this course will be conducted towards the end of the commissioning.

(e) The training program will consist of lectures and on-site practical demonstrations.

(f) Training for EHV Field Operator must conform to the principles of TasNetworks' Field Operator training and assessment standards and ensure that all training covers the relevant and pertinent aspects of changes to or replacement of equipment that results from the scope of works of the contract.

19.1 Components of the training

It is envisaged that the training will consist of a series of modules, and the attendance at the modules will be determined by TasNetworks to suit their requirements.

Suggested content for the component modules are:

(a) on-site familiarisation on completion of installation of major equipment;

(b) involvement of TasNetworks' operating personnel, during testing, to provide on-site familiarisation of testing requirements and performance of plant items;

(c) instruction on operating procedures and servicing of equipment based on the Operation and Maintenance Manuals to be supplied as part of the Contract; and

(d) operating, diagnosing and maintaining the Substation Control System equipment.

19.2 Content

The expected content of the training program must be as follows:

(a) All components must be based on the Operation and Maintenance Manuals prepared as part of the works.

(b) The training must include lectures and on-site practical demonstrations. Where practicable, all training should occur at site, however it may be necessary for the lecture portions to be held at TasNetworks' offices.

(c) The training must include participation in commissioning tests as necessary to understand the performance of the system and to learn how to test the equipment.

(d) The content must be prepared on the basis that personnel with good general experience in operation and maintenance of general substation equipment will attend.

(e) Care must be taken to provide detail on plant and systems not previously experienced by the personnel.

19.3 Assessment

The training program may include assessment of the attendees to ensure that the training objectives have been met. Records of the assessments must be forwarded to TasNetworks on completion of the training.

20 Information to be provided with offer

Relevant to the content of this standard, the Contractor must supply the following information at the time of offer:

(a) Information as required under various clauses of this standard including, as a minimum:

  (i) Details of the proposed Lead Testing Engineer.

  (ii) Details of the Commissioning Manager.

  (iii) Type Test certificates with test results.

  (iv) For equipment not covered in the standards, details of such tests deemed to be relevant to prove plant or equipment performance.

(b) Information required proving compliance with the specification.

(c) Any other specific information that will assist TasNetworks in evaluating the offered solution.

(d) Evidence of industry experience for all equipment on offer.

Requirements for information to be submitted as part of the offer are outlined in the Testing, Commissioning and Training Schedule document.

21 Deliverables

Deliverables required for the Testing, Commissioning and Training component of the Contract are listed below. This is not a complete list of deliverables or documents and is intended as a guide only. Deliverables

must include the requirements as listed in the standard under various sub clauses. As a minimum the following shall be provided:

(a) Details of the proposed commissioning team.

(b) Details of the proposed lead test engineer.

(c) Commissioning Program.

(d) Design and final installation drawings.

(e) Protection settings information and calculations.

(f) Inspection and Test Plans.

(g) Substation Control Systems settings and configuration files.

(h) Testing Schedule and sequence of all on-site tests.

(i) Test results and test reports.

(j) Operation and Maintenance Manuals.

(k) Training Program.

(l) Training manuals in TasNetworks format.

(m) Training attendance record sheet.

Requirements for project deliverables are outlined in the Testing, Commissioning and Training Deliverables document.

22 Hold points

The hold points for testing, commissioning and training include:

(a) Prior to delivery of equipment to site, the Factory Acceptance Testing results must be approved by TasNetworks.

(b) After pre-commissioning but prior to energisation the contractor must make available, for 10 working days, all new equipment and systems for purpose of inspections and training.

(c) Energisation and commissioning testing of new plant must not commence until the pre-commissioning ITP have been agreed and signed by both TasNetworks and the Contractor.

(d) Prior to each commissioning, TasNetworks will review the commissioning plan, all relevant test reports and ITPs.

TasNetworks' Project Delivery Requirements documents, for each project includes further hold points.