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Environmental Noise Assessment

Waste-To-Energy Facility, Hazelmere

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1 INTRODUCTION

The Eastern Metropolitan Regional Council (EMRC) operates the Hazelmere Recycling Centre on behalf of six local governments being:

- Town of Bassendean;
- City of Bayswater;
- City of Belmont;
- Shire of Kalamunda;
- Shire of Mundaring; and
- City of Swan.

The site is located at 77 Lakes Road, Hazelmere (refer *Figure 1-1*) and is open from 7am to 3pm Mondays to Saturdays.

The existing operations consist of timber and mattress recycling. EMRC are proposing to construct a 3MW Waste-To-Energy plant on the site – refer *Figure 1-2* for locality and *Figure 1-3* for the master plan of the site and proposed orientation. The new plant is expected to run from 8am to 10pm Mondays to Fridays.

Figure 1-1 Site Locality

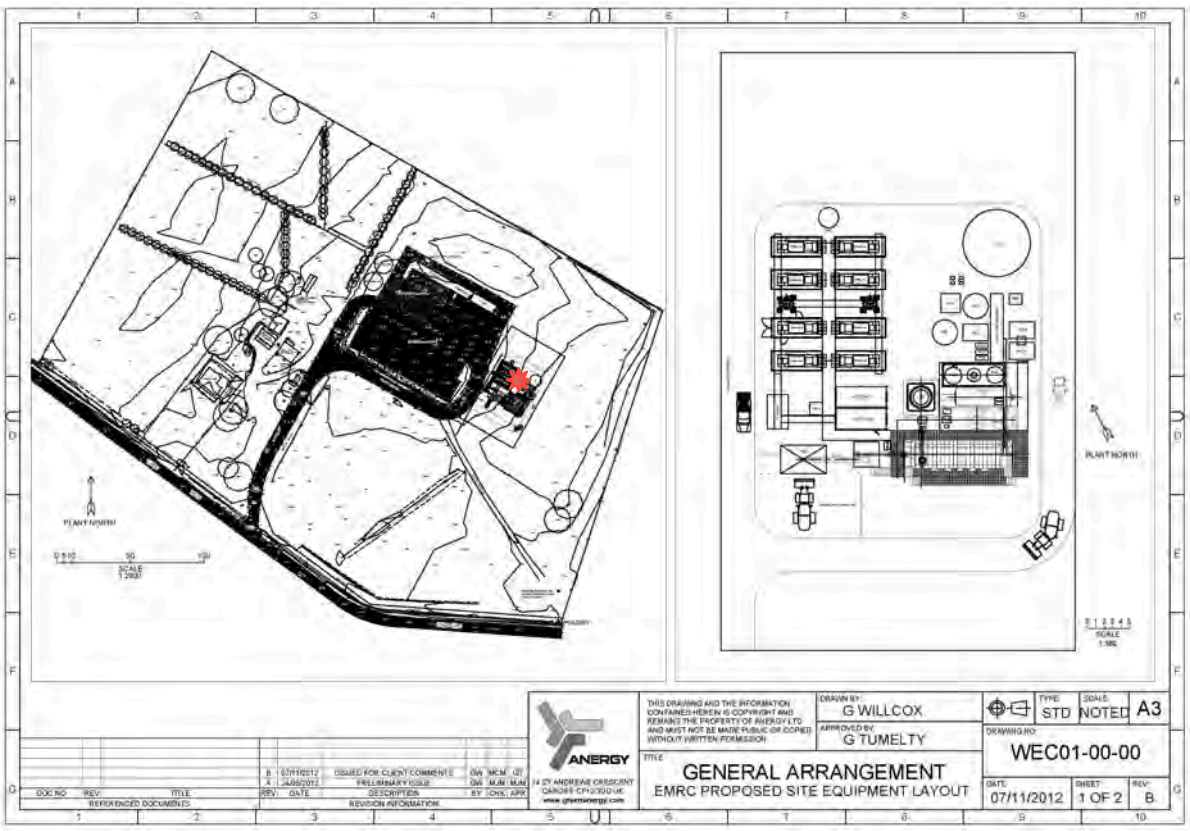

Figure 1-2 Waste-To-Energy Plant Locality

Figure 1-3 Waste-To-Energy Plant Locality on Master Plan

The proposed plant is based on the Anergy/Ansac pyrolysis technology, which uses an indirect-fired pyrolysis[1] kiln with the resultant syngas being used for power generation by gas engines. The engines cannot use all of the gas so the tar compounds are either converted to more favourable components or removed completely in a wastewater stream.

This report presents the results of noise modelling for the proposed plant. The results of the modelling are assessed against the relevant criteria, being the *Environmental Protection (Noise) Regulations 1997*.

Appendix A contains a description of some of the terminology used throughout this report.

2 CRITERIA

Environmental noise in Western Australia is governed by the *Environmental Protection Act 1986*, through the *Environmental Protection (Noise) Regulations 1997* (the Regulations).

Regulation 7 defines the prescribed standard for noise emissions as follows:

"7. (1) Noise emitted from any premises or public place when received at other premises –

(a) Must not cause or significantly contribute to, a level of noise which exceeds the assigned level in respect of noise received at premises of that kind; and

(b) Must be free of –

i. Tonality;

ii. Impulsiveness; and

iii. Modulation".

A "…noise emission is taken to *significantly contribute to* a level of noise if the noise emission exceeds a value which is 5 dB below the assigned level…"

Tonality, impulsiveness and modulation are defined in Regulation 9. Noise is to be taken to be free of these characteristics if:

(a) The characteristics cannot be reasonably and practicably removed by techniques other than attenuating the overall level of noise emission; and

(b) The noise emission complies with the standard after the adjustments of *Table 2-1* are made to the noise emission as measured at the point of reception.

Table 2-1 Adjustments for Intrusive Characteristics

Tonality	Modulation	Impulsiveness
+ 5dB	+ 5dB	+ 10dB

Note: The above are cumulative to a maximum of 15dB.

[1] Pyrolysis is the heating of organic based materials, in this case waste wood from the existing timber recycling plant, beyond 600oC without oxygen. Chemical reactions then break down the material into a process gas. Residual solid material of carbon and ash is char with significantly reduced volume.

The baseline assigned levels (prescribed standards) are specified in Regulation 8 and are shown in *Table 2-2*.

Table 2-2 Baseline Assigned Noise Levels

Premises Receiving Noise	Time Of Day	Assigned Level (dB)		
		L_{A10}	L_{A1}	L_{Amax}
Noise Sensitive[1]	0700 to 1900 hours Monday to Saturday (Day)	45 + influencing factor	55 + influencing factor	65 + influencing factor
	0900 to 1900 hours Sunday and public holidays (Sunday)	40 + influencing factor	50 + influencing factor	65 + influencing factor
	1900 to 2200 hours all days (Evening)	40 + influencing factor	50 + influencing factor	55 + influencing factor
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and public holidays (Night)	35 + influencing factor	45 + influencing factor	55 + influencing factor
Industrial	All hours	65	80	90

1. Applies within 15 metres of a building associated with a noise sensitive use, as defined in Schedule 1, Part C.

Nine residences have been selected for assessment purposes, providing an array of locations and allowable noise levels, since the influencing factor varies for different residences depending on proximity to industrial and commercial land and roads. The locations of the nine residences are shown on *Figure 2-1*. The influencing factor at each residence is provided in *Table 2-3*.

Table 2-3 Influencing Factor Calculation

Residence	% Industrial Land Within 100 metre Radius	% Industrial Land Within 450 metre Radius	Influencing Factor, dB
01	13.2	48.5	6
02	25.1	60.7	9
03	-	51.6	5
04	-	29.4	3
05	-	13.8	1
06	-	11.4	1
07	-	12.1	1
08	28.3	44.1	7
09	-	37.8	4

Also shown on *Figure 2-1* are the critical neighbouring industry locations.

Hazelmere Recycling Facility
LA10 Day Noise Level Contours

Figure 2-1

Signs and symbols
Receiver

6 September 2013

Length Scale 1:10000
0 50 100 200 300 400 m

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Table 2-4 shows the critical and relevant L_{A10} assigned noise levels including the influencing factor at the noise sensitive receiving locations.

Table 2-4 Daytime Assigned Noise Levels

Location Residence	Assigned Noise Level, dB L_{A10}	
	Monday to Saturday 7am to 7pm	Monday to Saturday 7pm to 10pm
Residence 01	51	61
Residence 02	54	64
Residence 03	50	60
Residence 04	48	58
Residence 05	46	56
Residence 06	46	56
Residence 07	46	56
Residence 08	52	62
Residence 09	49	59
Industry	65	65

BGC is the nearest industrial neighbour, located on both the north and east boundaries. On the north boundary is a stockpile area and to the east is a laydown area so that any areas occupied by personnel are setback further from the boundary.

The design goal is to be 5 dB less than the assigned noise levels. The reason for this is to allow for a tonal adjustment as per *Table 2-1* or for the new operations to not significantly contribute to existing noise at the site.

3 METHODOLOGY

Computer modelling has been used to predict the sound propagation from the plant to the surrounding areas. The software used was *SoundPLAN 7.2* with the CONCAWE algorithms selected. These algorithms have been selected as they are one of the few that include the influence of wind and atmospheric stability. Input data required in the model are:

- Meteorological Information;
- Topographical data;
- Ground Absorption; and
- Source sound power levels.

3.1 Meteorological Information

Meteorological information utilised (*Table 3-1)* is based on that specified in the *draft EPA Guidance for the Assessment of Environmental Factors No.8 Environmental Noise*. These conditions are considered the worst-case for noise propagation. At wind speeds greater than those shown, sound propagation may be further enhanced, however background noise from the wind itself and from local vegetation is likely to be elevated and dominate the ambient noise levels.

Table 3-1 Modelling Meteorological Conditions

Parameter	Day (0700-1900)
Temperature (^{o}C)	20
Humidity (%)	50
Wind Speed (m/s)	4
Wind Direction*	All
Pasquil Stability Factor	E

* Note that the modelling package used allows for all wind directions to be modelled simultaneously.

The EPA policy is that compliance with the assigned noise levels needs to be demonstrated for 98% of the time, during the day and night periods, for the month of the year in which the worst-case weather conditions prevail. In most cases, the above conditions occur for more than 2% of the time and therefore must be satisfied.

3.2 Topographical Data

Topographical data was a combination of that provided by EMRC (the site itself and Lloyd Street extension), data on file from previous projects, *Google Earth* and manually entering stockpiles (all assumed to be 3m high).

3.3 Ground Absorption

Ground absorption varies from a value of 0 to 1, with 0 being for an acoustically reflective ground (e.g. water or bitumen) and 1 for acoustically absorbent ground (e.g. grass). In this instance, the site and surrounding industrial areas and roads were provided a value of 0.2 with a value of 1.0 used elsewhere.

3.4 Source Sound Levels

Anergy Ltd provided the following information in relation to the most significant noise emitting items:

- Gas Engines – 80 dB(A) at 1 metre from acoustic enclosure
- Kiln Combustion Fan – 95 dB(A) at 1 metre
- SACTO[2] Combustion Fan – 97 dB(A) at 1 metre
- Cooling Air Fan – 75 dB(A) at 10 metres
- Scrubber Water Spray – 75 dB(A) at 3 metres

Noise modelling should ideally be undertaken with spectral information and as such, file data has been used to estimate the spectra of each significant noise source. Also, the gas engines have been separated into the sides, ends and roof of the enclosures. The size of the enclosures are assumed to be 6.0m (L) x 2.6m (w) x 2.4m (h). *Table 3-2* provides the sound power levels for each source, which align with the sound pressure levels at the nominated distances.

Table 3-2 Source Sound Power Levels, dB(A)

Description	Octave Band Centre Frequency (Hz)								Overall
	63	125	250	500	1k	2k	4k	8k	
Gas Engine – Enclosure End	59	72	80	82	81	77	75	76	**87**
Gas Engine – Enclosure Side	61	74	82	84	83	79	77	78	**89**
Gas Engine – Enclosure Roof	64	77	85	87	86	82	80	81	**92**
Kiln Combustion Fan	67	76	100	91	94	92	92	84	**102**
SACTO Combustion Fan	69	78	102	93	96	94	94	86	**104**
Cooling Air Fan	90	98	99	93	88	88	85	84	**103**
Scrubber Water Spray	67	75	76	76	75	75	73	68	**83**

With regards to the sound power levels, please note the following:

- All of the sound power levels are considered to represent the L_{A10} value.
- The plant orientation is as per the Master Plan (*Figure 1-3*), being 90 degrees clockwise of *Figure 1-2*.
- A final calibration is applied to the predicted noise levels of -2.4 dB to align with measurements and modelling undertaken for the existing operations.

[2] Staged Air Cyclonic Thermal Oxidiser

4 RESULTS

The results of the noise modelling are shown as noise level contour plots in *Figures 4-1 and 4-2* and summarised below in *Table 4-1*. Note that two scenarios have been modelled being the pyrolysis plant with the existing conditions ("Existing Conditions") and the pyrolysis plant with the future buildings - refer *Figure 1-2* Master Plan ("Ultimate Conditions").

Table 4-1 Summary of Noise Modelling: Predicted Downwind Noise Level, dB L_{A10}

Location	Existing Conditions	Ultimate Conditions
01 Lakes Road	42	35
02 Lakes Road	45	N/A
03 Lakes Road	41	36
04 Lakes Road	37	33
05 Lakes Road	34	31
06 Lakes Road	33	28
07 Hazelmere Circus	32	29
08 Bushmead Road	35	34
09 Stirling Crescent	37	35
BGC Site – Within 15m of Building	53	54
BGC Site – Near Site Boundary	57	59

Note: The 02 residence will be acquired by MRWA.

Hazelmere Recycling Facility

LA10 Day Noise Level Contours: Pyrolysis Plant Existing Conditions

Figure 4-1

Noise levels
LA10 dB

= 35
= 40
= 45
= 50
= 55
= 60
= 65

N

Signs and symbols

Receiver

22 November 2013

Length Scale 1:10000

0 50 100 200 300 400 m

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Hazelmere Recycling Facility

LA10 Day Noise Level Contours: Pyrolysis Plant with Future Buildings

Figure 4-2

Noise levels
LA10 dB

= 35
= 40
= 45
= 50
= 55
= 60
= 65

N

Signs and symbols

Receiver

24 November 2013

Length Scale 1:10000

0 50 100 200 300 400 m

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5 ASSESSMENT

Table 5-1 compares the predicted noise levels for the Pyrolysis Plant, based on the existing conditions, with the assigned noise levels.

Table 5-1 Assessment of Noise Levels for Existing Conditions

Location	Predicted Noise Level, dB L_{A10}	Exceedance to Assigned Daytime Noise Level, dB	Exceedance to Assigned Evening Assigned Noise Level, dB
01 Lakes Road	42	-9	-4
02 Lakes Road	45	-9	-4
03 Lakes Road	41	-9	-4
04 Lakes Road	37	-11	-6
05 Lakes Road	34	-12	-7
06 Lakes Road	33	-13	-8
07 Hazelmere Circus	32	-14	-9
08 Bushmead Road	35	-17	-12
09 Stirling Crescent	37	-12	-7
BGC Site – Within 15m of Building	53	-12	-12
BGC Site – Near Site Boundary	57	-8	-8

Note: Shaded Cells indicate noise levels are within 5 dB of the assigned level.

Table 5-2 compares the predicted noise levels for the Pyrolysis Plant, based on the ultimate conditions, with the assigned noise levels.

Table 5-2 Assessment of Noise Levels for Ultimate Conditions

Location	Predicted Noise Level, dB L_{A10}	Exceedance to Assigned Daytime Noise Level, dB	Exceedance to Assigned Evening Assigned Noise Level, dB
01 Lakes Road	35	-16	-11
03 Lakes Road	36	-14	-9
04 Lakes Road	33	-15	-10
05 Lakes Road	31	-15	-10
06 Lakes Road	28	-18	-13
07 Hazelmere Circus	29	-17	-12
08 Bushmead Road	34	-18	-13
09 Stirling Crescent	35	-14	-9
BGC Site – Within 15m of Building	54	-11	-11
BGC Site – Near Site Boundary	59	-6	-6

Note: Shaded Cells indicate noise levels are within 5 dB of the assigned level.

Assuming the pyrolysis plant is constructed prior to the buildings associated with the master plan ("Existing Conditions"), the noise levels will be within 5 dB of the assigned noise levels at Receivers 1 to 3 where the predicted noise level is within 4 dB, under worst-case meteorological conditions during the evening.

With the master plan buildings constructed, noise levels will typically reduce, as these will provide barrier attenuation where they are located between the pyrolysis plant and the receivers. A slight increase occurs on the BGC site due to some noise reflecting from the new buildings.

6 RECOMMENDATIONS

The design goal is to be at least 5 dB less than the assigned noise levels. This will allow for the new plant to not significantly contribute to existing noise levels. When the existing operations are not running but the pyrolysis plant is operating, this 5 dB tolerance also provides an allowance for tonality adjustment.

With the ultimate master plan scenario, noise levels satisfy the design goal in all instances.

The pyrolysis plant will be constructed prior to all new buildings and therefore, compliance with the design goal is required for the existing conditions. *Table 5-1* indicates that compliance with the design goal is marginal during the evening. All sources other than the scrubber water spray are contributing reasonably evenly at the receivers. As such, the required 1 dB reduction can be

obtained in a number of different ways. The gas engine enclosures are specified as 80 dB(A) at 1-metre which is likely to be near the practicable limit and it is therefore recommended that both combustion fans be considered for noise control by way of, or combinations of acoustic silencers or enclosures or combinations of the two. The engineering treatment of these fans will be undertaken during detailed design but each should target a 3 dB reduction.

Appendix A

Terminology

The following is an explanation of the terminology used throughout this report.

Decibel (dB)
The decibel is the unit that describes the sound pressure and sound power levels of a noise source. It is a logarithmic scale referenced to the threshold of hearing.

A-Weighting
An A-weighted noise level has been filtered in such a way as to represent the way in which the human ear perceives sound. This weighting reflects the fact that the human ear is not as sensitive to lower frequencies as it is to higher frequencies. An A-weighted sound level is described as L_A dB.

Sound Power Level (L_w)
Under normal conditions, a given sound source will radiate the same amount of energy, irrespective of its surroundings, being the sound power level. This is similar to a 1kW electric heater always radiating 1kW of heat. The sound power level of a noise source cannot be directly measured using a sound level meter but is calculated based on measured sound pressure levels at known distances. Noise modelling incorporates source sound power levels as part of the input data.

Sound Pressure Level (L_p)
The sound pressure level of a noise source is dependent upon its surroundings, being influenced by distance, ground absorption, topography, meteorological conditions etc and is what the human ear actually hears. Using the electric heater analogy above, the heat will vary depending upon where the heater is located, just as the sound pressure level will vary depending on the surroundings. Noise modelling predicts the sound pressure level from the sound power levels taking into account ground absorption, barrier effects, distance etc.

L_{ASlow}
This is the noise level in decibels, obtained using the A frequency weighting and the S time weighting as specified in AS1259.1-1990. Unless assessing modulation, all measurements use the slow time weighting characteristic.

L_{AFast}
This is the noise level in decibels, obtained using the A frequency weighting and the F time weighting as specified in AS1259.1-1990. This is used when assessing the presence of modulation only.

L_{APeak}
This is the maximum reading in decibels using the A frequency weighting and P time weighting AS1259.1-1990.

L_{Amax}
An L_{Amax} level is the maximum A-weighted noise level during a particular measurement.

L_{A1}
An L_{A1} level is the A-weighted noise level which is exceeded for one percent of the measurement period and is considered to represent the average of the maximum noise levels measured.

L_{A10}
An L_{A10} level is the A-weighted noise level which is exceeded for 10 percent of the measurement period and is considered to represent the "*intrusive*" noise level.

L_{Aeq}
The equivalent steady state A-weighted sound level ("equal energy") in decibels which, in a specified time period, contains the same acoustic energy as the time-varying level during the same period. It is considered to represent the "average" noise level.

L_{A90}
An L_{A90} level is the A-weighted noise level which is exceeded for 90 percent of the measurement period and is considered to represent the "*background*" noise level.

One-Third-Octave Band
Means a band of frequencies spanning one-third of an octave and having a centre frequency between 25 Hz and 20 000 Hz inclusive.

L_{Amax} assigned level
Means an assigned level which, measured as a $L_{A\ Slow}$ value, is not to be exceeded at any time.

L_{A1} assigned level
Means an assigned level which, measured as a $L_{A\ Slow}$ value, is not to be exceeded for more than 1% of the representative assessment period.

L_{A10} assigned level
Means an assigned level which, measured as a $L_{A\ Slow}$ value, is not to be exceeded for more than 10% of the representative assessment period.

Tonal Noise
A tonal noise source can be described as a source that has a distinctive noise emission in one or more frequencies. An example would be whining or droning. The quantitative definition of tonality is:

the presence in the noise emission of tonal characteristics where the difference between -

(a) the A-weighted sound pressure level in any one-third octave band; and

(b) the arithmetic average of the A-weighted sound pressure levels in the 2 adjacent one-third octave bands,

is greater than 3 dB when the sound pressure levels are determined as $L_{Aeq,T}$ levels where the time period T is greater than 10% of the representative assessment period, or greater than 8 dB at any time when the sound pressure levels are determined as $L_{A\ Slow}$ levels.

This is relatively common in most noise sources.

Modulating Noise
A modulating source is regular, cyclic and audible and is present for at least 10% of the measurement period. The quantitative definition of modulation is:

a variation in the emission of noise that —

(a) is more than 3 dB $L_{A\ Fast}$ or is more than 3 dB $L_{A\ Fast}$ in any one-third octave band;

(b) is present for at least 10% of the representative.

Impulsive Noise

An impulsive noise source has a short-term banging, clunking or explosive sound. The quantitative definition of impulsiveness is:

a variation in the emission of a noise where the difference between $L_{A\ peak}$ and $L_{A\ Max\ slow}$ is more than 15 dB when determined for a single representative event;

Major Road

Is a road with an estimated average daily traffic count of more than 15,000 vehicles.

Secondary / Minor Road

Is a road with an estimated average daily traffic count of between 6,000 and 15,000 vehicles.

Influencing Factor (IF)

$$= \frac{1}{10}(\%\ \text{Type A}_{100} + \%\ \text{Type A}_{450}) + \frac{1}{20}(\%\ \text{Type B}_{100} + \%\ \text{Type B}_{450})$$

where:

$\%\ \text{Type A}_{100}$ = the percentage of industrial land within a100m radius of the premises receiving the noise

$\%\ \text{TypeA}_{450}$ = the percentage of industrial land within a 450m radius of the premises receiving the noise

$\%\ \text{Type B}_{100}$ = the percentage of commercial land within a100m radius of the premises receiving the noise

$\%\ \text{TypeB}_{450}$ = the percentage of commercial land within a 450m radius of the premises receiving the noise

+ Traffic Factor (maximum of 6 dB)

= 2 for each secondary road within 100m

= 2 for each major road within 450m

= 6 for each major road within 100m

Representative Assessment Period

Means a period of time not less than 15 minutes, and not exceeding four hours, determined by an inspector or authorised person to be appropriate for the assessment of a noise emission, having regard to the type and nature of the noise emission.

Background Noise

Background noise or residual noise is the noise level from sources other than the source of concern. When measuring environmental noise, residual sound is often a problem. One reason is that regulations often require that the noise from different types of sources be dealt with separately. This separation, e.g. of traffic noise from industrial noise, is often difficult to accomplish in practice. Another reason is that the measurements are normally carried out outdoors. Wind-induced noise, directly on the microphone and indirectly on trees, buildings, etc., may also affect the result. The character of these noise sources can make it difficult or even impossible to carry out any corrections.

Ambient Noise

Means the level of noise from all sources, including background noise from near and far and the source of interest.

Specific Noise

Relates to the component of the ambient noise that is of interest. This can be referred to as the noise of concern or the noise of interest.

Peak Component Particle Velocity (PCPV)

The maximum instantaneous velocity in mm/s of a particle at a point during a given time interval and in one of the three orthogonal directions (x, y or z) measured as a peak response. Peak velocity is normally used for the assessment of structural damage from vibration.

Peak Particle Velocity (PPV)

The maximum instantaneous velocity in mm/s of a particle at a point during a given time interval and is the vector sum of the PCPV for the x, y and z directions measured as a peak response. Peak velocity is normally used for the assessment of structural damage from vibration.

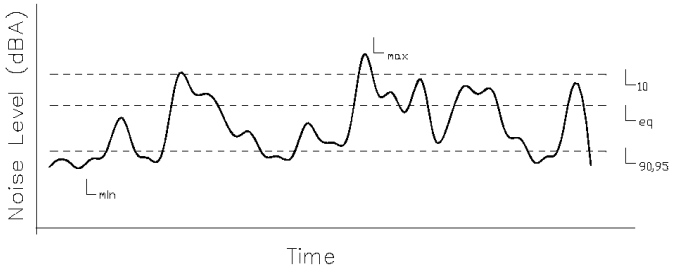
RMS Component Particle Velocity (PCPV)

The maximum instantaneous velocity in mm/s of a particle at a point during a given time interval and in one of the three orthogonal directions (x, y or z) measured as a root mean square (rms) response. RMS velocity is normally used for the assessment of human annoyance from vibration.

Peak Particle Velocity (PPV)

The maximum instantaneous velocity in mm/s of a particle at a point during a given time interval and is the vector sum of the PCPV for the x, y and z directions measured as a root mean square (rms) response. RMS velocity is normally used for the assessment of human annoyance from vibration.

Chart of Noise Level Descriptors



Typical Noise Levels