BESS
Hazard Identification (HAZID) Register

Project:
Title: AEC BESS Guidance Risk Register
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Project No.:
Client:
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Hazard I.D.	Project Area	Hazard Description	Cause	Consequence	Standard Control Measures	Risk Owner	Initial Risk Rating			Potential Control Measures And Actions	Responsibility	By When	Decision / Status	Residual Risk Rating			Comments / references
							Consequence	Likelihood	Risk Rating					Consequence	Likelihood	Risk Rating	
1	Environmental	Flammable gases	Production and accumulation of flammable gases in battery enclosure with ignition resulting in fire or explosion and thermal runaway	- Damage to BESS - Escalation of event (i.e. propagation to neighbouring BESS modules) - Injury to onsite personnel - Injury to surrounding populations (neighbouring industries, residents) - Bushfire, damage to environment - Heat radiation to the transformer. Transformer overheats and fails.	- Designed to Industry Acts and Standards (Occupational Health and Safety Act, AS/NZS ISO 14001:2016, AS/NZS ISO 45001:2018, UL1973, UL9540) including deflagration control (pressure sensitive vents and sparker system) - Compliance with applicable requirements from NFPA 855 and UL9540A - Vegetation management / clearance around BESS - Site specific emergency response and management plan - Multiple access and egress points on site to allow fire authority to access the fire water tank					- Include remotely accessible flammable gas monitoring to detect presence of flammable gases - Include appropriate signage and site manifest to identify hazardous chemical hazards associated with the contents of BESS - Consider and confirm unintended consequences of a noise wall if it is implemented, including accessibility to and from site, accumulation of hazardous gases and confinement of heat within the site ("heat island effect")							Arizona fire 2019 Victorian Big Battery fire 2021
2	Environmental	Toxic gases	Thermal runaway in BESS (including initiation) leading to production and dispersion of toxic gases	- Injury to onsite personnel - Injury to surrounding populations (nearby industrial area or residential) - Impacts to local flora and fauna	- Designed to Industry Acts and Standards (Occupational Health and Safety Act, AS/NZS ISO 14001:2016, AS/NZS ISO 45001:2018, UL1973, UL9540) - Compliance with applicable requirements from NFPA 855 and UL9540A - PPE for emergency response team and onsite personnel - Site specific emergency response and management plan - Selection of appropriate battery chemistry - Design of battery modules to slow and limit rate of gas generation					- Include remotely accessible flammable gas monitoring to detect presence of flammable gases - Include appropriate signage and site manifest to identify hazardous chemical hazards associated with the contents of BESS - Incorporate presence of toxic gases being generated from the BESS into site Emergency Response Procedures, including appropriate exclusion zones, PPE for Emergency Responders, and communications required to neighbouring industries and local residents - Confirm what toxic materials (type and volume) are produced from the BESS and ask the vendor to provide information on products of combustion - Determine the potential toxic hazard impact zone around the BESS using suitable air dispersion modelling with consideration of wind speeds and directions - Prepare information for community of the potential hazards to residents of toxic gas dispersion from the BESS, once dispersion modelling is complete - Consider and confirm unintended consequences of a noise wall if it is implemented, including accessibility to and from site, accumulation of hazardous gases and confinement of heat within the site ("heat island effect")							Toxic gases from recent PG&E (California) fire were HCN, CO, and trace amounts of HF Toxic gases can be generated due to the incomplete combustion of gases generated during the initial thermal runaway phase
3	Environmental	External fire	External thermal source (e.g. fire at neighbouring facility or bushfire) resulting in overheating of BESS	- Damage to BESS leading to disruption of power supply - Damage to power supply infrastructure causing disruption of power to community - Hardware failure - Heat radiation to the transformer. Transformer overheats and fails. - Potential for escalation to a thermal runaway event (and propagation between units)	- Vegetation Management / clearance around BESS (Asset Protection Zone with landscaping treatment, fencing and retaining constructed from fire resistant materials) - Access and egress suitable for prevention activities and firefighting - Housekeeping/maintenance to remove debris build up - Fire water requirements meet required guidance (e.g., CFA guidance material) - Other buildings within the BESS facility compound are designed for adequate fire protection - Site specific emergency response and management plan - Procedure/ controls for correct storage of any chemicals/ combustible materials brought onsite, to be away from units (if applicable) - All equipment clearances in accordance with AS2067 - Selection of appropriate battery chemistry - Design of battery modules to slow and limit rate of gas generation - Bushfire risk assessment					- Confirm fire water supply requirements to manage a BESS fire and determine the fire system scope of work (e.g., onsite tank, water main, etc.) - If a noise wall is required for the site, reconsider the size of the Asset Protection Zone to ensure it is sufficient - If a noise wall is required for the site, ensure noise wall material is fire resistant - If a noise wall is required for the site, determine the thermal radiation consequences for the site inside the noise wall - Include a procedure to shut down BESS during conditions where fire can spread externally into site (e.g. bushfire) as part of standard operating protocols - Position and design air conditioning vents on site buildings and BESS cabinets to prevent debris build up and fire propagation - Investigate designing louvres and shields on air intakes to batteries - Consider and confirm unintended consequences of a noise wall if it is implemented, including accessibility to and from site, accumulation of hazardous gases and confinement of heat within the site ("heat island effect") - Use of non-combustible materials for all adjacent hardware & equipment							
4	Environmental	External fire	Bushfire in the local bushland resulting in ember attack	- Ember attack ignites exposed cables - Damage to BESS leading to disruption to power supply - Damage to power supply infrastructure causing disruption of power to community - Potential for escalation to a thermal runaway event (and propagation between units)	-Non-combustible elements used for construction - Site specific emergency response and management plan - Procedure/ controls for correct storage of any chemicals/ combustible materials brought onsite, to be away from units (if applicable) - Fire water requirements meet required guidance (e.g., CFA guidance material) - Other buildings within the BESS facility compound are designed for adequate fire protection - Insulation around battery module to limit heat effects - Bushfire risk assessment					- Confirm fire water supply requirements to manage a BESS fire and determine the fire system scope of work (e.g., onsite tank, water main, etc.) - If a noise wall is required for the site, ensure noise wall material is fire resistant - Include a procedure to shut down BESS during conditions where fire can spread externally into site (e.g. bushfire) as part of standard operating protocols - Use of non-combustible materials for all adjacent hardware & equipment. - Complete Computational Fluid Dynamic modelling of the whole BESS facility							
5	Environmental	External ambient conditions / environment	Extreme temperature (e.g. hot day) or humidity resulting in overheating of BESS ***Note:*** *A noise wall around the facility may increase the hazard through the potential for a "heat island"*	- Damage to BESS leading to disruption of power supply - Degradation of equipment - Hardware failure - Reduction in BESS operating life - Deteriorating insulation leading to injury to personnel - Unable to comply with derating and regulatory requirements - Potential for escalation to a thermal runaway event (and propagation between units)	- Design BESS units for worse case site ambient conditions with appropriate IP rating - BMS to shut down BESS if temperature exceeds high temperature threshold - Fire water requirements meet required guidance (e.g., CFA guidance material) - Other buildings within the BESS facility compound are designed for adequate fire protection - Site specific emergency response and management plan - Selection of suitable battery chemistry					- Complete Computational Fluid Dynamic modelling of the whole BESS facility - Confirm fire water supply requirements to manage a BESS fire and determine the fire system scope of work (e.g., onsite tank, water main, etc.) - Consider and confirm unintended consequences of a noise wall if it is implemented, including accessibility to and from site, accumulation of hazardous gases and confinement of heat within the site ("heat island effect") - Selection of low noise fans and ventilation system design							

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6	Environmental	Severe storm event during operation (lightning)	Lightning strike to BESS unit	- Damage to BESS leading to loss of ancillary services (e.g., monitoring) - Potential for escalation to a thermal runaway event (and propagation between units)	- Vegetation Management / clearance around BESS - Dual redundancy - Lightning protection study, and appropriate lightning protections applied - Site specific emergency response and management plan												
7	Environmental	Severe storm event during operation (flooding)	Flash flooding inundating BESS facility, leading to: - ground instability - high water levels (potential to submerge BESS units)	- Limited access to site - Damage to BESS, with the potential to initiate a thermal runaway event depending on the extent of the flooding	- BMS to shut down BESS if temperature exceeds high temperature threshold - Site location considers flood regions and incorporates suitable facility design height - Site specific emergency response and management plan					- Conduct flood modelling of BESS site to determine potential impact zones and design drainage to mitigate the effects - Determine impact of flooding at substation including expansion on the BESS site (e.g. water runoff across site) and design drainage to mitigate the effects - Complete geotechnical studies to ensure stable ground conditions for light and heavy vehicles including in heavy rain / flooding events and seismic events							
8	Environmental	Storm water or local flooding during construction	Flooding inundating construction site, leading to: - ground instability - high water levels (potential to submerge BESS units)	- Limited access to site, delaying commissioning - Environmental impact - Local erosion, scouring, sediment flowing offsite - Onsite impact - ground conditions	- Civil design to comply with relevant standards - Design of temporary works to manage erosion control - Weather monitoring - Environmental inspections - Flood mapping of area - Site location considers flood regions - Construction management plan					- Conduct flood modelling of BESS site to determine potential impact zones and design drainage to mitigate the effects - Schedule construction in dry season to reduce the likelihood of environmental impacts from site drainage - Complete geotechnical studies to ensure stable ground conditions for light and heavy vehicles including in heavy rain / flooding events and seismic events							
9	Environmental	High winds during bushfire event	Windy conditions at BESS facility in combination with fire, resulting in ember propagation and attack	- Generation of microclimate around BESS facility - Potential for escalation to a thermal runaway event (and propagation between units) - Damage to surrounding BESS facility infrastructure	- Vegetation Management / clearance around BESS - BMS to shut down BESS if temperature exceeds high temperature threshold - Other buildings within the BESS facility compound are designed for adequate fire protection - Compliance with AS1170.2 - Site specific emergency response and management plan - BESS module design to withstand ember attack and external heat with insulation					- If a noise wall is to be implemented, ensure it is compliant with Australian Standards for wind loading - activation of site spray system if exists.							
10	Environmental	Seismic event	Earthquake causing ground instability	- Damage to BESS units - Damage to BESS facility infrastructure	- Set back distances from falling objects (trees or powerlines) - Designed to AS1170.4 - Site specific emergency response and management plan					- Complete geotechnical studies to ensure stable ground conditions for light and heavy vehicles including in heavy rain / flooding events and seismic events							Dependent on location
11	Environmental	Dust ingress to BESS	- Inadequate IP rating - Accumulation of dust within BESS module, resulting in overheating or electrical fault, potentially leading to thermal runaway	- Damage to BESS leading to loss modules - Potential for thermal runaway, explosion / fire, leading to: -> Injury to onsite personnel -> Injury to surrounding populations (neighbouring industries, residents) -> Bushfire	- Ventilation system - Maintenance strategy - IP rating of the ventilation system - BMS to shut down BESS if temperature exceeds high temperature threshold - Vegetation Management / clearance around BESS - Design includes two measures for explosion mitigation (sparker system and deflagration panels in roof) - Fire water requirements meet required guidance (e.g., CFA guidance material) - Other buildings within the BESS facility compound are designed for adequate fire protection					- Confirm current containment requirements for fire water used in fighting a BESS fire (e.g., implement holding tank and treatment for contaminated water) - Ensure all fire hazards are considered within a Fire Safety Study, including appropriate preventative and mitigative controls to ensure all hazard requirements are met - Thermal and airflow detectors							This scenario is dependent on the quality and number of independent layers of protection.
12	Environmental	Noise	Noise produced by BESS impacting nearby residents and community	Reputational impacts	- Complete noise modelling - Construction of a noise wall (if needed) - Suitable noise specification with supplier					- Undertake noise modelling to determine if a noise wall is required to reduce noise impacts to nearby residential areas - Consider and confirm unintended consequences of a noise wall if it is implemented, including accessibility to and from site, accumulation of hazardous gases and confinement of heat within the site ("heat island effect") - Utilise low noise fan and ventilation design							Applicable to all BESS facilities
13	Effluent	Contaminated fire water	Fire at BESS requiring use of fire water	Potential runoff of contaminated fire water into the environment resulting in environmental damage	- Civil design to comply with relevant standards - Fire water requirements meet required guidance (e.g., CFA guidance material)					- Determine the extent of contamination of water used to fight fires and any potential environmental impacts if released - Confirm current containment requirements for fire water used in fighting a BESS fire (e.g., implement holding tank and treatment for contaminated water)							Experience from VBB fire (2021) that a BESS module fire requires 6hrs fire water (TBC) and the fire water was not contaminated Consider CFA guidance for relevant criteria for fire water runoff in Victoria.

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14	Equipment	Internal thermal source (i.e., within the battery module)	Thermal event within a battery module due to various reasons including, but not limited to, the following: - Internal coolant leak - SCADA system offline during commissioning - Short circuit - Leakage of water to below cells resulting in damage and thermal runaway - Internal cell defect (e.g. manufacturing error)	- Damage to BESS leading to module loss - Heat radiation to the transformer. Transformer overheats and fails - Potential for thermal runaway, explosion / fire, leading to: -> Injury to onsite personnel -> Injury to surrounding populations (neighbouring industries, residents) -> Bushfire	- OEM QA procedures, SAT and FAT data - Maintenance strategy - BMS to shut down BESS if temperature exceeds high temperature threshold - Design includes two measures for explosion mitigation (sparker system and deflagration panels in roof) - Fire water requirements meet required guidance (e.g., CFA guidance material) - Other buildings within the BESS facility compound are designed for adequate fire protection - Designed to Industry Standards (UL1973, UL9540, AS2067) - Compliance with applicable requirements from NFPA 855 and UL9540A - Complete mapping of the supervisory control and data acquisition (SCADA) system to the control system and provide full data functionality and oversight to operators											
										- Confirm fire water supply requirements to manage a BESS fire and determine the fire system scope of work (e.g., onsite tank, water main, etc.) - If a noise wall is required for the site, reconsider the size of the Asset Protection Zone to ensure it is sufficient - If a noise wall is required for the site, ensure noise wall material is fire resistant - If a noise wall is required for the site, determine the thermal radiation consequences for the site inside the noise wall - Include a procedure to shut down BESS during conditions where fire can spread externally into site (e.g. bushfire) as part of standard operating protocols - Position and design air conditioning vents on site buildings and BESS cabinets to prevent debris build up and fire propagation - Investigate designing louvres and shields on air intakes to batteries - Consider and confirm unintended consequences of a noise wall if it is implemented, including accessibility to and from site, accumulation of hazardous gases and confinement of heat within the site ("heat island effect") - Use of non-combustible materials for all adjacent hardware & equipment. - Thermal imaging camera(s) included in O&M toolkit, allowing for monitoring of system in event of suspect behaviour. - Ensure all fire hazards are considered within a Fire Safety Study, including appropriate preventative and mitigative controls to ensure all hazard requirements are met							
15	Equipment	Electrical equipment fault	Fault in AC and DC electrical equipment in BESS resulting in arc flash	Injury to onsite personnel	- Designed to relevant standards (arc flash rating, isolations) - Live equipment procedures					- Conduct an Arc Flash study as part of BESS cabinet design for arc flash containment - Implement suitable operational procedures for LOTO, switching, etc. This includes procedures for substation operation during construction / commissioning of BESS interface							Lessons learned from Chinchilla BESS
16	Equipment	Contact with underground utilities and step and touch voltages	BESS installation earthing and connection to existing earth mat	Injury to personnel from step and touch potential	- Designed to applicable electrical Standards to minimise touch and step potential - Lift plan for lifting of BESS equipment over live BESS modules during construction, operation, replacement and decommissioning					- Develop and follow suitable lift plan for lifting of BESS equipment over live BESS modules during construction, operation, replacement and decommissioning - Implement suitable operational procedures for LOTO, switching, etc. This includes procedures for substation operation during construction / commissioning of BESS interface							Lessons learned from Chinchilla BESS
17	Equipment	Earth fault on the DC systems	- Insulation failure - Water ingress battery failure - Equipment fault	Damage to BESS leading to disruption of power supply	- Earthing Standards covered in battery storage (AS5139, AS3000) - Vegetation management / clearance around BESS					-Implement suitable operational procedures for LOTO, switching, etc. This includes procedures for substation operation during construction / commissioning of BESS interface							Lessons learned from Chinchilla BESS
18	Equipment	Fire in diesel generator unit (if applicable)	Diesel leak resulting in ignition and fire in the diesel generator unit	Heat radiation impact to adjacent structures	- Integrally bunded tank within the diesel generator unit - Low quantity of diesel stored (Less than 1000 L). - Storage faculty is classified as minor under AS 1940 and no segregation is required. - Adjacent building are non-combustible material					- Recommend compliance with the minor storage provisions of Section 2.3 of AS1940 for diesel storage and refuelling - For less than 1,000 L separation from buildings is unrestricted but 1.5 m from structures is recommended for access purposes							
19	Equipment	Communication panel	Electrical fault in communications panels	Fire in panel and potential loss of communication equipment fire growth into the room and adjacent equipment.	- Use of fire detection - Staff available near site for quick response if remote communication becomes unavailable - Switch gear is fail safe and can be operated manually - Room is constructed from non-combustible materials (low fuel load) - Low energy equipment in the communications panel.												
20	Equipment	Fire Protection & VESDA Panels - Control Room	Electrical fault in panels	Fire in panels, loss of fire protection system equipment, impaired fire suppression capabilities	- Use of early smoke detection and gas suppression to mitigate fire risk before damage can occur to the system - Equipment should be rated to withstand and detect fire in its vicinity - Fire system circuit is design as fail safe - Extra low voltage panel wiring												
21	Equipment	External impact	- External impact (e.g., vehicle) to high voltage equipment, BESS units, or surrounding infrastructure, due to fatigue, speeding, loss of vehicle control, inadequate road condition	- Equipment damage - Damage to BESS leading to module loss. Depending on the extent of impact, there is potential for thermal runaway, - Potential for injury to onsite personnel	- Safety rails and bollards - Fencing around site - Not many vehicles required/expected during operation and maintenance - Minimum compliance with AS2067, AS3000 and other requirements - Site speed limit - Steel frame of module					- Implement dedicated walkways and crossing points to reduce risk of vehicle interactions with pedestrians - Implement site speed limit to reduce risk of vehicle interactions with pedestrians and collisions with BESS and associated equipment							
22	Equipment	Failure during maintenance	Error in maintenance of BESS	- Cell failure, loss of performance - Potential for thermal runaway, explosion / fire, leading to: -> Injury to onsite personnel (if present) -> Injury to surrounding populations (neighbouring industries, residents) -> Bushfire	- Trained, competent, and qualified staff - OEM maintenance procedures - Fire water requirements meet required guidance (e.g., CFA guidance material) - Other buildings within the BESS facility compound are designed for adequate fire protection - Designed to Industry Standards (UL1973, UL9540, AS2067) - Compliance with applicable requirements from NFPA 855 - Site specific emergency response and management plan					- Confirm fire water supply requirements to manage a BESS fire and determine the fire system scope of work (e.g., onsite tank, water main, etc.)							

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23	Equipment	Dropped objects during construction	Dropped loads during installation due to poor load placement or lifting failure (live batteries dropped during construction or replacement)	- Equipment damage - Injury to onsite personnel	- Lift and construction sequencing plan which details lifting of BESS equipment over live BESS modules during construction, operation, replacement and decommissioning - Constructability and maintainability assessment and plan for the BESS site, to ensure adequate provision for future work activities on the site - Compliance with applicable requirements from NFPA 855												Although this risk specifically refers to live batteries being dropped on site, this is risk is applicable to all grid-scale BESS facilities which require lifting equipment at heights
24	Equipment	Dropped objects during operation and maintenance	Dropped loads during operation and maintenance due to poor load placement or lifting failure	- Equipment damage - Injury to onsite personnel	- Lift plan which details lifting of BESS equipment over live BESS modules during construction, operation, replacement and decommissioning - Constructability and maintainability assessment and plan for the BESS site, to ensure adequate provision for future work activities on the site - Compliance with applicable requirements from NFPA 855												Although this risk specifically refers to live batteries being dropped on site, this is risk is applicable to all grid-scale BESS facilities which require lifting equipment at heights
25	Emergency	Accessibility	- Inadequate spacing between BESS module rows (e.g. only - Restricted BESS facility access / egress routes for emergency evacuation and responders	- Injury to onsite personnel - Emergency responders unable to reach BESS as spacing between battery banks is insufficient for vehicle movement	- Specification includes access requirements for maintainability and emergency response purposes - design of two separate paths of egress - Layout review (in a later project stage) once the preferred supplier has been awarded - Minimum compliance with AS2067, AS3000 and other requirements - Compliance with applicable requirements from NFPA 855 - Engage with local fire authorities and other emergency services during layout design and site commissioning process					- Conduct a hazardous area assessment to determine the locations of release points in relation to potential ignition sources - Consider and confirm unintended consequences of a noise wall if it is implemented, including accessibility to and from site, accumulation of hazardous gases and confinement of heat within the site ("heat island effect")							
26	Occupational, Health and Safety	Accessibility	- Inappropriate layout of BESS area - Inadequate spacing between BESS module rows	- Injury to personnel (e.g. ergonomics) - Two way foot traffic not possible when completing checks and maintenance with one battery module cabinet door open due to current spacing requirements	- Layout review (in a later project stage) once the preferred supplier has been awarded - Minimum compliance with AS2067, AS3000 and other requirements - Compliance with applicable requirements from NFPA 855 - Inclusion of OH&S team during layout review discussions '- Low physical maintenance design of facility												
27	Occupational, Health and Safety	External ambient conditions / environment	BESS facility microclimate due to BESS operation in conjunction with hot ambient conditions (>40DegC)	- Injury to personnel (heat exhaustion and/or heat stroke)	- Site specific OH&S plans												
28	Occupational, Health and Safety	Contact with HV equipment	Personnel contact with damaged battery module	Electrocution leading to injury or fatality	- Review of OEM BESS safeguards to prevent high voltage exposure in various abuse conditions (e.g. battery modules sealed within enclosures in sub-groups) - Isolation and earthing on switchgear, boards and inverters - Provide interlocks on HV electrical equipment to minimise contact with HV electrical hazards - Develop an Energy and Isolation Standard for the site to minimise contact with HV electrical hazards												
29	Environmental / Hazardous material	Contact with coolant	BESS damage resulting in leaked battery coolant (e.g., due to mechanical damage) which does not escalate to thermal event	Leaked battery coolant leading to - Skin irritation - Environmental release and impact	- PPE when working in vicinity of battery units (gloves, protective clothing) - Containment of leaks and spills - Compliance with EPA guidelines - Site specific emergency response and management plan					- Ensure BESS units are stored per storage precautions recommended by OEM - Ensure the emergency response procedure includes a plan to evacuate the area in the case of a gaseous or liquid loss of containment - Include in the emergency response plan the requirement to minimise the exposure to hazardous gases by the use of respiratory protection - Determine the maximum volume of coolant that can be released in any credible loss of containment scenario and design suitable containment							
30	Environmental / Hazardous material	Hazardous material - refrigerant	BESS damage resulting in leaked refrigerant (e.g., due to mechanical damage)	Skin irritation or frostbite (if exposed to liquid refrigerant)	- Battery modules stored outside (adequate ventilation) - PPE when working in vicinity of battery modules - Site specific emergency response and management plan - Determine volume of refrigerant per battery module					- Include in the emergency response plan the requirement to use self-contained breathing apparatus (SCBA) in the case of a refrigerant leak							
31	Environmental / Hazardous material	Hazardous material - decomposition products	BESS damage during fire resulting in release of toxic/corrosive decomposition products (i.e. refrigerant decomposition chemicals)	Exposure to toxic/corrosive decomposition products impacting - Onsite personnel - Nearby residents	- Battery modules stored outside (adequate ventilation) - PPE when working in vicinity of battery modules - Site specific emergency response and management plan - Limited volume of refrigerant per battery module					- Include in the emergency response plan the requirement to use self-contained breathing apparatus (SCBA) in the case of a refrigerant leak - Determine volume of potential decomposition products							Item 2 talks about toxic combustion products. This issue is talking about decomposition of refrigerant (not combustion) that results from overheating of BESS. Decomposition products include HF, halogens, halogen acids, and possibly carbonyl halides

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32	Environmental / Hazardous material	Hazardous material - electrolyte	BESS damage resulting in release of flammable electrolyte (hydrocarbon + LiPF6)	Leaked electrolyte leading to: - ignition of vapours - irritation to eyes and skin	- Possibility of release of electrolyte is very remote (not much is in free liquid form but rather contained in electrodes) - Cells are in sealed steel compartments able to contain liquid from a number of cells (to be confirmed)					- Ensure the emergency response procedure considers leaked (or suspected leaked) electrolyte - use of PPE, ventilation of area, cleaning spills using dry absorbent material							PPE includes: air purifying respirator, safety goggles, gloves, protective clothing
33	Security	Unauthorised access from members of the public	Intentional access to site with no malicious intent (e.g. protestors)	Injury to members of the public	- Security fencing - CCTV and monitoring - Site security plan for the BESS site (e.g. mobile patrol, monitoring etc.)					- Confirm site security can be monitored using humans (control room) or technology (CCTV / AI) CPTED assessment and design of BESS facility							Applicable to all grid-scale BESS facilities
34	Security	Unauthorised access from members of the public	Intentional access and damage to BESS (e.g. sabotage, theft)	Damage to BESS and injury to onsite personnel	- Security fencing - CCTV and monitoring - Secure battery unit cabinets design - Locked control room - Site security plan for the BESS site (e.g. mobile patrol, monitoring etc.)					- Confirm site security can be monitored using humans (control room) or technology (CCTV / AI)							Applicable to all grid-scale BESS facilities
35	Security	Cyber attack	Intentional cyber attack of BESS facility, resulting in multiple, targeted thermal runaway events, or events that cause grid stability issues	- Damage to BESS leading to module loss - Heat radiation to the transformer. Transformer overheats and fails - Potential for thermal runaway, explosion / fire, leading to: -> Injury to onsite personnel (if present) -> Injury to surrounding populations (neighbouring industries, residents) -> Bushfire	- Conformance to the Security of Critical Infrastructure Act - User authentication (e.g., two factor) and site security protocol / verification - Regular cyber auditing (including routine system penetration testing) - Configuration of appropriate systems architecture (e.g., distributed, segmented, centralised) - Encrypted, secure communications - Software updates and regular backups					- Assess degree of impact from loss of operation as per Section 10 of Security of Critical Infrastructure Act (*https://www.cisc.gov.au/critical-infrastructure-centre-subsite/Files/register-critical-infrastructure-assets.pdf*) - Complete cyber security training for staff - Network and software penetration testing							Applicable to all grid-scale BESS facilities
36	Project	Lack of stakeholder engagement / consultation	Non-acceptance from community and stakeholders due to: - Disruption of local habitat - Environmental damage - Noise - Safety concerns	- Project delays resulting in financial impacts, disruption to operations - Protests - Reputational impacts	- Community consultation - Stakeholder management plan including communication/education to community about overall benefit of facility and proactively clear misconceptions on safety/environmental impacts - Early engagement with relevant regulatory authorities (e.g. fire authorities, land planning authorities, electrical etc.)												Applicable to all grid-scale BESS facilities
37	Design	Stacked battery units	- Limited land space available for BESS facility construction due to land value increases, movement to peri-urban locations - Creative approach to get more storage capacity within the same footprint	- Inadequate ventilation of the battery units due to stacked configuration - Increase in heat island effect, increasing local microclimate conditions - Damage to unit on ground level - Unable to access stacked units for maintenance without working at heights permit. This may present ergonomic issues - Potential for thermal runaway, explosion / fire, leading to: -> Injury to onsite personnel (if present) -> Injury to surrounding populations (neighbouring industries, residents) -> Bushfire						- Advanced thermal and fire modelling - Advanced ventilation approaches - Advanced battery chemistry and design suitable for such arrangements - Advanced insulation and fire protection systems -> Fire detection (including, VESDA, IR and thermocouples) -> Fire suppression (investigating feasibility and benefit of centralised suppression) - Rack and module isolation systems							
38	Design	Transport	- Damage during loading or unloading of battery unit into or out of shipping container (assuming brought in from overseas)	- Discharge of energy - Release of coolant, refrigerant, other hazardous materials, leading to short circuit - Damage to the battery cell or wiring structure leading to short circuit - Damage to the exterior of the battery module	- OEM inspection and testing program prior to shipping to site - OEM transportation guidance - Inspection and testing program in place which details the inspection measure required upon unloading the battery modules at site - Transportation insurance					- Advanced battery design, and module protection							

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39	Effluent	Vanadium electrolyte	Loss of containment of electrolyte from Vanadium Redox Flow grid-scale BESS facility as a result of: - leaks from associated infrastructure (e.g., piping) - failure of the electrolyte tanks - during maintenance activities	- Discharge of potentially toxic and corrosive electrolyte into the environment - Exposure to toxic/corrosive electrolyte impacting - Onsite personnel - Nearby residents	- Site containment measures, such as bunding to AS1940 or equivalent, implemented to prevent spread - PPE when working in vicinity of cells - Site specific emergency response and management plan - Qualified personnel conducting maintenance - Monitoring of tank levels, pressure and other criteria to either directly or indirectly indicate loss of electrolyte												Applicable to VRF BESS facilities. Long duration flow batteries will require storage of large volumes of chemicals that will likely trigger screening thresholds for hazards analysis and require consideration for handling and storage of corrosive materials
40	Environmental	Internal fire External fire	Production and accumulation of toxic and/or flammable gases	- Environmental impact - Exposure to onsite personnel and potentially offsite population	- Dangerous goods legislation - MSDS - Toxicity and handling requirements - Thermal monitoring												Applicable to VRF BESS facilities. Dependent on electrolyte composition and associated physical/chemical properties
41	Equipment	EMF	Exceeding environmental EMI International Commission on Non-Ionising Radiation Protection (ICNIRP)	- Exposure to onsite and offsite population with the potential for significant absorption greater than 100kHz	- Metal shielding of the modules - Distribution and low intensity of the modules												Reference: https://www.icnirp.org/cms/upload/publications/ICNIRPemfgdl.pdf

Vanadium redox flow battery related risks
Lithium-ion battery related risks
Risks related to both vanadium redox flow batteries and lithium-ion batteries