HV Connections Technical Requirements Chapter 5A <5MW CERM1135

For questions regarding or permission to release this Policy, please contact Essential Energy's Chief Risk and Compliance Officer.

If working from a printed copy of this document, check Policy Alerts and the Policy Library regularly for updates.

17 August 2021 – Original Issue
Approved By: Technical Operations Manager
Next review date: August 2024
COMMERCIAL-IN-CONFIDENCE

CONTENTS

1.0 INTRODUCTION

This document provides technical information related to 5.3A Embedded Generators (EGs < 5MW), assisting the proponent through the physical stages of connecting to Essential Energy's high voltage (HV) network.

1.1 Purpose

This document presents the approach of Essential Energy in the commissioning, connecting to the network and energisation of plant with a generating system less than 5MW. It aims to assist proponents to understand the principles, processes, information requirements and issues considered and required by Essential Energy when commissioning and energising generating systems.

This document is not intended to prescribe commissioning practice for Generators commissioning their generating plant nor to describe how Generators can demonstrate compliance with their own Performance Standards.

Therefore, the tests listed in this document are not exhaustive and do not include all tests that may be required for Generators undertaking their commissioning of generating systems.

1.2 Principles of Commissioning

The commissioning of new or augmented plant that interacts with the power system is an essential stage in the process of implementing a new or modified connection. Essential Energy applies the same principles for the commissioning of all generating systems, regardless of technology type. The commissioning process is directly managed by the proponent and Essential Energy. As the first stage of the commissioning process, the proponent must develop a Commissioning Program and submit the plan to Essential Energy for review.

Commissioning requirements will depend on the capability and connectivity of the generating system, and Essential Energy will consider a range of commissioning tests to prove that the generating system complies with the Performance Standards, Connection Agreement and is safe to remain connected to the power system.

The proponent is required to cooperate with Essential Energy to ensure that commissioning is undertaken in a manner that:

- assures the ongoing safety of staff and public;
- does not adversely affect other customers;
- does not affect power system security or quality of supply; and
- minimises the risk of damage to the equipment of other customers.

The proponent is responsible for specifying and undertaking commissioning tests and providing evidence to Essential Energy that demonstrates the performance of the plant.

The commissioning tests of interest to Essential Energy are considered a part of the overall commissioning activities, with Essential Energy expecting that the proponent would have additional commissioning requirements to assure the ongoing safety, reliability and performance of the proponent's plant.

General principles applied for the commissioning of generating systems across Essential Energy are:

- Commissioning tests are intended to provide evidence to Essential Energy at the time of commissioning that a generating system may remain safely connected to the power system, and the generating system meets the Performance Standards and any other technical requirements specified in the Connection Agreement.
- Essential Energy requires the proponent to compare the actual recorded results with the results expected from design or modelling.

Independent equipment is to be installed to collect commissioning results separate from the device under test; and the resolution and accuracy of the test instruments, for both time and recorded value, are required to be suitable to measure the response.

1.3 Essential Energy Role in Commissioning

Essential Energy's roles in relation to commissioning include:

- operator of the power system and responsible for power system security.
- provider of the network functions.

As the Distribution Network Service Provider (DNSP), Essential Energy becomes involved in the commissioning of all new plant connected to the distribution network, and all new plant connected to the sub-transmission network.

Essential Energy reviews the Commissioning Program and Performance Tests to ensure power system security is maintained. In these circumstances, Essential Energy ensures that the generating system complies with the agreed Performance Standards through the commissioning process.

Performance Tests are undertaken to demonstrate the generating system meets the Performance Standards, and to provide enough information to allow the generating system to remain online without direct supervision.

Where an existing Generator is changing settings or firmware or replacing part or all a generating system in such a way that it may impact on the Performance Standards of the generating system, Essential Energy expects that the same commissioning process will apply. Commissioning of the generating system may still be required if the replacement of part or all the generating system is expected to deliver identical performance (i.e., like-for-like replacement).

Replacement equipment may include:

- machine winding changes (including stator and rotor rewinds)
- voltage control system or excitation system setting changes or replacement.
- power control or governor control setting changes or replacement, including firmware.
- setting changes to dynamic reactive plant or replacement of parts of dynamic reactive plant that affect performance.

1.4 Specification of Inspections and Tests

The proponent is required to ensure that their equipment and plant is inspected and tested to demonstrate that it complies with relevant *Australian Standards*, the National Electricity Rules and their Connection Agreement with Essential Energy. In addition, the Service and Installation Rules of NSW are applicable as well as tests required by the manufacturer of specific items of plant and equipment.

Refer to https://www.essentialenergy.com.au/our-network/connecting-to-the-network/hv-connections-documents for further details of specific tests required by Essential Energy (for example CERM2456 Earth System Design & Test Requirements).

Where a particular Inspection or Test is specified by Essential Energy, a detailed ITP and Test Report template will be provided.

1.5 Types of Inspections and Tests

To assist in defining roles and responsibilities in the commissioning process, the following types of tests are referred to:

- Construction Testing.
- Site Acceptance Testing (SAT).
- Site Integration Testing (SIT).
- Controlled Energisation.
- Post Energisation Testing; and
- Performance Testing.

These are described further below.

1.5.1 Construction Testing

The main function of Construction Testing is to ensure quality and correctness of on-site construction and assembly.

Typical Construction Testing includes primary and secondary IR measurement, contact resistance, earthing checks, belling wiring/cabling, HV clearance checks, visual checks for damage.

1.5.2 Site Acceptance Testing (SAT)

The main function of SAT is to ensure that the delivered product meets agreed specification and performance expectations.

SAT is carried out on site, preferably with the equipment in its final installed position, in order to ensure that no damage has resulted from the equipment being transported or reassembled on site.

SAT often includes condition assessment tests and measurements that are used for whole of life management of the equipment.

Typical SAT includes transformer ratio, winding resistance, CT excitation curves.

1.5.3 Site Integration Testing (SIT)

SIT is performed on site to prove that a piece of equipment is correctly connected and integrated into the site to form a complete operational system that is safe and fit for service.

SIT can usually be substantially completed during pre-commissioning, however proof of system functionality with in-service plant and/or systems (i.e., finalisation of SIT) must be completed during final commissioning tests as part of the Commissioning Plan.

Typical SIT includes end to end SCADA checks from remote initiation through to remote back indication, functional checks, primary injections.

1.5.4 Controlled Energisation

Controlled energisation of any newly installed item of equipment at system voltage will require the following requirements.

- All new equipment has been tested to CEOM5125.23 and results are in date.
- Certificate of electrical compliance HV form CEOF 6720 has been completed.
- Precautions are taken during a controlled energisation so that any staff in the vicinity of the equipment will be shielded from any explosive failure.
- Upstream protection set on non-auto reclose.
- All switching on new equipment to be completed in a de-energised state.
- Once all switching is complete the upstream protection can be returned to auto-reclose after 20mins

A typical arrangement for controlled energisation is shown in Figure 1.

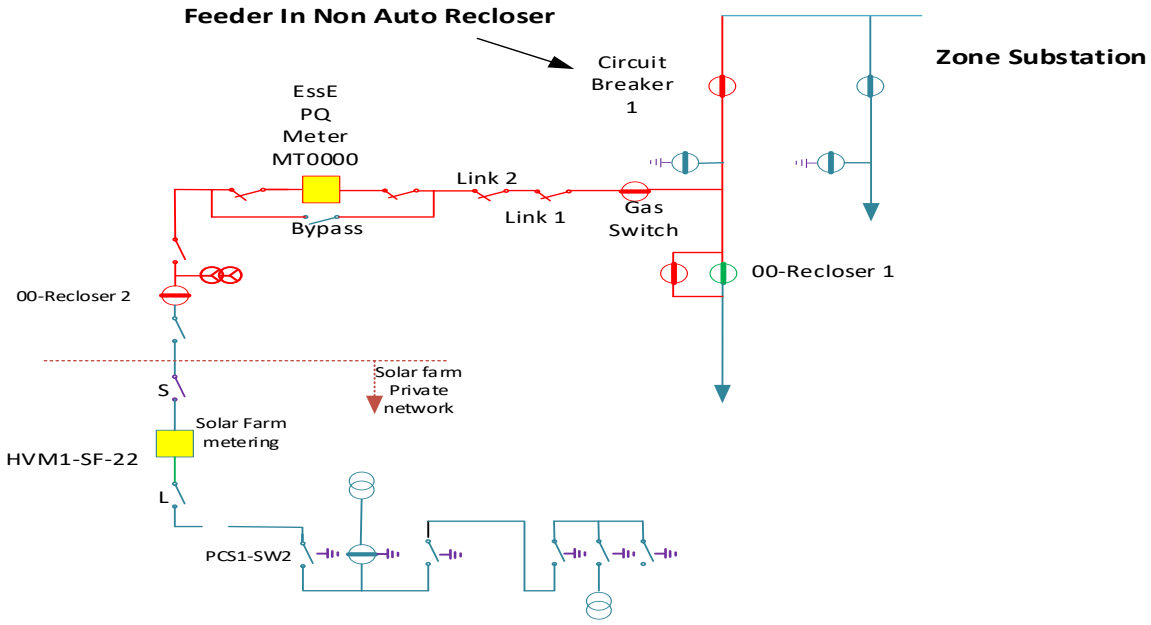

Figure 1: Typical arrangement for controlled energisation

1.5.5 Post Energisation Testing

Post Energisation Testing is carried out to confirm correct operation of newly installed equipment when energised at system voltage and, where required, carrying load.

An example of Post Energisation Testing are tests to confirm the correct operation of equipment under service condition, for example voltage measurements, primary and secondary current measurements, phase angle measurements, phase location stability checks, spill current measurements and automatic control function checks.

Post Energisation Testing on generation plants, defined as Warm Commissioning, is testing carried out on plant while running at limited output to check basic operation and control functionality prior to commencing Performance Testing. Some examples of this type of Post Energisation Testing are:

- AUX Transformer functional tests.
- Manufacturer post energisation inverter commissioning.

- Plant emergency shutdown functional tests.
- HMI / Inverter Control confirming that the plant reacts to remote commands.
- Power Quality readings.
- Communications to all inverters and PQ metering.
- Failsafe lockout levels set to prevent plant runaway at low output levels.
- Confirm power factor readings.
- Confirm accurate plant response to changes in active power set points whilst maintaining power factor.
- Confirm accurate plant response to changes in active power and power factor set points.
- Confirm functionally (plant lockout) of the communications failsafe control system including PQ meter.
- Confirm functionally of loss of phase volts on PQ meter (remove white phase Vt secondary fuse).

Post Energisation test plan should be broken up into hold points allowing the different functions to be tested in order.

1.5.6 Performance Testing

Performance Testing is carried out to confirm that elements of the network and the connected load/generation meet their agreed performance requirements. It includes a range of tests, measurements, and simulations to demonstrate that the performance and behaviour of the installed generating system matches the modelled system and Connection Agreement. This specific test plan will need to be developed in conjunction with Essential Energy's Connections Planning and Commissioning groups.

1.6 Scope

The process of commissioning a new high voltage asset from initial construction to full operation on the Essential Energy network entails a series of stages and phases, these are shown in Figure 2 below.

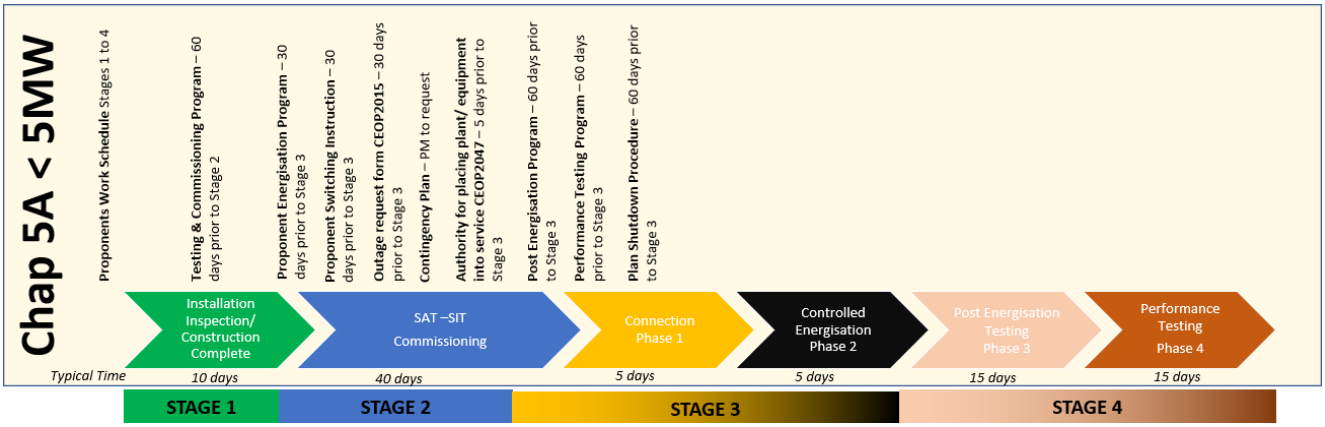

Figure 2: Commissioning Framework 5.3A <5MW

1.6.1 Commissioning Framework

Stage 1: The end of the Installation / Construction Complete stage signifies the practical completion of all physical and electrical construction to the point where pre-commissioning may begin. Construction Testing has been completed by the end of Stage 1.

Stage 2: SAT and SIT is carried out during Stage 2. SAT shall be completed by the end of Stage 2; however, the finalisation of some SIT activities may not be able to be completed until Stage 3 (depending on the control and protection configuration of the connection).

Stage 3: The Connection and Controlled Energisation Stage requires high level of involvement from Essential Energy with switching, access permit and operating agreements.

> **Phase 1** involves the actual connection of the proponent equipment to the Essential Energy Network.
>
> **Phase 2** involves the actual energisation; this process will be covered in both Essential Energy's and Proponent's energisation plan.

Stage 4: Post Energisation Testing and Performance Testing is carried out at Stage 4. It is the generator's responsibility to ensure that their testing program is adequate and to derive all the data appropriate for verifying the generating, control and protection systems used in their installation.

This specific test plan will need to be developed in conjunction with Essential Energy's planning and commissioning groups.

Any issues or events that cause any protection operation or network disturbances, all commissioning work will cease, and an incident or investigation report submitted to Essential Energy for approval within the Essential Energy commissioning team before re-commencing the commissioning.

Any changes to the agreed post energisation and performance test plan or Essential Energy switching instructions may take up to 48 hours to process the changes.

Responsibilities: The responsibilities for inspections and tests carried out during commissioning are described in the following sections of this document and are dependent on the type of asset: Essential Energy Assets, Gifted Assets or Non-Gifted Assets.

For all enquiries, Essential Energy can be contacted via email: networkconnections@essentialenergy.com.au

1.7 Definitions

Term	Definition
Access Permits	A form of authorisation which allows access to work on or near, or to test electrical apparatus.
Commissioning Tests	Means all the procedures and tests which, in accordance with the reasonable and prudent standard, and in compliance with industry guidelines, practices and standards.
CAS	Connection Access Standard form applies to all generating systems connecting under Chapter 5A of the NER. This document should be approved by the Essential Energy Connections Planning team prior to execution of a Connect Agreement.
CEOF6720	Certificate of Electrical Compliance High Voltage to filled out during various stages of the project.
Essential Energy Boundaries Document	The boundaries document advises the proponent when Essential Energy will require witness testing or any further testing on the proponent's equipment that is required prior to connection to the Essential Energy network.
High voltage (HV)	Voltages exceeding 35kV but less than 230kV.
Low voltage (LV)	Voltages not exceeding 1000V (line to line)
Medium voltage (MV)	Voltages exceeding 1000V but less than 35kV

Term	Definition
Operating Agreements	An Operating Agreement is an agreement between two Operating Authorities. It is used to confirm that an electrical apparatus
PowerOn	Essential Energy Scada viewer and control system
Operating Agreement	Operational state between the proponent and Essential Energy will be held in an agreed state until the Operating Agreement is cancelled.
Proponent	A person proposing to become a generator (the relevant owner, operator, or controller of the generating unit (or their agent))
Proponent Works Schedule	Plan or schedule of works showing milestones and key tasks and key dates
Hold Points	Critical milestones within the project. Hold Points are generally required whereby the generating system overall output is constrained to a number of pre-defined megawatt (MW) levels.
Essential Energy Assets	Essential Energy's distribution and sub-transmission network, including assets extending Essential Energy's network to facilitate the connection of gifted assets
Gifted Assets	Once installed, Essential Energy will commission and place in-service, ownership and responsibility for the asset is then transferred to Essential Energy.
Non-Gifted Assets	Once installed, commissioned and in-service, ownership and responsibility remain with the Proponent.
Non-Gifted Assets – Type A	Any Non-Gifted Asset that is connected between the Essential Energy Network up to and including the proponent first protection device. Any Non-Gifted Asset that forms an integral part of the Essential Energy network (for example the proponent owned assets of a unit protection schemes where Essential Energy owns one end of the scheme, and the proponent owns the other end).
Non-Gifted Assets – Type B	Non-Gifted Assets that are not Type A
System Controllers	Is an authorised person responsible for the operation of all or a designated part of the electricity network.
Switching Instruction	Switching instructions are written by an authorised operator and checked by an independent operator. Switching instruction covers any operation or action involved in de-energising, energising, or earthing a portion of electrical apparatus in accordance with a plan or switching program.

1.8 Abbreviations and Acronyms

Abbreviations / acronyms	Definition
AC	Alternating Current
ACS	Accredited Service Provider
AEMO	Australian Energy Market Operator
AER	Australian Energy Regulator
AS/NZS	A jointly developed Australian and New Zealand Standard
CSA	Connection Services Agreement

Abbreviations / acronyms	Definition
DC	Direct Current
DNSP	Distribution Network Service Provider
EG	Embedded Generation or Embedded Generating
EssE	Essential Energy
HV	High Voltage
IEC	International Electrotechnical Commission
IES	Inverter Energy System
LV	Low Voltage
MV	Medium Voltage
NEM	National Electricity Market
NER	National Electricity Rules
NMI	National Metering Identifier
PPC	Power Plant Controller

1.9 Terminology

Instructional terms are to be interpreted in the following way:

- the words ‘shall’ or ‘must’ indicate a mandatory requirement.
- the word ‘may’ indicates a requirement that may be mandatorily imposed on the Proponent; and
- the word ‘should’ indicates a recommendation that will not be mandatorily imposed on the Proponent

2.0 WORKPLACE SAFETY

2.1 General Working Practices

Where generation facilities are owned and operated by the proponent (e.g., a High Voltage Customer), the Proponent shall provide evidence that they have their own electrical safety rules.

Operating and commissioning personnel are to be appropriately trained such that they are competent with operating procedures and site **Electrical Safety Rules**.

Under Essential Energy electrical safety rules, there is some specific requirements dealing with connection of new conductors to a previous energised network.

- Essential Energy require that the actual connection between the proponent network and the Essential Energy network to be completed as close as practical to the energisation day and to be communicated in the energisation program/switching instruction.
- If any cable or conductor is fitted to a pole, cubicle or kiosk carrying energised apparatus but not connected, a set of construction earths shall be applied as soon as practical to the new assets at the closest point to the Essential Energy network.
- Once the proponent asset is connected to Essential Energy network the Operating Protocol is applicable. Additional earthing and Operating Agreements may need to be applied - this requirement needs to be included in the energisation program and switching instructions.

- All switching on the proponent HV network will require an authorised HV operator as per the Operating Protocol.

2.2 Authorised Staff for Switching

Only staff who have been authorised and provided evidence in writing to Essential Energy by the HV Customer/Generator High Voltage owner as part of the requirement of the Operating Protocol are permitted to carry out Customer / Generator switching this includes any SCADA switching of the HV network.

Essential Energy Network Control shall be notified prior to any high voltage switching operation on the proponent high voltage equipment unless in emergency then Essential Energy Network Control shall be notified directly after the event explaining the emergency.

3.0 DOCUMENTATION FROM THE PROPONENT

The documentation that shall be submitted by the Proponent for testing and commissioning are summarised in Table 1.

The following table should be read in conjunction with Figure 2, Commissioning Framework 5.3A <5MVA.

Table 1: Documentation Timeline for Projects 5.3A <5MVA

Document	When it is required
Proponent Operating SLD, Plant SLD, Protection SLD, Communications SLD, General Arrangement Drawings, Phasing Diagrams, Interface Schematics and Protection Report	60 days prior to Stage 1 - construction
Proponent works schedule	Prior to Stages 1 – construction to 4 – post-energisation
Proponent SAT and SIT program	60 days prior to stage 2 – SAT/SIT
Proponent energisation program	28 days prior to stage 3 – connection / controlled energisation
Proponent switching instruction	28 days prior to stage 3 – connection / controlled energisation
Outage request form CEOF6013	28 days minimum prior to stage 3 – connection / controlled energisation. Essential Energy will advise if a longer period is required due to outage requirements.
Contingency plan	On request from Essential Energy
Connection Agreement and Operating Protocol,	5 days prior to stage 3 – energisation
Certificate of Electrical Compliance CEOF6720	5 days prior to stage 3 – energisation and after Performance testing completion
Valid HV underground cable test report	5 days prior to stage 3
CEOF6047.20 authority for placing plant / equipment into service form. Gifted Assets	5 days prior to stage 3 – energisation and after Performance testing completion

CAS Form	60 days prior to stage 3 – energisation
Proponent Post Energisation Testing program	60 days prior to stage 3 – energisation
Proponent Performance Testing program	60 days prior to stage 3 - energisation
Plan Shutdown / Start-up procedure	30 days prior to stage 3 – energisation
Test Reports for Post Energisation / Performance Testing program	Preliminary test reports for each hold point showing any issues found during hold point are required to be completed prior to commencing the next hold point.
NSW Fair Trading electrical certificate of compliance	5 days after stage 3 energisation
Asset Commissioning and Performance Report	Final commissioning and performance report to be submitted to Essential Energy 30 days after the completion performance testing program stage 4.

3.1 Proponent Drawings and Reports

The following drawings and reports are required to be certified and form the basis for development of an integrated commissioning plan. Draft documents will not be accepted.

- Operating SLD
- Plant SLD
- Protection SLD
- Communications SLD
- General Arrangement Drawings
- Phasing Drawing
- Interface Schematics
- Earthing Report
- Protection Report

The proponent shall provide a phasing drawing for the site showing connections to metering devices and generator. The phasing drawing should be provided as part of the Design Pack and must be Certified by EE Contestable Design before construction starts. Essential Energy will then provide phase identification with phase marking on the closest three phase point of connection.

3.2 Proponent Works Schedule

The proponent shall prepare and maintain a project schedule. The requirements relevant to the preparation, provision and implementation of the project schedule include:

- The project schedule / Gantt Chart. This shall be maintained on a weekly basis.
- A Commissioning timeline.

A meeting between relevant parties will be held on a regular basis to share documentation and maintain the project schedule throughout the project.

3.3 Connection Access Standard (CAS) Form

As per Table 1 timeline, the Connection Access Standard form is required to be finalise and endorsed 60 days prior to energisation. The form outlines the chapter 5A connection technical requirements. These requirements are typically as shown below:

- Critical connection information.
- Generating system data including transformers.
- Active and reactive power control system operational data
- Communication fail-safe mechanism data.
- Reactive power capability.
- Storage system data (if installed).
- Power quality requirements.
- Fault ride through capability.
- Fault current.
- Special protection system requirements including anti-islanding.
- Operational requirements.
- Implemented augmentations (if required).
- Commissioning requirement.

3.4 Proponent Commissioning Program

Prior to energising or commissioning any HV equipment, a detailed step by step Commissioning Program must be submitted to Essential Energy for review. The Commissioning Program must be followed to ensure that the Project complies with the technical requirements specified in the relevant Connection Agreement.

The Commissioning Program must detail the sequence to be undertaken to commission each piece of high voltage equipment, the program must address SAT, SIT, Post Energisation and Performance Testing that includes the following detail:

- Purpose of the commissioning program.

- Definitions, abbreviations and acronyms.

- An overview of methodology for how the Proponent will complete their commissioning work, the phases and hold points of the project, and all details of the commissioning process.

- Confirmation that all work undertaken by the Connection Applicant for the project meets the relevant Australian Standards including AS3000, AS3007 (where applicable), Service and Installation Rules of NSW (any requirements specific to NSW, Victoria or QLD as applicable) as well as tests required by the manufacturer of specific items of plant and equipment.

- Roles / responsibilities / contact details for key commissioning personnel, lines of communication, officer with the authority to make decisions, and officer responsible for signing the authority to place into service form, authorised HV operator for the site, after hours contact details for emergency switching operations, the name and certification of any staff who will be completing and signing the commissioning forms.

- Security plan for both local and remote access to setting files, parameters and SCADA systems. This is to limit the access and version control to these systems during the performance testing program.

- Confirmation of inverter firmware to the accepted CAS document.

- Identification of site conditions, access to site, commissioning risk assessment, use of sub-contractors, safety or commissioning issues and conformance to the proponent's Electrical Safety Rules.

- The testing and commissioning plan shall not adversely affect the security of the electrical network or the quality of supply of electricity through the network. It shall minimise any possible threat of damage to the network, or any other equipment or installations of any other load or generation that is connected to the network.
- Testing and commissioning requirements of an Inverter Energy System Embed Generator (IES EG) systems include:

    - Compliance with the equipment manufacturer's specifications and demonstrate that the Inverter Energy System Embed Generator system meets the requirements of the Connection Agreement.
    - Requirement to demonstrate on site protection testing of all high voltage equipment ensuring that setting meet the agreed protection setting guidelines provided by the proponent.
    - Requirement for a corresponding NSW Fair Trading electrical certificate of compliance for all auxiliary equipment installed to be issued to Essential Energy when connected to network connection.
    - The name of the relevant accreditation authority for electrical certificates of compliance

On receipt of the Commissioning Program, Essential Energy will assess its adequacy. Essential Energy may require additional testing to be performed if it considers that the proposed Commissioning Program is not in accordance with Essential Energy's commissioning policies and procedures.

3.5 Test Reports

All tests shall be provided in a test report that clearly records test results and other information relevant to the test. This information normally includes details relating to the item under test, date, time, weather conditions, the testers name, test equipment used, calibration date of equipment, test voltages and currents applied and a record of whether or not the item under test met the acceptance criteria for the test.

The Test Report should cross reference the commissioning plan. The Test Report shall clearly indicate pass/fail criteria for each test. Copies of Test Reports shall be supplied to Essential Energy on request.

4.0 STAGE 1: CONSTRUCTION

All work within stage 1 within the generation site is completed by the proponent. Any work that is to be completed and gifted to Essential Energy will need to be managed by both the proponent and Essential Energy. During this stage, the proponent will need to provide documentation as per table 1 to allow Essential Energy to program the technical staff that may be required to complete any work prior to commissioning.

Asset types and their responsibilities are detailed in Table 2.

Table 2: Stage 1 Responsibilities

Asset Type	Responsibility for Completion of Construction Testing	Responsibility for Provision of ITP	Responsibility for Witnessing of Construction Testing
Essential Energy Asset	Essential Energy	Essential Energy	n/a
Gifted Asset	Proponent	Essential Energy (Note 1)	Essential Energy (Note 1)
Non-Gifted Asset (Type A)	Proponent	Proponent plus Essential Energy (Note 2)	Essential Energy (Note 2)
Non-Gifted Asset (Type B)	Proponent	Proponent	n/a

Note 1 – ITP and Test Report templates will be provided by Essential Energy to the proponent for completion. The ITPs will nominate if witness testing is required.

Note 2 – ITP and Test Report templates specifying the minimum required tests and inspections will be provided by Essential Energy to the proponent and the proponent may add additional tests and inspections if required. The ITPs will nominate if witness testing is required.

Additional witness testing may be carried out as part of a quality assurance inspection at any stage.

4.1 Earthing

The following details the Earthing requirements:

- Earth System Design & Test Requirements CERM2456 describes the requirements for solar farm earthing system design and verification testing.
- Division Manual: High Voltage A.C. Distribution Earthing CEOM5113.02 describes specific earthing requirements for any gifted assets (PQ Metering, Recloser)

The proponent may choose to bond the solar farm earthing system to Essential Energy's earthing system. This can be achieved at the approval of Essential Energy's Network Earthing Manager and successfully detailing that compliance is maintained.

5.0 STAGE 2: SAT/SIT

Stage 2 SAT/SIT covers all commissioning work completed on site before the site is connected to the Essential Energy network and energised.

Asset types and their responsibilities are detailed in Table 3.

Table 3: Stage 2 Responsibilities

Asset Type	Responsibility for Completion of SAT/SIT	Responsibility for Provision of ITP	Responsibility for Witnessing of SAT/ SIT
Essential Energy Asset	Essential Energy	Essential Energy	n/a
Gifted Asset	Essential Energy	Essential Energy	n/a
Non-Gifted Asset (Type A)	Proponent	Proponent	Essential Energy
Non-Gifted Asset (Type B)	Proponent	Proponent	n/a

Testing and commissioning acceptance may require Essential Energy to carry out witnessing at the proponent's expense.

5.1 Connected Assets up to Proponent First Protection Device

- Any equipment that is connected to the Essential Energy Network up to the proponent's first protection device shall be tested to Essential Energy standards as if it was an Essential Energy Asset.

- Test results for connected assets up to the Proponent's first protective device are valid for 28 days of the equipment being energised. Essential Energy reserves the right to request new tests when the equipment is being energised more than 28 days after the tests are conducted.

- Further information on Testing and Commissioning low to medium voltage distribution equipment can be found in CEOM5125.23 Network Asset Testing & Commissioning Manual.

5.2 Treatment of Non-Complying Systems

Where non-complying systems are found prior to energisation or final commissioning:

- the system will not be permitted to connect or reconnect until the proponent prepares a rectification plan and provides evidence of corrective actions and/or demonstrates compliance.
- depending on the severity of non-compliance, Essential Energy may be required to witness the testing at the proponent's expense prior to allowing connection.

6.0 STAGE 3: CONNECTION AND CONTROLLED ENERGISATION

6.1 Pre-requisites

Prior to energisation:

- Ensure completion of all new construction and commissioning work associated with the installation as per the proponents commissioning program.
- Gifted Assets - Ensure CEF6047.10– Authority for Placing Major Electrical Plant/Equipment into Service form (section 1) is completed and signed off for all equipment listing any limitations or issues on the form.
- Non-Gifted Assets - Ensure CEOF6720 – Certificate of Electrical Compliance form (section 1 to 3) is completed and signed off for all equipment listing any limitations or issues on the form.
- Ensure the Operating Protocol has been signed by both the Proponent and Essential Energy.

6.2 Phase 1 Connection to the Network

This work will involve outage requests, switching, and access permits. This requirement will be outlined in both the Essential Energy and Proponent energisation program. Also, these requirements should be included on both the Essential Energy and Proponent switching instructions.

Once the proponent's equipment is connected to Essential Energy network and can be energised by any operating work, the proponent's network is now a connected network and any work that needs to be completed will require an Operating Agreement and Access Permit as per the proponent's electrical safety rules.

Essential Energy will not proceed with connection of the Proponent until all SAT and all SIT (as far as can be practically completed) of gifted and non-gifted assets has been completed.

6.2.1 Outage Request Forms

All outage requests shall be discussed and submitted with Essential Energy a minimum of 28 days prior to stage 3. Essential Energy will advise if this minimum 28-day timeline will be required to be lengthen out due to complexity of the outage and the number of customers that are being affected.

6.2.2 Proponent Switching Instruction

The proponent shall an approved switching instruction from the proponent's authorised operating person, these instructions shall be provided with the proponent outage request form CEOF6013, to allow Essential Energy to prepare their energisation plan and switching instructions. Essential Energy can provide further information of how far into the proponent's network Essential Energy will require the switching instruction to cover.

6.2.3 Contingency Plan

With reference to the commissioning framework and specifically stage 3 (energisation), the Proponent may be required to develop and submit a contingency plan for all major jobs. The requirement for a contingency plan depends on:

- The type of outage;
- Outage recall time; and
- Amount of time and customers involved in the outage.

Essential Energy will advise if a contingency plan will be required.

The information covered within the contingency plan should include:

- timeline for the outage showing switching time and any in service checks required;
- timeline for construction;
- timeline will show staff fatigue management, for longer outages;
- failure modes for the outage including plant, tools, staff;
- recall times if required for any plant/network that may need to be put back into service urgently;
- plan to recall should a failure mode occur; and
- outage personnel contact details, including an after-hour plan and escalation procedure if required.

6.2.4 Certificate of Electrical Compliance HV CEOF6720

The proponent is required to fill out CEOF6720 for any non-gifted asset to enable connection and operation on Essential Energy's network.

Completing the form provides Essential Energy assurance that all necessary works associated with connecting the proponent's electrical infrastructure has been undertaken by qualified staff adhering to the relevant standards, procedures, rules, and regulations.

The Form has been broken into four stages that generally replicate the construction process and ultimate connection to EE's network.

Signatory requirements are shown below:

- Construction Compliance must be completed by the companies authorised officer responsible for the construction activities or the overarching Project Manager representing the Proponent.

- Commissioning Compliance must be completed by the companies authorised officer responsible for the Commissioning activities or the overarching Project Manager representing the Proponent.

- High Voltage Energisation must be completed by the authorised Officer responsible for connection to the Essential Energy Network, Energisation and Switching or the overarching Project Manager representing the Proponent.

- Plant Ready for Service (Generation/Load) must be completed by the proponent's CEO as the final signoff/acknowledgement.

Each stage is required to be completed as the project progresses and held on record by Essential Energy.

Noting Stages 1 to 3 must be completed and forwarded to Essential Energy 5 days prior to the agreed connection energisation date.

This Certificate of Electrical Compliance applies to:

- All new major electrical plant/equipment;
- Major electrical plant/equipment that has been out of service more than three months;
- Major electrical plant/equipment that has been removed from in situ; and
- New high voltage distribution electrical plant/equipment.

6.2.5 Gifted Assets Authority for Placing Equipment into Service

Any gifted assets to Essential Energy will require CEOF6047.20 authority for placing plant / equipment into service form. Section 1 must be completed and forwarded to Essential Energy 5 days prior to the agreed connection energisation date.

6.2.6 Metering

HV metering equipment shall be provided in accordance with the National Electricity Rules and Essential Energy's CEOS8027 Network Metering Standard.

- All metering points should be shown on the proponent SLD and should be numbered and labelled as per the appropriate SLD drawing and CEOM7112.02
- Essential energy standard drawing CEOM7112.02 provides installation information on 11kV /33kV metering unit pole to structure arrangement.

All metering is to be installed and commissioned prior to stage 3 phase 1 of the Commissioning framework, Figure 2. Further in-service checks are to be completed in stage 4 of the commissioning framework.

6.2.7 Metering for Power Quality Essential Energy Asset

The Power Quality metering installed and gifted to Essential Energy shall be commissioned and energised prior to the energisation of any of the proponent's equipment this will allow the recording of any power quality issues that can be inherited from the local network.

Essential Energy recommends that power quality monitoring be conducted for a sufficient period (typically 2 weeks) before modification of an existing point of connection or installation of a new site. Existing background information has proven to be invaluable in the process of achieving acceptance of the connection.

Example connection arrangement drawings are shown in Figures 3 and 4 for both underground and overhead options. Note these are sheets 2 of 3 and 4 of 4 respectively, meaning there are other connection configurations available. It is the proponent's responsibility to ensure the latest drawings are referenced.

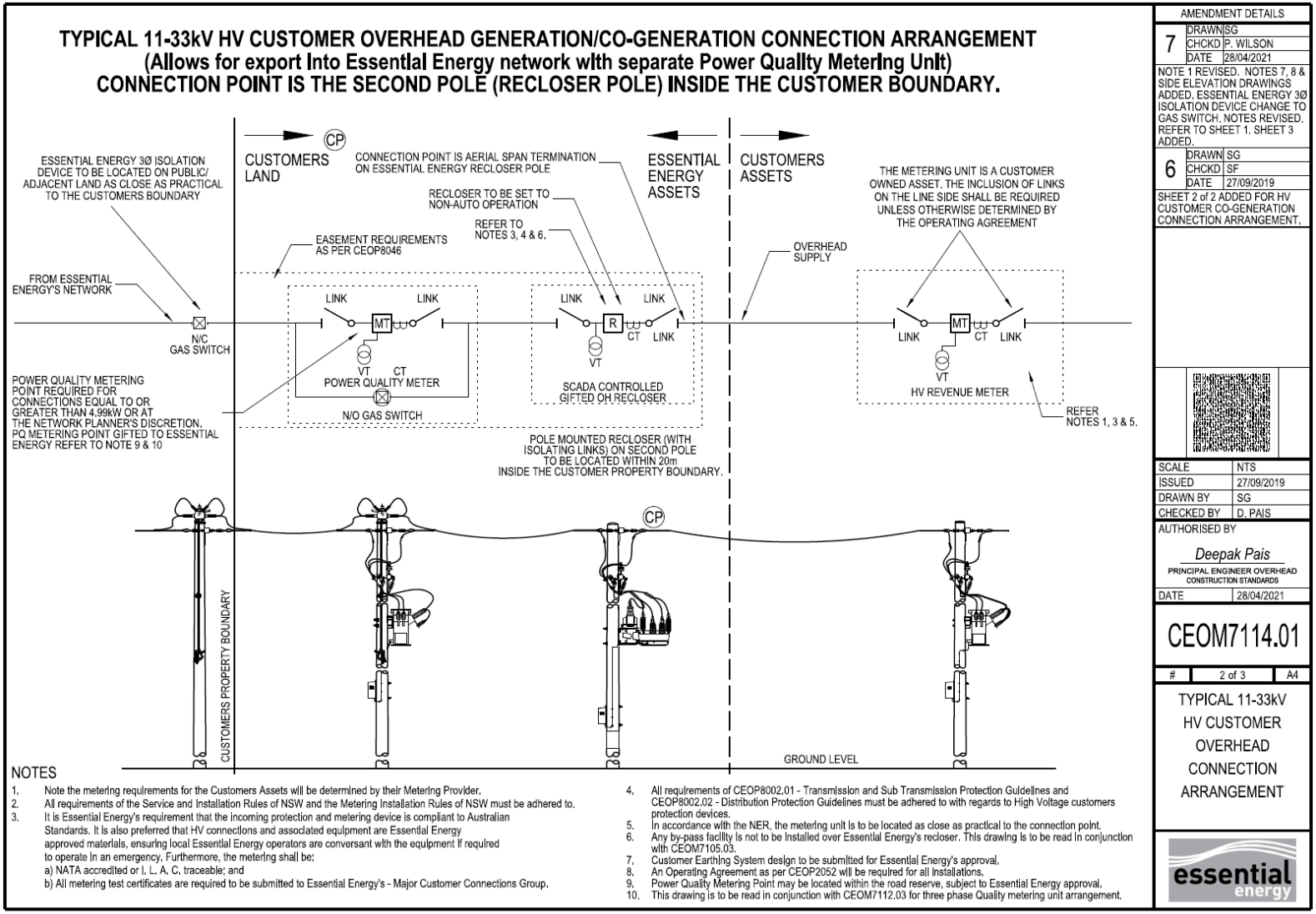

Figure 3: Typical Overhead Connection Arrangement sheet 2 of 3 of CEOM7114.01

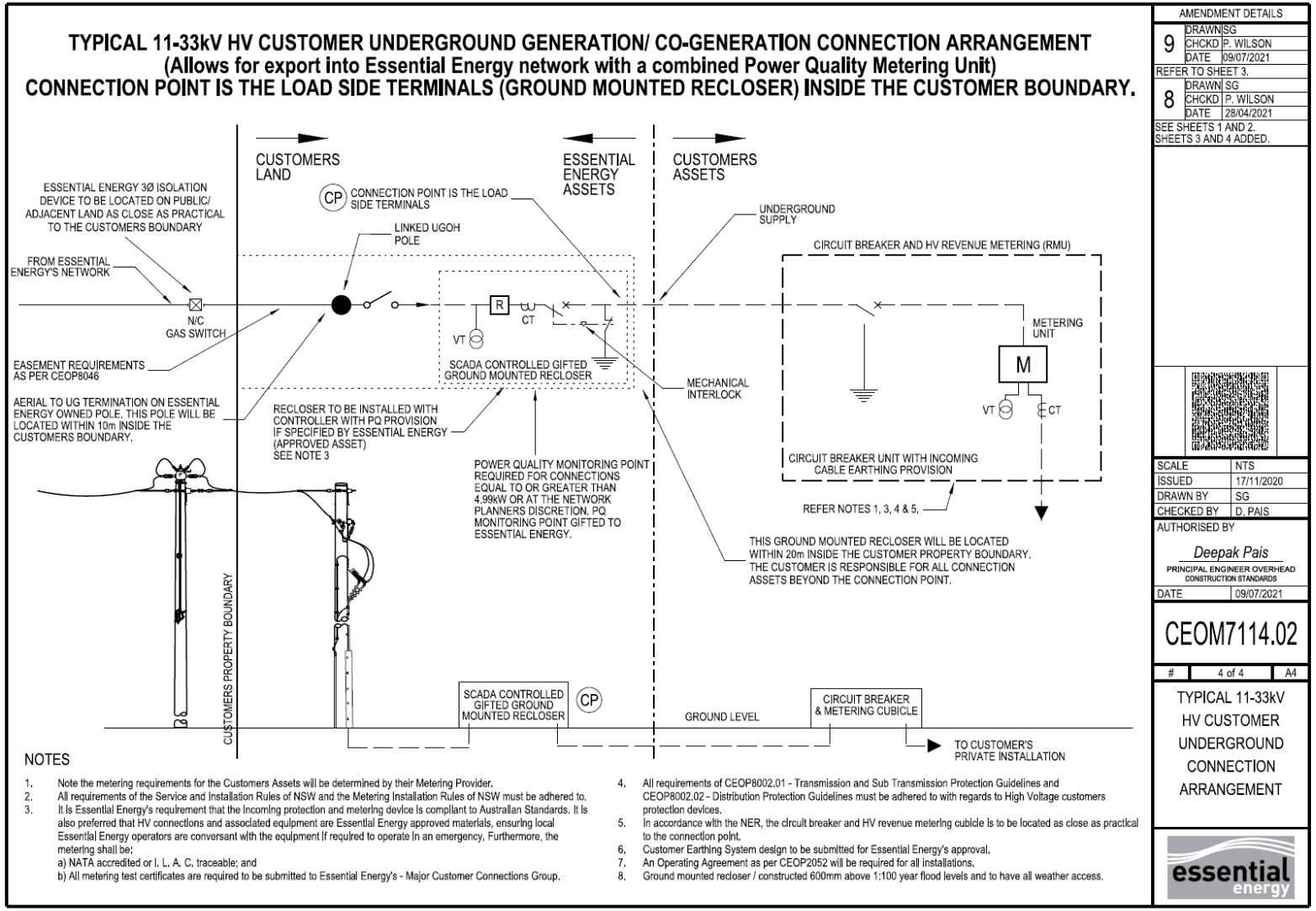

Figure 4: Typical Underground Connection Arrangement sheet 4 of 4 of CEOM7114.02

6.3 Phase 2 Controlled Energisation

Phase 2 is broken up into two paths and is covered by the Essential Energy and Proponent's energisation programs. Essential Energy will control the energisation up to and including the proponent's first protection device. Essential Energy involvement beyond this point will be limited and will be highlighted in the proponent's energisation program.

Essential Energy prefer a staged energisation program and good communications between the proponent and Essential Energy network Control during the energisation process.

6.3.1 Proponent Energisation Plan

With reference to the commissioning framework and specifically the stages 3 (energisation) to 4 (post-energisation), the proponent shall develop an energisation program for their equipment including their switching instructions and operators. This plan will need to be shared with Essential Energy at a minimum of 28 days prior to switching. This plan can be provided in a separate section within the commissioning plan. Staging diagrams shall be used showing the different phases of energising the proponent's network and equipment.

6.3.2 Essential Energy Energisation Plan

With reference to the commissioning framework and specifically the stages 3 (energisation) to 4 (post-energisation), Essential Energy shall develop an energisation program for their equipment including the proponent's equipment up to the first protective device on the proponent equipment. This plan will be developed from the proponent's commissioning program, SLD, energisation plan and switching instructions. This plan will need to be shared with proponent at a minimum of 15 days after receiving the proponent's energisation plan and switching instructions.

7.0 STAGE 4: POST ENERGISATION AND PERFORMANCE TESTING

Tables 4 and 5 show the Asset Type and the corresponding responsibilities.

Table 4: Post Energisation Testing Responsibilities

Asset Type	Responsibility for Completion of Post Energisation Testing	Responsibility for Provision of ITP	Responsibility for Witnessing of Post Energisation Testing
Essential Energy Asset	Essential Energy	Essential Energy	n/a
Gifted Asset	Essential Energy	Essential Energy	n/a
Non-Gifted Asset (Type A)	Proponent	Proponent	Essential Energy
Non-Gifted Asset (Type B)	Proponent	Proponent	n/a

Table 5: Performance Testing Responsibilities

Asset Type	Responsibility for Completion of Performance Testing	Responsibility for Provision of ITP	Responsibility for Witnessing of Performance Testing
Essential Energy Asset	Essential Energy	Essential Energy	n/a
Gifted Asset	Essential Energy	Essential Energy	n/a
Non-Gifted Asset (Type A)	Proponent	Proponent	Essential Energy (Note 1)
Non-Gifted Asset (Type B)	Proponent	Proponent	Essential Energy (Note 1)

Note 1 – Witnessing of Performance Testing is usually only associated with system modelling and/or Connection Agreement compliance.

This specific test plan (Hot Commissioning) will need to be developed in conjunction with Essential Energy's Connection Planning and Commissioning groups. Essential Energy require all test plans to be broken up into number of hold points where the generating system overall output is constrained to several pre-defined outputs. Examples of test plans can be obtained from Essential Energy.

- The commissioning program shall demonstrate that the proponent equipment meets the requirements of the Connection Agreement and system modelling.
- Depending on size and inverter/generator numbers, the performance testing shall include different hold points at a rising output level.
- Confirm correct function of Anti-islanding, testing to be completed after full capacity is reach but prior to any testing that goes over 60 minutes.
- Confirm Auto Shutdown and Start-up of plant, commissioning staff must be on site to monitor both conditions.
- For successful test completion, Essential Energy recommends that a number of online tests are carried out at an output power level of no less than 90% of the generating system's nominal output power. The required tests can vary depending on the project and must be agreed by both Essential Energy and the proponent.
- All results of Post Energisation testing must be forwarded to Essential Energy for review before moving to Performance Testing. Performance Testing may include hold points where specific performance requirements must be met before moving on to the next test.
- As per section 1.6, any issues or events that cause any protection operation or network disturbances, all commissioning work will cease, and an incident or investigation report submitted to Essential Energy for approval within the Essential Energy commissioning team before re-commencing the commissioning.

8.0 PERFORMANCE VERIFICATION

To verify the performance of the plant, it is operated for greater than 5 days and the measured energy generated is assessed against the expected energy generation. This period of testing is carried out after the completion of stage 4 and must include generation on higher loaded periods (weekdays) and lighter loaded periods (weekend).

Typical compliance tests include assessments of the power plant voltage control (fixed reactive power / voltage / voltage-droop / power factor), active power dispatch control, frequency control and PQ analysis.

9.0 ASSET COMMISSIONING AND PERFORMANCE REPORT

After the completion of all performance testing, the commissioning report must be approved by Essential Energy. The generating system may be constrained to 0MW (when reasonably required by Essential Energy) while the commissioning report is being assessed by Essential Energy. This report should be submitted to Essential Energy 30 days after the completion of the performance testing (stage 4).

The commissioning report should contain but not limited to the following requirements:

- Earthing system tests.
- Pre-energisation power quality recording (background).
- Communication system tests.
- SCADA system tests.
- Generating unit's capability tests.
- Generating system performance and capability tests.
- Special Protection System test.
- Full output power quality recordings.
- Compliance monitoring.

Additional following attachments needs to be provided and addressed within the commissioning report:

- Metering unit's calibration certificates.
- Factory acceptance testing.
- PV I-V curve tracing.
- Generating units commissioning report from the Manufacturer.
- High voltage plant elements tests including Transformers, HV cables, Protection system, Switchgear insulation and timing results.

10.0 REFERENCES

Internal		
Document title	**Document Name**	**Document type**
CEOP8079	Connection Process Guideline: Negotiated High Voltage Retail Customer Connections and Embedded Generators	Guideline
CEOP8012	Generation Connection: Protection Guidelines	Guideline
CEOM5125.23	Network Asset Testing & Commissioning Manual	Guideline
CEOS8027	Network Metering Standard	Guideline
CEOP2015	Contestable works Guidelines	
CEOM7109.01	Distribution System earthing low to medium voltage	Drawing
CEOM7109.09	Earthing Resistance Guideline low to medium voltage	Drawing
CEOM5113.02	High Voltage AC distribution Earthing Design	Guideline
CEOM7114.01	Typical 11-33kV HV Customer Overhead Connection Arrangement	Drawing
CEOM7114.02	Typical 11-33kV HV Customer Underground Connection Arrangement	Drawing
CEOP8030	Electrical Safety Rules	Operational Procedure
CERM2456	Earth System Design & Test Requirements CERM2456	Guideline
CEOF6720	Certificate of Electrical Compliance HV	Form
CEOF6047.20	Distribution Plant/Equipment Authority to place into service	Form

External		
AS/NZS 3000	Electrical Installations – Wiring Rules	AS/NZS Standard
AS 2067:2016	Substations and high voltage installations exceeding 1 kV a.c.	AS/NZS Standard
AS/NZS 4777	Grid connection of energy systems via inverters (multiple parts)	AS/NZS Standard
AS/NZS 5033	Installation and Safety Requirements for Photovoltaic (PV) Arrays	AS/NZS Standard
	NSW Service and Installation Rules	

11.0 REVISIONS

Issue No.	Section	Details of changes in this revision	Change Risk Impact?