Appendix D:

Vibration Screening Study

This copied document to be made available
for the sole purpose of enabling
its consideration and review as
part of a planning process under the
Planning and Environment Act 1987.
The document must not be used for any
purpose which may breach any
copyright

ADVERTISED
PLAN

Technical Memorandum

To:	Sigi Psutka-Jones	**From:**	Arvind Deivasigamani
Company:	ARES		**SLR Consulting Australia**
cc:		**Date:**	2 September 2024
		Project No.	620.041535.00001

RE: Camperdown BESS
Vibration Screening Study

Confidentiality
This document is confidential and may contain legally privileged information. If you are not a named or authorised recipient, you must not read, copy, distribute or act in reliance on it. If you have received this document in error, please notify us immediately and return the document by mail.

Australian Renewable Energy Services Pty Ltd (ARES) has engaged SLR Consulting Australia Pty Ltd (SLR) to undertake a vibration screening assessment at the proposed Battery Energy Storage System (BESS) site Camperdown in Victoria. The site is located in proximity to the Warrnambool train line and the purpose of this study is to estimate the effects of rail-induced vibration on the BESS and its ancillary systems.

1.0 Site Context

The proposed Camperdown BESS site is located approximately 1.5 km to the east of the Camperdown train station, just north of the train line (see **Figure 1**). The proposed site boundary is hard up against the rail corridor fence line, which is approximately 7-8 m from a single train track.

Figure 1 Proposed site location

ADVERTISED
PLAN

This copied document to be made available for the sole purpose of enabling its consideration and review as part of a planning process under the Planning and Environment Act 1987. The document must not be used for any purpose which may breach any copyright

The train line is part of the broad-gauge network from Melbourne City to Warrnambool carrying diesel passenger trains, called Vlocity trains (Diesel Multiple Units - DMUs), occasional locomotive hauled passenger trains and freight trains. From available information, we understand that there might be up to 10 passenger train movements a day through this line. Specific freight train movements are unknown, however it is assumed that the movements would be less than 10 in a day (typically 3-4 trains per day).

The proposed BESS site would accommodate battery units, inverters, Medium Voltage (MV) transformers, substations and switchgears.

2.0 Review of Criteria

The client is currently reviewing suppliers for the BESS and ancillary systems at the time of this assessment. Consequently, there is no information currently available in relation to the vibration tolerance of the specific equipment to be installed. Appropriate vibration thresholds have therefore been nominated based on relevant industry best-practices.

2.1 AS 2834

AS 2834 – 1995: Computer Accommodation provides general environmental requirements for computer accommodation spaces such as server rooms which house electronic devices and hard disks. Realistically, this is very conservative as these thresholds govern writing on a hard drive. A PCB and electronic equipment in BESS in general would be more robust. However, in the absence of equivalent criteria, a more conservative benchmark is considered.

This copied document to be made available for the sole purpose of enabling its consideration and review as part of a planning process under the Planning and Environment Act 1987. The document must not be used for any purpose which may breach any copyright.

Section 2.9 of this Standard suggests a **vibration limit of 2.5 m/s^2 Root-Mean-Square (RMS)** overall in the frequency range 3 Hz to 1000 Hz for floors housing computer devices and server racks.

Note that vibration levels from trains are typically quoted in the frequency ranges of 5 Hz to 200 Hz, and typical dominant frequencies for ballasted trackforms range between 40 Hz and 100 Hz. As such, an assessment within this range is deemed sufficient for this study.

2.2 ACARP

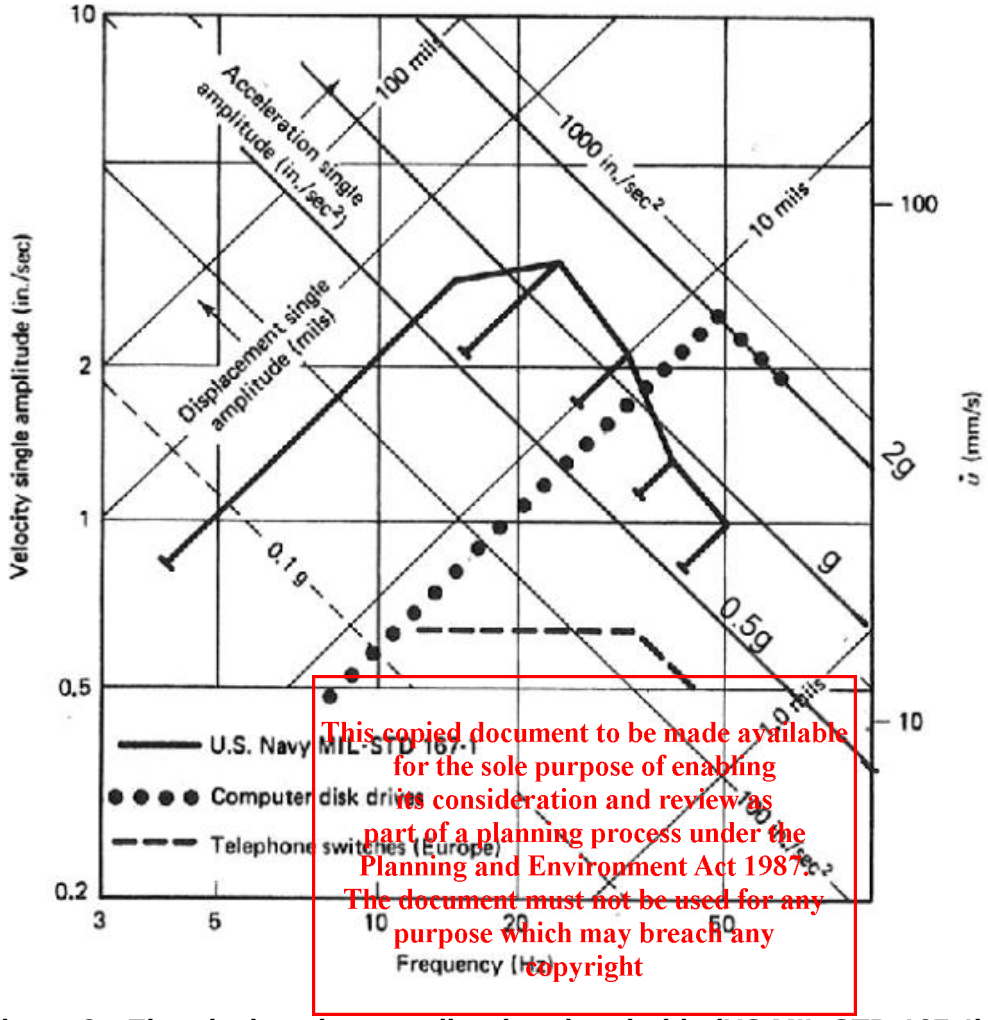
The Australian Coal Association Research Program (ACARP) has undertaken a project (ACARP Project C14057) to investigate the effects of blasting on mine infrastructure. As part of this project, effects of vibration on several types of infrastructure including electrical substations with switches were reviewed based on real-life evidence and available literature. The key aspect reviewed in the study was to prevent the inadvertent tripping of control and overload switch gear by excessive vibration.

The study states that substations with Buckholz switches were the most sensitive, and there is anecdotal evidence of **Peak Particle Velocities (PPVs) of 10 mm/s** causing potential Buckholz switch trips in substations.

2.3 US Military

The United States Military Standard, *US MIL-STD-167-1: Mechanical Vibration of Shipboard Equipment,* provides guidance on vibration sensitivity of electrical and electronic equipment. The standard recommends a **PPV limit of 25 mm/s at 5 Hz, increasing to 50 mm/s at 10 Hz for electrical equipment or equipment racks, and a vibration limit of 12 mm/s at 8 Hz, increasing up to 60 mm/s at 50 Hz for computer disk drives.** These thresholds are reproduced from this Standard in **Figure 2**.

ADVERTISED PLAN



This copied document to be made available for the sole purpose of enabling its consideration and review as part of a planning process under the Planning and Environment Act 1987. The document must not be used for any purpose which may breach any copyright

Figure 2 Electrical equipment vibration thresholds (US MIL-STD-167-1)

2.4 Project Criteria

The vibration sensitivity of equipment in the aforementioned Standards is frequency dependent, and depending on the nature of the equipment, a RMS threshold and/or instantaneous PPV threshold might be used for assessing potential effects.

For the purposes of this screening study, conservative criteria are nominated based on the aforementioned guidelines and are presented in **Table 1**. When vibration levels are predicted or measured to exceed the nominated thresholds, it does not suggest that adverse effects will occur. Rather, it indicates that further detailed assessment, including incident dominant frequencies, is warranted.

Table 1 Nominated vibration screening threshold

Equipment	RMS threshold	PPV threshold
Battery and inverters	2.5 m/s^2	12 mm/s
Transformers, Substations and switch gears	-	10 mm/s

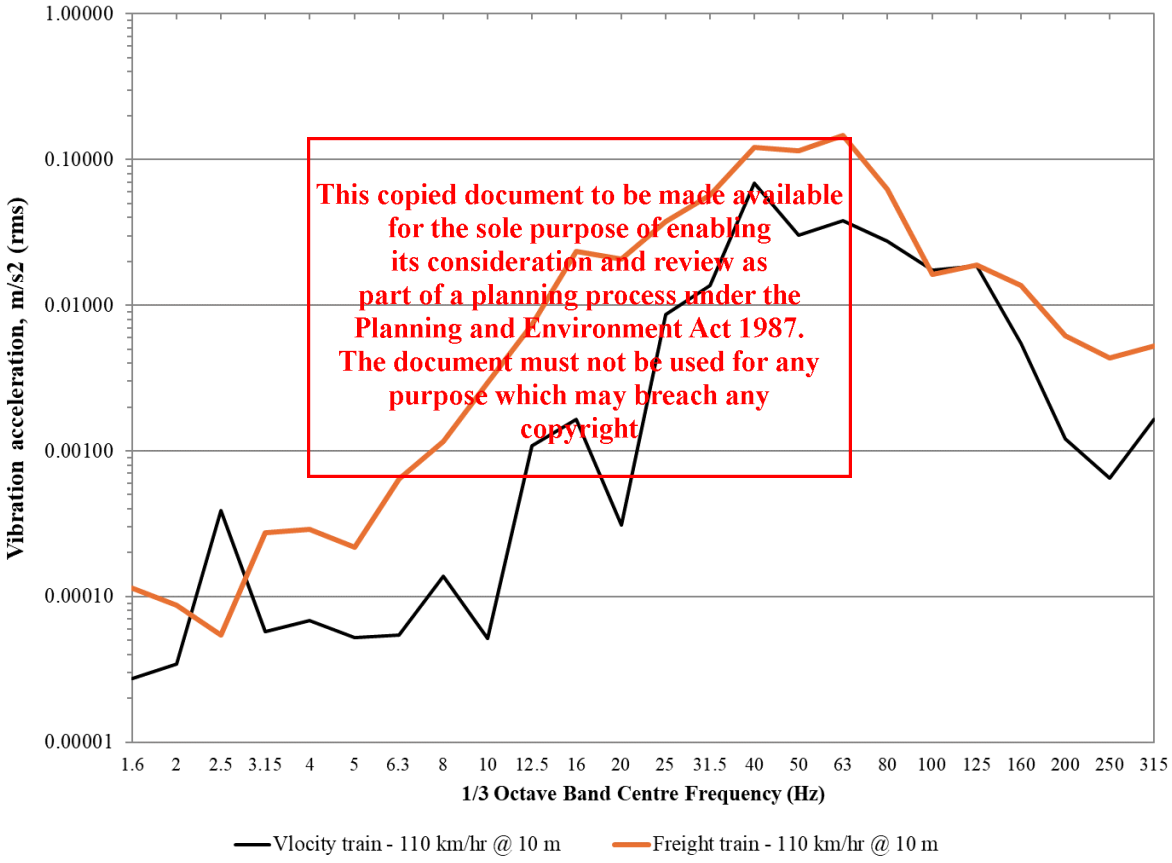
ADVERTISED PLAN

3.0 Screening Assessment

Source vibration levels from train pass-bys were determined from a large database of previous measurements. Measurements of Vlocity trains and freight trains on the Werribee line were used for this study as the same rolling stock travel trough to Camperdown.

The measurements were undertaken at varying distances from the tracks and at various travel speeds. All measurements were normalised to an offset distance of 10 m and to a speed of 110 km/hr which is understood to be the posted speed for the section of the corridor of interest. In reality, trains might be travelling slower, and hence this assumption is considered to be conservative. Measurements in 1/3 octave band were used and the 95th percentile worst-case levels were chosen from the database.

RMS acceleration values of the Vlocity and freight trains used for the screening study are presented in **Figure 3**. These values are considered representative for this study. Whilst local soil propagation properties were not determined in the study area, they are not expected to influence the vibration levels at such short separation distance of 10 m.



This copied document to be made available for the sole purpose of enabling its consideration and review as part of a planning process under the Planning and Environment Act 1987. The document must not be used for any purpose which may breach any copyright.

Figure 3 Reference vibration source levels

The overall vibration levels at 10 m are compared against the established screening criteria in **Table 2**. Vibration levels from freight train were used as it is the worst-case scenario.

In order to derive PPV from RMS vibration levels, a crest factor of 4 (ratio between peak and RMS) was used. This crest factor is considered representative for rail vibration as guided by the United States Federal Transit Authority (US FTA) guidelines.

ADVERTISED PLAN

Table 2 Vibration screening assessment results

Parameter	Prediction @ 10m	Threshold	Compliance
RMS acceleration	0.25 m/s^2	2.5 m/s^2	YES
PPV	3.5 mm/s	10 mm/s	YES

The results indicate that the vibration levels from rail movements at a nominal distance of 10 m from the track have a low likelihood of causing adverse effects to the BESS infrastructure.

Whilst there might be some level of variation in vibration levels from train movements, the study indicates that there is a significant margin of safety against the established thresholds.

4.0 Closure

A vibration screening study has been undertaken for the proposed BESS site and the study indicates that there is low likelihood of adverse vibration effects from train movements to the BESS infrastructure at 10 m from the track.

It is understood that the rail corridor fence line is approximately 7-8 m from the track centreline. In addition to this offset distance, there may be further setback planning requirements such as bushfire exclusion zones that might limit the installation of BESS infrastructure closer to the southern site boundary. Therefore, train vibration effects are not judged to be a critical consideration in the site's spatial layout.

It is recommended to revisit the assessment presented in this study once the specific vibration sensitivities and thresholds are provided from the chosen equipment suppliers to confirm the conclusions reached.

Regards,

SLR Consulting Australia

Reviewed by: DD

Date: 02/09/2024

Arvind Deivasigamani
VIC Team Lead - Acoustics

ADVERTISED PLAN

This copied document to be made available for the sole purpose of enabling its consideration and review as part of a planning process under the Planning and Environment Act 1987. The document must not be used for any purpose which may breach any copyright