Proposed Residential Development

Le Maresquet Field, La Hure Mare Road, Northside, Vale, Guernsey

soundsolution CONSULTANTS

Vibration Impact Assessment

TECHNICAL REPORT

27691-3-R1

Proposed Residential Development

Vibration Impact Assessment

Prepared for: Sunnyside Developments

Site location: Le Maresquet Field, La Hure Mare Road, Northside, Vale, Guernsey

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soundsolution CONSULTANTS
Cornwall Suite, Dencora Business Centre, Whitehouse Road, Ipswich IP1 5LP
Tel: 0845 5212 096 | Fax: 0845 5212 097
info@soundsolutionconsultants.co.uk | www.soundsolutionconsultants.co.uk
VAT No. 844 9267 90 | Registration No. 5651834
Registered Address: 2 Lemons Hill, Tattingstone, Ipswich, Suffolk IP9 2NH

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Originated	 Jalal Amine-Eddine MEng. (Hons) AMIOA AMIMechE | Acoustic Consultant	24th August 2017
Checked	 Mark Page MIOA | Managing Director	24th August 2017

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1	Original Report	-

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1 INTRODUCTION

1.1 The site under consideration is located at Le Maresquet Field, La Hure Mare Road, Northside, Vale, Guernsey (hereinafter, "The Site").

1.2 This assessment forms part three of three reports concerned with planning, noise, and vibration for the proposed residential development at The Site.

Part 1) Planning and noise (First assessment of The Site).

Part 2) Planning and noise (Supplement to Part (1) assessment).

Part 3) [This Report] Vibration.

1.3 It is relevant to acknowledge the planning history of the development whereby, subsequent to Part (1), Guernsey Electricity were granted planning permission (Ref: FULL/2015/2730), 20th April 2016, for a further D Station engine (3D) with associated works to the building. The Office of Environmental Health and Pollution Regulation (EOHPR) issued a letter (Ref: WK/201601435, 21st June 2016) for which, in summary, it was stated that:

"We strongly recommend that further investigations are carried out into the feasibility of the development taking into account the accumulated impact from the addition of the 3D generator at the Guernsey Electricity Site."

1.4 In light of the above comments and concerns, Sound Solution Consultants Limited have been commissioned to conduct a Vibration Impact Assessment with the aim of investigating the potential impact of vibrations on The Site, which include the recent Guernsey Electricity development.

1.5 A site-based study of vibration is used to evaluate the impact of activities associated with vibration at The Site, in the context of the proposed for residential use. The methodology of this assessment will refer to current practice and guidance documents which determine health limits and impacts.

1.6 A Glossary of Acoustic Terms can be found in Appendix A that may assist with the terminology used within this report.

2 DEVELOPMENT SITE

2.1 The location of the proposed development site ("The Site") is highlighted in Appendix B, Figures 1 to 3. Apart from the exception of the introduction of the new 3D generator at the power station, there are no notable changes to the industrial activities in the locale, since the first noise impact assessment.

2.2 Report 22227 R1 (Table 1, Page 5) details industrial activities in the proximity of The Site that have the potential to cause noise disturbance. Upon site attendance for this assessment, it was not evident that there have been any changes to the activities and times of operation, and that there has neither been the introduction or removal of any noise source that should be separately accounted for.

2.3 Vale Power Station (Guernsey Electricity) is currently producing energy for the island of Guernsey and shares the energy supply with mainland cable. The Power Station has several power generators with varying specifications and are activated at times when the island's energy demand requires their use. It is understood that the generators do not have the capability to store energy for use outside of their operation times.

2.4 It is known that the nature of operations at the power station impose limitations on this assessment as the number of generators active during the time of survey are correspondingly operated in accordance with the island's energy demand. However, Guernsey Electricity has demonstrated a reasonable balance on the economic and environmental cost to facilitate the requirements of this assessment.

2.5 Appendix C contains photographs of the site during times of site assessment.

3 VIBRATION ASSESSMENT

BS6472-1:2008 GUIDE TO EVALUATION OF HUMAN EXPOSURE TO VIBRATION IN BUILDINGS.

3.1 The British Standard 6472-1:2008 'Guide to evaluation of human exposure to vibration in buildings' offers guidance on acceptable vibration criteria within buildings. Ground vibrations may cause reactions ranging from 'just perceptible', through 'concern' to 'alarm' and 'discomfort'. The subjective response varies widely and is a function of situation, information, time of day and duration.

3.2 BS 6472-1:2008 provides guidance on vibration dose values (VDVs) at which complaints are probable. VDVs may be used to assess the severity of impulsive and intermittent vibration, such as experienced from blasting at quarries or from rail traffic, and steady vibration such as from a busy road or fixed plant. The adoption of the VDV parameter is based on social studies undertaken in the 1980s and early 1990s into human response to vibration. BS 6472 requires that the VDV is determined separate for the 16-hour daytime (07.00-23.00) and 8-hour night-time (23.00-07.00) periods.

3.3 VDV is measured in each of the three whole-body orthogonal axes and the maximum from the three axes is used. Where the vibration conditions are constant or regularly repeated throughout the day and assessment is based on measured data, only one representative period need be measured, and the 16-hour daytime (or 8-hour night-time) overall VDV level may be calculated from the shortened measurement using appropriate formulae.

3.4 The predicted or measured VDV may then be compared to Table 1 in Section 6 of BS 6472. When the appropriately-weighted vibration measurements or predictions have been used to derive the VDV for day or night at the relevant places of interest, their significance in terms of human response for people in those places can be derived; against the probability that the VDV might result in adverse comment by those who experience it.

Place and time	Low probability of adverse comment* $ms^{-1.75}$	Adverse comment possible $ms^{-1.75}$	Adverse comment probable** $ms^{-1.75}$
Residential buildings 16h day	0.2 to 0.4	0.4 to 0.8	0.8 to 1.6
Residential buildings 8h night	0.1 to 0.2	0.2 to 0.4	0.4 to 0.8

**Adverse comment is not expected below. **Adverse comment is very likely above.*

Table 1 – Vibration Dose Value ranges which might result in various probabilities of adverse comment within buildings, taken from Table 1 in Section 6 of BS6472-1:2008.

3.5 Perception thresholds for continuous whole-body vibration vary widely among individuals. Approximately half the people in a typical population, when standing or seated, can perceive a vertical weighted peak acceleration of 0.015 m/s^2. The weighting used is Wb. A quarter of the people would perceive a vibration of 0.01 m/s^2 peak, but the least sensitive quarter would only be able to detect a vibration of 0.02 m/s^2 peak or more. Perception thresholds are slightly higher for vibration duration of less than about 1 second.

BS6472-1:2008 VIBRATION ASSESSMENT

3.6 A vibration assessment was undertaken from Monday 24th to Tuesday 25th July 2017. An accelerometer was fixed to a ground spike and positioned as indicated in Appendix B. For measurements in accordance with BS 6472-1, considering internal excitation, the measurement position should be made at or near to where most adverse comment would be generated. The measurement position is located in the South-West corner development nearest the source of the generated vibration.

3.7 The equipment used during the study meets the requirements of BS EN ISO 8041 as appropriate for the measurement of building vibration and human response.

3.8 Calibration checks of the device using a hand-held vibration shaker indicate suitable functionality against the reference acceleration value of 10 m/s^2 in all orthogonal directions.

3.9 The device was configured to record W_d weighting in the X and Y directions and W_b weighting for the Z axis. Clause 3.2.2 of BS 6472 requires these parameters for measurement, whose weighting curves are defined by BS 6841. The vibration instrumentation was set up to record both vibration dose and acceleration, in single figure values for orthogonal (X Y Z) axis as well as in frequency.

Manufacturer	Model No.	Description	Serial No.	Calibration Due Date
Larson Davis	HVM200	Human Vibration Meter	1043	Feb 2018
Larson Davis	356B18	Triaxial Accelerometer	141631	Feb 2018

Table 2 – Vibration monitoring equipment.

3.10 The accelerometer was positioned as shown in Appendix B. The device was tested before and after use, in-situ, to ensure that it was recording values of acceleration, dose and frequency values for assessment.

3.11 For simplicity of reporting, the following table considers the measurement periods taken when both generators were in operation on Monday 24th July 2017. All data was recorded in 10-minute time history where the total VDV for the relevant period has been calculated in accordance with equations (2) and (3) of BS 6472-1.

Location	Period	VDV $ms^{-1.75}$ (Highest in X axis)	Impact as defined by BS6472-1:2008
South-West corner of The Site	Day (07:00 – 23:00)	0.36	**Low probability of adverse comment**
	Night (23:00 – 07:00)	0.16	

Table 3 – Measured Vibration Dose Values during times of operation on Monday 24th July 2017.

ASSESSMENT COMMENTARY

3.12 The objective measurements characterised by Vibration Dose Values show that the data is transient and, while the generators are known to operate continuously throughout the measurement period, the measured values did not show levels that were consistent with typical generator activity.

3.13 Various activities were observed nearby the measurement position including heavy-goods vehicles passing along the road bounding The Site and light industrial work involving lump hammers. These activities were not observed to correlate with the measurements taken, most notably in the case of HGV pass-bys. It was noted that levels in the cross-axes (X and Y axis) were significantly higher than the vertical (Z-axis), however, the calculated VDV indicates that the impact of the levels measured in the most significantly affected axis have a low probability of adverse comment.

3.14 Furthermore, given that measurements have been recorded in free-field conditions, vibrations passing from open ground into proposed building structures will be reduced due to the change in medium (i.e. soil to foundations). The vibration levels within the building may be reduced by up to 60% of the free-field value, however, this reduction varies with frequency and is highly dependent on the ground conditions, foundation structure, the building construction and flooring used. It is also valid to note that resonance frequencies may be amplified for a given structure, which are dependent on building's construction.

3.15 The findings of this investigation have determined that the vibration levels, although not correlated with any specific nearby activity, are judged to cause minimal adverse comment during all potential periods of operation. The levels measured are likely to be less within buildings that are properly designed and engineered structures.

4 CONCLUSIONS

4.1 The primary aim of this assessment has been to inform a proposed residential development at Le Maresquet Field, in Vale, Guernsey, of vibration impacts on future occupiers.

4.2 Assessment of human response to vibration inside the proposed building, in accordance with BS 6472-1:2008, confirms that there is a low likelihood of adverse comment from vibration. The vibration levels measured cannot be correlated to any specific activities including the generators operating at Vale Power Station.

4.3 The impact of vibration, while minimal, will be further reduced with appropriate design and engineering of the proposed buildings' structures. The specific design and engineering of such a system is reasonably beyond the scope of this assessment.

Appendix A: Glossary of Acoustic Terms

Vibration can be generated from any dynamic source of sufficient energy. The vibration generated will be composed of various wave types of differing characteristics and significance collectively known as seismic waves. These seismic waves will spread radially from the vibration source decaying rapidly as distance increases.

There are four interrelated parameters that may be used in order to define ground vibration magnitude at any location. These are:-

Displacement - *the distance that a particle moves before returning to its original position, measured in millimetres (mm).*

Velocity - *the rate at which particle displacement changes, measured in millimetres per second (mms^{-1}).*

Acceleration - *the rate at which the particle velocity changes, measured in millimetres per second squared (mms^{-2}) or in terms of the acceleration due to the earth's gravity (g).*

Frequency - *the number of oscillations per second that a particle undergoes measured in Hertz (Hz).*

Vibration will usually be measured in three independent, mutually perpendicular directions at any one location in order to ensure that the true value is captured. These directions are longitudinal (or radial), vertical and transverse.

The maximum of any one plane measurements is the accepted standard worldwide and as recommended by the British Standards Institution and the International Standards Institute amongst others. It is also the basis for all the recognised investigations into satisfactory vibration levels with respect human perception (Vibration Dose Value) or damage to structures (Peak Particle Velocity).

Appendix B: Site Plan

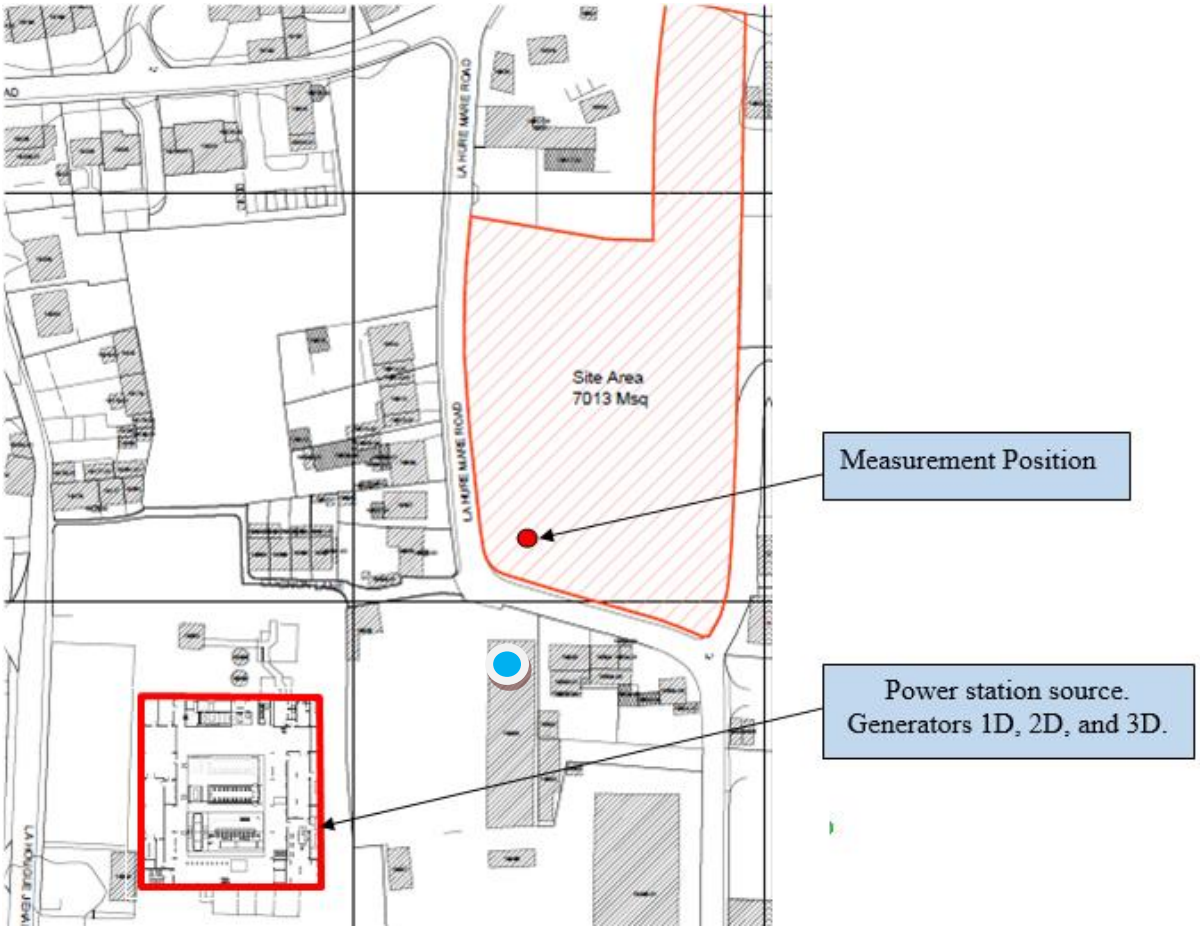


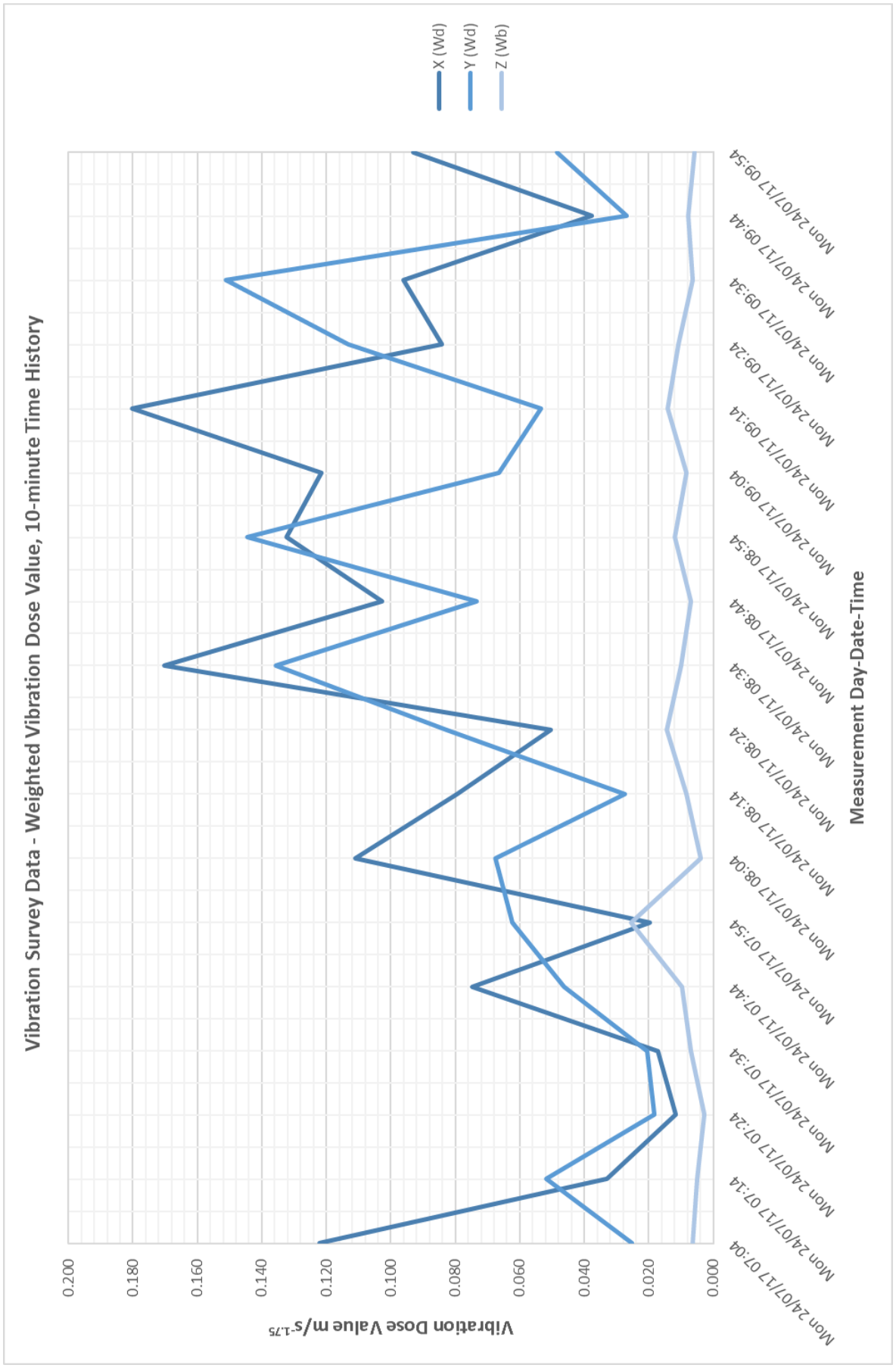
Figure B1 – Site plan with annotated vibration measurement location.

Appendix C: Site Photographs

Figure C1, vibration measurement position at corner of field.

Figures C2, close-up photograph of vibration transducer and mounting position.

Appendix D: Vibration Survey Data



Appendix F: Acousticians Qualifications and Status

Reporting:	**Jalal Amine-Eddine MEng. (Hons) AMIOA AMIMechE**
Position Held:	Acoustic Consultant.
Qualifications:	MEng. (Hons) Acoustical Engineering.
Affiliations:	Associate Member of the Institute of Acoustics.
	Associate Member of the Institute of Mechanical Engineers.
Acoustics Experience:	2 years.
Core Competences:	Environmental acoustics, industrial noise control.

Survey & Approval:	**Mark Page MIOA**
Position Held:	Managing Director.
Qualifications:	Institute of Acoustics Diploma in Acoustics and Noise Control.
Affiliations:	Corporate Member of the Institute of Acoustics.
Acoustics Experience:	18 years.
Core Competences:	Building and Environmental acoustics.

DOREY LYLE & ASHMAN
CONSULTING ENGINEERS

Our Ref: CJM/215 122

29 September 2015

Mr A Merrett
Lovell, Ozanne & Partners Ltd
Island House
Grande Rue
ST MARTIN
Guernsey
GY4 6RU

Dear Andy

Ref: Vibration Testing at Les Maresquet

As instructed, we carried out vibration testing on the site of the proposed development at Les Maresquet. The vibration testing was carried out over a 24 hour period, and the results indicate that background vibration levels equal and exceed those caused by generator operation at the adjacent power plant.

Prior to the testing, a concrete pad was poured in the field of a similar size and depth to the expected foundations that will be used in the development. Vibration readings were measured using a Vibrock V901 seismograph placed on the pad, between 13:30 on 03/08/15 and 14:33 on 04/08/15. It is not possible for Guernsey Electricity to foresee when they will be running generators and a 24 hour period was chosen to try and capture different generator running scenarios. During this period, generators 4C and 2D ran together for a period concurrently and generator GT4 ran twice for two different time periods.

The vibration is measured by the seismograph in values of peak particle velocity (PPV) and the results are detailed below:

- Generators 4C and 2D running together: Maximum PPV = 0.350 mm/s
- Generator GT4 running: Maximum PPV = 0.325 mm/s
- No generators running: Maximum PPV = 0.400 mm/s, average PPV = 0.303 mm/s
- Assumed values for four generators running together: Maximum PPV = 0.400 mm/s

It can be seen from this information that the maximum vibration experienced when two generators were running was less than the maximum vibration experienced when no generators were running. It is worth noting that the vibration levels measured were based at foundation level. This vibration will attenuate through the structure and so will be less inside properties that are constructed on the site.

In the British Standard BS7385-2: 1993 (Evaluation and measurement for vibration in buildings – Part 2: Guide to damage levels from ground borne vibration) the most conservative threshold value for minor/cosmetic damage for sensitive structures is 2.5mm/s PPV.

It is clear from the above that the vibration levels are not high enough to cause any structural damage in the proposed development. The maximum background vibration levels are higher than those caused by the generators in the power plant. No special allowances will need to be made to accommodate vibration due to the proximity of the power plant.

If you require any further information, please contact the writer.

Yours sincerely
Dorey, Lyle & Ashman Ltd

C J Milne B.E.(Hons)