

BEST PRACTICE GUIDE: BATTERY STORAGE EQUIPMENT ELECTRICAL SAFETY REQUIREMENTS

SUPPORTED BY:



This best practice guide has been developed by industry associations involved in renewable energy battery storage equipment, with input from energy network operators, private certification bodies, and other independent stakeholder groups and individuals, as well as consumer and electrical safety regulators. The following organizations participated in the development of the draft:

Australian Industry Group
Consumer Electronics Suppliers Association, Australia
Clean Energy Council
CSIRO
Energy Networks Australia
Smart Energy Council

This guide is open to use by all manufacturers and importers, and others in the supply chain, to assist them to address identified safety risks of battery storage equipment.

Disclaimer

While this guide has been developed by people with current knowledge and experience in battery storage equipment technologies and associated risks, it is not guaranteed that this document covers all safety issues of all types of design, construction and technologies.

The information presented in this guide is provided as an information source only, and does not override any legislative requirement or duties of any person or company in the supply chain of battery storage equipment. You must obtain your own legal and professional advice and satisfy yourself regarding the actions necessary to ensure your compliance with legal and commercial duties and obligations.

To the extent permissible by law the authors disclaim all responsibility and liability (including liability in negligence) for all expenses, losses, damages and costs incurred as a result of your reliance on information or requirements of this guide or for any breach by you of your commercial, contractual or legislative duties and obligations.

The document is not intended to preclude application of additional safety requirements, or requirements not related to safety, should any person or company wish to apply, or identify a need to apply, such requirements (or be required to apply under any legislative provisions or contractual arrangements).

This *Best Practice Guide: battery Storage Equipment – Electrical Safety Requirements* and *Battery Energy Storage Equipment Risk Matrix* (excel spreadsheet) are located at www.batterysafetyguide.com.au

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PART 1 – INTRODUCTION AND DEFINITIONS

1.1 Why has this guide been developed?

Battery storage equipment is an important part of the energy usage mix for households to consider for reliability, affordability and efficiency. However, prior to this guide being developed, there was no specific product safety standard expressly covering the risks of a completed battery storage equipment assembly in a household situation. This allowed manufacturers and importers of battery storage equipment to apply different standards to show the electrical safety of the equipment, leading to concerns about how the safety of a particular type, brand or model of equipment can be ensured and compared with others.

Stakeholders, including equipment manufacturers and importers, identified the need to develop consistent and transparent minimum safety criteria that can be applied when assessing the safety of battery storage equipment. In the first instance it was identified equipment using lithium technology needed clear and consistent safety criteria to be applied, which are detailed in this guide.

By applying the safety criteria, manufacturers and importers can demonstrate that their equipment meets the minimum acceptable level for safety for installation in household environments and provides an acceptable level of protection against hazards such as electrical, mechanical, thermal, fire and radiation. This will give homeowners confidence that equipment complying with this guide, that is installed and maintained in accordance with manufacturer's instructions and standards such as AS/NZS 4509.1 *Stand-alone power systems*, AS/NZS 5139 *Electrical installations – Safety of battery systems for use with power conversion equipment* (when published) and AS/NZS 3000 *Wiring rules*, will pose a minimal risk during the equipment's normal operation.

All Australian states and territories have legislative requirements that electrical equipment supplied and installed is electrically safe. This guide applies the principles of AS/NZS 3820:2009 *Essential safety requirements for electrical equipment* in determining appropriate minimum safety criteria that applies to battery storage equipment for household situations. AS/NZS 3820:2009 sets out high level, generic, outcome orientated criteria for the safety of electrical equipment. AS/NZS 3820:2009 points to the need to apply relevant product safety standards to provide measureable criteria, and also notes that reference to multiple standards and additional reports or information may be necessary to address all identified risks.

This guide has been developed in conjunction with a Risk Matrix - *Battery Energy Storage Equipment – Risk Matrix* which forms an integral part of this guide and is included as Appendix 1.

Although this guide has been developed to apply consistent and transparent minimum safety criteria, there may still be other risks with any particular equipment design or technology used that have not been considered within this guide. Equipment designers and manufacturers should ensure that any such risk has been adequately addressed.

Compliance with this guide does not excuse suppliers (including those at all levels in the supply chain) from meeting their statutory obligations under the Australian Consumer Law (ACL).

[1.2 Who should use this guide?](#)

Manufacturers and importers can use the criteria contained in this guide to demonstrate their battery storage equipment meets industry best practice electrical safety standards. They can do this by applying the minimum requirements of one of the mandatory methods in full and also applying any of the optional criteria to show the processes and procedures they have in place to ensure on-going verification for the battery storage equipment.

Regulatory authorities, testing laboratories, certifiers, importers, retailers, installers and others can use the principles in this guide as a consistent standard against which they can assess whether battery storage equipment is safe to install and operate in household environments.

The task of verifying compliance with the mandatory and optional provisions in this guide is to be performed by an appropriately qualified, competent and experienced person.

[1.3 Which equipment does this guide apply to?](#)

[1.3.1 Scope of the guide](#)

This guide provides safety criteria for battery storage equipment that contains lithium as part of the energy storage medium. Battery storage equipment is generally complete, pre-packaged, pre-assembled, or factory built equipment within the one enclosure (except for master/slave configurations where there is a main unit and additional battery module units that can be connected together). This includes types that are:

- Battery module
- Pre-assembled battery system (BS) equipment
- Pre-assembled integrated battery energy storage system (BESS) equipment

This guide applies to battery storage equipment, including battery modules that are installed within the battery storage equipment, that are within the following criteria:

- The equipment is intended to or able to be installed for household, domestic, residential or similar use.
- The battery contains lithium as part of the energy storage medium.
- The battery storage equipment has a rated capacity of equal to or greater than 1kWh and up to and including 200kWh of energy storage capacity when measured at 0.1C.
- For battery modules, the output voltage upper limit is 1500Vd.c. (noting that such parts are not accessible to users and energised parts are not accessed by installers).
- For pre-assembled battery storage equipment, the output voltage upper limit is 1500Vd.c.
- For pre-assembled integrated battery energy storage system equipment, the output voltage upper limit is 1000Va.c. (noting there is no internal d.c. voltage limit of such equipment, as any internal d.c. voltage is not to be accessible, even when equipment is opened for assembly, installation, maintenance or repair on site).
- The equipment is permanently connected to an electrical installation.

This guide is intended to cover battery storage equipment that would be within the scope of AS/NZS 5139 *Electrical Installations – Safety of battery systems for use with power conversion equipment*

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(when published). While this guide doesn't specifically cover equipment being used in commercial, industrial or other non-domestic/residential settings, or for systems with an energy storage capacity of over 200kWh, the general requirements and principles of this guide and risk matrix may be applied to offer some guidance in those situations, though there may be additional hazards in those circumstances that have not been identified in this guide.

Battery storage equipment may be supplied as separate parts for transport and require assembly on site into the one enclosure, however the parts as assembled in accordance with manufacturer's instructions is the battery storage equipment that has been tested to the requirements of this guide. Except for a master/slave configuration of equipment, there is no external interconnecting cables or cords or other connections (such as busbars) connecting between discrete groups of equipment. If this occurs (interconnection between discrete groups of equipment), it is considered an installation of a group of individual battery storage equipment.

This guide does not provide information on the installation of a battery storage equipment at a site or multiple battery storage equipment units together at a site. Installation must comply with manufacturer's instructions and an appropriate installation standard such as AS/NZS 4509.1 *Stand-alone power systems*, AS/NZS 5139 *Electrical installations – Safety of battery systems for use with power conversion equipment* (when published) and AS/NZS 3000 *Wiring rules*, and considering any suitable industry guide for installation. Designers of installations and installers need to carefully consider each installation and the likely risks associated with that installation.

1.3.2 Application of this guide to inverters assessed under uninterruptible power supply (UPS) standards

This guide must be applied to battery storage equipment claimed to be compliant to this guide in addition any requirements of AS 62040.1.1:2003(R2013) *Uninterruptible power systems* (or later editions) that may have been applied to inverters for use in inverter energy systems that have energy storage (batteries) as the only possible energy source (as currently referenced in clause 5.1 of AS/NZS 4777.2:2015). The UPS standards alone do not address a number of safety issues specific to battery storage equipment that have been covered by this guide.

If the equipment is claimed to be compliant to this guide and it

- falls within the criteria listed in section 1.3.1 above,
- is a UPS that complies with the UPS standards,
- is permanently connected to an installation and
- has the ability to generate a.c. in parallel with, or inject into, the consumer mains (i.e. back into the grid) or is an off grid or stand-alone installation,

it must be shown to comply with the requirements of this guide, not just compliance with UPS and inverter standards.

Note 1: Where the equipment does comply with AS 62040.1.1:2003(R2013) *Uninterruptible power systems* (or later editions), then Method 3 of this guide may be the most appropriate method to apply.

Note 2: A separate inverter, for use in inverter energy storage systems, that simply has d.c. inputs for connection of external battery modules is not, by definition, battery storage equipment or a master/slave configured battery storage equipment.

1.4 Definitions

Definition of battery storage equipment

Battery Storage Equipment

For the purpose of this guide, battery storage equipment is pre-packaged, pre-assembled, or factory built equipment that has been designed, manufactured and tested/verified as a stand-alone complete package supplied by the one manufacturer or importer for installation. It may be supplied in several parts for transport and assembled on site, but does not need on-site modification or manufacturing or supply of other parts for that assembly to occur.

Battery storage equipment could be any of the following three types:

Battery module

One or more cells linked together. It may also have incorporated electronics for monitoring, charge management and/or protection.

Battery modules are installed within pre-assembled battery system equipment or pre-assembled integrated battery energy storage system equipment or as part of a master/slave configuration of such equipment.

Pre-assembled battery system (BS) equipment

A system comprising one or more cells, modules or battery system, and auxiliary supporting equipment such as a battery management system and protective devices and any other required components as determined by the equipment manufacturer. It does not include a Power Conversion Equipment (PCE). Pre-assembled battery system equipment come in a dedicated enclosure. The equipment is a complete package for connection to a d.c. bus or d.c. input of a PCE (see Diagram 1).

Pre-assembled integrated battery energy storage system (BESS) equipment

A battery energy storage system manufactured as a complete integrated package with the PCE, one or more cells, modules or battery system, protection devices, power conversion equipment and any other required components as determined by the equipment manufacturer. Pre-assembled integrated battery energy storage system equipment are supplied in a dedicated enclosure. Integrated battery energy storage system equipment is a complete package that has a.c. output for connection to the electrical installation (see Diagram 2).

Note: Pre-assembled battery system (BS) equipment or pre-assembled integrated battery energy storage system (BESS) equipment may have d.c. outputs for connection of extra d.c. battery storage equipment in an assembly of a master/slave configuration of equipment. All configurations of equipment parts will need to be able to be shown to comply with this guide, as individual equipment parts and also as the assembled equipment master/slave configuration.

Note: Battery storage equipment would generally be supplied as a complete 'pre-assembled' package with the only electrical connection or assembly requirements for installation being the connections to the a.c. or d.c. terminals and mounting the equipment on suitable support or base as appropriate. However due to transport and handling safety issues (such

as weight and dangerous goods requirements) some battery equipment may be a master/slave equipment system or be components supplied in separate parts for combining on site. However the final installed equipment is the same package (of varying sizes of energy storage or configurations of internal components as designed and tested by the manufacturer/importer) irrespective of where it is supplied and installed. The critical aspect of these devices is they are the one unit designed, manufactured and tested to this guide by the manufacturer or importer as one configured piece of equipment within a pre-built enclosure that is supplied as part of the equipment, or are master/slave parts within their own enclosures but still assessed as one piece of equipment to this guide.

For clarity, battery storage equipment is not:

- Separate third party supplied parts to be assembled on site (that is an installation).
- A separate PCE connected to a separate assembled battery system matched together by a system designer or installer.
- Bespoke equipment designed for, and has separate parts installed for, a particular site, or designed or modified on site by installer, or equipment from various third party manufacturers, importers or suppliers installed together on site.

Diagram 1: An example of parts of pre-assembled battery storage equipment

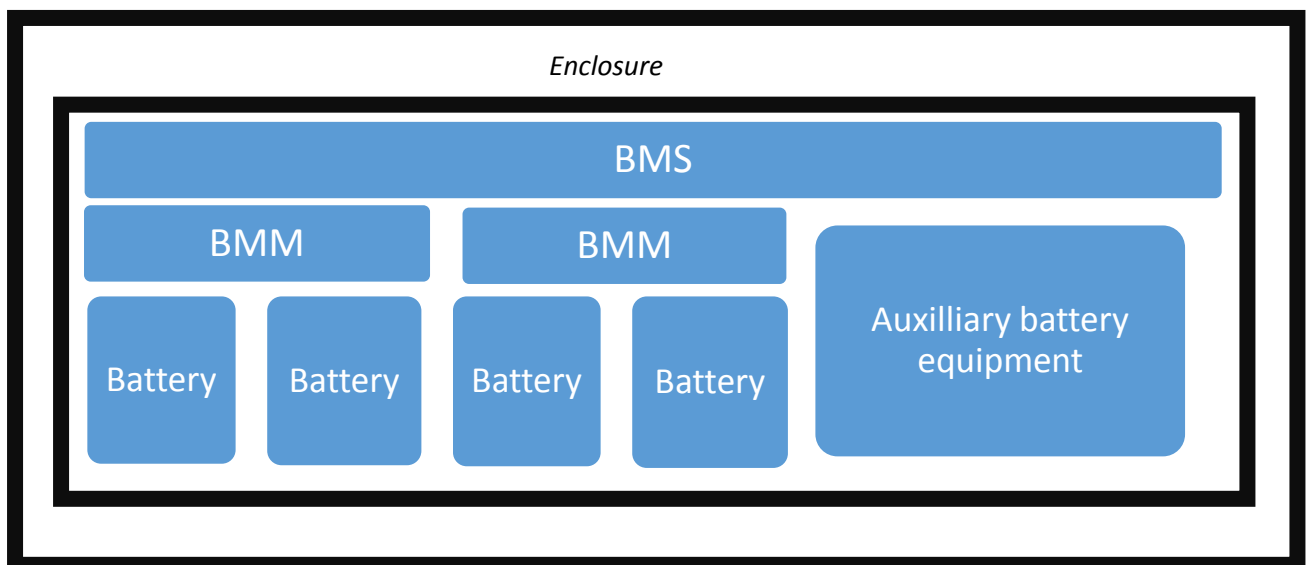
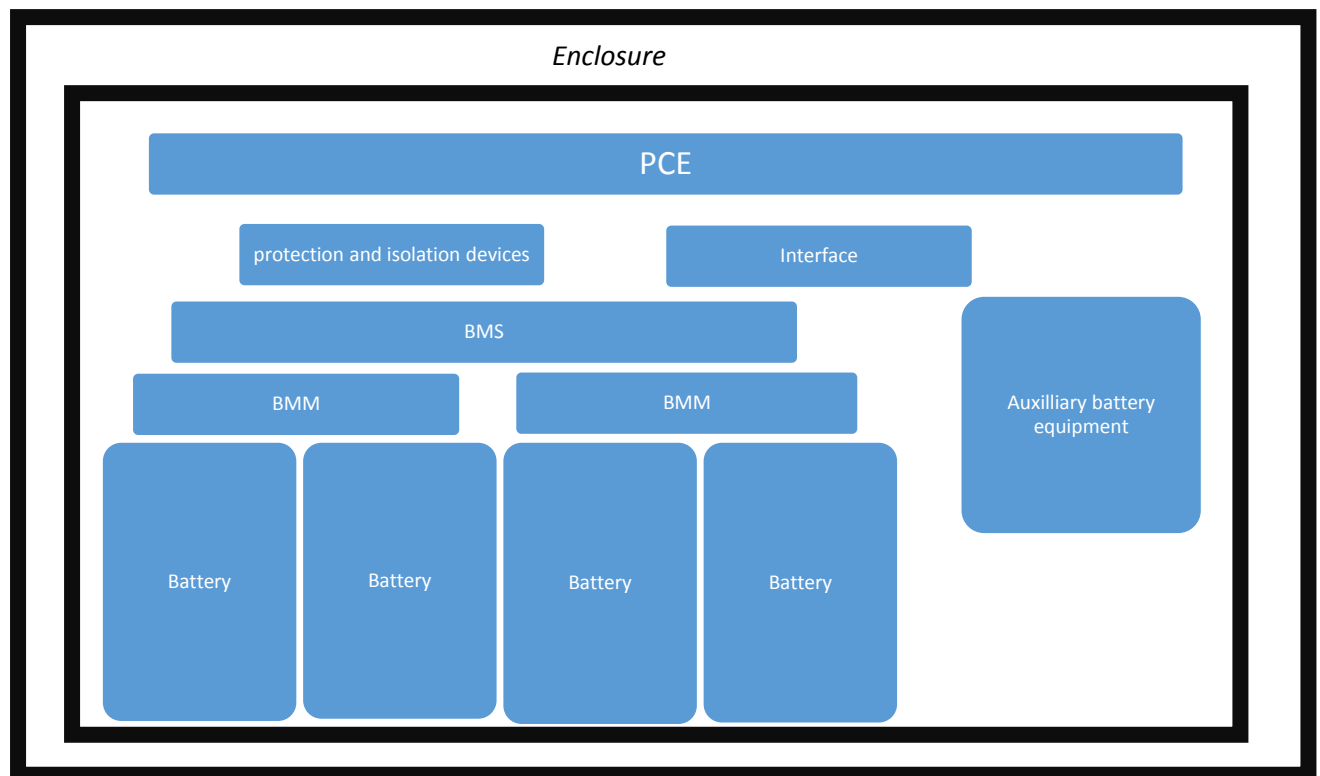


Diagram 2: An example of parts of pre-assembled integrated battery storage system equipment



Additional definitions

Auxiliary battery equipment

Various components that may be included in the equipment, including pumps, storage tanks, fire suppression, communications equipment, cooling components/systems and any other equipment required for the battery system to operate, excluding BMM and BMS.

Battery

Unit consisting of one or more lithium battery cells connected in series, parallel or series parallel arrangement.

Battery management module (BMM)

Distributed battery and battery module devices that feed into the BMS and are generally part of the electronics on an individual cell or module.

Battery management system (BMS)

An electronic system that monitors and manages a battery or battery system's electric and thermal states enabling it to operate within the safe operating region of the particular battery. The BMS provides communications between the battery or battery system and other parts of the device (e.g. vents or cooling).

Note: The BMS monitors cells, battery or battery modules to provide protective actions for the battery system in the case of overcharge, overcurrent, over discharge, overheating, overvoltage

and other possible hazards that could occur. Additional BMS functions may include active or passive charge management, battery equalization, thermal management, specific messaging or communications regarding charge rates and availability.

Cell

Basic functional unit, consisting of an assembly of electrodes, electrolyte, container, terminals and usually separators, which is a source of electric energy obtained by direct conversion of chemical energy.

Isolation devices

Devices used to electrically separate parts, such as a switch disconnector operating in all live conductors to isolate the battery parts from other parts within the equipment.

Interface

Point for connection for communication to other devices/systems. Examples include connection to a computer or communications system, or a digital display on the device.

Manufacturer

The company that is responsible for the design, assembly, testing and claims of compliance of the parts together as the final assembled battery storage equipment is the manufacturer. This may be a different company to the manufacturer(s) of any particular components.

Master/slave configuration

A configuration of parts that have been designed, manufactured, tested and assessed as compliant to this guide when installed as a combined unit. Each part is its own battery module, pre-assembled battery system (BS) equipment or pre-assembled integrated battery energy storage system (BESS) equipment that have been combined together by the manufacturer to be one unit. All connections between parts are via connection means also supplied by the manufacturer. If there are multiple combinations of a master/slave configuration then all combinations must be tested and assessed to this guide. Master/slave configuration may be two types:

- The parts may be supplied separately and assembled together by installer on site into the one supplied enclosure. The parts as combined together in the configuration in the enclosure must have been tested and assessed as battery storage equipment to this guide. An example of this is where there are multiple battery modules that can be added into an enclosure, which already has a pre-assembled integrated battery energy storage system (BESS), to increase capacity of the battery storage equipment and the BESS (master) controls the battery module (slave).
- The parts may be in separate enclosures. If the master/slave configuration are in separate enclosures then only one device connects directly to the electricity installation, the other parts connect to that device, and there is one device (master) that has control over all the connected devices (slave). The separate parts would be expected to be physically co-located and these parts connected together in the final configuration must have been tested and assessed as battery storage equipment to this guide. An example of this is where there is a pre-assembled integrated battery storage system equipment (BESS) that can have connected to it a pre-assembled battery system (BS) to increase the overall energy storage of the equipment and the BESS (master) controls the BS (slave). In this

situation the combined BESS and BS have been tested by the manufacturer as the one battery storage equipment to this guide.

Note: A master/slave configuration is not a collection of separate individual battery storage equipment devices combined together on site (in series, parallel, individually connected to installation wiring or any other combination) and configured to operate in unison, or controlled by a separate energy management system or the like. These situations are an electrical installation of multiple battery energy storage equipment. Each individual battery storage equipment may be within this guide, but the combination is an installation to be designed and installed in accordance with appropriate installation standards.

Power Conversion Equipment (PCE)

An electrical device converting and/or manipulating one kind of electrical power from a voltage or current source into another kind of electrical power with respect to voltage, current and/or frequency. Examples include but are not limited to d.c./a.c., inverters, d.c./d.c. converters, charge controllers.

Note: Battery management systems are not considered to be PCEs for the purpose of this guide.

Protection devices

Device to operate to limit a hazardous situation, such as overcurrent protective devices.

Protective electronic circuit

An electronic circuit that prevents a hazardous situation under abnormal operating conditions, but not an electronic circuit that is purely for functional requirements.

Suitably competent person

A person who has obtained appropriate knowledge of the relevant battery topology, risks and hazards and has:

- A degree qualification in electrical engineering and at least two years experience in the use of electrical equipment safety standards for regulatory purposes; or
- An advanced diploma or equivalent qualification in an electrical discipline and at least three years experience in the use of electrical equipment safety standards for regulatory purposes; or
- A trade qualification in an electrical discipline and at least four years experience in the use of electrical equipment safety standards for regulatory purposes.

Safety related software

Programmable protective electronic circuits used to ensure compliance with this guide in the event of a fault occurring. It is not software used for functional purposes or normal operation.

PART 2 – HOW TO USE THE GUIDE AND MAKE A CLAIM OF COMPLIANCE

[2.1 Application of this guide](#)

For a manufacturer/importer to claim their battery storage equipment complies with this guide, they must select a Method for assessing their equipment from the list provided in Part 3, and ensure the mandatory minimum safety criteria of that method is satisfied. This process must be undertaken by a suitably competent person with relevant expertise. The manufacturer or importer may utilise in-house expertise, others in the supply chain, or other independent expertise to assist. Notes within this guide are part of the document and not just advisory.

This guide provides for two levels of compliance, and manufacturers or importers can choose whether their product's compliance is assessed against the mandatory requirements only, or both the mandatory and any or all of the optional requirements listed. Assessing to the optional requirements potentially enables manufacturers or importers to further distinguish their product from others in the market. Either level of claimed compliance requires the same documentation and evidence as indicated in section 2.6.

To carry out an assessment, the manufacturer, importer or person conducting the assessment should take the following steps:

Step 1: Identify whether this guide applies to the equipment by considering the criteria listed in section 1.3, including:

- whether the battery energy storage equipment type/classification is one of the following:
 - Battery module (BM)
 - Pre-assembled battery system (BS) equipment
 - Pre-assembled integrated battery energy storage system (BESS) equipment
- installation location (i.e. household/domestic/residential fixed installation),
- battery type,
- energy storage capacity, and
- voltage rating.

Step 2: Choose a Method from the list of mandatory Methods in Part 3, to apply to the equipment.

When applying a Method:

- apply the main standard(s) first in full;
- apply any secondary standard(s) in full (or the clauses as listed in full);
- apply criteria of any specialist standards listed in the separate specific requirements section for particular risk as appropriate;
- apply any other separate specific requirements as appropriate; and
- consider the expected minimum safety criteria of the Risk Matrix for the relevant hazards and whether those criteria have been met

Step 3: Consider the optional requirements and apply them (or alternate equivalent criteria) as appropriate or as required by their client.

NOTE: The optional criteria is a guide for what is expected and criteria may be partly or fully applied as listed within this document, or have other processes and criteria applied to show similar compliance suitability.

Step 4: Consider the additional hazards not covered by the mandatory or optional requirements and, if required, address them appropriately.

Step 5: Verify that all brands, models, variants, master/slave configurations (if applicable) of the equipment have had the required testing and assessments to claim compliance and compile a compliance folder. The manufacturer/importer also ensures that on-going compliance is maintained throughout their manufacture and supply to market processes (quality assurance processes).

[2.2 Application of standards when assessing compliance under a chosen Method](#)

The requirements in the Methods generally reference a relevant technical standard to test and assess the battery storage equipment against. The standards listed in these Methods have been identified by edition/year of publication to clarify particular clauses referenced. As standards are continually updated with amendments or re-issued as new editions, the use of a later edition or additional amendments to the standard listed is acceptable when assessing compliance to the Methods of this guide. As clause numbering or wording in particular clauses may change in new editions or amendments, a suitably competent person should apply the clause(s) most relevant to the existing clause, rather than the exact clause number listed in this guide. Manufacturers and importers are encouraged to apply amendments or new editions of standards as soon as practicable.

The Methods in the guide list Main standard(s), Secondary standard(s) and Separate specific requirements (which include specific specialist standard(s) and other criteria). Each Method indicates which standards are required, or which may be an alternative to choose, or which are applicable depending on the equipment design, and if relevant what clauses are to be applied.

Where conflict exists between different standards, the criteria of the main standard(s) shall generally be applied over the criteria in the secondary standard(s) or specific specialist standards, unless those secondary or specialist standards list a particular clauses or requirement, in which case that requirement is still to be applied. If the product does not comply with an element of the main standard(s), criteria in a secondary standard or specialist standard shall not be applied just to overcome the non-compliance.

The specified clauses of secondary standards shall be applied in full except where criteria is the same as, or lower than, criteria of a main standard(s) or another secondary standard that has already been applied. It is optional to apply the secondary standard in full.

The specified clauses of a specific specialist standard shall be applied in full to assess the specific hazard/risk listed. It is optional to apply the specific specialist standard in full.

The Risk Matrix referenced in Part 4 of this guide outlines the potential safety hazards of each type of equipment and expected minimum criteria that must be met to address the hazards and comply

with this guide. When applying the requirements listed in the Method, the assessor must consider how the risk/hazards and the 'minimum expectations to meet' criteria in the Risk Matrix have been addressed. If safety standards other than those listed in one of the Methods are used to assess equipment (i.e. as provided under Method 4), the suitably competent person must ensure the hazards detailed in the Risk Matrix are addressed by the alternative standard.

Where requirements in a Method do not list a standard, criteria that can be objectively tested, assessed and reviewed by a suitably competent person as being compliant to requirements have been included instead.

2.3 Claims of compliance to this guide

To claim that battery storage equipment complies with this guide, a suitably competent person must sign off on its compliance with one of the mandatory Methods listed in Part 3, at a minimum.

The suitably competent person conducting the assessment or review (whether test laboratory, in-house or independent) would consider factors including, but not limited to:

- whether standards were applied correctly,
- whether tests were conducted correctly and test reports have sufficient detail and data recorded,
- whether equipment used in testing was appropriate and had traceable calibration,
- interrogation of documentation and declarations,
- consideration of circuitry, software and protective circuits,
- review of suitability of processes and procedures.

The claim of compliance should refer to this guide by title, and include the battery storage equipment type, and the Method used.

This can be used for manufacturer or importer declared claims, independent test evidence of compliance and independent certification of claims of compliance.

Means of claiming compliance include test reports by competent test laboratories to relevant standards and tests listed. Such laboratories using suitably competent persons could also assess the additional specific requirements and optional requirements if they have expertise and knowledge in the areas mentioned.

Manufacturers or importers could conduct the assessments (and tests if they have suitable test expertise) and make declarations of compliance to the mandatory standards and specific requirements, as well as the optional requirements, if they have a suitably competent person in-house.

Independent certification bodies with suitably qualified and competent persons in the relevant areas could issue certificates based on suitable assessment of the evidence supplied by the manufacturer or importer. Certification, being a higher level of independent verification than a manufacturer or importer's declaration, should be based on accredited test results where any criteria lists a relevant standard to be assessed to. Where no standard exists, the competence of the person making manufacturer or importer's declarations would need to be reviewed before acceptance of such declarations related to issuing of any certificate.

To guide uniformity and transparency, certification should be issued in general agreement with the requirements of the Equipment Safety Rules of the Electrical Equipment Safety System or other electrical safety regulator published document, or similar published document of equivalent or higher criteria.

Note: This does not imply the certification body has to be accredited to any one or more particular scheme, but rather they have at least one recognised independent third party accreditation of their systems and processes, such as the Joint Accreditation System of Australia and New Zealand (JAS-ANZ) accreditation, or an Electrical Safety Regulatory Agency accreditation, or the like.

[2.4 False claims of compliance to this guide](#)

False claims of compliance to this guide may result in failure to meet contractual requirements, possible breach of Australian Consumer Law and of electrical safety duties and legislative requirements. Civil actions or regulatory actions may be taken against person who make false claims.

[2.5 Timing for compliance to the criteria in the Methods](#)

Claims of compliance to this guide need to demonstrate compliance at the time the claim is made and that compliance is maintained in an on-going manner. Compliance with the mandatory requirements and any optional requirements claimed need to meet the requirements of the guide in force at the time the claim is made. Equipment should be periodically inspected, and if necessary re-tested, and documentation reviewed to ensure on-going compliance to the claimed requirements of this guide is maintained.

At the time of publishing this guide, some optional requirements have been identified as being eligible for review after a 12 month period, to assess whether they will become mandatory requirements or remain as optional requirements. These requirements have been identified as features that will lead to continuous improvements in safety standards, rather than addressing a hazard that is essential for the sale and use of the battery storage equipment. Providing a transition period will allow the manufacturer/importer to assess and apply these requirements that have been identified during the development of the risk matrix as desirable, but may not have been fully addressed in the past.

[2.6 Documentation required to claim compliance](#)

[2.6.1 Information required to be retained by the manufacturer or importer of the equipment](#)

The information to verify compliance with this guide (i.e. compliance with the mandatory methods in Part 3 and, if applied, the optional requirements) is to be maintained by the manufacturer or importer in a compliance folder. Compliance folders would be compiled prior to making a claim of compliance to this guide, but would also be maintained up to date with records of any changes, amendments, modifications, incidents, issues, actions taken as and when they occur – all verified by a suitably competent person - to ensure the claim of compliance to the guide is maintained.

A compliance folder would contain all documentation relevant to the electrical safety of the equipment, written in English. At the minimum it would contain:

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- all declarations made and details of who made them (and their qualifications),
- signed assessments/declarations of compliance to the mandatory Method (and any optional requirements) of this guide by the suitably competent persons and/or certification to the requirements of this by a recognised Australian certification body,
- type of battery storage equipment,
- detail of the mandatory Method of this guide chosen,
- all evidence used to claim that compliance the mandatory requirements of the Method including test reports, specifications of components, declarations and justifications for using those declarations, assessments made (and by whom),
- any optional requirements of this guide for which compliance is claimed,
- all evidence used to claim compliance to the optional requirements including test reports, specifications of components, declarations and justifications for using those declarations, assessments made (and by whom),
- listing of all standards applied,
- copies of all test reports, details of the test facilities accreditations or evidence of their competence to conduct the tests and assessments,
- circuit diagrams,
- colour photographs of layout and components,
- component listings,
- individual component certifications or declarations as applicable,
- software/firmware/hardware versions,
- nameplate markings and ratings,
- brands and models (including part numbers for each model) covered (and their relationship to each other – i.e. variations between the models),
- details of updates and modification (and evidence of compliance of those changes),
- any processes for auditing, quality assurance, production checks and the results of such processes,
- copy of installation, operating and maintenance instructions that are supplied with the equipment,
- copy of safety data sheets, and
- details of any electrical safety related complaints/incidents and reports on findings and actions undertaken from any report recommendations.

Some of this information will be intellectual property or commercial in confidence and not for general release, however all such information will need to be able to be obtained in the event of a regulatory authority conducting an examination of the equipment due to an incident or complaint, or due to general auditing for safety that the regulator may be undertaking to maintain public safety.

All data and information may not necessarily be in one location, it may be in different forms and stored in different medium, but will be able to be accessed and supplied if requested.

2.6.2 Information required to be supplied with the equipment

Information to be supplied with the equipment to the on-seller or installer of the equipment, and left with the purchaser, as evidence of compliance to this guide shall include, as a minimum requirement:

- Claim of compliance, by either:
 - Declaration of compliance to the chosen mandatory Method (and any optional requirements) of this guide by the suitably competent persons (including use of statements of compliance as listed in sections 2.7, 2.8 and 2.9 of this guide); or
 - Certification to the requirements of this guide (including use of statements of compliance as listed in sections 2.7, 2.8 and 2.9 of this guide) by a recognised Australian certification body;
- Copy of installation, operating and maintenance instructions; and
- Copies of technical data sheets and safety data sheets.

2.7 Statement of compliance with mandatory compliance parts

A statement of compliance can be used where the battery storage equipment has been assessed as complying with a mandatory part of this guide. The statement will be linked to the relevant manufacturer/importer/brand/model/software version (if applicable) or any other critical variation relevant.

Where compliance is claimed to any part of the guide, the wording of this section is to be marked on the equipment, and may also be in the information accompanying the equipment. It may also be marked on any promotional literature, websites, or other manufacturers' documentation or the like.

For example:

For a battery module, where Method 1 of this guide was chosen, the statement:

Compliant to Best Practice Guide for Battery Storage Equipment – Electrical Safety Requirements – version 1 - Battery Module - Method 1 mandatory requirements

For pre-assembled battery storage equipment, where Method 2 of this guide was chosen, the statement:

Compliant to Best Practice Guide for Battery Storage Equipment – Electrical Safety Requirements – version 1 - Pre-assembled battery system equipment - Method 2 mandatory requirements

For pre-assembled integrated battery energy storage system (BESS) equipment, where Method 1 of this guide was chosen the statement:

Compliant to Best Practice Guide for Battery Storage Equipment – Electrical Safety Requirements – version 1 - Pre-assembled integrated battery energy storage system equipment - Method 1 mandatory requirements

[2.8 Statement of compliance with optional compliance parts](#)

A statement of compliance can be used where the battery storage equipment has been assessed as complying with an optional part of this guide. The optional section of this guide (section 3.5 *Optional requirements*) could have compliance to each individual optional item (each individual item as listed in section 3.5 as a) through to q)), there does not have to be compliance to every part (some items may not apply to particular equipment).

For example:

For a battery module, where options a), b), e), g) and m) of this guide was chosen, the statement:

Compliant to Best Practice Guide for Battery Storage Equipment – Electrical Safety Requirements – version 1 - Battery Module – Optional requirements – a), b), e), g) and m)

For pre-assembled battery storage equipment, where options a), c), f), g) and m) of this guide was chosen, the statement:

Compliant to Best Practice Guide for Battery Storage Equipment – Electrical Safety Requirements – version 1 - Pre-assembled battery system equipment- Optional requirements – a), c), f), g) and m)

For pre-assembled integrated battery energy storage system (BESS) equipment, where options a), b), c), d), e), f), g), h), i), j), k), l), m) and n) of this guide was chosen, the statement:

Compliant to Best Practice Guide for Battery Storage Equipment – Electrical Safety Requirements – version 1 - Pre-assembled integrated battery energy storage system equipment - Optional requirements – a), b), c), d), e), f), g), h), i), j), k), l), m) and n)

[2.9 Statement of compliance with mandatory and optional compliance parts combined](#)

Where both mandatory and optional requirements have been applied, they can be combined into the one statement.

For example:

Compliant to Best Practice Guide for Battery Storage Equipment – Electrical Safety Requirements – version 1 - Pre-assembled integrated battery energy storage system equipment - Method 1 mandatory requirements and Optional requirements – a), b), c), d), e), f), g), h), i), j), k), l), m) n) and p).

PART 3 – MANDATORY AND OPTIONAL METHODS TO ADDRESS HAZARDS

3.1 Method 1

The complete equipment is tested and assessed together as one device (the only exception is the battery module which may be tested separately to its requirements, but is still assessed as part of the equipment). Any master/slave configurations is also tested as one complete 'equipment'.

Apply

- Main standards: 1, and 2.1 or 2.2 as chosen, and 3.1 or 3.2 as applicable; and
- Secondary standards: 1.1 or 1.2 as chosen; and
- All the separate specific requirements including specialist standards and applying requirements related to outdoor use or indoor use as appropriate.

3.1.1 Main standards

1. AS IEC 62619:2017 *Secondary cells and batteries containing alkaline or other non-acid electrolytes* (or IEC 62619 Ed 1 2017)

Note: when applying AS IEC 62619:2017 the following is to be applied:

Clause 8 risk assessments not related to the lithium battery module should refer to other main and secondary standards within this Method for test process and pass criteria.

2. Either:
 - 2.1. AS/NZS 60950.1:2015 *Information technology equipment - Safety*

Note: AS/NZS 60950.1:2015 indicates within its scope that it is not applicable to *power supply systems which are not an integral part of the equipment, such as motor-generator sets, battery backup systems and distribution systems*. The standard is listed to be applied along with the other main standards and is to be applied to the extent it can be applied for the assessment of the complete equipment as distinct from the lithium battery module and management unit (which is assessed to AS IEC 62619:2017).

or

- 2.2. AS/NZS 62368.1:2018 *Audio/video, information and communication technology equipment Safety requirements*

Note: AS/NZS 62368.1:2018 indicates within its scope that it is not applicable to *power supply systems which are not an integral part of the equipment, such as motor-generator sets, battery backup systems and distribution systems*. The standard is listed to be applied along with the other main standards and is to be applied to the extent it can be applied for the assessment of the complete equipment as distinct from the lithium battery module and management unit (which is assessed to AS IEC 62619:2017).

3. Either

- 3.1. AS/NZS 4777.2:2015 *Grid connection of energy systems via inverter requirements** for inverter in equipment for connection to grid installations (applicable to pre-assembled integrated battery energy storage system equipment).

* AS/NZS 4777.2:2015 clause 5.1 requirement of inverter energy system that have energy storage (batteries) as the only possible energy source to comply with AS 62040.1.1:2003(R2013) does not need to be applied. The other standards listed in clause 5.1 of AS/NZS 4777.2:2015 and those listed in this Method may be applied instead of AS 62040.1.1:2003(R2013).

or

- 3.2. IEC 62109.1 Ed1 2010 and IEC 62109.2 Ed1 2011 for inverter in equipment for connection to Off-grid installations (applicable to pre-assembled integrated battery energy storage system equipment).

3.1.2 Secondary standards

1. Either

- 1.1. AS/NZS 60335.1:2011 *Household and similar electrical appliances – Safety General requirements*, clause 22.46 (software),

or

- 1.2. UL 1973:2013 *Batteries for use in light electric rail applications and stationary applications*, section 5.8.1.3 (software).

Note: if software testing that has been conducted to AS IEC 62619:2017 (or IEC 62619 Ed 1 2017) can be shown as equivalent to criteria of 1.1 or 1.2 then no additional testing is required.

3.1.3 Separate specific requirements

1. External enclosure of the battery storage equipment is metallic material having a minimum thickness not less than 0.20 mm at any point, or is a polymeric material classified as 5VA according to IEC 60695-11-20:2015 (provided that the test sample used for the classification was no thicker than the relevant part of the enclosure). Small openings or parts of polymeric materials of enclosures (with any one hole or polymeric material not exceeding 20cm² and up to a combined total area of all holes or polymeric material not exceeding 100cm²) are exempt from this requirement. Openings in vents required for normal safe operation of the equipment are also exempt. Decorative trim over metallic material or over material classified as 5VA is also exempt.

Note: This is not an alternate to other flame test/resistance to propagation of fire tests of the listed standards, this is in addition to those requirements.

2. Battery module is a sealed component with no access to cell components. Access to the cell components cannot be obtained without damaging the enclosure of the cell components or fixing devices of the enclosure of the cell components.

Note: The intention is there is no maintenance required at cell component level or any on site repair or replacement at cell component level – for any of this type of activity the battery

module is returned to manufacturer/service agent, and so prevent unsafe situations of large energy release and arc flash issues.

3. Isolation devices are required for external or internal isolation including at points within equipment to ensure parts to be installed/removed are isolated with no access to the energised parts (live parts or extra low voltage battery storage circuit parts). All isolation devices are to operate in all live (a.c. - active and neutral or d.c. – positive and negative) conductors.

Note: The intention is that any energised parts (low voltage or extra low voltage, external or internal) can be isolated before any maintenance, installation, repair or replacement activity occurs. This is to ensure the possibility of a shorting of terminals or live connections is prevented, and to prevent unsafe situations of large energy release and arc flash issues.

4. Detailed safety datasheets (SDS) to be supplied with equipment. This includes SDS, including clear detail on any chemical hazard within the equipment or its components, and how to deal with safety issues related to those chemicals.

To ensure SDS are consistently written, the model code of practice for preparing safety data sheets for hazardous chemicals shall be followed. See https://www.safeworkaustralia.gov.au/resources_publications/model-codes-of-practice for details of requirements for SDS including *Model Code of Practice: Preparation of safety data sheets for hazardous chemicals*.

Note: For clarity, a SDS is required for compliance to this guide irrespective of any exemption that may be suggested under any particular laws or codes (for example the SDS model code indicates a SDS is not required for 'chemicals in batteries while they are incorporated in plant', however this guide specifically requires a SDS for batteries, and any other chemicals, in the battery storage equipment).

5. Detailed installation instructions to be supplied with equipment. At a minimum the instructions need to specify:
 - 5.1. Distances of any standoff from a wall, floor, ceiling/roof;
 - 5.2. Distance from any heat source (e.g. hot water systems, gas heaters or the like);
 - 5.3. Distance/clearances from any equipment/wall/structure to the sides, bottom, top;
 - 5.4. Clearance distances from any vents to any wall, other equipment, structure;
 - 5.5. If the equipment is for indoor only or outdoor only installation (or for either indoor or outdoor installation), and if it can be mounted in a position exposed to direct sunlight or is required to be shaded;
 - 5.6. If for indoor use, any ventilation requirements (for cooling of the equipment or to expel hazardous toxic or ignitable gases that may occur in normal or expected abnormal situations).

Note: Normal and abnormal test criteria in the Risk Matrix requires that there shall be “*no emissions of toxic or ignitable gases, smoke or the like in hazardous amounts*”, this instructional requirement is not intended to be a means to override that compliance criteria. Rather this is to ensure that if there have been any emission during testing (that were not in hazardous amounts during testing) or the safety data sheet indicates a need for venting of possible emissions, the emissions will be suitably expelled from the installation location.

6. Any user maintenance or optional process or procedures for the user need to be supplied with the equipment (including any shut down or isolation processes and associated labels or warnings).
7. Marking needs to be suitably UV resistant – if instructions include it is for outdoor use:
 - 7.1. Legibility of markings on equipment intended for outdoor use shall not be degraded by UV radiation. This requirement does not apply to markings that are physically engraved, embossed or etched with durable markings.

Compliance is checked as follows (from IEC 60068-2-5 Ed3 2018):

- 7.1.1. Ten samples of the markings are to be exposed for 720 h to open-flame sunshine carbon-arc, in accordance with ISO 4892-4.
 - 7.1.2. The test samples are mounted on the inside of the cylinder in the ultraviolet light apparatus perpendicular to the light source and in such a way that the samples do not touch each other.
 - 7.1.3. There shall be continuous exposure to light and intermittent exposure to water spray. The cycle shall consist of 102 min without water spray and 18 min with water spray. The apparatus shall operate with an open-flame sunshine carbon-arc lamp, borosilicate glass Type 1, inner and outer optical filters, a spectral irradiance of 0,35 W/m²/nm at 340 nm and a black panel temperature of (63 ± 3) °C. The temperature of the chamber shall be (45 ± 3) °C. The relative humidity in the chamber shall be (50 ± 5) %.
8. Equipment shall have minimum IP ratings related to location of installation as follows:
 - 8.1. Indoor - IP2X
 - 8.2. Outdoor - IP23

NOTE: equipment for outdoor use may require higher IP rating depending on installation location.

3.2 Method 2

The complete equipment is tested together as one device (the only exception is the battery module which may be tested separately to its requirements, but is still assessed as part of the equipment). Any master/slave configurations is also tested as one complete 'equipment'.

Apply:

- Main standards: 1, and 2.1 or 2.2 as applicable; and
- Secondary standards: None applicable at present; and
- All the separate specific requirements including specialist standards and applying requirements related to outdoor use or indoor use as appropriate.

3.2.1 Main standards

1. UL 1973:2013 *Batteries for use in light electric rail applications and stationary applications* or UL 1973:2018 *Batteries for use in light electric rail applications and stationary applications*
2. Either
 - 2.1. AS/NZS 4777.2:2015 *Grid connection of energy systems via inverter requirements* * for inverter in equipment for connection to grid installations (applicable to pre-assembled integrated battery energy storage system equipment).

* AS/NZS 4777.2:2015 clause 5.1 requirement of inverter energy system that have energy storage (batteries) as the only possible energy source to comply with AS 62040.1.1:2003(R2013) does not need to be applied. The other standards listed in clause 5.1 of AS/NZS 4777.2:2015 and those listed in this Method may be applied instead of AS 62040.1.1:2003(R2013).

or

- 2.2. IEC 62109.1 Ed1 2010 and IEC 62109.2 Ed1 2011 for inverter in equipment for connection to Off-grid installations (applicable to pre-assembled integrated battery energy storage system equipment).

3.2.2 Secondary standards

None applicable at present.

3.2.3 Separate specific requirements

1. External enclosure of the battery storage equipment is metallic material having a minimum thickness not less than 0.20 mm at any point, or is a polymeric material classified as 5VA according to IEC 60695-11-20:2015 (provided that the test sample used for the classification was no thicker than the relevant part of the enclosure). Small openings or parts of polymeric materials of enclosures (with any one hole or polymeric material not exceeding 20cm² and up to a combined total area of all holes or polymeric material not exceeding 100cm² are exempt from this requirement. Openings in vents required for normal safe operation of the equipment are also exempt. Decorative trim over metallic material or over material classified as 5VA is also exempt.

Note: this is not an alternative to other flame test/resistance to propagation of fire tests of the listed standards, this is in addition to those requirements.

2. Battery module is a sealed component with no access to cell components. Access to the cell components cannot be obtained without damaging the enclosure of the cell components or fixing devices of the enclosure of the cell components.

Note: The intention is there is no maintenance required at cell component level or any on site repair or replacement at cell component level – for any of this type of activity the battery module is returned to manufacturer/service agent, and so prevent unsafe situations of large energy release and arc flash issues.

3. Isolation devices are required for external or internal isolation including at points within equipment to ensure parts to be installed/removed are isolated with no access to the energised parts (live parts or extra low voltage battery storage circuit parts). All isolation devices are to operate in all live (a.c. - active and neutral or d.c. – positive and negative) conductors.

Note: The intention is that any energised parts (low voltage or extra low voltage, external or internal) can be isolated before any maintenance, installation, repair or replacement activity occurs. This is to ensure the possibility of a shorting of terminals or live connections is prevented, and to prevent unsafe situations of large energy release and arc flash issues.

4. Detailed safety datasheets (SDS) to be supplied with equipment. This includes SDS, including clear detail on any chemical hazard within the equipment or its components, and how to deal with safety issues related to those chemicals.

To ensure SDS are consistently written the model code of practice for preparing safety data sheets for hazardous chemicals shall be followed. See https://www.safeworkaustralia.gov.au/resources_publications/model-codes-of-practice for details of requirements for SDS including *Model Code of Practice: Preparation of safety data sheets for hazardous chemicals*.

Note: For clarity, a SDS is required for compliance to this guide irrespective of any exemption that may be suggested under any particular laws or codes (for example the SDS model code indicates a SDS is not required for ‘chemicals in batteries while they are incorporated in plant’, however this guide specifically requires a SDS for batteries, and any other chemicals, in the battery storage equipment).

5. Detailed installation instructions to be supplied with equipment. At a minimum the instructions need to specify:
 - 5.1. Distances of any standoff from a wall, floor, ceiling/roof;
 - 5.2. Distance from any heat source (e.g. hot water systems, gas heaters or the like);
 - 5.3. Distance/clearances from any equipment/wall/structure to the sides, bottom top;
 - 5.4. Clearance distances from any vents to any wall, other equipment, structure;

- 5.5. If the equipment is for indoor only or outdoor only installation (or for either indoor or outdoor installation), and if it can be mounted in a position exposed to direct sunlight or is required to be shaded;
- 5.6. If for indoor use, any ventilation requirements (for cooling of the equipment or to expel hazardous toxic or ignitable gases that may occur in normal or expected abnormal situations).

Note: Normal and abnormal test criteria in the Risk Matrix requires that there shall be “*no emissions of toxic or ignitable gases, smoke or the like in hazardous amounts*”, this instructional requirement is not intended to be a means to override that compliance criteria. Rather this is to ensure that if there have been any emission during testing (that were not in hazardous amounts during testing) or the safety data sheet indicates a need for venting of possible emissions, the emissions will be suitably expelled from the installation location.

6. Any user maintenance or optional process or procedures for the user need to be supplied with the equipment (including any shut down or isolation processes and associated labels or warnings).
7. Marking needs to be suitably UV resistant – if instructions include it is for outdoor use:
 - 7.1. Legibility of markings on equipment intended for outdoor use shall not be degraded by UV radiation. This requirement does not apply to markings that are physically engraved, embossed or etched with durable markings.

Compliance is checked as follows (from IEC 60068-2-5 Ed3 2018):

- 7.1.1. Ten samples of the markings are to be exposed for 720 h to open-flame sunshine carbon-arc, in accordance with ISO 4892-4.
 - 7.1.2. The test samples are mounted on the inside of the cylinder in the ultraviolet light apparatus perpendicular to the light source and in such a way that the samples do not touch each other.
 - 7.1.3. There shall be continuous exposure to light and intermittent exposure to water spray. The cycle shall consist of 102 min without water spray and 18 min with water spray. The apparatus shall operate with an open-flame sunshine carbon-arc lamp, borosilicate glass Type 1, inner and outer optical filters, a spectral irradiance of 0,35 W/m²/nm at 340 nm and a black panel temperature of (63 ± 3) °C. The temperature of the chamber shall be (45 ± 3) °C. The relative humidity in the chamber shall be (50 ± 5) %.
8. Equipment shall have minimum IP ratings related to location of installation as follows:
 - 8.1. Indoor - IP2X,
 - 8.2. Outdoor - IP23

NOTE: equipment for outdoor use may require higher IP rating depending on installation location.

3.3 Method 3

The complete equipment is tested together as one device (the only exception is the battery module which may be tested separately to its requirements, but is still assessed as part of the equipment). Any master/slave configurations is also tested as one complete 'equipment'.

Apply:

- Main standards: 1, and 2.1 or 2.2 as chosen, and 3.1 or 3.2 as applicable; and
- Secondary standards: 1.1 or 1.2 as chosen; and
- All the separate specific requirements including specialist standards and applying requirements related to outdoor use or indoor use as appropriate.

3.3.1 Main standards

1. AS IEC 62619:2017 *Secondary cells and batteries containing alkaline or other non-acid electrolytes* or IEC 62619 Ed 1 2017

Note: when applying AS IEC 62619:2017 the following is to be applied:

Clause 8 risk assessments not related to the lithium battery module should refer to other main and secondary standards within this Method for test process and pass criteria.

2.
 - 2.1. AS 62040.1.1:2003 (R2013) *Uninterruptible power systems*, including application of any reference to AS/NZS 60950.1 is to be to the latest edition of AS/NZS 60950.1,

Note: AS 62040.1.1:2003 (R2013) references AS/NZS 60950.1:2003. AS/NZS 60950.1:2003 within its scope indicates it is not applicable to *power supply systems which are not an integral part of the equipment, such as motor-generator sets, battery backup systems and distribution systems*. The standard is listed to be applied along with the other main standards and is to be applied to the extent it can be applied for the assessment of the complete equipment as distinct from the lithium battery module and management unit (which is assessed to AS IEC 62619:2017).

or

- 2.2. IEC 62040.1:2017 (including IEC 62477-1:2012)

Note: IEC 62040.1:2017 indicates batteries may be installed in separate rooms or separate cabinets or compartments or within compartments of the UPS. For equipment complying with this guide the batteries are expected to be within the UPS or in a master/slave configuration as detailed in this guide. The standard is listed to be applied along with the other main standards and criteria of this guide and is to be applied to the extent it can be applied for the assessment of the complete equipment as distinct from the lithium battery module and management unit (which is assessed to AS IEC 62619:2017).

3.
 - 3.1. AS/NZS 4777.2:2015 *Grid connection of energy systems via inverter requirements* for inverter in equipment for connection to grid installations (applicable to pre-assembled integrated battery energy storage system equipment).

or

- 3.2. IEC 62109.1 Ed1 2010 and IEC 62109.2 Ed1 2011 for inverter in equipment for connection to Off-grid installations (applicable to pre-assembled integrated battery energy storage system equipment).

3.3.2 Secondary standards

1. Either
 - 1.1. AS/NZS 60335.1:2011 *Household and similar electrical appliances – Safety General requirements*, clause 22.46 (software),

or

- 1.2. UL 1973:2013 *Batteries for use in light electric rail applications and stationary applications*, section 5.8.1.3 (software).

Note: if software testing that has been conducted to AS IEC 62619:2017 (or IEC 62619 Ed1 2017) can be shown as equivalent to criteria of 1.1 or 1.2 then no additional testing is required.

3.3.3 Separate specific requirements

1. External enclosure of the battery storage equipment is metallic material having a minimum thickness not less than 0.20 mm at any point, or is a polymeric material classified as 5VA according to IEC 60695-11-20:2015 (provided that the test sample used for the classification was no thicker than the relevant part of the enclosure). Small openings or parts of polymeric materials of enclosure (with any one hole or polymeric material not exceeding 20cm² and up to a combined total area of all holes or polymeric material not exceeding 100cm²) are exempt from this requirement. Openings in vents required for normal safe operation of the equipment are also exempt. Decorative trim over metallic material or over material classified as 5VA is also exempt.

Note: This is not an alternative to other flame test/resistance to propagation of fire tests of the listed standards, this is in addition to those requirements.

2. Battery module is a sealed component with no access to cell components. Access to the cell components cannot be obtained without damaging the enclosure of the cell components or fixing devices of the enclosure of the cell components.

Note: The intention is there is no maintenance required at cell component level or any on site repair or replacement at cell component level – for any of this type of activity the battery module is returned to manufacturer/service agent, and so prevent unsafe situations of large energy release and arc flash issues.

3. Isolation devices are required for external or internal isolation including at points within equipment to ensure parts to be installed / removed are isolated with no access to the energised parts (live parts or extra low voltage battery storage circuit parts). All isolation devices are to operate in all live (a.c. - active and neutral or d.c positive and negative) conductors.

Note: The intention is that any energised parts (low voltage or extra low voltage, external or internal) can be isolated before any maintenance, installation, repair or replacement activity

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occurs. This is to ensure the possibility of a shorting of terminals or live connections is prevented, and so prevent unsafe situations of large energy release and arc flash issues.

4. Detailed safety datasheets (SDS) to be supplied with equipment. This includes SDS, including clear detail on any chemical hazard within the equipment or its components, and how to deal with safety issues related to those chemicals.

To ensure SDS are consistently written the model code of practice for preparing safety data sheets for hazardous chemicals shall be followed. See https://www.safeworkaustralia.gov.au/resources_publications/model-codes-of-practice_for_details_of_requirements_for_SDS_including_Model_Code_of_Practice:_Preparation_of_safety_data_sheets_for_hazardous_chemicals.

Note: For clarity, a SDS is required for compliance to this guide irrespective of any exemption that may be suggested under any particular laws or codes (for example the SDS model code indicates a SDS is not required for 'chemicals in batteries while they are incorporated in plant', however this guide specifically requires a SDS for batteries, and any other chemicals, in the battery storage equipment).

5. Detailed installation instructions to be supplied with equipment. At a minimum the instructions need to specify:
 - 5.1. Distances of any standoff from a wall, floor, ceiling/roof;
 - 5.2. Distance from any heat source (e.g. hot water systems, gas heaters or the like);
 - 5.3. Distance/clearances from any equipment/wall/structure to the sides, bottom top;
 - 5.4. Clearance distances from any vents to any wall, other equipment, structure;
 - 5.5. If the equipment is for indoor only or outdoor only installation (or for either indoor or outdoor installation), and if it can be mounted in a position exposed to direct sunlight or is required to be shaded;
 - 5.6. If for indoor use, any ventilation requirements (for cooling of the equipment or to expel hazardous toxic or ignitable gases that may occur in normal or expected abnormal situations).

Note: Normal and abnormal test criteria in the Risk Matrix requires that there shall be “*no emissions of toxic or ignitable gases, smoke or the like in hazardous amounts*”, this instructional requirement is not intended to be a means to override that compliance criteria. Rather this is to ensure that if there have been any emission during testing (that were not in hazardous amounts during testing) or the safety data sheet indicates a need for venting of possible emissions, the emissions will be suitably expelled from the installation location.

6. Any user maintenance or optional process or procedures for the user need to be supplied with the equipment (including any shut down or isolation processes and associated labels or warnings).

7. Marking needs to be suitably UV resistant – if instructions include it is for outdoor use:

7.1 Legibility of markings on equipment intended for outdoor use shall not be degraded by UV radiation. This requirement does not apply to markings that are physically engraved, embossed or etched with durable markings.

Compliance is checked as follows (from IEC 60068-2-5 Ed3 2018):

7.1.1 Ten samples of the markings are to be exposed for 720 h to open-flame sunshine carbon-arc, in accordance with ISO 4892-4.

7.1.2 The test samples are mounted on the inside of the cylinder in the ultraviolet light apparatus perpendicular to the light source and in such a way that the samples do not touch each other.

7.1.3 There shall be continuous exposure to light and intermittent exposure to water spray. The cycle shall consist of 102 min without water spray and 18 min with water spray. The apparatus shall operate with an open-flame sunshine carbon-arc lamp, borosilicate glass Type 1, inner and outer optical filters, a spectral irradiance of 0,35 W/m²/nm at 340 nm and a black panel temperature of (63 ± 3) °C. The temperature of the chamber shall be (45 ± 3) °C. The relative humidity in the chamber shall be (50 ± 5) %.

8 Equipment shall have minimum IP ratings related to location of installation as follows:

8.1 Indoor - IP2X,

8.2 Outdoor - IP23

NOTE: equipment for outdoor use may require higher IP rating depending on installation location.

3.4 Method 4

This Method is to allow for other main standards to those identified in Methods 1, 2 or 3 to be used to assess suitability of the battery storage equipment. The chosen standard is required to be identified by use of the Risk Matrix to objectively address identified risks and apply defined compliance criteria (i.e. not just a 'risk assessment' process).

Note: Work to improve standards is ongoing and so standards other than those mentioned in Methods 1, 2 and 3 may become available to use, or there may be existing standards that could also be applied, so an additional method for applying the risk matrix to other standards to identify objective test and assessment criteria and compliance criteria to enable use of the other standard is included.

While this method is available and it is primarily for use to allow for improved standards to be applied when published, it may be used to apply other current available standards. However for consistency of assessment the preferred methods for existing available standards are Methods 1, 2 or 3 above.

The complete equipment is tested together as one device (the only exception is the battery module which may be tested separately to its requirements, but is still assessed as part of the equipment). Any master/slave configurations is also tested as one complete 'equipment'.

Apply

- Main standards: 1, 2, and 3.1 or 3.2 as applicable; and
- Secondary standards: 1.1 or 1.2 as chosen; and
- All the separate specific requirements including specialist standards and applying requirements related to outdoor use or indoor use as appropriate.

3.4.1 Main standards

1. Standard(s) as identified by assessment - Use risk matrix to confirm hazards covered.
2. AS IEC 62619:2017 *Secondary cells and batteries containing alkaline or other non-acid electrolytes* or IEC 62619 Ed1 2017.

Note: when applying AS IEC 62619:2017 the following is to be applied:

Clause 8 risk assessments not related to the lithium battery module should refer to other main and secondary standards within this Method for test process and pass criteria.

3.

- 3.1. AS/NZS 4777.2:2015 *Grid connection of energy systems via inverter requirements* * for inverter in equipment for connection to grid installations (applicable to integrated battery energy storage system equipment).

* AS/NZS 4777.2:2015 clause 5.1 requirement of inverter energy system that have energy storage (batteries) as the only possible energy source to comply with AS 62040.1.1:2003(R2013) does not need to be applied. The other standards listed in clause 5.1

of AS/NZS 4777.2:2015 and those listed in this Method may be applied instead of AS 62040.1.1:2003(R2013).

or

- 3.2. IEC 62109.1 Ed1 2010 and IEC 62109.2 Ed1 2011 for inverter in equipment for connection to Off-grid installations (applicable to integrated battery energy storage system equipment).

3.4.2 Secondary standards

1.

- 1.1. AS/NZS 60335.1:2011 *Household and similar electrical appliances – Safety General requirements*, clause 22.46 (software),

or

- 1.2. UL 1973:2013 *Batteries for use in light electric rail applications and stationary applications*, section 5.8.1.3 (software).

Note: if software testing that has been conducted to AS IEC 62619:2017 (or IEC 62619 Ed1 2017) can be shown as equivalent to criteria of 1.1 or 1.2 then no additional testing is required.

3.4.3 Separate specific requirements

1. External enclosure of the battery storage equipment is metallic material having a minimum thickness not less than 0.20 mm at any point, or is a polymeric material classified as 5VA according to IEC 60695-11-20:2015 (provided that the test sample used for the classification was no thicker than the relevant part of the enclosure). Small openings or parts of polymeric materials of enclosure (with any one hole or polymeric material not exceeding 20cm² and up to a combined total area of all holes or polymeric material not exceeding 100cm²) are exempt from this requirement. Openings in vents required for normal safe operation of the equipment are also exempt. Decorative trim over metallic material or over material classified as 5VA is also exempt.

Note: This is not an alternative to other flame test/resistance to propagation of fire tests of the listed standards, this is in addition to those requirements.

2. Battery module is a sealed component with no access to cell components. Access to the cell components cannot be obtained without damaging the enclosure of the cell components or fixing devices of the enclosure of the cell components.

Note: The intention is there is no maintenance required at cell component level or any on site repair or replacement at cell component level – for any of this type of activity the battery module is returned to manufacturer/service agent, and so prevent unsafe situations of large energy release and arc flash issues.

3. Isolation devices are required for external or internal isolation including at points within equipment to ensure parts to be installed/removed are isolated with no access to the energised parts (live parts or extra low voltage battery storage circuit parts). All isolation devices are to operate in all live (a.c. - active and neutral or d.c. – positive and negative) conductors.

Note: The intention is that any energised parts (low voltage or extra low voltage, external or internal) can be isolated before any maintenance, installation, repair or replacement activity occurs. This is to ensure the possibility of a shorting of terminals or live connections is prevented, and to prevent unsafe situations of large energy release and arc flash issues.

4. Detailed safety datasheets to be supplied with equipment. This includes SDS, including clear detail on any chemical hazard within the equipment or its components, and how to deal with safety issues related to those chemicals.

To ensure SDS are consistently written the model code of practice for preparing safety data sheets for hazardous chemicals shall be followed. See https://www.safeworkaustralia.gov.au/resources_publications/model-codes-of-practice for details of requirements for SDS including *Model Code of Practice: Preparation of safety data sheets for hazardous chemicals*.

Note: For clarity, a SDS is required for compliance to this guide irrespective of any exemption that may be suggested under any particular laws or codes (for example the SDS model code indicates a SDS is not required for 'chemicals in batteries while they are incorporated in plant', however this guide specifically requires a SDS for batteries, and any other chemicals, in the battery storage equipment).

5. Detailed installation instructions to be supplied with equipment. At a minimum the instructions need to specify:
 - 5.1. Distances of any standoff from a wall, floor, ceiling/roof;
 - 5.2. Distance from any heat source (e.g. hot water systems, gas heaters or the like);
 - 5.3. Distance/clearances from any equipment/wall/structure to the sides, bottom top;
 - 5.4. Clearance distances from any vents to any wall, other equipment, structure;
 - 5.5. If the equipment is for indoor only or outdoor only installation (or for either indoor or outdoor installation), and if it can be mounted in a position exposed to direct sunlight or is required to be shaded,
 - 5.6. If for indoor use, any ventilation requirements (for cooling of the equipment or to expel hazardous toxic or ignitable gases that may occur in normal or expected abnormal situations).

Note: Normal and abnormal test criteria in the Risk Matrix requires that there shall be “*no emissions of toxic or ignitable gases, smoke or the like in hazardous amounts*”, this instructional requirement is not intended to be a means to override that compliance criteria. Rather this is to ensure that if there have been any emission during testing (that were not in hazardous amounts during testing) or the safety data sheet indicates a need for venting of possible emissions, the emissions will be suitably expelled from the installation location.

6. Any user maintenance or optional process or procedures for the user need to be supplied with the equipment (including any shut down or isolation processes and associated labels or warnings).

7. Marking needs to be suitably UV resistant – if instructions include it is for outdoor use:

7.1 Legibility of markings on equipment intended for outdoor use shall not be degraded by UV radiation. This requirement does not apply to markings that are physically engraved, embossed or etched with durable markings.

Compliance is checked as follows (from IEC 60068-2-5 Ed3 2018):

7.1.1 Ten samples of the markings are to be exposed for 720 h to open-flame sunshine carbon-arc, in accordance with ISO 4892-4.

7.1.2 The test samples are mounted on the inside of the cylinder in the ultraviolet light apparatus perpendicular to the light source and in such a way that the samples do not touch each other.

7.1.3 There shall be continuous exposure to light and intermittent exposure to water spray. The cycle shall consist of 102 min without water spray and 18 min with water spray. The apparatus shall operate with an open-flame sunshine carbon-arc lamp, borosilicate glass Type 1, inner and outer optical filters, a spectral irradiance of $0,35 \text{ W/m}^2/\text{nm}$ at 340 nm and a black panel temperature of $(63 \pm 3) \text{ }^\circ\text{C}$. The temperature of the chamber shall be $(45 \pm 3) \text{ }^\circ\text{C}$. The relative humidity in the chamber shall be $(50 \pm 5) \%$.

8 Equipment shall have minimum IP ratings related to location of installation as follows:

8.1 Indoor - IP2X,

8.2 Outdoor - IP23,

NOTE: equipment for outdoor use may require higher IP rating depending on installation location.

3.5 Optional requirements

The requirements in this section are listed as optional, that is they are not part of any mandatory method of this guide and not required for minimum claims of compliance to this guide. However it is preferred these optional requirements are addressed and actioned where applicable as some relate to improved safety, and/or process to ensure on-going safety, and possibly as a means to show compliance to legislative requirements. Additionally, should anything in this section be required by any legislative or contractual provision then claims they are 'optional' based on this guide would not be relevant.

Some optional requirements reference a relevant standard for testing and assessment. Where requirements do not list a standard there may be standards available that a suitably competent person can reference for assessment, however there is still generally criteria stated that can be objectively tested, assessed and reviewed by a suitably competent person as being compliant to requirements.

- a) IEC 61000-4 series *Protection for hazards due to electromagnetic influences on the supply mains*.

As part of on-going reviews for continuous improvements in best practice, point a) will be reviewed after 12 months to consider being moved into the mandatory requirements of this guide or remain as an optional requirement.

To protect against electromagnetic influences on the mains power supply, pre-assembled integrated battery energy storage system equipment, where the equipment has a protective electronic circuit (an electronic circuit that prevents a hazardous situation under abnormal operating conditions – but not an electronic circuit that is purely for functional requirements) the following IEC 61000-4 series standards are applicable:

- I. IEC 61000-4-2 Ed2 2008 – the equipment is subjected to electrostatic discharges in accordance with IEC 61000-4-2 Ed 2 2008, test level 4 being applicable. Ten discharges having a positive polarity and ten discharges having a negative polarity are applied at each preselected point.
- II. IEC 61000-4-3 Ed 3.2 2010 – the equipment is subjected to radiated fields in accordance with IEC 61000-4-3 Ed 3.2 2010, test level 3 being applicable. The frequency ranges tested shall be 80 MHz to 1 000 MHz and 1,4 GHz to 2,0 GHz. Note: The dwell time for each frequency is to be sufficient to observe a possible malfunction of the protective electronic circuit.
- III. IEC 61000-4-4 Ed 3 2012 – the equipment is subjected to fast transient bursts in accordance with IEC 61000-4-4 Ed 3 2012. Test level 3 with a repetition rate of 5 kHz is applicable for signal and control lines. Test level 4 with a repetition rate of 5 kHz is applicable for the power supply lines. The bursts are applied for 2 min with a positive polarity and for 2 min with a negative polarity.
- IV. IEC 61000-4-5 Ed 3.1 2017 – the power supply terminals of the equipment are subjected to voltage surges in accordance with IEC 61000-4-5 Ed 3.1 2017, five

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positive impulses and five negative impulses being applied at the selected points. Test level 3 is applicable for the line-to-line coupling mode, a generator having a source impedance of 2 Ω being used. Test level 4 is applicable for the line-to-earth coupling mode, a generator having a source impedance of 12 Ω being used. Note: If a feedback system depends on inputs related to a disconnected heating element, an artificial network may be needed. For equipment having surge arresters incorporating spark gaps, the test is repeated at a level that is 95 % of the flashover voltage.

- V. IEC 61000-4-6 Ed 2.1 2009 – the equipment is subject to injected currents in accordance with IEC 61000-4-6 Ed 2.1 2009, test level 3 being applicable. During the test, all frequencies between 0,15 MHz to 80 MHz are covered. Note: The dwell time for each frequency is to be sufficient to observe a possible malfunction of the protective electronic circuit.
 - VI. IEC 61000-4-11 Ed 2.1 2017 – for equipment with rated current not exceeding 16A, the equipment is subject to the class 3 voltage dips and interruptions in accordance with IEC 61000-4-11 Ed 2.1 2017. The values specified in Table 1 and Table 2 of IEC 61000-4-11 are applied at zero crossing of the supply voltage.
 - VII. IEC 61000-4-34 Ed 1.1 2009 – for equipment with rated current in excess of 16A, the equipment is subject to the class 3 voltage dips and interruptions in accordance with IEC 61000-4-34 Ed 1.1 2009. The values specified in Table 1 and Table 2 of IEC 61000-4-34 are applied at zero crossing of the supply voltage.
- b) UL 1973:2013 clause 36 - resistance to external fire – if instructions include for indoor use.

As part of on-going reviews for continuous improvements in best practice, point b) will be reviewed after 12 months to consider being moved into the mandatory requirements of this guide or remain as an optional requirement.

- c) IEC 60068-2-52 Ed3 2017 - Salt fog mist test – if instructions include it is for outdoor use.

As part of on-going reviews for continuous improvements in best practice, point c) will be reviewed after 12 months to consider being moved into the mandatory requirements of this guide or remain as an optional requirement.

- d) Wind loading/wind ratings if applicable (depending on installation instructions and mounting locations). For example UL 1973:2013 - cl. 26 static force test + cl. 29 wall mount test- however this should also be an installation requirement more than a product requirements. Or use of AS 1170.2:2011 *Structural design actions – wind actions* as guidance.
- e) Software updates – Software version must be able to be interrogated on equipment. Any safety related software updates related to compliance to this guide needs to be listed in compliance document. Safety related software updates related to compliance to this guide need to be reassessed by test lab as suitable and modification to any independent certification made. Safety related software updates related to compliance to this guide, if updated remotely, must include a process of validation.

- f) Use of user alarm/warning systems operation and effectiveness - adequate warning alarms at local point (i.e. on site), specifically where the failure/degradation would eventually cause a safety hazard – that is warn of the safety issue that has caused device to shut down/reduced output.
- g) Use of alarm/warning connectivity to internet/Wi-Fi or telecoms systems for monitoring/back to base or supplier systems - equipment must be able to operate safely without the alarm/warning/3G or 4G connection in place. (i.e. if this connection is present the failure of a connection will not create a safety hazard).
- h) Warning instructions/safety signs (optional if supplied) to meet relevant installation standards.
- i) Installation standard labels - if labels related to installation are supplied they comply with the installation standard requirements.
- j) Adequate review of any design changes made during production - systems in place to ensure no changes made that affect safety unless adequately assessed.
- k) Quality assurance processes of manufacture of equipment - systems in place to ensure no changes made that affect safety unless adequately assessed.
- l) Random sampling/testing of production - systems in place to ensure no changes made that affect safety unless adequately assessed.
- m) Quality control for issues of change of components – review or design/retest as required - systems in place to ensure no changes made that affect safety unless adequately assessed.
- n) Quality control of component manufacturers/importers and parts sourced from third parties - systems in place to ensure no changes made that affect safety unless adequately assessed.
- o) Quality control over complete supply chain to ensure no substitution/unauthorised modifications - systems in place to ensure no changes made that affect safety unless adequately assessed.
- p) Auditing of manufacturers/importers - systems in place to ensure no changes are made that affect safety unless adequately assessed.
- q) Systems, process and plans in place for on-going monitoring and review of the safety of the equipment. Processes to investigate any safety incidents reported and act on identified issues to improve, enhance, modify, rectify, repair or recall equipment or modify installation instructions/safety information as/if required.

3.6 Additional hazards and risks that should be considered

This section contains general hazards and risks that were identified as relevant to battery storage equipment during the development of this guide. However they were considered not specifically

related to electrical safety, or the criteria already in the guide was suitable to address the issue without the need for specific criteria to be added.

While these hazards are not required to be addressed to claim compliance to this guide, the hazards are considered important to be highlighted to manufacturers/importers as related areas they should consider (or may need to be addressed for legislative requirements other than electrical safety).

Arc flash

Arc flashes can be dangerous causing serious burns and electrocution and control measures must be implemented to avoid the risk.

Arc flash safety requirements within this guide are intended to be covered by the criteria that terminals for the battery modules shall not be accessible in pre-assembled battery storage equipment. The equipment installed in field has no access to such parts that may cause arc flash and any repair, which may result in arc flash risk, requires the whole equipment to be taken back to workshop for repairs.

However manufacturers/importers of battery storage equipment should be aware of the risks associated with arc flash and ensure their design and manufacture always limits exposure to possible arc flash and its consequences. Arc flash occurs when electrical current passes through air between electrified conductors when there is insufficient isolation or insulation to withstand the applied voltage.

Intensity, and resultant harm to workers or other person nearby, of arc flash is dependent on various factors including the voltage, the arcing current, the arcing time, the amount of energy available, the distance from the arc, the location of the arc and other barriers in place that may direct the arc in a particular direction.

Manufacturers/importers should consider the hazard of arc flash, even if it is not specifically part of this guide and ensure they have adequate design and manufacture techniques to reduce this hazard as much as practicable.

Chemical hazards

Chemical hazards have several areas of concern. Internal chemical hazard and external chemical hazard.

Internal chemical hazard is identified as an issue, however this guide only acknowledges that safety data sheets related to internal chemicals and their hazards shall be provided with the equipment. Installers would need to comply with those requirements to meet health and safety laws for their workers and for the safe operation of the installed product.

External chemical hazards are too broad to be included within this guide, however manufacturers/importers/installers need to consider the location of installation and if any other external chemicals may be present in that location. If that is likely, the manufacturer/importer/installer should consider what basic steps they can take to reduce or eliminate any hazard from external chemical attack.

Storage, handling and transport

Storage, handling and transport issues are not specifically electrical safety related. There are safety requirements related to these issues, particularly related to any hazardous chemicals and qualities of such chemicals. It should be noted that while a single unit of battery storage equipment may be under certain limits for storage and transport of chemicals, storage or transport of multiple units of battery storage equipment in the one location may result in requirements of higher limits of such materials being required to be met.

Vibration – transport or seismic activity

It is noted that in some locations seismic activity may be an issue to be considered. While not part of this guide, if installation of the battery storage equipment is to be in such locations the installer should consult the manufacture/importer. Manufacturers/importers should supply information as to the suitability of their equipment for such locations and any necessary additional steps to be taken to ensure safety (both electrical and mechanical – for example a tipping hazard – safety).

If transport vibrations may cause damage to parts of the battery storage equipment the manufacturer/importer should ensure the transport process eliminates any likely damage or there are adequate inspection processes to verify no damage has occurred.

UV protection and resistance

This guide does not take into account the possible UV radiation hazards caused by battery storage equipment being exposed to direct sunlight for extended periods. It is understood most manufacturers/importers would have instructions to require the battery storage equipment to not be installed in locations of constant direct sunlight, however if not the manufacturer/importer should ensure no hazard would result from installation in locations where direct sunlight is possible.

Cyber security

Cyber security is emerging area of concern and manufacturers/importers of battery storage equipment should consider what hazards could occur to their equipment in this area. There is various work underway internationally in this area related to electricity network security and equipment security. While noting this is an area to consider, this guide does not address any issues related to cyber security.

PART 4 – HAZARDS / RISK MATRIX

Risk Matrix

The Appendix 1 - **Battery Energy Storage Equipment Risk Matrix** (excel spreadsheet) outlines the potential safety hazards of each type of equipment and expected minimum criteria that must be met to address the hazards and comply with this guide. The risk matrix forms part of this guide and when applying the requirements listed in the Methods in Part 3, the assessor must consider how the risk/hazards and the 'minimum expectations to meet' criteria in the Risk Matrix have been addressed. If safety standards other than those listed in one of the Methods are used to assess equipment, the suitably competent person must ensure the hazards detailed in the Risk Matrix are addressed by the alternative standard.

Hazards

The following list of risk areas and issues were considered in the development of the Risk Matrix and subsequently considered as mandatory requirements, optional requirements, additional hazard listed in this guide, or as not relevant to the equipment covered by the guide. Some of the risks/hazards were identified as co-dependant/interrelated/just compliance criteria of another hazard and have been combined within the final document.

- 1) Access to live parts – electric shock risk - direct contact
- 2) Access to live parts – electric shock risk - indirect contact
- 3) Excessive temperatures – during normal operation
- 4) Excessive temperatures – during abnormal operation
- 5) Overload – over current protection
- 6) Overload – over charging protection
- 7) Low voltage protection
- 8) Over voltage protection
- 9) Over discharge
- 10) Low temperature charging
- 11) High temperature charging
- 12) Arcs - internal
- 13) Arc flash hazard to user/installer/maintenance person
- 14) Burn hazard (from excessive temperatures, arcs, fire)
- 15) Radiation (including microwave emissions or magnetic fields)
- 16) Insulation properties – suitable for electrical, mechanical, chemical and physical stresses
equipment likely to be subject to including protection against internal tracking between different polarities
- 17) Suitable earthing/double/reinforced insulation properties and creepage/clearance distances
for voltages insulation is exposed to
- 18) Adequate segregation from other systems (for example accessible alarm circuitry,
communications/data wiring)
- 19) Resistance to rusting/corrosion effects likely
- 20) Unexpected starting or stopping of operation of equipment
- 21) Failure to stop if dangerous situation arises
- 22) Chemical hazards
- 23) Spill containment
- 24) Fire hazard

- 25) Prevention of propagation of fire (fire containment under fault conditions)
- 26) Prevention of propagation of fire (due to external fire encroachment)
- 27) Energy hazards
- 28) Explosion hazard – internal hazards
- 29) Explosion hazards – from release of explosive gases (during normal or fault conditions)
- 30) Toxic smoke/toxic gas emissions
- 31) Protection from mechanical damage
- 32) Mechanical hazards of the equipment
- 33) Mechanical stability/tilting
- 34) Weatherproof/humidity/moisture ingress suitability and ratings (as appropriate)
- 35) Protection from external contaminants and pollution
- 36) Immunity from effects of electromagnetic radiation (separate from the equipment not causing electromagnetic radiation)
- 37) Transient overvoltage protection (surges, spikes, lightning)
- 38) Adequate testing/assessment validation of components used in equipment
- 39) Suitable methods of connection to electrical systems
- 40) Hazards due to any electronic component/circuit failure
- 41) Hazards due to any software/firmware faults
- 42) Correct operation of any protective devices/systems/safety interlocks
- 43) Safety in situations of a 'single fault', consideration of foreseeable multiple fault situations
- 44) Adequate isolation of equipment as required (for example during maintenance, repair, anti-islanding if connected to grid system)
- 45) Isolation of energy sources within equipment when equipment is isolated (for example auto switch off of internal d.c. parts if the external isolation device is activated)
- 46) Adequate ability to identify manufacturer/importer/supplier on equipment (and components as necessary)
- 47) Appropriate rating labels on equipment to ensure correct installation and use
- 48) Adequate information for safe transportation and storage of equipment prior to installation
- 49) Adequate installation and set-up instructions to be properly assembled (if required), installed, interconnected and correctly commissioned
- 50) Adequate operation and maintenance requirements and instructions
- 51) Vibration (due to transport, seismic activity, operation of device)
- 52) Documentation/labels – equipment related
- 53) Validation of any remote software safety related updates as effective
- 54) Use of user alarm/warning systems operation and effectiveness
- 55) Use of alarm/warning connectivity to internet, 3G or 4G systems for monitoring/back to base or supplier systems
- 56) Adequate warning instructions and safety signage on equipment, or supplied for installation and use with equipment as necessary
- 57) Adequate review of any design changes made during production
- 58) Quality assurance processes of manufacture of equipment
- 59) Random sampling/testing of production
- 60) Quality control for issues of change of components – review or design/retest as required
- 61) Quality control of component suppliers and parts sourced from third parties
- 62) Quality control over complete supply chain to ensure no substitution/unauthorised modifications

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