

Consultants Advice Notice

Project:	Glenbrae BESS	Ref No.:	RCE-22233
From:	Sarah Torrington	Date:	21 st March 2023
		Revision:	0
Attention	Company	Email	
To: Jane Bai	ACENERGY Pty Ltd	jane.bai@acenergy.com.au	
Re: Glenbrae BESS Leaching Risk Assessment			

1.0 Introduction

1.1 Project Background

Acenergy Pty Ltd (Acenergy) has proposed to develop a grid-scale Battery Energy Storage System (BESS) in Glenbrae, Victoria. As part of the application process the Pyrenees Shire Council has requested a review of the potential for leaching of chemicals from the batteries into the ground water. To assist with this review, Acenergy has requested Riskcon Engineering Pty Ltd to prepare a Consultants Advice Notice (CAN) assessing the potential for leaching and how this is mitigated by the design of the batteries and storages.

1.2 Scope of Services

The scope of services is to undertake a high level literature review of the battery chemistries, design, and containment capabilities of the batteries to assess the potential for leaching and communicate this in a CAN to close out the Council's query.

2.0 Methodology

The following methodology is proposed:

- Provide background information on how the battery works in terms of their construction individually and as a unit,
- Discuss the failure modes of batteries and how loss of containment could occur,
- Review how leaching into groundwater could occur from the failure modes,
- Highlight the protection measures incorporated in the overall design to demonstrate that such an outcome is a low probability and low consequence event, and
- Report on the findings in this CAN for submission to the Council.

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3.0 BESS Leaching Assessment

3.1 Literature Review

A review of the batteries proposed to be used as part of this project indicates the battery chemistry is Lithium Iron Phosphate (LiFePO₄, or simply LFP) which are considered to be one of the safest battery chemistries within the industry. When exposed to external heat the thermal rise of typical lithium ion battery chemistries is 200-400 °C/min resulting thermal run away and fire which can then propagate to adjacent batteries escalating the incident to a full container fire. Fires would be considered the primary source of battery chemical release to the environment. For LFP batteries, the thermal rise of the batteries at peak is 1.5 °C/min which results in a gradual temperature rise and does not result in fire and incident propagation to other batteries.

The thermal rise of various battery chemistries is provided in **Figure 3-1** with a zoomed in temperature rise for LFP provided in the top right of **Figure 3-1**. The stability of the batteries is due to the cathode which does not release oxygen therefore preventing violent redox reactions resulting in rapid temperature rise as the oxygen oxides the electrolyte.

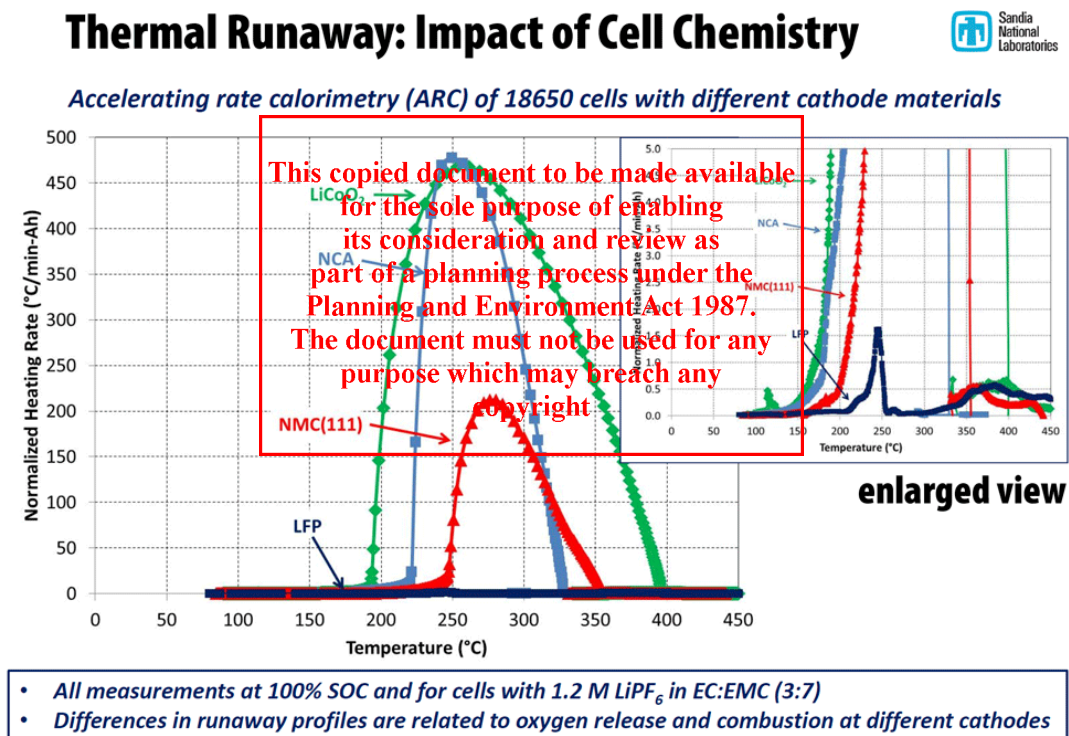


Figure 3-1: Temperature Rise of Lithium-Ion Battery Chemistries (Ref. [1]).

Additional testing for shock and damage to batteries (i.e. nail puncture test) has shown that LFP batteries when punctured through membranes (which typically results in a shorting of the battery and fire) does not result in ignition of the battery. Therefore, this demonstrates that the battery chemistry is protected against shock damage. This is also important for preventing the release of battery chemicals to the environment.

Furthermore, the chemistry of the LFP batteries is significantly less hazardous to the environment than traditional Li-ion or lead-acid batteries. LFP batteries contain no heavy metal components, eliminating the potential for bioaccumulation of heavy metals in the environment from battery leaching. The LFP batteries are constructed of materials such as copper, iron and graphite, which

are commonly present in the natural environment and do not pose a high risk of environmental damage, even to sensitive areas such as waterways (Ref. [2]). Additionally, the phosphate salts that are used in the LPF batteries are less soluble than the metal oxides traditionally used in batteries which further reduces the risk of leaching if the battery fails or is improperly used/disposed of.

3.2 Failure Modes and Analysis

Based on the literature review above, the following failure modes were identified to have the potential to result in a release of battery chemicals into the environment:

- Physical Damage to Battery Unit
- Fire Within Battery Unit
- Minor Releases from Defective Equipment

Each of these are discussed in the following sections to determine whether leaching into the environment is a credible risk.

3.2.1 Physical Damage to Battery Unit

The batteries may be impacted by vehicles or intentional vandalism which, if the battery casing were punctured, could result in a release of the battery liquid electrolyte and other chemical components. The site layout is provided in **Figure 3-2** which shows the BESS units protected from physical damage by fencing around the area. The site is restricted access only and has a site security system to protect from vandalism.

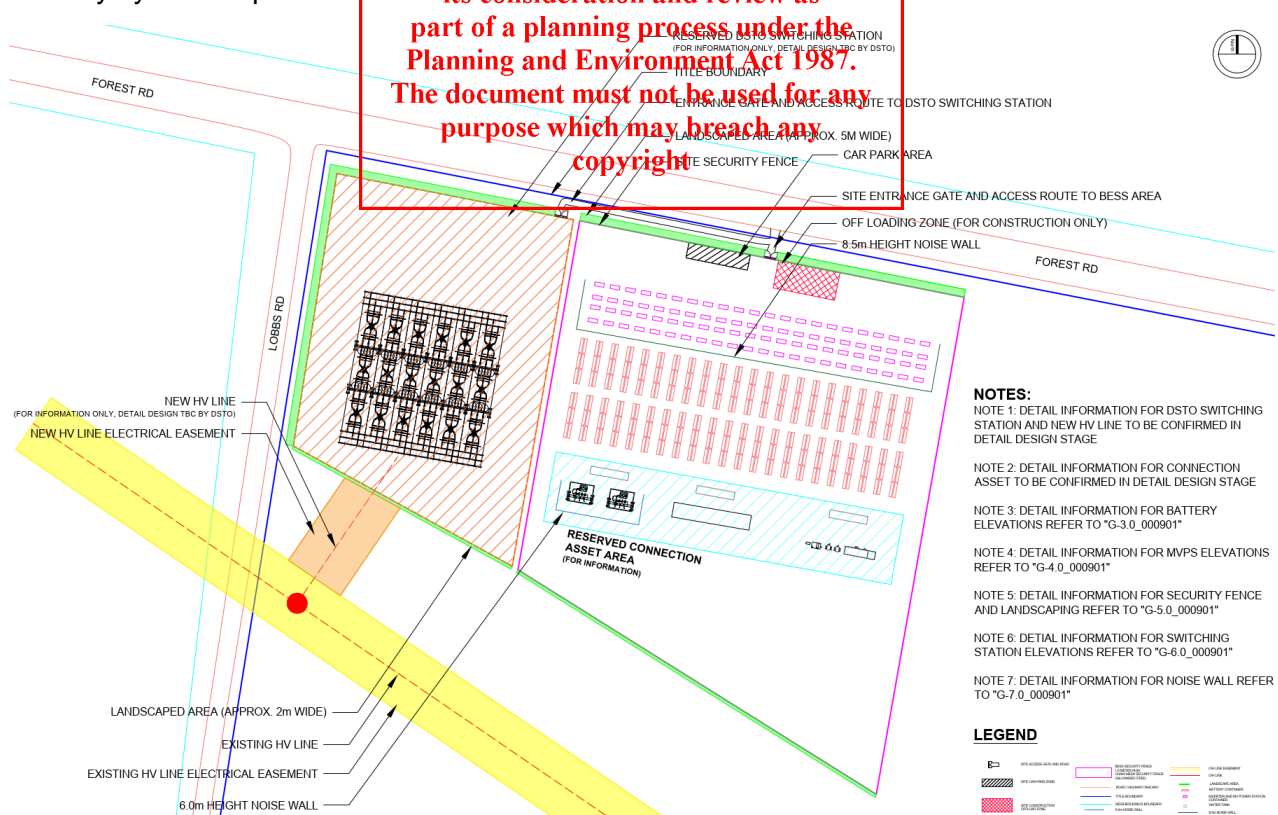


Figure 3-2: Layout of the BESS within the Site

The specific BESS proposed for the Glenbrae site is Sungrow ST2752UX (liquid cooling) energy storage system. This system has continuous monitoring for faults, including specific fault location identification, which alerts operators to any damage to the batteries prior to issues occurring. The units also have integrated battery performance monitoring which provides an additional layer of protection to identify any damage prior to it resulting in a release scenario.

Nonetheless, the literature review (**Section 3.1**) indicates that even if the units were damaged and the damage were to go unnoticed, the chemicals would not have the potential to significantly impact the environment due to the different materials of construction between LFP and traditional Li-ion batteries. In addition, any loss of containment would be contained within the containerised unit to prevent direct contact of any releases with the surrounding land. Therefore, this is not considered a credible risk of leaching and environmental contamination.

3.2.2 Fire Within Battery Unit

The literature review demonstrated that a fire within the BESS units would be extremely unlikely to occur due to the inherent resistance to thermal runaway of LFP batteries. Additionally, the Sungrow ST2752UX (liquid cooling) energy storage system proposed for the Glenbrae site has an automatic shut-down capability if major faults are detected, including fire, an integrated aerosol system as well as NFPA 69 explosion prevention and ventilation to prevent flammable gas buildup.

Furthermore, the battery cell itself (which contains liquid chemical components) is enclosed in a dedicated metal wrap to form a battery pack, and the battery packs are enclosed in a container. This is a double layer of protection to prevent any leaching.

Finally, as discussed in **Section 3.1** the batteries do not contain chemicals which pose significant risks to the environment so even in the extreme event where a BESS unit catches fire and the aerosol discharges on the unit, the likelihood of any of the discharge leaching harmful chemicals into the ground or waterways is low. Therefore, it is considered that the potential for leaching as a result of a fire is not a credible risk.

3.2.3 Minor Releases from Defective Equipment

Minor defects in equipment would be more likely to occur than the catastrophic failures discussed in **Section 3.2.1** and **Section 3.2.2**. A minor defect such as improper sealing of electrolytes or overheating of battery components may result in small releases of battery chemicals. However, as discussed in Section 3.2.2 the battery cells are enclosed within the BESS units and therefore multiple failures would have to occur simultaneously for any release to escape the unit.

The continuous monitoring of the systems and the design and construction of batteries and BESS units to international standards such as IEC 62477-1, IEC 61000-6-2, IEC 61000-6-4, and IEC 62619 (Ref. [3], [4], [5], [6]) provides high reliability and an assurance that the equipment is fit for purpose upon installation. This reduces the potential for any undetected minor failures to result in releases.

Therefore, the potential for a release to occur unnoticed is considered negligible and additionally, the chemicals used do not pose a major threat of contamination to the environment. Therefore, this scenario is not considered to pose a risk of leaching.

4.0 Conclusions and Recommendations

4.1 Conclusions

A literature review of Lithium Iron Phosphate (LFP) batteries was conducted to understand the chemistry involved from both failure potential and chemical component perspectives. Following the literature review, a number of failure modes were identified which may have the potential to result in leaching of battery chemicals into the environment. However, based on the analysis within this CAN it is considered that the risk of the battery units at the Glenbrae BESS site leaching hazardous chemicals into the environment are considered negligible due to the relatively non-hazardous nature of the LFP battery chemistry, the protection systems integrated into the Sungrow ST2752UX (liquid cooling) energy storage systems and the high level of testing that the systems undergo to comply with a variety of international standards.

4.2 Recommendations

Based on the assessment within this report, no further recommendations have been made.

Yours faithfully,

Riskcon Engineering Pty Ltd

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A handwritten signature in black ink, appearing to be "Renton Parker", written in a cursive style.

Renton Parker

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5.0 References

- [1] Power Tech Systems, "Safety of Lithium-Ion batteries," Power Tech Systems, 2022. [Online]. Available: <https://www.powertechsystems.eu/home/tech-corner/safety-of-lithium-ion-batteries/>. [Accessed 13 April 2022].
- [2] RELiON Battery , "LiFePO4 And The Environment," Wisconsin, USA, 2020.
- [3] International Electrotechnical Commission, "IEC 62477-1:2022 Safety requirements for power electronic converter systems and equipment - Part 1: General," IEC, 2022.
- [4] International Electrotechnical Commission, "IEC 61000-6-2:2016 Electromagnetic compatibility (EMC) - Part 6-2: Generic standards - Immunity standard for industrial environments," IEC, 2016.
- [5] International Electrotechnical Commission, "IEC 61000-6-4:2018 Electromagnetic compatibility (EMC) - Part 6-4: Generic standards - Emission standard for industrial environments," IEC, 2018.
- [6] Internatinoal Electrotechnical Commission, "IEC 62619:2017 - Secondary cells and batteries containing alkaline or other non-acid electrolytes – Safety requirements for secondary lithium cells and batteries, for use in industrial applications," 2017.

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