INSPECTION OF GRID CONNECTED SYSTEMS

FUNDAMENTALS OF SYSTEM INSPECTION AND CASE STUDIES

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INTRODUCTION

Presenter:

Cody Hancock

Technical Lead – Training Team

- 3 years in US solar sector
- 3 years in Germany for Master's degree and research
- 1 year with GSES

AS/NZS 4777 ESSENTIAL LEARNING MODULE

GSES's 4777 updates course has been approved to fulfil the new SAA essential learning requirement.

We are offering this course for **FREE** to all SEIA members. Please contact **tutor@gses.com.au** and copy in **admin@seia.org.au** for your free coupon code.

TRAINING UPDATE

Grid Connect Battery Storage (GCBS)

Accreditation Type	Unrestricted Electrical License Required	Pre-Requisite Units of Competency	Required Units of Competency#
GCBS Design Only *Click here for the list of training providers*	No	**UEERE0054* +** **UEERE0061* +** **UEERE0051/UEEEL0039~**	**UEERE0060*** or VU22123 + VU22125
GCBS Installation Only *Click here for the list of training providers* ***This is only available as an add on to an existing accreditation, not as the first accreditation. Note that the prerequisite units are required.***	Yes	**UEERE0054* +** **UEEEL0012~**	**UEERE0077 + UEERE0078*** or VU22123 + UEERE4001
GCBS Design & Installation *Click here for the list of training providers*	Yes	**UEERE0054* +** **UEERE0061* +** **UEEEL0012~ +** **UEEEL0039~**	**UEERE0060 + UEERE0077 + UEERE0078*** or VU22123 +VU22125 + UEERE4001 or UEERE4001 + UEERE5001

BATTERY FAST TRACK

- No PV experience needed
- Can get Battery Design and Install as 1st Accreditation
- Only 2 days practical, else online at YOUR pace
- Custom made to save you time and money

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Design and Install GSES courses have been approved for 50% Keystone Rebate!!!

COURSE OUTLINE

- Selection and Onboarding of Inspectors
- Inspection Program Methodology
- Inspection Logistics
- Inspection Outcomes and Safety
- Case Studies

SELECTION OF INSPECTORS

- Vetting criteria depends on the program however you may be required to provide:
  - Drivers License (or other proof of identity)
  - Electrical Contractors License (for each state you wish to inspect in)
  - SAA Accreditation for each type of inspection (eg. GCPV, GCBS, SAPS)
  - Deed of Confidentiality (or Non Disclosure Agreement)
  - AFP Police Check (completed within the last 6 months)
  - Current Liability Insurance Cover
  - Other Professional Qualifications (eg. White Card, Working at Heights Card, EWP Operators Card, Silica and Asbestos Awareness Training, etc.)
  - Signed Statutory Declaration stating that information provided is true

SELECTION OF INSPECTORS

- Furthermore, the contracting company or customer is likely to conduct a search to ensure you're a highly capable contractor which may include
  - SAA demerit search
  - CER inspection review
  - Google Reviews
  - Contacting Referees
  - Interview

- In the future, it is likely you will also need to complete UEERE0072 and/or UEERE0074

ONBOARDING

Conflict of Interest:

- Inspectors will also have to complete a conflict of interest check for each inspection they conduct to ensure they are not:
  - the installer of the system they are being asked to inspect
  - they are neither directly or indirectly related to the install or installer in anyway.

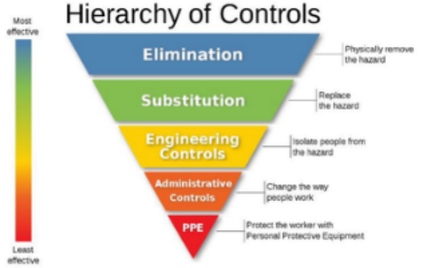
ONBOARDING

WHS/SWMS:

- Inspectors will also have to show that they have prepared SWMS specific to the activities they will be performing and that those SWMS take into account the specifics of the site location.
- SWMS should be broken down into activities accompanied by a list of risks, a risk level assessment and mitigation measures in place.
- SWMS should also account for any induction specifics that are required to gain access to a particular site.

Consequence	Likelihood			
	Unlikely	Possible	Likely	Almost certain
Catastrophic (kill or permanently maim)	MEDIUM	HIGH	EXTREME	EXTREME
Major (long term injury or illness)	MEDIUM	MEDIUM	HIGH	EXTREME
Moderate (Medical attention with several says off work)	LOW	MEDIUM	MEDIUM	HIGH
Minor (first aid needed)	LOW	LOW	MEDIUM	MEDIUM

Unlikely: The event could occur, but probably never will
Possible: The event could occur, but only rarely
Likely: The event could occur at some time
Almost Certain: The event is expected to occur in most circumstances.



Requirements

In addition to the control measures identified over page, inspection teams must ensure:

High visibility uniforms are worn	☐
Inspection team has access to suitable first aid kit	☐
Inspection team has access to fire extinguisher	☐

QUIZ TIME!

Question 1

Not yet answered

Marked out of 1.00

Flag question

Edit question

v1 (latest)

What are some examples of additional professional qualifications that might be useful for an inspector to have? (Select all that apply)

- [ ] White card
- [ ] Working at heights card
- [ ] Certificate IV in training and assessment
- [ ] EWP Operators card
- [ ] Silica and asbestos awareness training

QUIZ TIME!

Question 2

Not yet answered

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Flag question

Edit question

v1 (latest)

Which of the following units of competency could potentially be required in the future to be an inspector of Grid-connected and SAPS systems?

- [ ] UEERE0072 Inspect grid connected renewable energy systems
- [ ] UEERE0073 Inspect micro grid renewable energy systems
- [ ] UEERE0074 Inspect off-grid renewable energy systems
- [ ] UEERE0084 Manage renewable energy (RE) projects
- [ ] UEERE0085 Plan renewable energy (RE) projects

QUIZ TIME!

Question 3

Not yet answered

Marked out of 1.00

Flag question

Edit question

v1 (latest)

Which of the following are potential conflicts of interest for inspectors?

- [ ] The inspector has inspected the site before
- [ ] The inspector installed the system
- [ ] The inspector's company installed the system but they were not directly involved
- [ ] The inspector has a family member who installed the system

QUIZ TIME!

Question 4

Not yet answered

Marked out of 1.00

Flag question

Edit question

v1 (latest)

Which of the following must an inspector provide before going to a site?

- [ ] Current electrical license
- [ ] SAA Accreditation for the inspection type being conducted
- [ ] Inspection site report
- [ ] Conflict of interest check
- [ ] SWMS for the site
- [ ] Business ABN

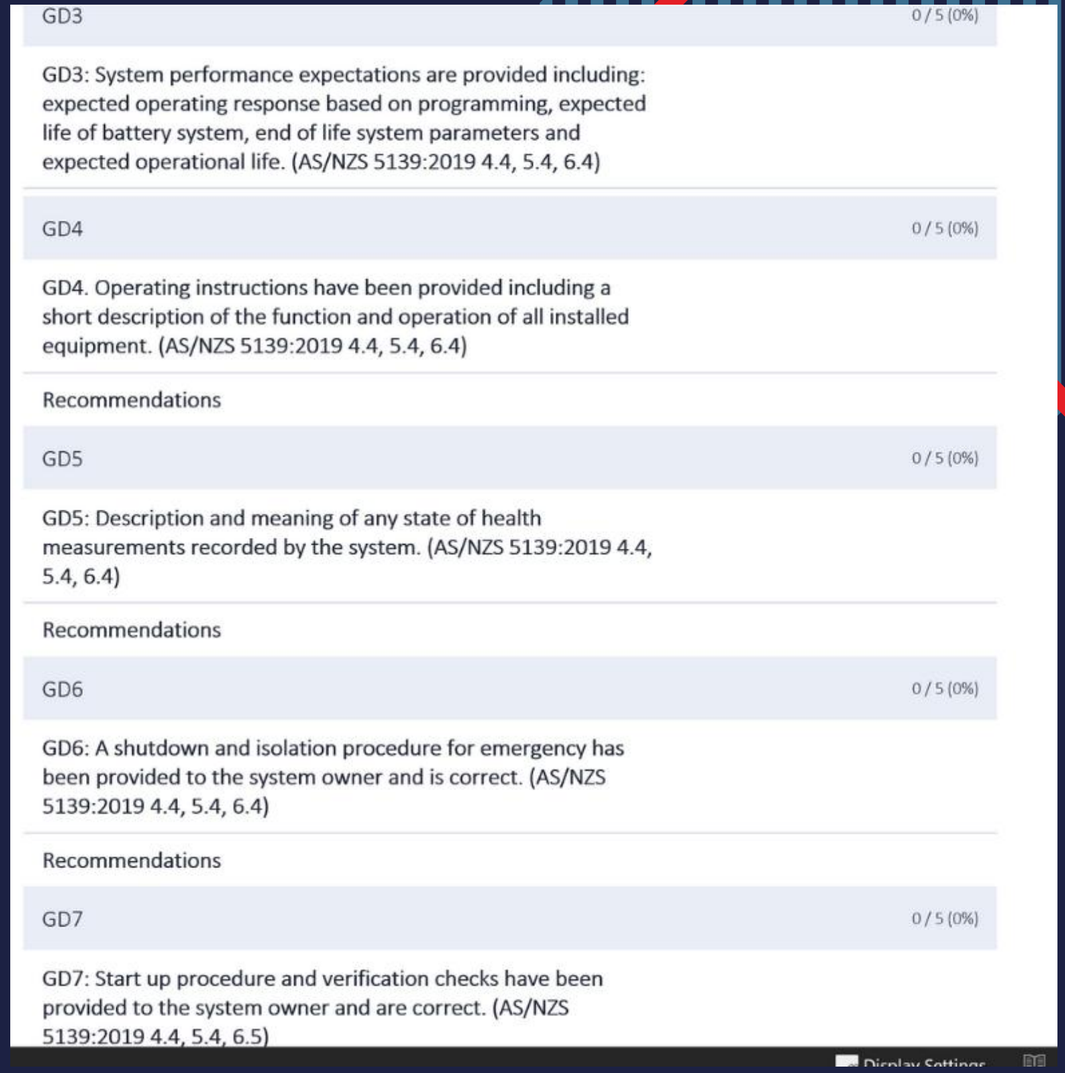
INSPECTOR QUALITY ASSURANCE

- Inspectors should be required to have:
  - pre-inspection training
  - ongoing toolbox talks
  - white paper industry updates (eg Standards, recalls, etc.)
  - inspection audits completed by either the principal inspection contractor, the customer or both.

INSPECTION PROGRAM METHODOLOGY

Inspection Checklist

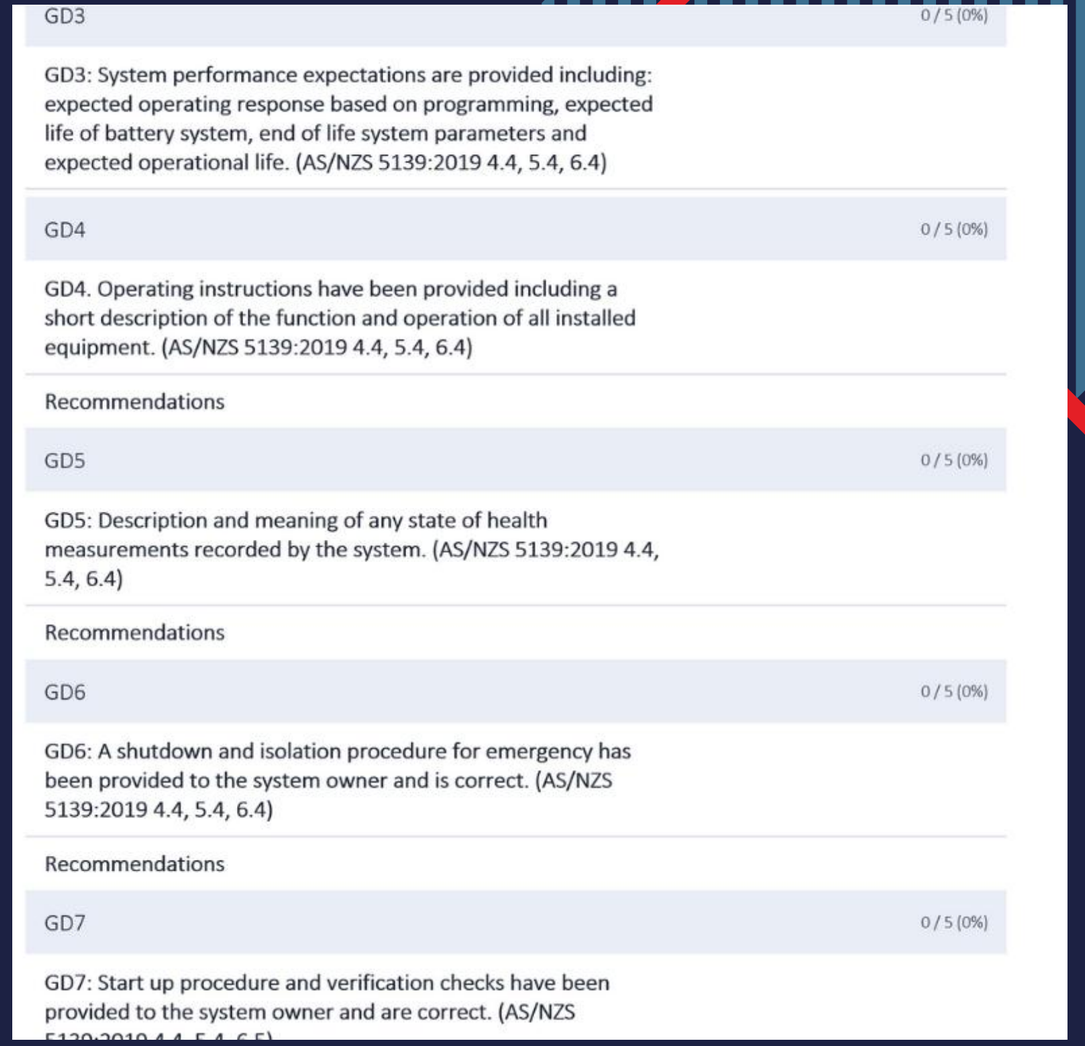
- Perhaps the most important component of the inspection program is the checklist
- The checklist should be created by industry experts and should draw from and reference to Australian Standards, Guidelines, OEM Installation Manuals, State Rules and Program Specifications (if relevant)



INSPECTION PROGRAM METHODOLOGY

Inspection Checklist Cont...

- Logical organisation
- Canned responses with ability for custom responses on each question
- Rectification recommendations
- Allow photo/video upload to each item
  - Photos should be timestamped
  - Should be taken: before, during, and after



INSPECTION PROGRAM METHODOLOGY

Inspection Item Example - “GI6: An Earth Fault alarm has been installed at all inverters and is compliant with standards (5033:2021 4.6.7)”

- “GI6” is the item number, this is important for traceability
- The instruction is for the Installer to confirm an earth fault alarm is present according to the standard clause called out
- An item method will also be included (eg. Take a photo of the alarm and/or inverter monitoring portal confirming alarms can be sent)
- If there are common errors, recommendations can be canned. Custom recommendations should also be made for each inspection and each item.

INSPECTION PROGRAM METHODOLOGY

Traceability and Trackability

- Because processes and checklists must be rigorous, it is highly recommended that they be **digital,** using a purpose built platform
- A unique identifier should be used for each inspection for ease of recall and inspection outcomes should be kept for a period of time (ideally 20 years)
- Inspections are “live documents” until they are closed, and closure can only occur when all stakeholders have provided comments and confirmed that required actions have been taken.
- The Inspection is also the mechanism for escalation to safe work authority, electrical authority and accreditation body if/when necessary

INSPECTION PROGRAM METHODOLOGY

Inspector tools

- Insulation Resistance Tester (Megger)
- Voltage Meter
- Current Clamp Meter
- Irradiance Meter
- Infrared Camera
- Simple hand tools (insulated screwdrivers etc.)
- IV-Curve Tester (Optional)

Also Inspectors should carry a base level of equipment for “make safe” activities which may include MC4s, MCBs, DC Isolators, etc. It is NOT the job of the Inspector to rectify the site, but it is their job to make it safe.

QUIZ TIME!

Question 1

Not yet answered

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Flag question

Edit question

v1 (latest)

Which of the following are required for good inspection quality assurance?

- [ ] Identical inspection outcomes
- [ ] Pre-inspection training
- [ ] Ongoing toolbox talks
- [ ] White paper industry updates
- [ ] Inspection audits

QUIZ TIME!

Question 2

Not yet answered

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Flag question

Edit question

v1 (latest)

What is the most important part of an inspection program?

- Quality assurance
- Inspector tools
- Scheduling matrix
- Inspection checklist
- Toolbox talks

QUIZ TIME!

Question 3

Not yet answered

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Flag question

Edit question

v4 (latest)

What are important attributes of an inspection checklist?

- [ ] Created by experts and tied to standards, installation manuals, state rule, and program specifications
- [ ] The checklist should be done on paper
- [ ] Organised in a logical way that optimises work flow
- [ ] Provide canned responses or option to provide a custom response depending on the situation
- [ ] Provides relevant rectification methods
- [ ] Ability to add photos and videos to each item
- [ ] The checklist should be digital and made using a purpose-built platform

QUIZ TIME!

Question 4

Not yet answered

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Flag question

Edit question

v1 (latest)

Which of the following tools should be carried by an inspector at a minimum? (Select 6)

- [ ] Insulation resistance testers (megger)
- [ ] Volt meter
- [ ] Current clamp meter
- [ ] Irradiance meter
- [ ] Infrared camera
- [ ] Drone for aerial views of the site
- [ ] Simple hand tools
- [ ] Hydraulic cable crimper

COMMUNICATION STRATEGY

Stakeholder communication is critical for the inspections process including:

- Scheduling with the facility occupant/homeowner
- Confirming inspection time with calendar invites, automated text messages or similar
- Having a re-scheduling system in place and/or having a backup inspector in place
- Communicating outcomes to the inspection program principal
- Communicating outcomes with installers for comments and proof of rectification (if required)
- Communication with Electrical Authority, Accreditation Body and DNSP when required.

All stakeholders communicate in different ways and the Inspector must ensure they are organised and capable of meeting the needs of the stakeholders

COMMUNICATION STRATEGY

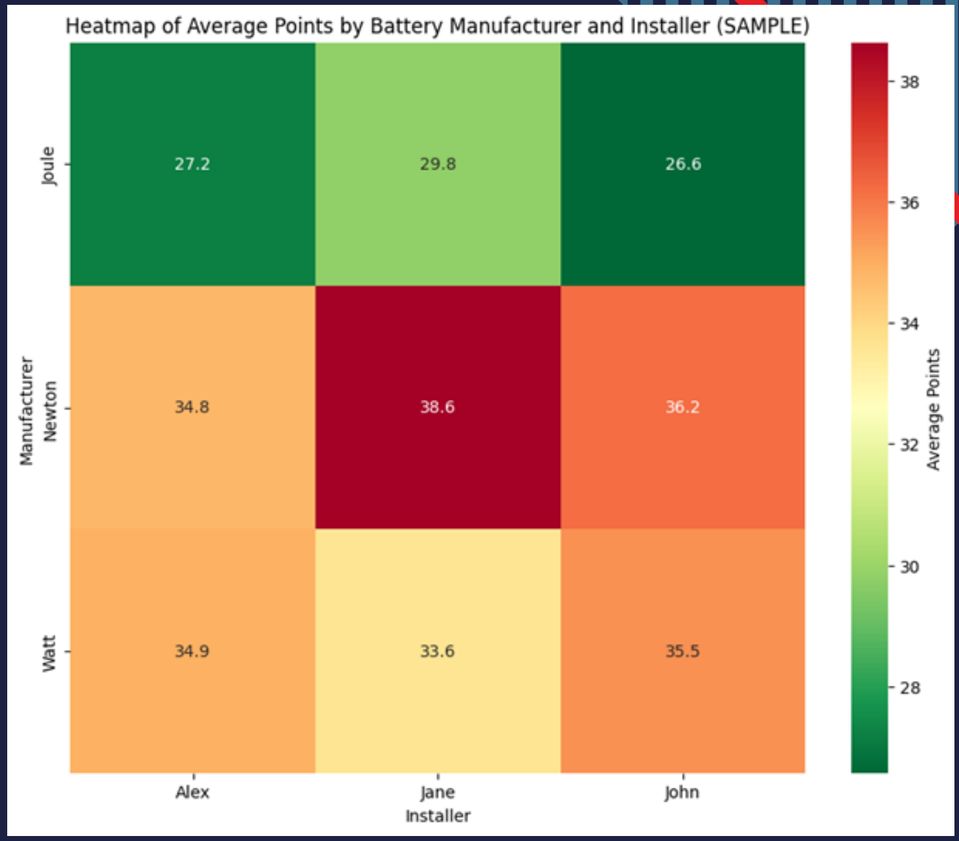
Inspection Principal Contractor Communication:

- Communication between the principal contractor and the inspectors in the field is critical
  - Industry updates
  - resolution to controversial outcomes
  - communicating solutions to common issues
  - identification and product recalls
- Inspectors in the field must have a frictionless method of communicating with the principal contractor
  - Identify issues in workflow,
  - Scheduling
  - confirmation of real time issues.
- Principal contractors should have QA personnel
  - answer questions for field service personnel
  - issue white papers or other written updates
  - should hold toolbox talks on a regular basis.

INSPECTION PRIORITISATION

Where inspections programs involve multiple inspections, an inspection prioritisation methodology may be required:

- According to the Inspection Customer Specific Requirements
- A least cost approach
  - Bundling sites and reducing travel costs
- A risk weighted approach
  - according to correlation between some installation parameter and negative outcomes
- A targeted approach
  - A misbehaving installer



SCHEDULING

Scheduling is often one of the most challenging components of the inspection regime:

- Inspectors may have to complete specific induction or training modules
- Inspection Principal Contractors must schedule inspectors whilst
  - balancing inspection and travel costs
  - inspector and occupant availability
- Inspections often require rescheduling due to
  - poor weather conditions
  - Illness of the customer or inspector etc.
- Scheduling is certainly a process that can be optimised but is often also an art
  - learning inspector behaviour
  - getting context from occupants
  - planning backup inspectors when necessary, etc.

QUIZ TIME!

Question 1

Not yet answered

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Flag question

Edit question

v1 (latest)

Which of the following are relevant stakeholders to be communicated with for an inspection?

- [ ] Occupant/homeowner
- [ ] Local council
- [ ] Inspector
- [ ] Inspection program principal
- [ ] Installers
- [ ] Electrical authority, accreditation body, and DNSP

QUIZ TIME!

Question 2

Not yet answered

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Flag question

Edit question

v1 (latest)

What are some methods of inspection prioritisation?

- [ ] Following the inspection program principal's customer specific requirements
- [ ] A random approach
- [ ] A least cost approach
- [ ] A risk weighted approach
- [ ] A targeted approach

QUIZ TIME!

Question 3

Not yet answered

Marked out of 1.00

Flag question

Edit question

v1 (latest)

What is often the most challenging aspect of inspection logistics?

- Training
- Scheduling
- Communicating
- Travel

QUIZ TIME!

Question 4

Not yet answered

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Flag question

Edit question

v1 (latest)

What are common complications associated with scheduling

- [ ] It requires a technical software
- [ ] Inspectors may require training before going to site
- [ ] Often times inspections need to be rescheduled
- [ ] Must balance costs with availability of both occupant and inspector

INSPECTION OUTCOME PROCEDURE

Inspection outcomes should be categorised for simple and accurate triage of inspections.

- Unsafe - Unsafe systems are systems that create a dangerous or harmful situation for people or equipment
  - Substandard - This category is for any major non-compliance findings whereby a future hazard may occur but is not currently present (eg. no water ingress found, but glands have not been used)
  - Adequate - This category is for any medium or minor non-compliance (eg. breaks standard or is poor workmanship but does not represent a hazard, such as missing labels)
  - Compliant - This category is for inspection items which meet the standard

INSPECTION OUTCOME PROCEDURE

Overall Inspection Outcomes must have rigour around them, however there may be times where the Inspector should use discretion to amend an outcome. For example:

- If an inspection finds a single “unsafe” item, the whole inspection will be deemed “unsafe”
- If a nominal number of medium and minor non-compliances are found, the inspection will be deemed adequate
- If the inspection is riddled with medium non-compliances, the inspector may choose to issue a sub-standard outcome at their discretion. Discretionary outcomes should always be confirmed by the QA team.

SAFETY MANAGEMENT

Safety MUST be the highest priority for the inspection regime.

Occupant Safety:

- Inspectors must identify themselves by showing ID on site and getting a consent form singed
- Inspectors must ensure occupants are at a minimum safe distance to the Inspectors workspace
- Inspectors must communicate clearly and kindly to occupants and must refer to the principal contractor when in doubt

Inspector Safety:

- Inspectors must follow WHS policies and procedures
- Must follow SWMS
- Should ask occupant for hazards specific to the site (eg. pets on site) and should update SWMS accordingly
- Report immediately to the principal contractor if there are any concerns
- Report immediately to the principal contractor if there is a safety incident or near miss

SAFETY MANAGEMENT

Unsafe Systems:

Unsafe systems must be made safe for the safety of all stakeholders and according to legislation

1. Photos and videos must be sent to the principal contractor to confirm the issue and action to be taken
2. The unsafe system should be made safe in the least invasive way possible and should be locked out and tagged out

(All of the above should happen immediately)

3. Within 24 hours the principal contractor should report to the electrical authority, the DNSP and the accreditation body (if required)
4. The principal contractor should liaise with the installer to ensure the unsafe system is made permanently safe
5. And proof is provided of the changes and added to the inspection report.

QUIZ TIME!

Question 1

Not yet answered

Marked out of 1.00

Flag question

Edit question

v1 (latest)

Which of the following is **NOT** a valid inspection outcome?

- Unsafe
- Substandard
- Adequate
- Compliant
- Installed

QUIZ TIME!

Question 2

Not yet answered

Marked out of 1.00

Flag question

Edit question

v1 (latest)

How many unsafe items during an inspection deem a site "Unsafe"?

- 1
- 2
- 3
- 4

QUIZ TIME!

Question 3

Not yet answered

Marked out of 1.00

Flag question

Edit question

v1 (latest)

About how long after an unsafe site is identified should it be made safe?

- Immediately
- Within an hour
- Within the day
- Within a week

QUIZ TIME!

Question 4

Not yet answered

Marked out of 1.00

Flag question

Edit question

v1 (latest)

When an inspector identifies a potential unsafe site what steps should they take, Please put the following in the correct order:

1.
2.
3.
4.
5.

The installer should be notified they installed an unsafe site and told to rectify it

The principal contractor should report the unsafe site to the electrical authority, DNSP, and accreditation body

Ensure the site is made safe and LOTO

Proof of the unsafe site being made permanently safe by the installer should be received and added to the report

Take photo and video evidence and send to the principal contractor to get a second opinion

QUIZ TIME!

Question 4

Correct

Mark 1.00 out of 1.00

Flag question

Edit question

v1 (latest)

When an inspector identifies a potential unsafe site what steps should they take, Please put the following in the correct order:

1. Take photo and video evidence and send to the principal contractor to get a second opinion ✓
2. Ensure the site is made safe and LOTO ✓
3. The principal contractor should report the unsafe site to the electrical authority, DNSP, and accreditation body ✓
4. The installer should be notified they installed an unsafe site and told to rectify it ✓
5. Proof of the unsafe site being made permanently safe by the installer should be received and added to the report ✓

CASE STUDY 1

Earthing of Exposed Conductive Parts depends on:

- The protection class of the device.
- The Decisive Voltage Classification (DVC) of the system.
- The section of the standard applicable to the system
  - Section 4 or Section 5 of AS/NZS 5139:2019
- The manufacturer's earthing strategy.

CASE STUDY 1

AS/NZS 3000:2018 – Electrical Installations (Wiring Rules)

- Section 1: Equipment Classifications and Earthed Situations
  - Clause 1.4.31, 1.4.32, 1.4.33, 1.4.48, and 1.4.50: These clauses define terms such as “protective earth,” “exposed conductive parts,” and classifications of electrical equipment based on their construction and the necessity for earthing.
- Section 5: Earthing Arrangements and Earthing Conductors
  - Clause 5.4.1.1: This clause mandates that exposed conductive parts of electrical equipment must be earthed in certain situations
- Section 7: Special Electrical Installations
  - Clause 7.3.6: Specifies that any exposed conductive parts of an electricity generation system must be earthed by connection to the main earthing conductor at the main switchboard.

CASE STUDY 1

AS/NZS 5139:2019 – Electrical Installations – Safety of Battery Systems for Use with Power Conversion Equipment

- Clause 4.3.1.3.1: Emphasizes that the earthing of a pre-assembled integrated Battery Energy Storage System (BESS) must follow both the manufacturer's earthing requirements and the earthing requirements specified in AS/NZS 3000.
- Clause 5.3.1.6 and Clause 5.3.1.7: These clauses define earthing arrangements for pre-assembled battery systems, specifying various configurations depending on whether the system is separated or non-separated and the relevant Decisive Voltage Classification (DVC).
- Clause 6.3.1.7: Similar to Clause 5.3.1.7 but applies to battery systems not covered in Sections 4 or 5, reinforcing the importance of following manufacturer instructions and appropriate earthing according to the DVC

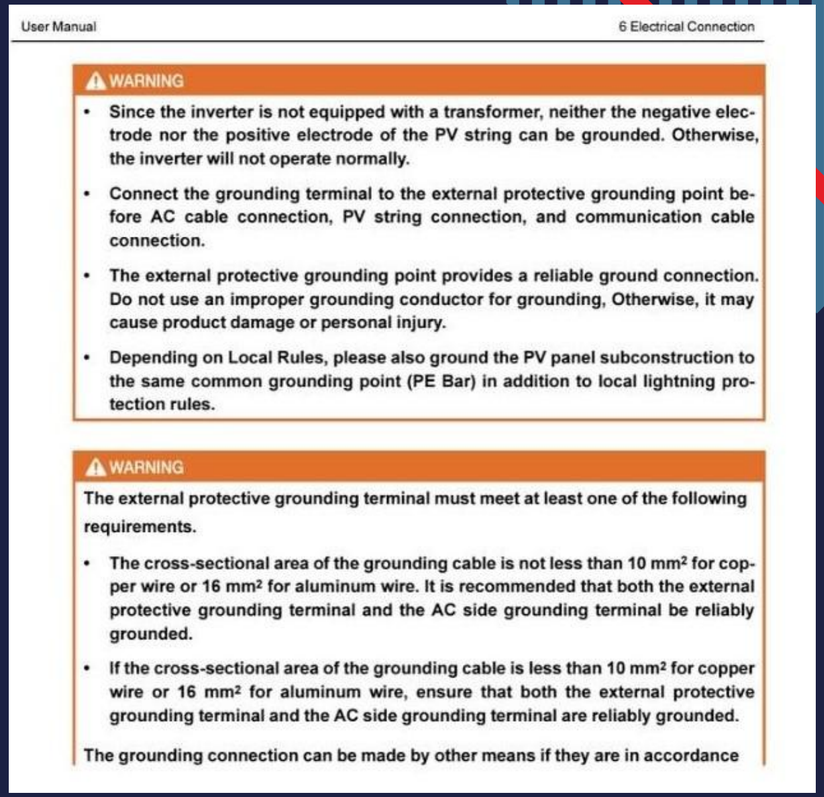
CASE STUDY 1

Whether unused earth terminals in an installation are unsafe depends on the factors outlined above. In many cases, not using an earth terminal is not inherently unsafe, provided that:

- The equipment is correctly classified and meets the conditions specified in AS/NZS 3000:2018 and AS/NZS 5139:2019.
- The system design aligns with the appropriate DVC and follows manufacturer guidelines.
- Proper insulation and protective measures are in place, such as double insulation or the use of SELV/PELV systems.

However, neglecting to use an earth terminal when it is required by the standards or manufacturer instructions can lead to significant safety risks, including electric shock and fire hazards.

Therefore, it is imperative to thoroughly understand and adhere to the earthing requirements specific to each installation.



User Manual 6 Electrical Connection

WARNING

- Since the inverter is not equipped with a transformer, neither the negative electrode nor the positive electrode of the PV string can be grounded. Otherwise, the inverter will not operate normally.
- Connect the grounding terminal to the external protective grounding point before AC cable connection, PV string connection, and communication cable connection.
- The external protective grounding point provides a reliable ground connection. Do not use an improper grounding conductor for grounding, Otherwise, it may cause product damage or personal injury.
- Depending on Local Rules, please also ground the PV panel subconstruction to the same common grounding point (PE Bar) in addition to local lightning protection rules.

WARNING

The external protective grounding terminal must meet at least one of the following requirements.

- The cross-sectional area of the grounding cable is not less than 10 mm² for copper wire or 16 mm² for aluminum wire. It is recommended that both the external protective grounding terminal and the AC side grounding terminal be reliably grounded.
- If the cross-sectional area of the grounding cable is less than 10 mm² for copper wire or 16 mm² for aluminum wire, ensure that both the external protective grounding terminal and the AC side grounding terminal are reliably grounded.

The grounding connection can be made by other means if they are in accordance

QUIZ TIME! – Case Study 1

Question 1

Not yet answered

Marked out of 1.00

Flag question

Edit question

v2 (latest)

Not using an earth terminal is not unsafe when which of the following are met?

- [ ] The equipment is correctly classified and meets the conditions specified in AS/NZS 3000:2018 and AS/NZS 5139:2019
- [ ] The system design aligns with the appropriate DVC and follows manufacturer guidelines
- [ ] The manufacturer installation manual says you should use the earth terminal
- [ ] Proper insulation and protective measures are in place, such as double insulation or the use of SELV/PELV systems

QUIZ TIME! - Case Study 1

Question 2

Not yet answered

Marked out of 1.00

Flag question

Edit question

v1 (latest)

Which standards are important to reference for determining when earth terminals shall be used?

- [ ] AS?NZS 4509.1:2009
- [ ] AS/NZS 3000:2018
- [ ] AS/NZS 1170:2021
- [ ] AS/NZS 5139:2019

QUIZ TIME! – Case Study 1

Question 3

Not yet answered

Marked out of 1.00

Flag question

Edit question

v1 (latest)

If I have a Section 5 pre-assembled battery that is high voltage such as BYD HVM or Sungrow SBR connected to a transformerless hybrid inverter, what is the DVC of the system?

- DVC-A
- DVC-B
- DVC-C

QUIZ TIME! – Case Study 1

Question 4

Not yet answered

Marked out of 1.00

Flag question

Edit question

v3 (latest)

What is "Earthing of Exposed Conductive Parts" dependent upon?

- [ ] The protection class of the device
- [ ] The Decisive Voltage Classification (DVC) of the system.
- [ ] Relying on a phone call the installer had with the manufacturer
- [ ] The section of the standard applicable to the system (e.g., Section 4 or Section 5 of AS/NZS 5139:2019)
- [ ] The manufacturer's earthing strategy

CASE STUDY 2

AS/NZS 5139:2019 dictates batteries CANNOT be installed in restricted locations. Restricted locations include:

- Any restrictions as defined for switchboards (AS/NZS 3000)
- Within 600mm of any exit or entry
- Within 600mm of any vertical side of a window, or any building ventilation, opening into a habitable room
- Within 600mm of any appliance
- Within 900mm below 2, 3, and 4
- In ceiling spaces
- In wall cavities
- On roofs (except where specifically deemed suitable)
- Under stairways
- Under access walkways
- In an evacuation route or escape route.
- Within a habitable room

An exit, as mentioned above, includes garage doors. However, according to the ERAC clarification, **for all states but NSW**, if a person can enter/exit the garage 900mm from the battery, it can be less than 600mm from the garage door.

CASE STUDY 2

A habitable room is defined as a room associated with a domestic or residential electrical installation used for normal living activities and includes:

- Bedroom
- Living room
- Lounge room
- Music room
- Television room
- Kitchen
- Dining room
- Sewing room
- Study
- Playroom
- Family room
- Home theatre
- Sunroom

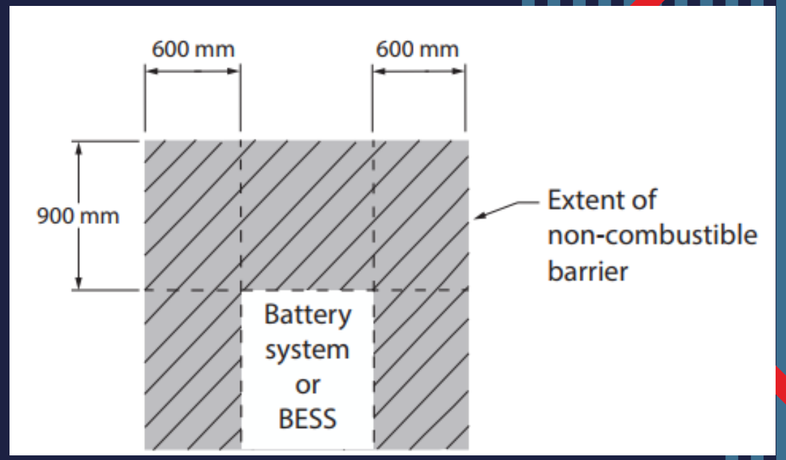
A garage that is used as lounge room or workspace may also be considered a habitable room. It is recommend to avoid installing batteries where the homeowner might spend a considerable amount of time.

Additionally, any manufacturer clearance zones need to be maintained for batteries, inverters, and switchboards. These can vary, and you must check the manufacturer's documentations, but a general rule of thumb is often 200-300mm on all sides of the equipment.

CASE STUDY 2

Materials deemed suitably non-combustible based on AS 1530.1:

- Brick or masonry block
- Concrete
- Compressed cement sheeting
- Ceramic or terracotta tiles



When installing the battery on a wall shared with a habitable room that is made of combustible material (e.g. wood), a non-combustible barrier must be placed between the battery and the wall.

This barrier must extend 600mm to each side of the battery and 900mm above the battery even if there is a corner or a roof (so that it wraps around the corner or ceiling). We also recommend adding a non-combustible barrier if the wall is shared with a staircase or main walkway, for example, near the front door of the house.

QUIZ TIME! - Case Study 2

Question 5

Not yet answered

Marked out of 1.00

Flag question

Edit question

v2 (latest)

Can you install a battery on a brick wall outside of a habitable room if there is a window that does not open <600mm away to a non-habitable room such as a bathroom?

- Yes, the while the window is <600mm away from the battery it does not ventilate into a habitable room
- No, even though the window does not open, the window itself is not a non-combustible material and so this would not be acceptable

QUIZ TIME! – Case Study 2

Question 6

Not yet answered

Marked out of 1.00

Flag question

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v2 (latest)

Can a battery always be installed on the outside wall of a garage?

- ○ Yes, it is a non-habitable room and an exterior wall will not abut a habitable room
- ○ No, in some cases garages can be considered habitable such as being used as a lounge room or workspace for significant periods of a day. This is up to the discretion of the inspector, but if you see a TV or sofa for example probably consider it habitable.

QUIZ TIME! – Case Study 2

Question 7

Not yet answered

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v1 (latest)

In which locations is it acceptable to install a battery in a non-habitable garage <600mm from the garage door?

- [ ] QLD
- [ ] VIC
- [ ] NSW
- [ ] WA
- [ ] SA
- [ ] TAS
- [ ] NT
- [ ] ACT

CASE STUDY 3

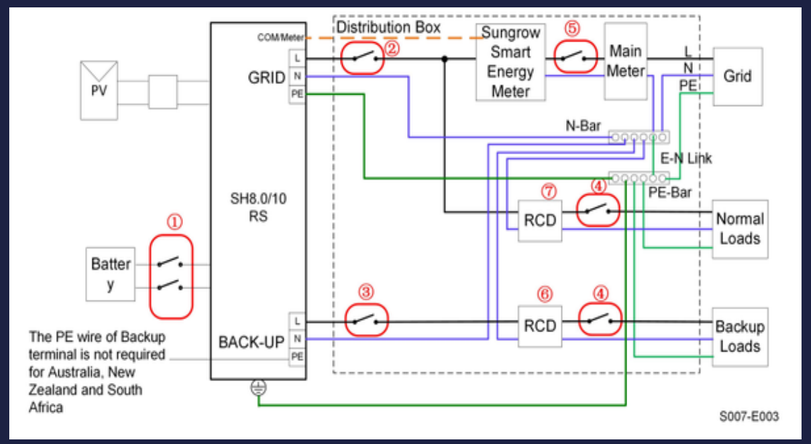
Solar and Battery Hybrid Inverters are being used to power essential services (also called emergency sub-circuits, dedicated loads or selected loads) during grid outages.

One of the key requirements for these systems is to ensure that the neutral connection for the emergency circuit is managed in line with the Multiple Earth Neutral (MEN) system. This is vital for both system functionality and electrical safety.

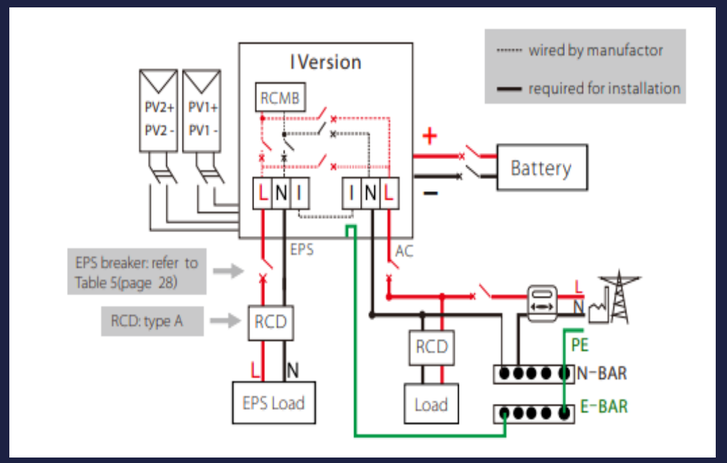
According to Clause 5.3.5 of AS/NZS 3000, the MEN connection must be maintained at the main switchboard where the neutral is bonded to the earth. This is to ensure that the protective earth has a direct connection to the neutral conductor, providing the necessary fault protection. If this connection is disrupted, the protective devices like RCDs (Residual Current Devices) may not function correctly, leading to safety risks.

CASE STUDY 3

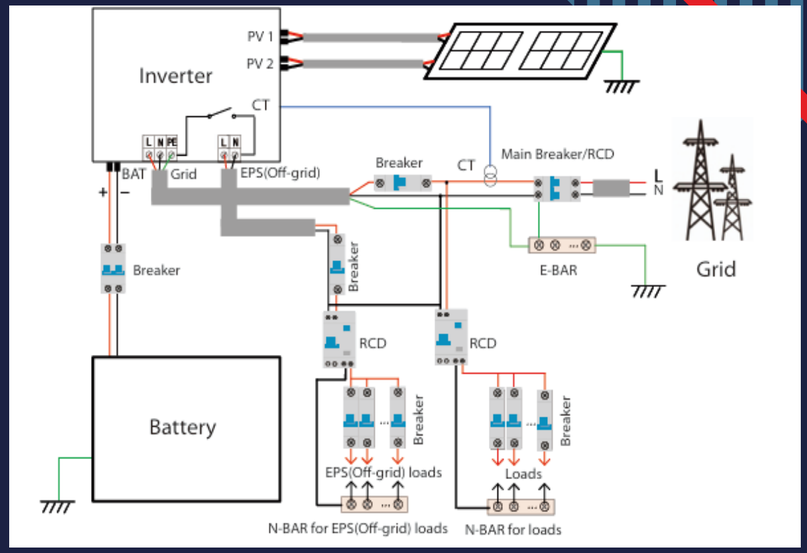
Different inverter manufacturers deal with the neutral connection in varying ways when switching between grid mode and backup (off-grid) mode. It is critically important that systems installers are aware of how the neutral connection is configured in the hybrid inverter they are installing. Below are some configurations that are commonly found and require the installer to deal with the neutral in different ways.



No Internal Neutral Connection

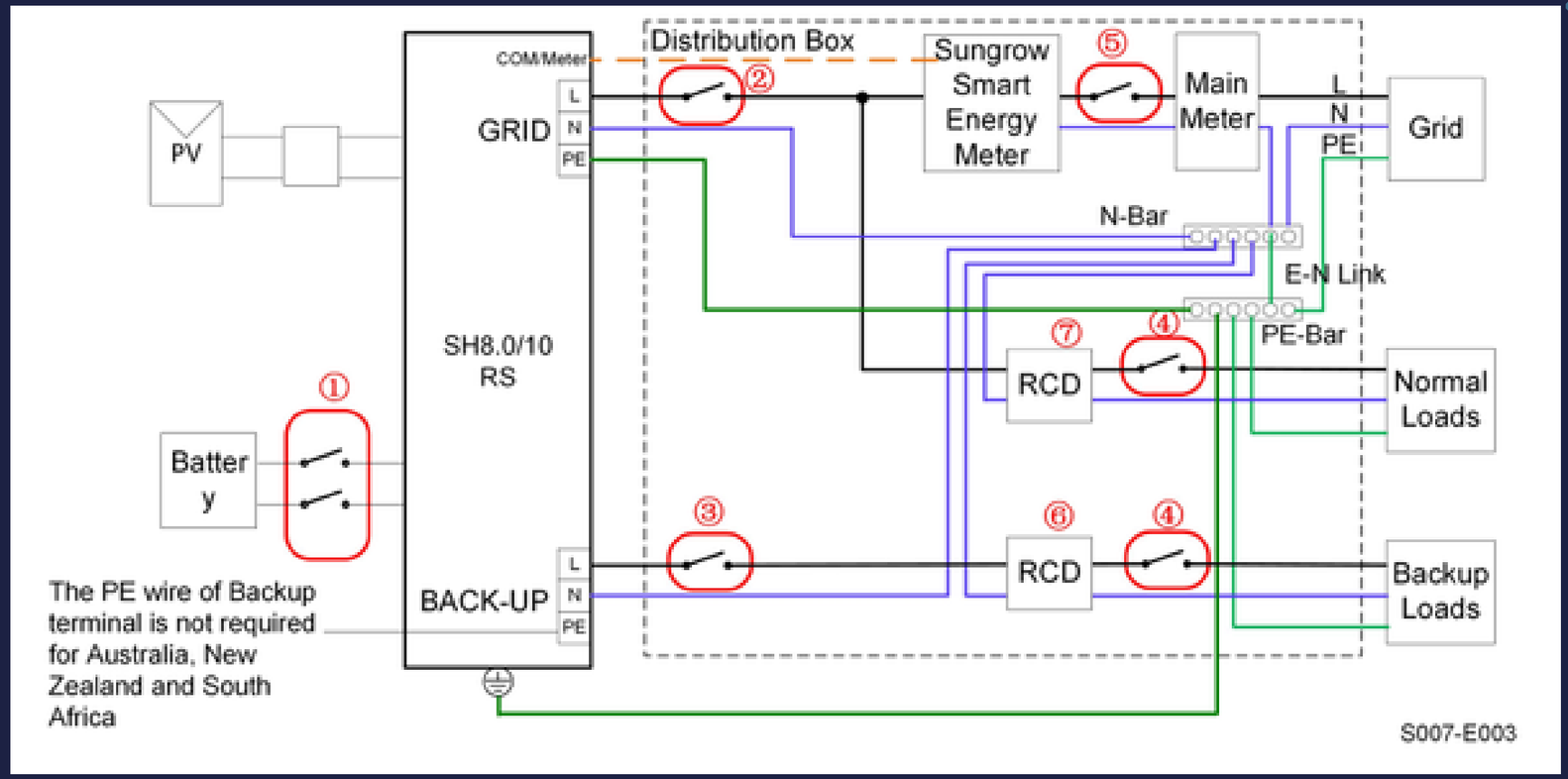


Neutral Bridge Internally Wired by OEM



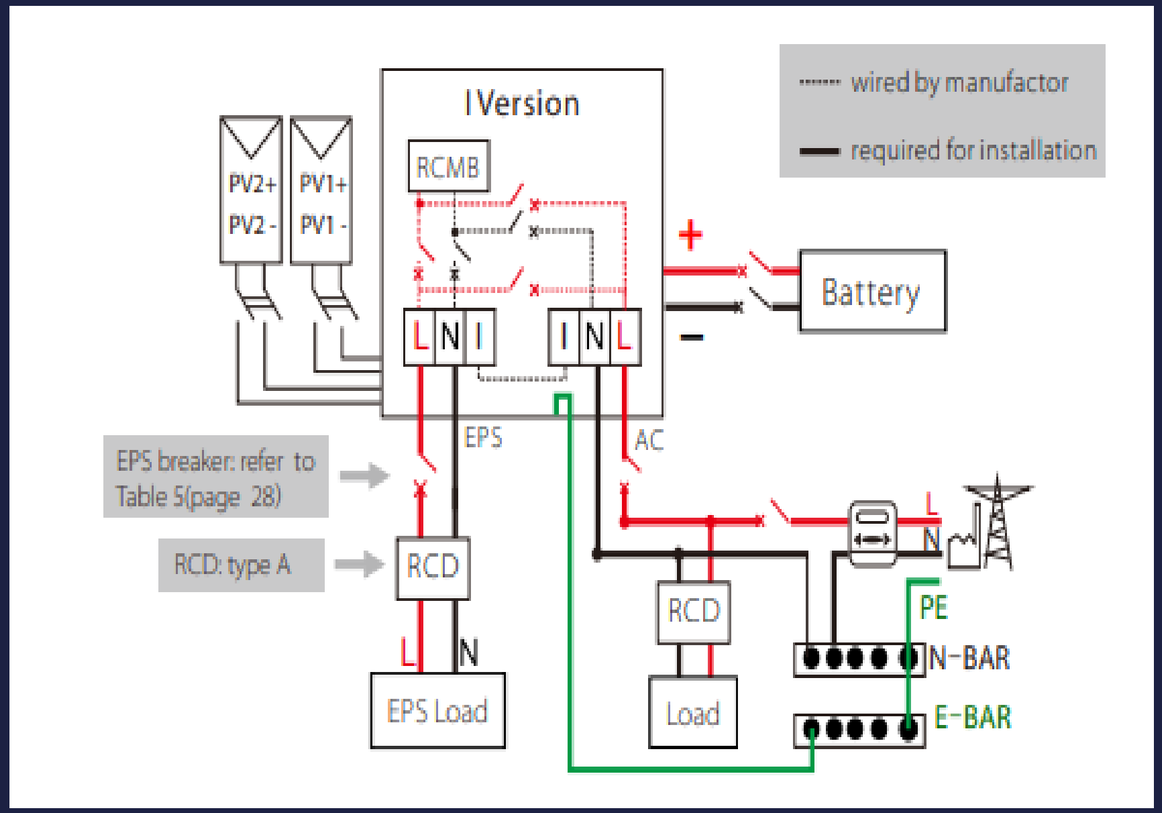
Neutral Switched Internally

CASE STUDY 3



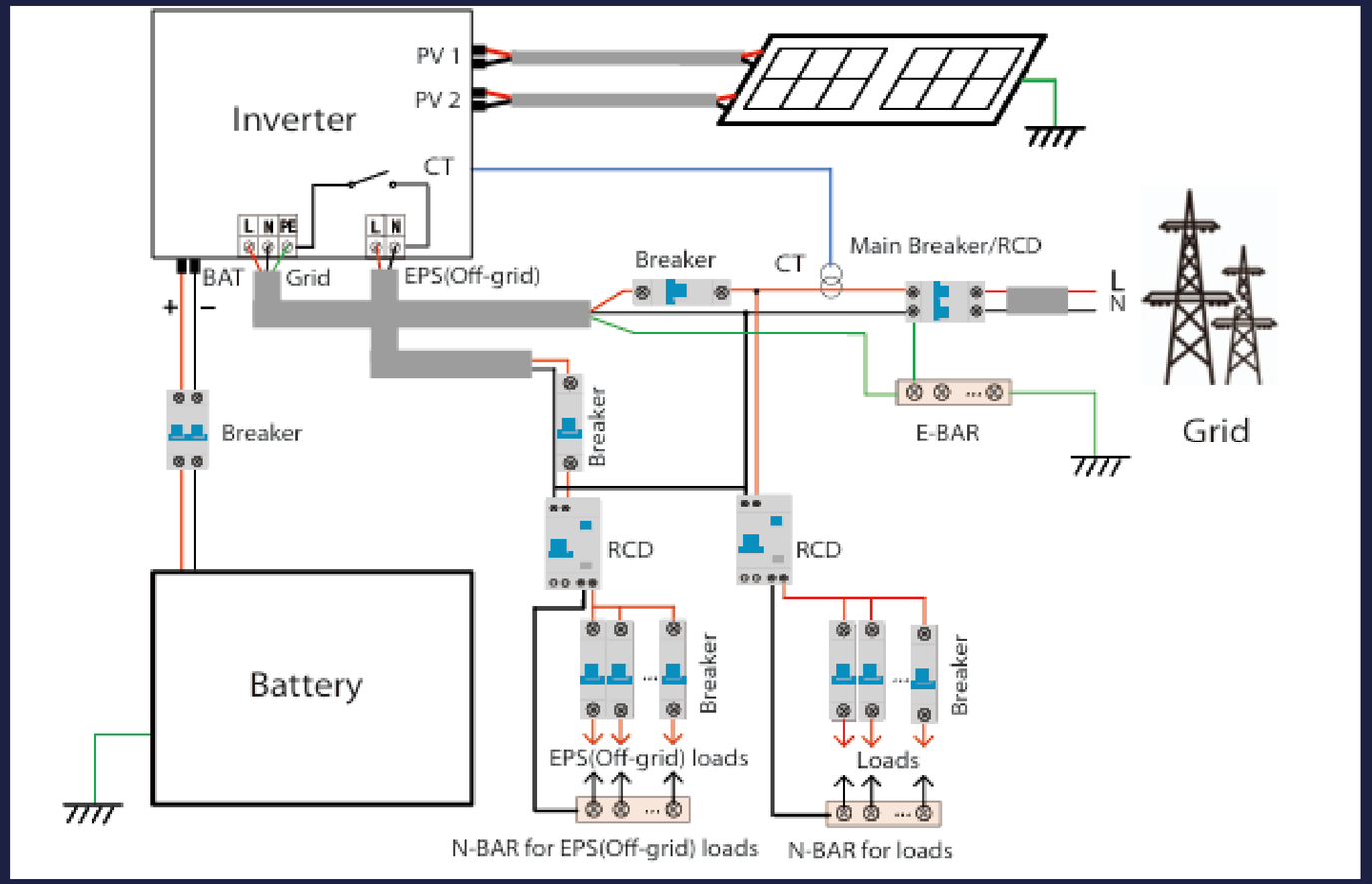
No Internal Neutral Connection

CASE STUDY 3



Neutral Bridge Internally Wired by OEM

CASE STUDY 3



Neutral Switched Internally

CASE STUDY 3

AS/NZS4777.1:2024 Clause 5.3.2.2 – Explains that “The device shall open all active conductors of the grid supply when the alternative supply is connected. The devices should not break the continuity of the neutral conductor or disrupt the operation of RCDs. Where the device interrupts the neutral conductor, then an alternative arrangement to maintain the continuity of the neutral conductor and operation of RCDs shall be provided. The device shall not disconnect the neutral conductor of the incoming grid supply at the main switchboard where the MEN link is provided.”

Finally, the fact that the issue described exists at all implies that proper testing is not being completed on these systems. It is important for installers to conduct the appropriate testing and commissioning on these systems, including, but not limited to the testing requirements in Clause 8.3 in AS/NZS 4777.1:2024.

QUIZ TIME! – Case Study 3

Question 8

Not yet answered

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v1 (latest)

The battery neutral must be maintained at all times all the way back to the ____?

- Inverter
- Alternative supply distribution board
- MEN
- PV array

QUIZ TIME! – Case Study 3

Question 9

Not yet answered

Marked out of 1.00

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v2 (latest)

If the neutral conductor is switched internally in the inverter due to a grid outage, what must the installer do?

- Nothing, the neutral is switched and will connect back
- Install a jumper to ensure the neutral maintains continuity with the MEN
- Install a secondary switch to switch the neutral
- Install an RCD on the alternative supply main switch

QUIZ TIME! – Case Study 3

Question 10

Not yet answered

Marked out of 1.00

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v2 (latest)

Is an installer required to test the continuity of the neutral to MEN in both supplementary and alternative supply scenarios as a part of commissioning?

- ○ No, this is the role of the manufacturer
- ○ Yes, it is a part of AS/NZS 4777.1:2024 Clause 8.3. Neutral continuity is imperative for system safety and must always be tested

CASE STUDY 4

RCD Requirements for Backup Power from Solar PV Inverters

Some solar PV inverters offer a backup circuit that can be used even without the presence of batteries. This backup circuit offers the ability to power a small load, when the PV system is generating energy and when the grid is unavailable. Examples of these inverters include the following:

1. Fronius GEN24 Plus (with “PV Point”)

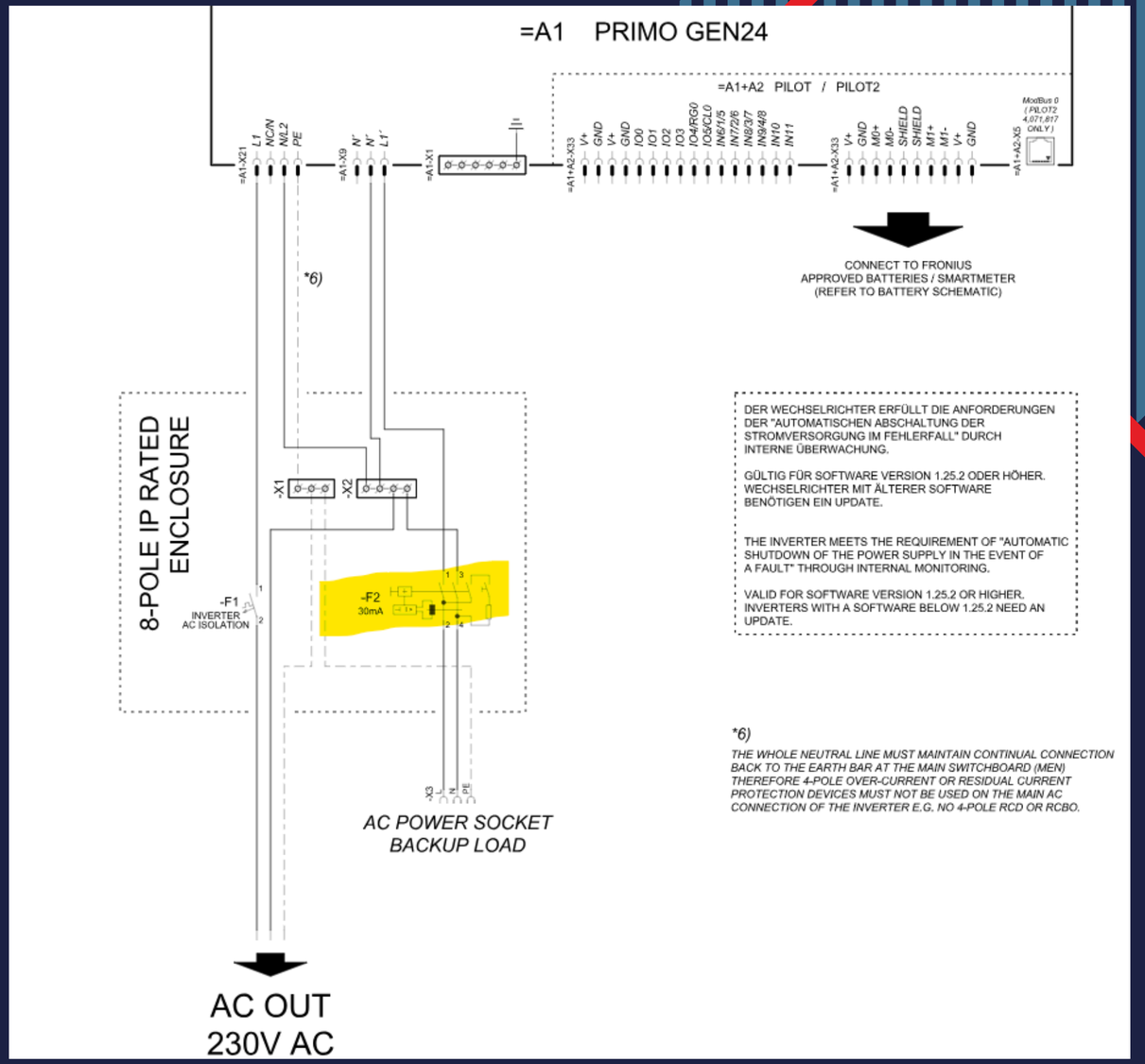
2. SMA Sunny Boy (with “Secure Power Supply – SPS”)

3. Goodwe DNS Inverter (with EPS):

CASE STUDY 4

As per the AS/NZS 3000:2018 (Wiring Rules), Clause 2.6 addresses Additional Protection by Residual Current Devices and specifically Clause 2.6.3 discusses Additional Protection by Residual Current Devices on final subcircuits. This clause states that:

- RCD protection is required on all final subcircuits with a rated current not exceeding 20A that supply power to socket outlets, lighting, and certain other circuits. The standard specifies that these RCDs must have a maximum residual current of 30mA.



QUIZ TIME! – Case Study 4

Question 11

Not yet answered

Marked out of 1.00

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Edit question

v3 (latest)

Which of the following require the installation of an outlet with RCD?

- [ ] Fronius Gen24 Plus with "PV Point"
- [ ] SMA Sunny Boy with "Secure Power Supply – SPS
- [ ] Goodwe DNS Inverter with EPS
- [ ] A Substitute Supply system as laid out in AS/NZS 4777.1:2024 that is an electrically separated system

QUIZ TIME! – Case Study 4

Question 12

Not yet answered

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v1 (latest)

What is the maximum allowable residual current rating of an RCD?

- 10 mA
- 20 mA
- 30 mA
- 40 mA
- 50 mA

CASE STUDY 5

An earth fault is an unintentional connection between a current-carrying conductor and a grounded metal part. On the DC side of a PV array, earth faults typically occur on either the positive or negative wire. They can also happen on one of the ungrounded conductors (L1, L2, or L3) on the AC side of the system. The accidental connection could be with the frame, racking, conduit, electrical box, or any other metal part.

An earth fault can take two basic forms:

- A hard earth fault is a sustained, low-resistance connection between the current-carrying wire and the metal part. This connection remains unbroken over time.

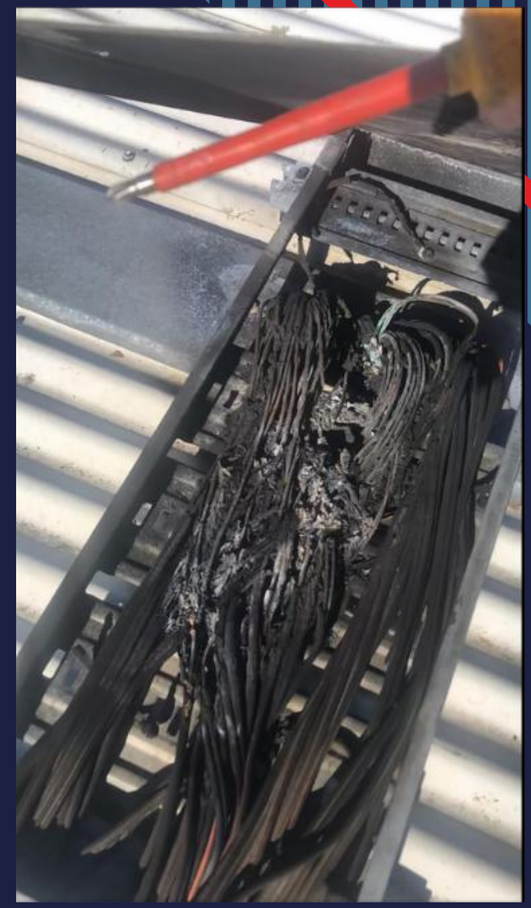
- An intermittent fault is more challenging to locate. It happens when the current-carrying wire occasionally connects to the metal part. A connection can happen during a rainstorm when there's less resistance or when there is mechanical action (due to wind or other vibrations) bringing an exposed conductor into contact with a grounded metal part. Over time, an intermittent earth fault may turn into a hard earth fault.

CASE STUDY 5

How to test energized DC PV string circuits with earth faults

Once the insulation resistance is confirmed to be below the required value as per AS/NZS 4777.2 Table 2.1 and the affected string or strings are identified, further testing can begin.

The specific location of the earth fault can be identified by measuring the voltage of the affected string or strings. Module open circuit voltage (Voc) can be found on the module label or data sheet and the PV string voltage is calculated by multiplying the module Voc by the number of modules in series.



CASE STUDY 5

Test for current on each string first

It’s critical that you test for current on both the positive and negative conductors before opening the circuit. Double earth faults or installation errors can lead to closed circuits where short circuit current (Isc) may be present.

Opening a fuse holder, disconnection point or ELV connector (eg MC4) while current is flowing is dangerous. It can create a DC arc that can harm both you and the equipment

Use a current clamp to verify zero current in each PV circuit string before opening the circuit.
De-energize and lockout/tagout (LOTO) where you’re working
Isolate the equipment to be tested. Open (turn off) the load break rated disconnect in the section where you’re working — this may be a specific area or every isolator or disconnection point in the array.

CASE STUDY 5

How to locate an earth fault in a PV string circuit by the numbers:

A PV string circuit without an earth fault will have open circuit voltage (Voc) between positive and negative conductors. It will have zero volts from positive to ground and from negative to ground.

When an earth fault is present, measurement will show Voc between positive and negative conductors, but it may also reveal a value other than zero on the positive to ground, negative to ground, or both.

A severe fault may include line to line faults as well as earth faults where location identification may be easier to achieve visually. However, if the earth fault is localised then the earth fault can be located using the proportion of voltage from array positive or negative to earth over the open circuit voltage compared to the number of panels in the string

CASE STUDY 5

Let's look at an example:

Voltage to Ground on Both Positive and Negative Sides
In this example, a string of 16 modules with a Voc of 50.62 VDC per module should expect a total open circuit voltage on the string of around 809.92V

- Measure between positive and negative conductors:
  - Reading: 809.92 VDC
- Measure positive-to-ground:
  - Reading: 607.44 VDC
- Measure negative-to-ground:
  - Reading: 202.48 VDC
- These readings indicate voltage to ground on both sides. We can determine location

by dividing the voltages by the string Voc (eg 202.48V/809.92V is 25% of the string)

- Result: The fault is located at or after module 4 and before module 5 from t negative.

CASE STUDY 5

Some earth faults only appear in wet conditions, either with morning dew, rain or even condensation in combiner boxes or within PV modules. Unfortunately, these types of faults can only be located when those conditions are present. In order to recreate these conditions, it may be necessary to spray the system down with a hose and conduct the tests as described above.

If this is required to be done however, it is critical that extra safety precautions must be taken since you have now created a dangerous situation for working with electrical equipment in a wet environment and working on a wet slippery roof. These safety precautions must be identified clearly in your Safe Work Method Statements (SWMS) and adhered to during the works. The photos below show an intermittent earth fault caused by a small nick in a panel cable.

QUIZ TIME! – Case Study 5

Question 13

Not yet answered

Marked out of 1.00

Flag question

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v2 (latest)

If you have a PV string of 10 modules with a total Voc of 500V, identify the location of the earth fault if you receive the following measurements:

- Positive to Negative: 500 VDC
- Positive to Earth: 150 VDC
- Negative to Earth: 350 VDC

- ○ Between the 3rd and 4th module from the negative side
- ○ Between the 3rd and 4th module from the positive side
- ○ On the negative conductor between the inverter and array
- ○ On the positive conductor between the inverter and array

QUIZ TIME! – Case Study 5

Question 14

Not yet answered

Marked out of 1.00

Flag question

Edit question

v2 (latest)

Why can earth faults be tricky to identify and troubleshoot?

- ○ They aren't; Earth faults are dangerous but once present they are always present
- ○ They are only caused by faulty or sensitive inverters
- ○ They are black magic and only exist when you aren't on site
- ○ They can be intermittent only showing up in specific scenarios such as rain or dewy morning when conductivity is higher

QUESTIONS?

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