

Test and Commissioning Manual



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1. PURPOSE AND SCOPE

This document defines the commissioning process in the context of the Ergon Energy project delivery process. This manual is applicable for all substation projects regardless of the delivery mode (internal/external).

It is not the intention of this manual to repeat, nor supersede information and guidelines which are detailed in the Ergon Energy Standard Work Practices, Reference Documents or Inspection and Test Plans. If a conflict exists between this document and the Ergon Energy published Standard Work Practice, Reference Document or ITP then clarification from the Commissioning and Maintenance Group shall be obtained.

The Scope of this manual includes:

- i. Define the roles and responsibilities of the Test and Commissioning Officer/Engineer during the development and implementation phases of a project.
- ii. Define the required deliverables for the Test and Commissioning Team during project development and implementation phases.
- iii. Define the required quality assurance documentation that will be completed during project implementation.

The information provided in this manual has been written with the intent of safely delivering the test and commissioning portion of Ergon Energy projects. The definitions and processes presented in this manual have been written with a focus on test and commissioning works and do not cover nor attempt to cover the definitions or processes of other project delivery groups. Where there exists uncertainty in the interpretation of the material presented within this document the reader should always seek clarification from the assigned Commissioning Engineer/Officer.

2. DEFINITIONS, ABBREVIATIONS AND ACRONYMS

The following terms and acronyms have been defined to provide clarity and consistency during commissioning activities.

Commissioning Authority to Energise: the Commissioning Authority for Energising Electrical Plant Form (MN000301F174) is used to signify the completion of three critical stages of the commissioning process. The first section of this document is signed by the Testing Officer responsible for Site Integration Testing (SIT) to signify that all site integration testing has been successfully completed. The next section is signed and issued by the Project Manager to the Commissioning Officer/Engineer to provide clearance that all required prerequisites have been met to allow the plant to be energised. The final section is signed by the Commissioning Officer/Engineer to provide final clearance to energise the plant. This section also lists all outstanding items affecting network operation and/or maintenance activities as well as any additional testing required before the plant is released for normal operation.

Commissioning Co-ordination Program: is a detailed technical document which specifies the required steps to be performed on site to provide a final audit check of critical operations and functions. Under the Commissioning Co-ordination Program all new plant/systems will be integrated and tested into the operational network.

Commissioning Officer/Engineer: is an experienced engineer or technician appointed to coordinate and control the testing and commissioning of new or refurbished plant and/or systems. The Ergon Energy P53 Operate the Network Enterprise Process defines this role as the Commissioning Co-ordinator. Note that portions of the Commissioning Officer/Engineer role fulfil Ergon Energy's non-delegable responsibility under the Electrical Safety Act to ensure that plant and systems are tested appropriately prior to energisation and cannot be fulfilled by a contractor.

Commissioning Outage Plan: details primary plant and secondary system outages and switching requirements to achieve the commissioning outages as described in the Commissioning Staging Plan.

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Commissioning Schedule: is a time based representation of the tasks required to complete the commissioning works including the resources required to perform these tasks. The Commissioning Schedule forms part of the overall project schedule.

Commissioning Stage: is defined as the works portion which progress a primary plant item or secondary system from manufacturers testing through to system integration and final commissioning testing. In general, a commissioning stage requires that all five phases of testing be successfully completed culminating in the successful energisation of new plant or system into the Ergon Energy network.

Commissioning Staging Plan: is a plan developed by the Commissioning Officer/Engineer which details the proposed substation, distribution and transmission/sub-transmission primary plant configurations during each of the proposed commissioning stages. This plan is developed to allow all key stakeholders to understand, review and comment on proposed staging during the project development phase.

Construction Release: for the purpose of test and commissioning the Construction Release Form (MN000301F175) is used to provide a clear delineation between the completion of construction activities and testing phases. This form is completed and signed by the officer responsible for construction to signify that construction activities for the listed plant have been completed in accordance with the quality control systems specified in the construction manual and that all personnel involved with the construction have surrendered access to the equipment. This clear delineation is required to allow testing activities to be safely performed and to ensure that tested plant is not compromised by unauthorised access.

Testing Phase Release: the Testing Phase Release Form (MN000301F183) is used to provide clear delineation of a testing phase from subsequent phases. This form is to be completed whenever handover of a testing phase to a different party is carried out. The form is to be signed by the officer responsible for the testing phase to signify that testing activities associated with the listed phase have been completed and that all personnel involved with this testing have surrendered access to the equipment.

Development Phase of a Project: The Project Development Phase is initiated on receipt of the Project Initiation Advice and is the time in which the detailed project planning is performed to produce a project plan. During this phase, as part of the high level design performed by the design group, the commissioning officer/engineer will develop a commissioning staging plan and commissioning schedule. The staging plan will be used to ensure that staged design requirements are identified and that the final design outcomes reflect the need for commissioning staging. The commissioning schedule will be used by project manager to produce the Gate 3 Estimate (G3E) for customer approval.

Implementation Phase of Project: The Project Implementation Phase commences once Gate 3 Approval has been achieved. During this phase the construction and test and commissioning activities are performed. The Implementation Phase ends on achievement of the Certificate of Practical Completion (CPC) milestone.

Factory Acceptance Testing (FAT): is defined as the Testing Phase performed by the manufacturer on an item of plant or equipment to prove that the item operates in accordance with its design specifications. Factory Acceptance Testing is commonly, but need not be, performed at the place of manufacture prior to delivery of the plant or equipment.

In cases where the piece of equipment under test is comprised of a number of subsystems or components then FAT may include the testing of individual components or of the system as a whole.

Inspection and Test Plan (ITP): is a Quality Control document which is used to specify the testing requirements for a particular testing phase and plant/system item. The ITP is a high level technical document which specifies test types which will be performed and is used in conjunction with the relevant test report documentation.

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Maintenance Acceptance Criteria (MAC): is a joint workings document developed to define plant condition acceptance criteria. The MAC is used to evaluate substation and distribution plant condition and defines test acceptance criteria.

Post-Energisation Testing: is defined as the Testing Phase required to confirm that critical system components are operating as per design requirements. This type of testing is generally covered by a series of on-load tests to confirm system component operability and stability.

Pre-Connection Hold Point: is defined as the point in time in which plant transitions from being under general access to requiring High Voltage Isolation and Access procedures to be followed in accordance P53 Operate the Network Enterprise Process.

Pre-Energisation Testing: is defined as the Testing Phase required to provide final confirmation that the system is safe to be energised. Pre-energisation testing can only be performed once the item of plant or equipment has successfully passed SIT

Project Manager: is the person assigned with the accountability for overall delivery of a project. As the responsible person for project delivery, the project manager must be included in all decision making processes that have a material effect on the project schedule, cost, quality or scope.

Site Acceptance Testing (SAT): is defined as the Testing Phase performed at the final installation site of a piece of plant or equipment to prove that the item meets, within an acceptable level of risk, it's design specifications. This type of testing is required to ensure that no damage has resulted from the plant or equipment being transported or reassembled on site.

Site Integration Testing (SIT): is defined as the Testing Phase performed on site to prove that a piece of plant or equipment is correctly connected and integrated into the site to form a complete operational system.

Whilst Site Integration Testing proves that plant and secondary systems operate correctly as an integrated system, for commissioning purposes, the SIT component only provides integration testing of plant and systems not in service. Proof of system integration functionality with in service plant and/or systems will be performed during Pre-energisation testing under the control of a Commissioning Co-ordination Program.

Standard Work Practice (SWP): is a Quality Control document developed by Ergon Energy which details the requirements and methodology to be followed when performing plant/system testing.

Test Report: is an approved Quality Control document used to record test result information.

Testing Phase: is defined as set or suite of tests designed to prove, within an acceptable level of risk, that a plant item or system meets design specifications. For Ergon Energy commissioning purposes five phases have been defined, these being Factory Acceptance Testing (FAT), Site Acceptance Testing (SAT), Site Integration Testing (SIT), Pre-Energisation Testing and Post-Energisation Testing. Note that these five phases do not include testing prior to commissioning such as type tests, routine tests or construction testing.

Validation: Inspection, testing, measurement, simulations and audits to confirm that the installed plant and equipment and the system design is fit for the intended purpose and meets all regulatory requirements and the appropriate standards.

Verification: Inspection and testing to confirm that the installed plant and equipment complies with the system design.

Works Portion: is any work performed by an entity to achieve an objective. This includes works performed under P53 procedures. Works Portions are commonly used to break down complex or lengthy projects in manageable components. Often a Works Portion will align with a Commissioning Phase.

Under Direction: When a task or work is performed under direction the entity providing direction does not assume responsibility for the safety obligations of those performing the works. It remains the obligation of the entity performing the works to ensure that all works are completed in accordance with approved work practices and risk management strategies.

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3. REFERENCES

- MN000301F123. Construction Safety Clearance – High Voltage Apparatus (Form)
- MN000301F174. Commissioning Authority for Energising Electrical Plant (Form)
- MN000301F175. Construction Release (Form)
- MN000301F176. Customer Authority to Energise Customer Owned Electrical Plant (Form)
- MN000301F183. Testing Phase Release (Form)
- MN000301R165. 8 Level Field Test Competency (Reference)
- STNW1160. Maintenance Acceptance Criteria (Standard)
- P53 Operate the Network (Enterprise Process)

4. ROLE AND RESPONSIBILITIES OF THE COMMISSIONING OFFICER / ENGINEER

The role of the Commissioning Officer/Engineer with respect to the delivery of Ergon Energy projects is to provide technical support and advice for the Project Manager regarding the commissioning phases of the project and to carry out the project commissioning responsibilities described in this section.

Note that the Project Manager is not required to have detailed technical knowledge of commissioning works and is reliant on regular briefings from the Commissioning Officer/Engineer to keep up to date with commissioning activities and progress. Where any potential impact on project cost, quality (scope) or time (schedule) becomes evident to the Commissioning Officer/Engineer, the Project Manager shall be notified as soon as possible so that project impact and risk can be evaluated. Any decision that alters project cost, quality (scope) or time (schedule) shall be made by the Project Manager. This decision should be made in consultation with impacted parties.

The Commissioning Officer/Engineer is responsible for:

- a) **Development of a Commissioning Staging Plan**– a Commissioning Staging Plan will be developed by the Commissioning Officer/Engineer during the project development phase. The staging plan will detail the proposed substation, distribution and transmission/sub-transmission primary plant configurations during each of the proposed commissioning stages.

The commissioning staging information is to be used when producing design specifications to ensure that all primary plant, secondary systems and protection systems designs are produced for each of the proposed commissioning stages. Once developed, the Commissioning Staging Plan will be reviewed and modified as necessary to gain approval from the project Key Stakeholders.

The Commissioning Staging Plan is the overarching or high level document which describes the proposed commissioning staging. It is supported by the more specific and detailed Commissioning Co-Ordination Programs as described below.

As the project progresses towards its commissioning stage/s the Commissioning Staging Plan will be further refined by the Commissioning Officer/Engineer to include and reflect more detailed information as this information becomes available.

An example of a Commissioning Staging Plan is available on the Commissioning and Maintenance Beacon Site.

- b) **Development of a Commissioning Outage Plan** – the Commissioning Outage Plan will provide a high level detail of the primary plant and secondary system outages required to

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achieve the planned commissioning staging for the project. Close consultation with Power System Management and the Regional Asset Manager is required during development of the outage plan to ensure network risks are managed appropriately during commissioning.

- c) **Production of Inspection and Test Plans (ITPs) and Test Reports** – these are quality control documents which specify the testing requirements for primary plant and secondary systems. Ergon Energy has developed a set of tools which automatically produce engineering approved standard ITPs and Test Reports for primary plant and secondary system Testing and Commissioning Works – refer to Section 10 for further information.

The Ergon Energy assigned Commissioning Officer/Engineer will be responsible for producing the ITPs and Test Reports for each of the commissioning stages at the start of the project implementation phase. Where non-standard ITPs are required these ITPs must be approved in accordance with Section 18, “Authorisation and Approval of Commissioning Documentation” of this document.

In consultation with the Project Manager, the Commissioning Officer/Engineer may request additional testing to more effectively manage project risk – for example partial discharge testing of an MV switchboard in a transportable building may be carried out initially when the switchgear is installed in the building (in order to detect defects in the switchboard as early as possible) and again when the building is installed on site (in order to detect transport damage).

Where contractors are performing test and commissioning works the Commissioning Officer/Engineer will forward the prepared ITPs and test reports to the project manager who will pass these documents onto the contractor test and commissioning representative.

- d) **Development of a Commissioning Co-ordination Program** – the Commissioning Co-ordination Program is a detailed technical document produced by the Commissioning Officer/Engineer during the project implementation phase to detail the required steps to be performed on site to energise or de-energise substation plant. This document will detail the following information:

1. A high level overview of secondary systems isolation requirements.
2. A high level overview of works to be performed.
3. A works co-ordination programme detailing the order in which works need to be undertaken to commission the plant and secondary systems. The order of works detailed in the commissioning co-ordination program will reflect and align with the commissioning outages.
4. A high level overview of secondary systems testing and primary injection requirements to prove system functionality and stability pre plant energisation. Where new work interfaces to existing plant, all secondary circuitry testing shall be carried out to known and proven points, i.e. there shall be an overlap in the testing. All protection systems should be in service for energising of new plant.
5. Requirements for temporary protection systems or wiring (for example if appropriate protection functionality cannot be maintained during commissioning or construction).
6. Requirements for commissioning setting groups (for example a non-directional distance zone may be required until relay directionality can be confirmed).
7. Phasing checks required.
8. On-load or post-energisation checks required.

- e) **Developing the Commissioning Schedule** – the Commissioning Officer/Engineer is required to provide SME input to the Project Manager to ensure scheduling and sequencing of commissioning activities is incorporated appropriately into the overall project schedule.

5. THE COMMISSIONING PROCESS

The Commissioning Process is shown in the flowchart provided in Annex 1. This process has been divided into the Project Development and Implementation Phases to achieve alignment with the project management phases of the project lifecycle. Within the project implementation phase the commissioning activities have been further broken down into the commissioning phases to identify the divisible portions of the test and commissioning lifecycle. The major components of the commissioning activities in relation to their project lifecycle phases are further detailed in the following sections of this document.

6. COMMISSIONING STAGING PLAN AND COMMISSIONING OUTAGE PLAN

At the project development phase of the project lifecycle the project objectives will be fully defined however the project scope will not be clear. Until a Commissioning Staging Plan has been developed and approved the project scope cannot be fully determined. In order for the Commissioning Officer/Engineer to develop a staging plan the Project Manager must provide the following information to the Commissioning Officer/Engineer:

- a) A single line protection diagram showing the final plant configurations for all effected substations as defined by the project objectives.
- b) A general arrangement drawing showing the final plant layout for all effected substations as defined by the project objectives.
- c) A proposed transmission and distribution feeder arrangement layout for all effected substations as defined by the project objectives.

Once the above information has been provided, the Commissioning Officer/Engineer will develop a Commissioning Staging Plan. The staging plan will detail the proposed substation, distribution and transmission/sub-transmission primary plant configurations during each of the required commissioning stages. Once developed, the project manager will arrange for a meeting to facilitate a review of the Commissioning Staging Plan with the following key stakeholders:

- ❖ Project Design Manager – for confirmation and approval that the primary plant and secondary systems infrastructure can be constructed to meet the Commissioning Staging Plan requirements and that all designs will be provided for each of the proposed commissioning stages.
- ❖ Protection Design Engineer – for confirmation and approval that all primary plant can be adequately protected during all proposed commissioning stages.
- ❖ Regional Asset Manager – for confirmation and approval that network risk associated with the commissioning staging is acceptable to the Asset Manager.
- ❖ Lines / Customer Delivery Manager - for confirmation and approval that network risk and customer impacts associated with the commissioning staging is acceptable.
- ❖ Network Operations and Outage Co-ordination Groups – for confirmation and approval that the proposed commissioning staging and required outages to achieve this staging will be supported by these groups and that any operational concerns have been identified and conveyed to the commissioning officer/engineer.
- ❖ Project Manager – for approval of the commissioning staging including resource and time requirements to execute these plans.

On completion of the review stakeholder approval of the Commissioning Staging Plan will be formalised by signing the approvals section of the Commissioning Staging Plan document.

Once finalised, the requirements of the Commissioning Staging Plan are to be incorporated into the Commissioning Outage Plan. The Commissioning Outage Plan will continue to be modified and updated in the implementation phase as detailed design information becomes available.

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7. HANDOVERS

7.1. Design Handover

At least six weeks prior to the start of execution of each of the commissioning stages the Project Manager will call for a handover meeting. The purpose of the handover meeting is to ensure that all Stakeholders receive the required documentation to allow the Commissioning Stage to proceed. Key handover documentation will include:

- ❖ A complete Secondary System Design for the upcoming stage of work. This will include a complete set of approved Secondary System Design Drawings, Remote Terminal Unit (RTU) Configuration Files, an RTU SCADA Points Test List and RTU Logic Drawings.
- ❖ A complete Protection System Design for the upcoming stage of works. This will include an approved set of all Protection Relay Setting Files, Protection Setting Requests (PSRs) and Protection Relay Logic Drawings.
- ❖ A complete set of approved Inspection and Test Plans and Test Reports for the SAT and SIT Phases of Testing.
- ❖ Confirmation from the Project Manager that all resources have been scheduled and will be available as per the Commissioning Schedule.

The Design Handover will be called for in the Commissioning Staging Plan. It is the responsibility of the Project Manager to ensure that all deliverable be made available to the appropriate Stakeholders at the handover meeting.

7.2. Construction Handover

At the completion of construction activities for a Works Portion a plant handover must take place prior to the start of Site Integration Testing. This handover will take the form of a signed Construction Release Form (Form MN000301F175) which relinquishes construction access to the plant and acknowledges that the plant construction quality control documentation has been completed and assessed to be fit for purpose in accordance with the requirements detailed in the construction manual. This handover is required to ensure all tested plant and equipment not be interfered with once site integration testing has commenced.

The Construction Release Form (MN000301F175) is to be completed by the officer responsible for construction and returned to the Commissioning Officer/Engineer or an approved commissioning delegate.

A Construction Release Form may cover an entire project, a single bay, or a section of a bay as determined by the Commissioning Officer/Engineer to manage safe, efficient delivery of the project.

Prior to the Construction Release Form being submitted by the officer responsible for construction, works by other parties (for example the Testing Officer carrying out SAT) must be co-ordinated through the officer responsible for construction to ensure that the safety of all work parties is maintained.

Where additional construction works are required on previously released plant these works must be suitably controlled to ensure that tested plant is not compromised by additional construction works.

7.3. Vendor Handover

Where the procurement contract has specified that the vendor will install and test the plant/equipment item then the handover will take the form of a vendor release document. The vendor release will provide all test results as specified by the contract for that item and a vendor signed acknowledgement that their work is completed.

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A copy of the signed vendor release and associated test results will be issued to the Commissioning Officer/Engineer for verification at the time specified in the Commissioning Staging Plan.

Note that the test results provided by the vendor may only be a portion of the tests required prior to the plant/equipment being placed into service.

7.4. Testing Handover

Whenever the party carrying out a testing phase (eg Site Integration Testing) is not the same party that has completed the preceding testing phase (eg Site Acceptance Testing) for that Works Portion, then at the completion of the first phase a handover must take place prior to the start of the next phase. This handover will take place in the form of a signed Testing Phase Release Form (Form MN000301F183) which relinquishes access to the listed plant items and acknowledges that testing has been completed in accordance with the approved test schedules.

On completion of Site Integration Testing the Testing Officer responsible for SIT is responsible for completing and signing off the relevant sections of the Commissioning Authority for Energising Electrical Plant Form (MN000301F174). Completion of this form signifies that all SIT works have been completed and that the resources responsible for performing these works have been informed and have acknowledged that the equipment tested is now to be treated as 'LIVE'.

8. DRAWING MANAGEMENT

In accordance with Ergon Energy operational requirements a correct copy of Design Drawings is to remain on site at all times. This requirement holds true during commissioning activities and thus the following guidelines have been developed to ensure that commissioning works can be performed whilst meeting operation requirements.

- a) Approved drawings must be available on site such that through a combination of the green lined drawings, isolation sheets and switching sheets the active state of the substation can be readily determined.
- b) Where the substation state cannot be clearly identified in accordance with point a) above, design will be required to provide stage specific approved drawings.
- c) The single line diagram for a substation must at all times accurately represent the substation plant under OCC control. Due to this requirement approved designs must be made available whenever primary plant is either commissioned or decommissioned. The only exception to this requirement occurs when there is no resultant change to the single line diagram due to the works being performed.

It is the responsibility of the Design Group to review the existing Substation Drawings and the proposed Commissioning Staging Plan to determine if the above requirements can be met and where new design drawings will be required. In general this decision will be made during the Design Verification Process of the project.

Refer to the Substation Controlled Drawings (Reference) NI000401R117 and associated Substation Controlled Drawings (Quick Reference Guide) NI000401R118 for details of the drawing management process.

The Greenlining and Bluelineing of Ergon Energy Substation Drawings (MN000301R167) describes how continuity and functional testing is carried out during the testing and commissioning process

Note that:

- Greenlining is carried out on the Greenlining Test Copy (Drawing Set 6). Each workgroup must use a different colour highlighter from the previous workgroup when doing continuity testing, and clearly identify on the first drawing of the set which colour belongs to them. Green is always reserved for the first workgroup.

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- Bluelining is carried out on the Bluelining Test Copy (Drawing Set 12). Each workgroup must use a different colour highlighter from the previous workgroup when doing functional testing, and clearly identify on the first drawing of the set which colour belongs to them. Blue is always reserved for the last (SIT) workgroup.

Drawing Sets 1 (Master Copy), 6 and 12 are not “owned” by any one workgroup - the workgroup doing the relevant work is the temporary custodian before passing the drawings on to the next workgroup. If another workgroup has the drawing set you need, it is still your responsibility to transfer the relevant mark-ups/greenlining/bluelining to the correct set when you receive it.

Drawing sets shall not be split up between different workgroups because of the risk of losing drawings or making errors in version control.

It is the responsibility of the Officer Responsible for Testing to ensure that all mark-ups recorded on the “Bluelining Test Copy” (Drawing Set 12) are transferred to the “Site Initial Record Copy” (Drawing Set 13) and the “Master Copy” (Drawing Set 1) prior to returning the drawings to the project manager.

The “Site Initial Record Copy” (Drawing Set 13) will be retained on site with all mark-ups for use as the site copy until it is replaced with “Substation As Constructed” (Drawing Set 20) copy. The “Site Initial Record Copy” will not be used for capturing testing progress.

When on site test and commissioning activities have been completed the “Bluelining Test Copy” will be retained by the local test section such that they can perform operational response duties. The “Bluelining Test Copy” will be retained by the local test section until the “Test Section As Constructed” copy (Drawing Set 21) are issued to the test section.

9. SUBMISSION OF APPLICATION FOR WORK REQUESTS AND SYSTEM OUTAGES

The commissioning officer/engineer is accountable for tentatively entering AFWs relating to integration and testing activities in the Ergon Energy FeederSTAT system. The commissioning officer/engineer should be recorded as the AFW applicant (to ensure they are automatically notified of any changes to or the rejection of the AFW). It will be the responsibility of the supervisors of crews working under the AFW to review the AFW to ensure it is suitable for the work being undertaken. Where contractors are working under the AFW, the Contracts Officer / Project Delivery Co-ordinator is required to review the AFW to ensure it is suitable for the work being undertaken.

Where planned field crews performing the work change due to unforeseen circumstances it is the responsibility of the supervisor to ensure that newly appointed staff are provided sufficient time to review and familiarise themselves with the AFW details.

The commissioning officer/engineer will provide ongoing support as required to ensure that the co-ordination of multiple work groups is correctly reflected in the AFW.

10. COMMISSIONING TESTING

The Commissioning Testing philosophy adopted by Ergon Energy and detailed in this manual is designed to ensure that, within an acceptable level of risk, the following outcomes are achieved:

1. Personnel and public safety is maintained
2. Substation plant and systems are verified in accordance with their design
3. Test results are captured for baseline/benchmark recording and trending purposes

In order to meet these requirements it may be necessary to repeat some tests throughout the commissioning lifecycle.

Commissioning Testing has been divided into the five distinct phases, these being Factory Acceptance Testing (FAT), Site Acceptance Testing (SAT), Site Integration Testing (SIT), Pre-Energisation Testing and Post-Energisation Testing.

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There are five main types of field testing documentation applicable to testing Ergon Energy projects.

- 1) Standard Work Practice (SWP) – an SWP details the requirements and methodology to be followed when performing plant/system testing
- 2) Reference Document – SWPs relating to testing are being phased out and replaced by Reference Documents which include a higher level of technical support information and justification. For the purpose of this manual, the term SWP and Reference Document can be considered interchangeable.
- 3) Inspection and Test Plan (ITP) – an ITP specifies the test and inspections to be performed and is used in conjunction with the relevant test report documentation.
- 4) Test Report - used to record test result information
- 5) Tool (Construction Tool or Commissioning Tool) – this is an automated excel tool that generates a standardised combined ITP and Test Report related to the specified test phase. All Tools have provision for the sign off of test results and/or check sheet lists

The documentation listed above is available on the Ergon Energy Commissioning and Maintenance Beacon Site. Some content of this site is also published on the Ergon Energy Internet Site.

Prior to commencing testing it is the responsibility of the entity performing the testing to ensure that the documentation version being used is the correct version.

It is the responsibility of the lead person performing the testing works to sign the recorded results to signify that the tests have been performed in accordance with the approved standard work practice and that the results reported are a true and correct record of the test results. Where more than one entity performs the testing requirements detailed in the test tool then the lead person performing the testing must ensure that signatures are recorded by the persons responsible for the reported test results.

It is important to note that during the commissioning phase/s of a project, the Commissioning Officer/Engineer is responsible for the verification of the plant and systems in accordance with the approved design and will use the results recorded in ITPs and Test Reports in this verification. Where the Commissioning Officer/Engineer identifies issues with the suitability or implementation of a design the Commissioning Officer/Engineer will raise these issues with the appropriate subject matter expert for design validation. It remains the responsibility of the subject matter expert to ensure that all designs are correct, fit for their intended purpose and meet regulatory requirements.

If the case of a Vendor or Contractor proposing an alternate suite of tests and documentation rather than the approved Ergon Energy ITPs and Test Reports, this (or part thereof) may be approved by the Commissioning Officer / Engineer in accordance with Section 18 “Authorisation and Approval of Commissioning Documentation” provided that this does not introduce additional risk to the project. Such a situation may occur for GIS or 61850 commissioning where the vendor has developed a tailored, specialised testing solution.

10.1. Primary Plant Testing

All primary plant testing is to be carried out in accordance with the relevant Standard Work Practice (SWP), Inspection and Test Plan (ITP) and Test Report documentation.

For consistency (as well as due to frame leakage considerations), substation exit cables are considered part of the substation and therefore the Tools should be used rather than the Simple Commissioning Process.

10.2. Secondary Systems Testing

All secondary systems testing is to be carried out in accordance with the relevant Standard Work Practice (SWP), Inspection and Test Plan (ITP) and Test Report documentation

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For protection relay Site Acceptance Testing, engineering approved Ergon Energy Standard Test Plans will be used where available. If an approved Standard Test Plan is not available then it will be the responsibility of the testing entity to develop a suitable Test Plan and seek Ergon Energy engineering approval for the Test Plan. Standard Test Plan approval is to be performed in accordance with the guidelines provided in the Protection Relay Testing for Commissioning Standard Work Practice document.

The obligations and requirements pertaining to the use and development of protection relay Standard Test Plans are detailed in Annex 3 of this document.

10.3. Substation Communications System Testing

Substation Communications Systems form an integral and essential part of Substation SCADA and Protection Schemes. Due to the dependency on substation communications paths it is often the case that these paths will need to be established to allow commissioning testing to be performed. The Commissioning Officer/Engineer will specify these requirements in the Commissioning Staging Plan.

Whilst System Integration Testing which requires the use of a substation communications path will be the responsibility of the Commissioning Officer/Engineer, the establishment and testing of the communications path remains the responsibility of the Communications Systems Groups. The co-ordination of these resources to meet the project needs as detailed in the Commissioning Staging Plan will be the responsibility of the Project Manager.

10.4. Revenue and Statistical Metering Testing

In situations where additional accuracy testing is required to prove Substation Metering Systems this will be co-ordinated by the Project Manager. Where required, the Commissioning Officer/Engineer will schedule the metering testing into the Commissioning Schedule so that the Project Manager can arrange for these resources to be made available.

10.5. Substation Miscellaneous System Testing

For all substation system or plant not covered by Sections 10.1 through 10.4 above, testing is to be carried out in accordance with the relevant Standard Work Practice (SWP), Inspection and Test Plan (ITP) and Test Report documentation. If this information is not available for a particular system, the commissioning officer/engineer will seek engineering advice from a Senior Commissioning Engineer.

10.6. Test Result Assessment

Test result assessment will be performed in accordance with the Maintenance Acceptance Criteria (MAC) document (EE STNW1160). Where test results are assessed as a fail or not fit to be energised against the MAC criteria, or assessment criteria is not available, the commissioning officer/engineer will seek engineering advice from a Senior Commissioning Engineer.

11. REPORTING OF PLANT, CONSTRUCTION AND DESIGN DEFECTS DURING THE COMMISSIONING PROCESS

In order to improve Design, Plant Procurement and Construction processes Defect Recording and Reporting will be carried out throughout the Commissioning Process. Defect information capturing will be achieved using the Ergon Energy Defect Reporting Tool Form MN000301F171.

Ergon Energy has also developed a Project Variation Reporting Tool within its corporate information technology systems. The Defect Reporting Tool is to be used to support and complements the corporate system by allowing field data to be efficiency captured and reported to the Project Manager. During the commissioning phases of a project the Commissioning Officer/Engineer will be responsible for issuing the defect reporting tool to the responsible work crew leaders. The work crews performing the works are responsible for entering and maintaining the defect data within the reporting tool and reporting the information back to the Commissioning Officer/Engineer. At the conclusion of each of the commissioning phases the Commissioning

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Officer/Engineer is responsible for ensuring that all defect reporting tools are returned to the Commissioning Officer/Engineer and that the defect information, including rectification status and rectification hours have been completed.

Project time and/or cost variations resulting from the correction of reported defects will be reported to the Project Manager by the Commissioning Officer/Engineer. The Project Manager will be responsible for reporting and approving these changes in the project variation system and coordinating with all effected resources to ensure that the commissioning works can progress as detailed in the Commissioning Staging Plan.

It is the responsibility of the Commissioning Officer/Engineer to review all reported defects to assess the impact of these defects on the Commissioning Staging Plan and advise the Project Manager should there be any impact on the planned commissioning dates. In addition to this the Commissioning Officer/Engineer will be responsible for reporting defects which they consider systemic to the project delivery process into the Ergon Energy eSafe system so that these issues can be addressed through the Continuous Improvement process.

During the Project Close-Out Phase all collected defect information will be provided by the Commissioning Officer/Engineer to the Project Manager for entry into the project variation tool and for use in providing ongoing improvement of procurement contracts, construction processes and design standards. This information will also be used to provide validation of cost escalation during the project implementation phases.

12. PRE-CONNECTION HOLD POINT

A pre-connection hold point can be used by the Commissioning Officer/Engineer to ensure that all pre-commissioning checks have been completed as per the Ergon Energy Project ITP Tool. Once these checks have been completed by the Commissioning Officer/Engineer the Commissioning Officer/Engineer will provide authorisation to perform plant H.V. connections. The Commissioning Officer/Engineer's authorisation will also signify that "Queensland Electricity Entity Procedures for Safe Access to High Voltage Electrical Apparatus" procedures are now enforced in order to make any H.V. connections.

13. COMMISSIONING AUTHORITY FOR ENERGISING ELECTRICAL PLANT

On completion of Site Integration Testing the Testing Officer responsible for SIT is responsible for completing and signing off the relevant sections of the Commissioning Authority for Energising Electrical Plant Form (MN000301F174). Completion of this form signifies that all SIT works have been completed and that the resources responsible for performing these works have been informed and have acknowledged that the equipment tested is now to be treated as live and can only be accessed in accordance with H.V.I.A. processes by authorised personnel. When completed, the signed form is to be issued to the Project Manager to provide formal notification that the SIT component of works has been completed and that all testing resources no longer have access to that equipment.

On receipt of the signed Commissioning Authority for Energising Electrical Plant Form from the Testing Officer responsible for SIT it is the responsibility of the Project Manager to ensure that the relevant section is completed and signed. The Project Manager will then issue the Commissioning Authority for Energising Electrical Plant Form to the Commissioning Officer/Engineer.

The Commissioning Officer/Engineer will be responsible for providing final authority to energise the equipment listed on the Commissioning Authority for Energising Electrical Plant Form and complete the relevant section of this document. Once completed, this document will be stored by the Commissioning Officer/Engineer as per the instructions detailed on the document.

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14. CUSTOMER AUTHORITY TO ENERGISE CUSTOMER OWNED PLANT

The Customer Authority to Energise Customer Owned Plant Form (MN000301F176) is the official notification from a customer to Ergon Energy that their plant is ready to be energised. Without a completed Customer Authority to Energise Customer Owned Plant Form customer owned plant cannot be energised.

It is the responsibility of the Project Manager to ensure that the Customer Authority to Energise Customer Owned Plant Form is completed and signed by a Responsible Customer Representative.

Section 221 of the Electrical Safety Regulation 2013 (PDF, 846 KB) (the ES Regulation) requires that an auditor inspect high voltage electrical installations before connection or reconnection to a source of electricity, if:

- the high voltage electrical installation is being connected for the first time
- electrical installation work has been performed on the high voltage electrical installation.

The pre-commissioning inspection ensures that the installation, related electrical equipment and protective equipment have correct certification and comply with certification documentation and appropriate standards.

15. COMMISSIONING AND DECOMMISSIONING NOTICES

A Commissioning/Decommissioning Notice (Form MN000301F124) will be completed by the Commissioning Officer/Engineer and returned to the Asset Maintenance Officer within 5 working days of the commissioning/decommissioning date.

16. STORAGE OF TEST RESULTS

All test result will be stored using the Ergon Energy automated ITP tools and transferred to the network server \\ecasd01\Protection\Test Data - (Test-Commissioning-Maintenance) by the Officer Responsible for Testing. Where addition test results files (as specified by the Ergon Energy automated ITP tools) are required these files will be named in accordance with the format specified by Ergon Energy automated ITP tool and transferred to the network server \\ecasd01\Protection\Test Data - (Test-Commissioning-Maintenance) by the Officer Responsible for Testing.

It is the responsibility of the Commissioning Officer/Engineer to ensure that all test results are reviewed and correctly stored at the completion of each of the commissioning phases. In cases where the Officer Responsible for Testing does not have access to the network server, then the test results will be provided to the Commissioning Officer/Engineer by the Testing Officer for correct storage.

17. POST COMMISSIONING CLOSEOUT

At the completion of each of the commissioning stages the Commissioning Officer/Engineer will be responsible for completing a stage close out. To complete a Stage Closeout the Commissioning Officer/Engineer will:

- a. Confirm that all test reports and results have been saved to the Ergon Energy shared drive.
- b. Ensure that all defect reporting tools have been completed and saved to the Ergon Energy shared drive.
- c. Perform a defect consolidation using the Ergon Energy Defect Summary tool (form MN000301F172) and forward the complete tool to the Project Manager.
- d. Confirm that all Commissioning/Decommissioning notices have been completed and returned to the Asset Maintenance Officer.
- e. Storage of all commissioning documentation on the Ergon Energy shared drive.

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- f. Ensure that all systemic defects have been entered into eSafe.
- g. Participate in the project close out debrief as arranged by the Project Manager.

18. AUTHORISATION AND APPROVAL OF COMMISSIONING DOCUMENTATION

Ergon Energy has a number of systems and tools to provide a high level of consistency and continuity of testing and management of its commissioning activities. These systems have been RPEQ approved and are not to be modified without approval from the Senior Commissioning Engineer.

It is the responsibility of the Commissioning and Maintenance Manager to ensure that these systems and tools remain up to date and reflect the requirements detailed in the Standard Work Practice Documentation and MAC criteria.

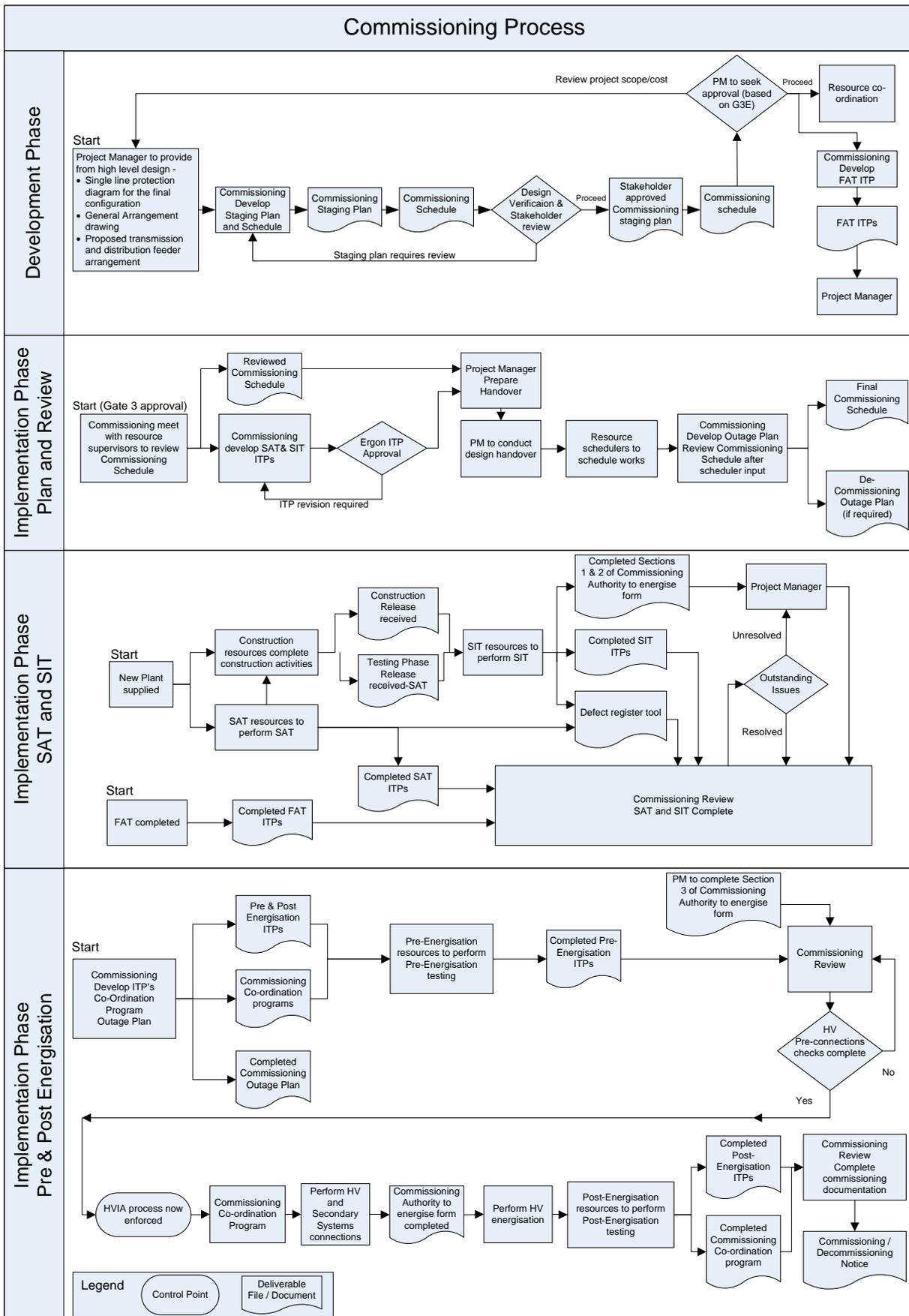
A breakdown of the required Qualifications/Competencies for the development, approval and modification of Ergon Energy Commissioning Documentation is provided below in Table 1.

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Document	Approval Level	Contractor Approval Level
ITP developed from approved SWPs or approved ITP templates	PP4/PP5/PM2/PM3	Level 6 Field Test Competency
Non-standard ITP	RPEQ	Not Applicable
Co-ordination Plan	PP4/PP5/PM2/PM3	Not Applicable
Test Results (where pass/fail criteria have been defined)	PP4/PP5/PM2/PM3	Level 6 Field Test Competency
Test Results (no defined pass/fail criteria)	RPEQ	RPEQ
Work Instruction, Standard Work Instruction, Inspection or Test Plan Template	RPEQ	Not Applicable
Form Template	PP5/PM2/PM3	Not Applicable

Table 1: Ergon Energy Commissioning Documentation Development, Approval and Modification Authorisation Requirements.

A1. ANNEX 1 – COMMISSIONING PROCESS FLOWCHART



A2. ANNEX 2 – COMMISSIONING PROCESS INPUTS AND OUTPUTS

Commissioning Process Inputs and Outputs								
Development Phase	Inputs	Provided By	Provided To	Comments	Outputs	Provided By	Provided To	Comments
	Single Line Protection Diagram	Project Manager	Commissioning officer/engineer	showing the final plant configurations for all effected substations as defined by the project objectives Created during high level design process	Commissioning Staging Plan	Commissioning officer/engineer	Project Manager	Stakeholder approved staging plan Used by project manager to achieve Gate 3 approval
	General Arrangement Drawing	Project Manager	Commissioning officer/engineer	showing the final plant layout for all effected substations as defined by the project objectives Created during high level design process	Commissioning Schedule	Commissioning officer/engineer	Project Manager	Developed from the approved staging plan to show resource requirements Used by project manager to achieve Gate 3 approval and works planning to determine resource allocations
	Proposed transmission and distribution feeder arrangement	Project Manager	Commissioning officer/engineer	showing the proposed layout for all effected substations as defined by the project objectives	FAT ITPs	Commissioning officer/engineer	Project Manager	Completed on gate 3 approval Used to capture FAT test results for commissioning group
Implementation Phase Plan and Review	Inputs	Provided By	Provided To	Comments	Outputs	Provided By	Provided To	Comments
	Commissioning Staging Plan	Commissioning officer/engineer	Test Resource Supervisor	For information purposes for the test resource supervisor	Finalised Commissioning Schedule	Commissioning officer/engineer	Project Manager	Approved by test resource supervisor and resource scheduler Used to manage resource requirements during commissioning execution
	Commissioning Schedule	Commissioning officer/engineer	Test Resource Supervisor	Test resource supervisor review	De-Commissioning Outage Plan	Commissioning officer/engineer	Scheduler and Outage Coordinator	Scheduler and Outage Coordinator to also receive commissioning staging plan De-Commissioning outage plan only required if plant to be de-commissioned to allow construction activities to be carried out Used by scheduler to submit AFWs Used by Outage Coordination to assess outage requirement
Implementation Phase SAT and SIT	Inputs	Provided By	Provided To	Comments	Outputs	Provided By	Provided To	Comments
	New plant and/or systems supplied	Project Manager	Construction Coordinator SAT test resources	FAT testing successfully completed prior to delivery	Completed SAT and SIT ITPs	Testing Officers responsible for SAT and SIT	Commissioning officer/engineer	Commissioning group to review and store SAT and SIT test results
	FAT test results	Project Manager	Commissioning officer/engineer	FAT results successfully assessment against MAC criteria Reviewed by commissioning group and stored to ERGON Energy corporate system	Completed SAT and SIT Defect Reporting Tools	Testing Officers responsible for SAT and SIT	Commissioning officer/engineer	Commissioning to review defects and report to project manager Project manager to record defects into project variation system Commissioning to enter systemic problems into eSafe system
				Completed Commissioning Authority to Energise Electrical Plant form sections 1 and 2	Testing Officer responsible for SIT	Project Manager	SAT and SIT testing resources relinquish access to all plant and systems	
Implementation Phase Pre & Post Energisation	Inputs	Provided By	Provided To	Comments	Outputs	Provided By	Provided To	Comments
	Pre and Post commissioning ITPs	Commissioning officer/engineer	Testing officer responsible for commissioning testing	Completed ITPs and test reports to be returned to commissioning	Completed Commissioning Authority to Energise Electrical Plant form	Commissioning officer/engineer	Operation data storage system	Verbal notification of commissioning provided by the commissioning officer/engineer to the operational control centre. Electronic version of the completed form filed to the 'ecasd01\data\' storage system by the commissioning officer/engineer
	Commissioning coordination programs	Commissioning officer/engineer	Testing officer responsible for commissioning testing	On completion of the Pre-Commissioning coordination program for new plant, secondary system isolation procedures will be enforced	Commissioning/Decommissioning notice	Commissioning officer/engineer	Asset maintenance officer	Initiates plant maintenance cycle
	Commissioning outage plan	Commissioning officer/engineer	Outage coordination and resource schedulers	Commissioning outage plan and commissioning staging plan used to create and support AFWs submission	Completed pre & post commissioning ITPs	Commissioning officer/engineer	Corporate data storage system	Commissioning to store data to corporate data system
	Commissioning Authority to Energise Electrical Plant form	Project Manager	Commissioning officer/engineer	Project manager to complete section 3 of the Commissioning Authority to Energise Electrical Plant form and issue to commissioning group	Completed commissioning coordination programs	Commissioning officer/engineer	Corporate data storage system	Commissioning to store data to corporate data system

A3. ANNEX 3 – TERMS AND CONDITIONS OF USE OF ERGON ENERGY DEVELOPED AUTOMATED TEST REPORTING TOOLS, STANDARD WORK PRACTICES AND STANDARD PROTECTION RELAY TEST PLANS

Ergon Energy will make available published Tools, Standard Work Practices, Standard Protection Relay Test Plans and associated documents for use during testing and commissioning works. These associated documents include Reference Documents, Test Reports, Commissioning Checklists, Competency Assessments, Job Safety Analysis and Inspection and Test Plans (collectively, the Commissioning Documents).

Ergon Energy cannot be deemed liable for any loss suffered as a result of using the Commissioning Documents.

Provision of the Commissioning Documents to any party does not convey any interest of a proprietary nature, and in particular but without limitation, does not transfer any interest in any intellectual property.

Ergon Energy does not warrant or represent that the information contained in the Commissioning Documents is correct or appropriate for use for a particular site. The user of the Commissioning Documents should carry out its own enquiries and investigations in relation to any irregularities in relation to the Commissioning Documents and the site itself.

The user of the Commissioning Documents will take all necessary steps to ensure that they are in possession of the most recent version of any of the Commissioning Documents prior to the commencement of any work.

The Commissioning Documents may not cover all aspects of testing required to ensure an electrical installation is fit for service or to the relevant standards or regulations.

The Commissioning Documents are intended to set a minimum standard and do not relieve the user of the obligation to meet their due diligence requirements when testing equipment.

Standard Protection Relay Test Plans may not fully align with actual settings and schemes used at a particular site. Accordingly, if modifications are made to a Standard Protection Relay Test Plan they must be made in accordance with the appropriate Standard Work Practice or Reference Document and in consultation with the Commissioning Officer/Engineer.

A4. ANNEX 4 – TESTING COODINATION WITH MAJOR CUSTOMERS

Where a Major Customer has a direct Secondary Systems interface to Ergon Energy systems, the Ergon Energy Commissioning Officer/Engineer will liaise with their counterpart from the Customer to develop a joint Inspection and Test Plan (ITP) with respect to this interface.

- a. Functions/signals transmitted from Ergon Energy to the Customer (SIT). This includes items such as a trip from Ergon protection to the Customers circuit breaker, or a VT secondary output from an Ergon VT to the Customers control system. For these functions, Ergon shall actuate the function and the Customer shall confirm it has the required effect on their asset. Where actuation is not possible, simulation may be used as an alternative.
- b. Functions/signals transmitted from the Customer to Ergon Energy (SIT). This includes items such as a trip from the Customers protection to an Ergon circuit breaker, or a live bus indication back to an Ergon protection relay or control system. For these functions, the Customer shall actuate the function and Ergon shall confirm it has the required effect on their asset. Where actuation is not possible, simulation may be used as an alternative.
- c. Joint Functions (SIT). This includes functions such as differential protection or communicating distance protection that span the asset boundary. For these functions, a composite team shall carry out measurements and tests on equipment on one side of the asset boundary followed by repeat measurement/testing on equipment on the other side of the asset boundary. The owner of the asset shall lead the tests on their assets while witnessing the tests on their counterpart's assets.
- d. Witness Testing (SAT/SIT/Pre-Eng/Post-Eng). This includes functions contained within one party's equipment that are deemed to be high risk or high impact to the other party, for example anti-islanding protection. For these functions, one party shall witness on-site testing carried out by the other party.
- e. On-Load Tests (Post-Eng). On load testing and measurements shall be carried out as soon as practical after load is available. Each party shall carry out measurements on their own assets as part of a co-ordinated commissioning program.

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A5. ANNEX 5 – ADDITIONAL REQUIREMENTS FOR GENERATORS

There are two main standards that outline the requirement for connection of generators to the Ergon Energy network:

1. Standard for Connection of Embedded Generators in the Ergon Energy Distribution Network (30 kW to 5MW) STNW1165
2. Standard for Embedded Generation (5MW and above) STNW3365

As per these standards:

“Prior to the connection of the embedded generator to the Network, Ergon Energy is entitled to inspect and, where necessary, require the Generator to test those parts of the embedded generation plant that have a direct effect on the Network. This is to enable Ergon Energy to verify that the embedded generation plant is acceptable for connection and complies in all respects with the requirements of the Technical Report and Applicable Standards and Regulations. This Technical Report shall be certified by a Registered Professional Engineer of Queensland (RPEQ)

The Proponent will conduct commissioning tests to demonstrate compliance of the embedded generation plant and network connection with the Engineering Report and NER Schedule 5.2.

The Proponent must submit to Ergon Energy for approval, the proposed commissioning program including test procedures and proposed test equipment to be used in the commissioning.

The generation unit’s commissioning program and test shall include all relevant tests to confirm the embedded generation plant compliance with the Engineering Report.

The Proponent will develop commissioning program and test procedures for the embedded generation plant to ensure that the commissioning of the embedded generator:

- Does not adversely affect the security of the Network or the quality of supply of electricity from the Network; and
- Minimises any possible threat of damage to the Network, or any other plant, equipment or installations of any other person that is connected to the Network.”

In addition, testing and commissioning of generation plant is required to comply with:

1. AEMO R2 Testing Guideline - provides guidance for preparing test programs intended to validate models and derive data.
2. AEMO Turbine Governor Testing and Model Validation Guideline – provides Generators with test guidelines suitable for demonstrating compliance with agreed performance standards, as well as deriving validated turbine-governor model data.
3. AEMO National Electricity Rules (refer Chapter 5 and Schedule 5.2)

Although the commissioning plan for a generator is customised for the particular plant, control and protection design, the generator commissioning plan has several common key elements;

1. Secondary Systems interface testing. Refer Annex 4 above.
2. Verification of NER Compliance (pre-synchronising). Includes verification and witnessing of protection system performance (S5.1a.8/S5.1.9/S5.2.5.8-10), trips/intertrips/cb fail, anti-islanding, reverse power, under voltage, over voltage, under frequency, over frequency, loss of incomer.
3. Verification of HV audit compliance (pre-energisation)
4. Pre-synchronising and Synchronising phasing checks

5. On-load tests
6. Verification of NER Compliance, including frequency (S5.1a.2/S5.1.3/S5.2.5.3/S5.2.5.11), system stability (S5.1a.3/S5.1.8/S5.2.5.5), power frequency voltage (S5.1a.4/S5.1.4/S5.2.5.4), voltage fluctuations (S5.1a.5/S5.1.5/S5.2.5.2), voltage waveform distortion (S5.1a.6/S5.1.6/S5.2.5.2), voltage unbalance (S5.1a7/S5.1.7/S5.2.5.2), reactive power capability (S5.2.5.1/S5.2.5.13), active power capability (S5.2.5.14), generator response to system voltage disturbances, load rejection (S5.2.5.7), impact on network capability (S5.2.5.12)
7. Verification of additional requirements of Connection Agreement such as impact on Audio Frequency Load control, local and remote OLTCs and voltage control, local and remote SVCs/Statcoms, ramp down, maximum import/export limits.
8. Verification of consequential upstream and downstream network changes due to the generator connection such as protection changes, plant changes (due to fault level impacts).