FREIGHT AND LOGISTICS COUNCIL OF WESTERN AUSTRALIA

BULLETIN

BULLETIN # 07

ISSUED OCTOBER 2015

INTRODUCTION

Bulletin No. 7 from the Freight and Logistics Council of Western Australia discusses recent research by the Council into freight rail noise impacts. It provides additional information on freight rail noise to help inform land use planning and the appraisal of appropriate noise levels in new development proposed along freight rail corridors.

Bulletin No. 5 looked generally at the standards and procedures of the Western Australian Planning Commission's (WAPC) *State Planning Policy 5.4: Road and Rail Transport Noise and Freight Considerations in Land Use Planning* (SPP 5.4) and related guidelines.

Bulletin No. 7 looks specifically at new research that explains how freight rail noise has important differences to road and passenger rail noise and why a clear understanding of freight rail noise is important for effective land use planning along rail freight corridors.

The new research includes additional technical standards on the distinctive characteristics of freight rail noise to more fully inform land use planning along freight rail lines. This includes treatment packages for residential development along freight rail lines that will maintain an adequate level of amenity within adjacent residential buildings.

Bulletin No 7 makes the FLCWA research available to assist with land use planning along freight rail lines and to inform the current review of SPP 5.4. The Bulletin is for information purposes and does not replace any requirements or criteria in SPP 5.4.

FREIGHT RAIL NOISE POLICY AND PRACTICE

SOUND AND NOISE

Noise is described as "unwanted sound" that can cause annoyance, speech interference and sleep disruption.

Sound comprises waves, and is described by two parameters – frequency and loudness. Frequencies are perceived by people differently. For example, the lower frequency sounds produced by drums compared with those produced by a whistle.

In terms of loudness, the decibel scale matches the way our ear and brain "auditory system" interprets sound pressures:

- In a normal environment, a 3 dB change is generally the threshold of perceptibility. A 3-dB increase represents doubling the sound energy.
- A change of 6 dB is clearly perceptible. A 6-dB increase requires four times the sound energy.
- A change of 10 dB is required before the sound seems twice as loud. A 10-dB increase requires ten times the sound energy.

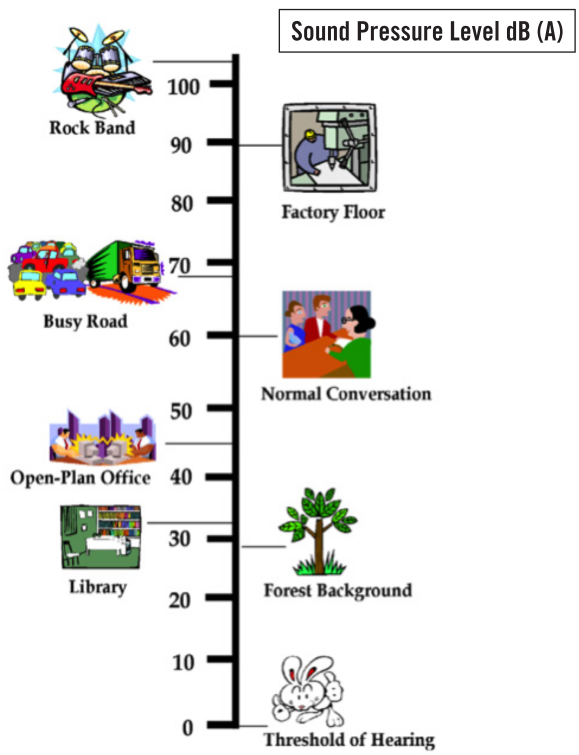

Figure 1: Typical noise levels db(A)

The decibel is a complex quantity based on sound pressure. It can be measured by a range of methods that express sound levels differently for distinctive purposes.

Two common noise measurement methods used for the measurement and expression of transport noise are L_{Aeq} and L_{Amax}. These methods are discussed next in relation to road and rail freight noise.

SPP 5.4 NOISE CRITERIA

SPP 5.4. adopts the L_{Aeq} noise measurement method and establishes outdoor and indoor noise criteria as follows:

Outdoor Noise Criteria

Outdoor noise criteria at a noise-sensitive land use such as a house or apartment are shown in *Table 1*. These criteria apply at any point one metre from a habitable façade of a noise sensitive premises and in one outdoor living area. Compliance with these criteria are to give regard to a 15-20 year transport horizon.

Time of Day	Noise Target	Noise Limit
Day (6am– 10 pm L_{Aeq}(Day)	55dB	60dB
Night (10 pm– 6 am L_{Aeq}(Night)	50dB	55dB

Note: The 5 dB difference between the target and the limit is referred to as the margin.

Table 1: SPP 5.4 Outdoor Noise Criteria

Indoor Noise Criteria

SPP 5.4 indoor standards are shown in Table 2.

Time of Day	Acceptable Noise Level	
	Living and work areas	Bedrooms
Day (6am– 10 pm L_{Aeq}(Day)	40dB	n/a
Night (10 pm– 6 am L_{Aeq}(Night)	n/a	35dB

Table 2: SPP 5.4 Indoor Noise Criteria

L_{AEQ} AND L_{AMAX} TRANSPORT NOISE MEASUREMENT METHODS COMPARED

The L_{Aeq} noise measurement used in SPP 5.4 describes the average noise during a measurement period. The measurement is well suited to the large number and constant movements typical of road traffic. It is also reasonably suited to the regular and frequent movements of passenger rail.

The potential (maximum) noise impacts from road and passenger rail are therefore considered to be reasonably represented in the L_{Aeq} noise criteria set out in SPP5.4.

Freight rail is different from road noise as it is characterised by a low number of irregular movements, which results in significant noise fluctuation from a very low level to a very high level as freight trains pass.

The problem arises that a low track use may still have a significant acoustic impact on noise-sensitive neighbours because although infrequent, individual freight trains have a high maximum noise level.

Applying the SPP 5.4 L_{Aeq} noise measurement method to freight rail may result in low noise level values due to the averaging effect for a low number of movements. This may not therefore reflect the acceptable or apparent indoor noise levels in a noise-sensitive development such as a residential apartment. In particular, concerns arise from the potential for residents to be woken up several times during an evening despite SPP 5.4 L_{Aeq}(Night) noise criteria of 35dB(A) having been met.

RAIL FREIGHT NOISE CRITERIA

An alternative method more suited to the assessment of noise from intermittent sources with high noise levels such as aircraft and freight trains is L_{Amax} which is the maximum level measured over a period event i.e. a train pass-by.

Time of Day	Noise Target	Noise Limit
Day + Night (L_{Amax})	75dB	80dB

Table 3: Recommended Outdoor Criteria for Freight Rail Noise

Time of Day	Living Room	Bedroom
Day + Night (L_{Amax})	60dB	60dB

Table 4: Recommended Indoor Criteria for Freight Rail Noise

As a guide, a generally acceptable level which was previously included in the 2005 draft version of the SPP 5.4 is the outdoor criteria of a 75 dB L_{Amax} target and 80 dB L_{Amax} limit. An internal level equivalent is considered to be 60 dB L_{Amax} applicable to bedrooms and living rooms. This level is consistent with the L_{Amax} approach taken for aircraft.

Freight train noise is not continuous and the Australian Standard for aircraft noise considers sensitivity of the L_{Amax} measurement to the frequency of pass-by events. Similarly, for rail freight, some lines will be busier than others. The 60 dB L_{Amax} guideline level can be adjusted slightly up where freight trains are less frequent, or adjusted slightly down where freight trains are more frequent.

ROAD AND RAIL NOISE COMPARED

Figure 2 compares diagrammatically how the L_{Aeq} and L_{Amax} measurements function for road and rail noise.[1] In terms of the L_{Aeq} noise measurement, road traffic noise oscillates in a consistent way as volumes gradually build from night to morning peak hour, reasonably consistent during the day to afternoon peak hour and then fall away again at night. The levels shown for road traffic are 66 dB L_{Aeq}(Day) and 60 dB L_{Aeq}(Night). In terms of the L_{Amax} noise measurement, as each freight trains pass the noise generated fluctuates significantly into sharp peaks as indicated in the diagram with the other noise representing background noise from wind, wildlife, distant traffic etc.

1 *Measurements were taken at 25 metres from the road and freight rail line edge*

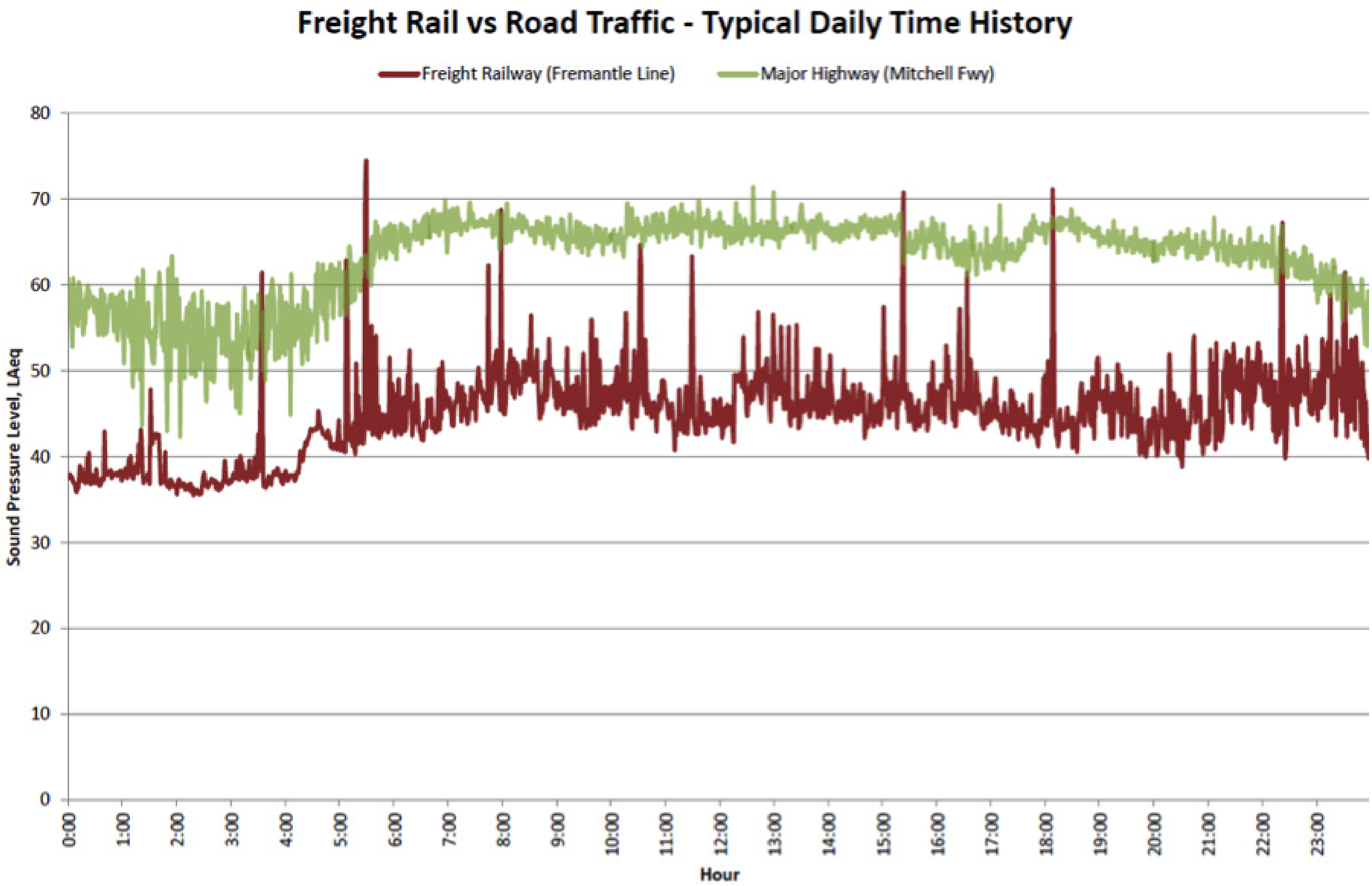

Figure 2: Road and Rail Noise Compared – Daily Time History

Low frequency noise can be a disturbance to sensitive people in their homes. Freight rail has a significant low frequency component as compared to road traffic as indicated on Figure 3 which shows that freight rail has louder external and internal low frequency noise than road traffic.

Conventional building construction and glazing in particular is relatively poor at moderating low frequency noise. Increasing building mass is the most effective counter to low frequency noise with useful materials including masonry walls (instead of stud walls) and clay tiles (instead of steel roofing).

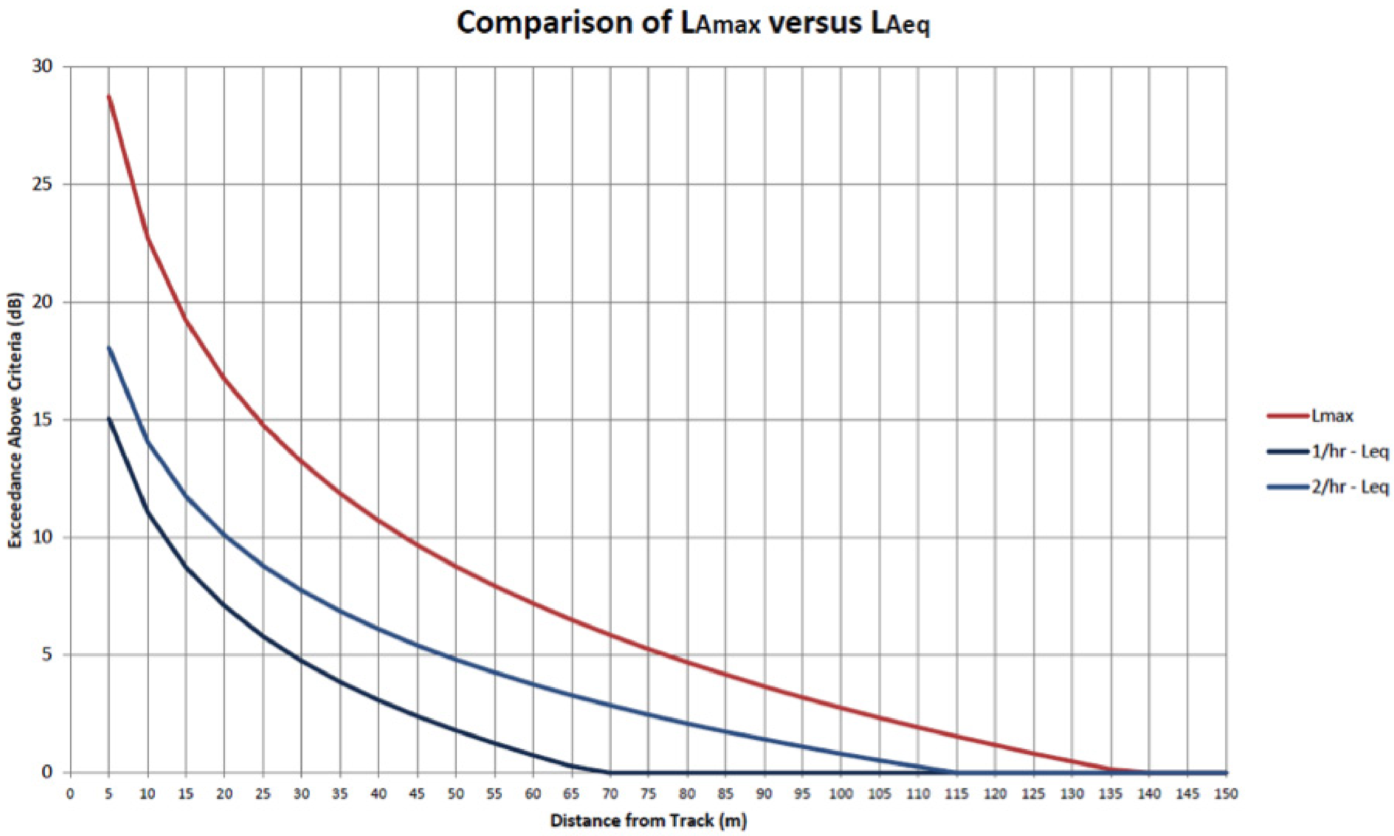

Figure 3: Case Study Chart 1 Comparison of L_{Amax} Versus L_{Aeq} - Measured vs Guidelines

CASE STUDY[2]

The Freight and Logistics Council of W.A. commissioned a case study by Lloyd George Acoustics to assess the performance for land use planning of the two noise measurement measures of L_{Aeq} and L_{Amax}.

The Fremantle line was selected to test the applicability of the criteria of the Implementation Guidelines for SPP 5.4 – Screening Assessment of one freight rail movement per hour minimum and two per hour. Measurements of freight train noise were collected on the Fremantle line and analysed to compare:

1. Maximum noise level L_{Amax}
2. Average measured noise and L_{Aeq}
3. L_{Aeq} noise forecast - in accordance with the SPP 5.4 Guidelines method of less than 1 train movement per hour assumption for the track.

The Implementation Guidelines for SPP 5.4 prescribe that irrespective of the number of movements on a freight track, a minimum of one train per hour must be assumed in the L_{Aeq} calculation. This may assume a higher number of freight trains than is forecast to occur which has the effect of increasing the L_{Aeq} value, and in turn requiring more stringent noise criteria to be met. By this work-around method, SPP 5.4 attempts to address noise impacts from intermittent events. This was considered a round-a-bout way to assess potential L_{Amax} noise impacts.

A comparison of L_{Amax} with L_{Aeq} for the Fremantle line is shown in Figure 3 above.

The values provided in the SPP 5.4 Guidelines are higher (more conservative) than actual measurements along the Forrestfield - Fremantle Port track. Therefore the relative difference between the L_{Amax} and L_{Aeq} values is not as great when the Guidelines values are applied.

The key points from Figure 3 are summarised below:

- The L_{Aeq}(Night) criteria was satisfied at 70 metres from the track based on the measurements, whereas this is now increased to around 150 metres for the Guidelines values.
- The L_{Amax} criteria is always more critical than the LAeq(Night) measured values, whereas at a distance of around 105 metres the L_{Amax} becomes less critical than the Guidelines L_{Aeq}(Night).
- At a distance of 25 metres, and assuming 1 train movement per hour, the L_{Aeq}(Night) exceedance is noted as 6 dB for the measured values. Therefore Acceptable Treatment Package B would be applicable to development at this location. Using the Guidelines L_{Aeq}(Night) values, the exceedance would be 10 dB, therefore Package C would be applicable. Whilst the latter is more stringent, it is still insufficient to accommodate the 15 dB L_{Amax} exceedance.

The case study demonstrates that an L_{Amax} assessment will still be critical, in a range of situations, even if the more conservative L_{Aeq}(Night) values set out in Appendix A of the SPP 5.4 Guidelines are applied.

The Case Study did not look at situations where there are more than two freight trains per hour on a line, such as on the Forrestfield Freight Rail line. Specialist noise studies would be required in this circumstance.

2 The case study contains further technical information. A copy can be found on the FLCWA web-site

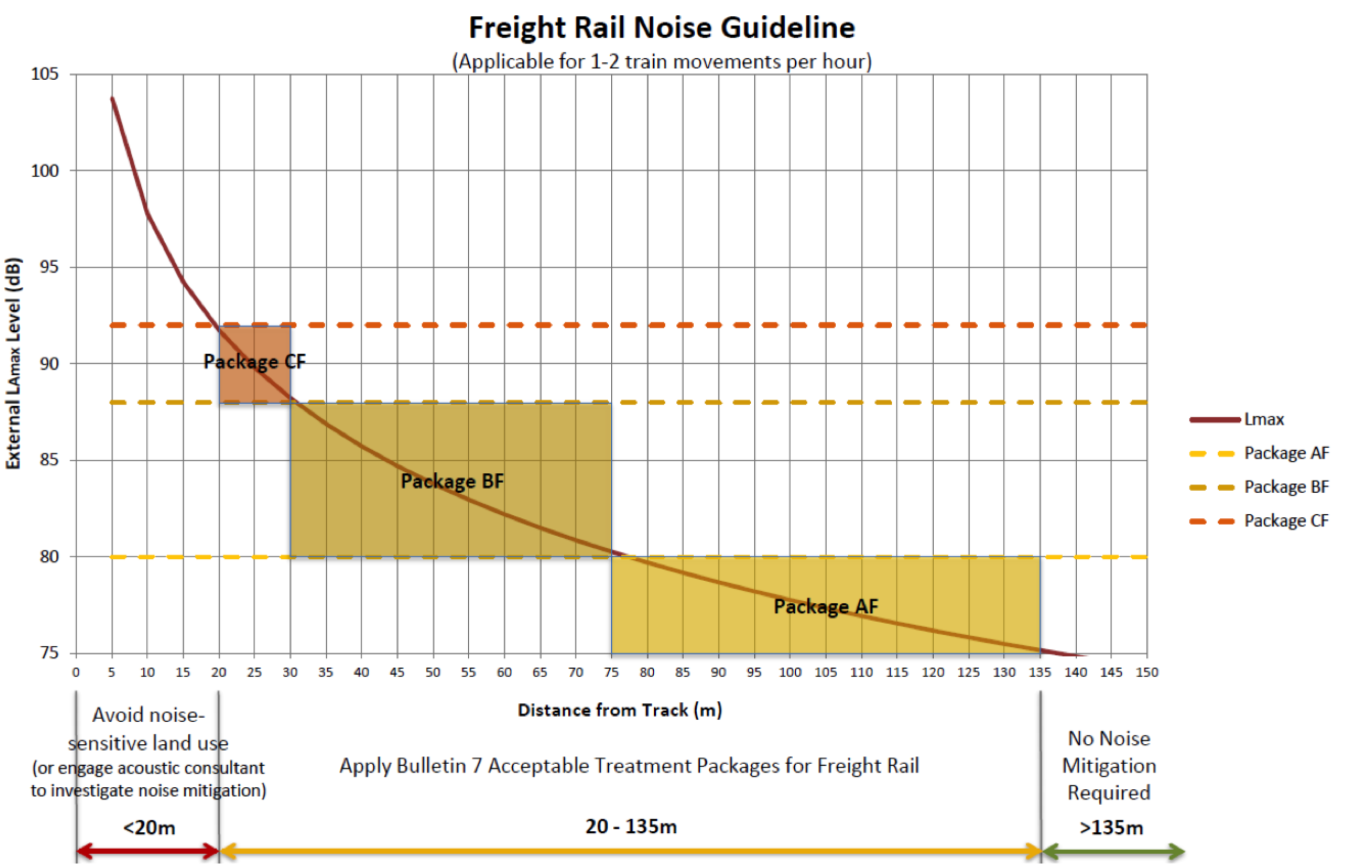

Figure 4: Freight Rail Noise Guideline

LAND USE PLANNING STANDARDS FOR DEVELOPMENT ALONG FREIGHT RAIL LINES

Introduction

The FLCWA commissioned case study tested the suitability of the L_{Aeq} and L_{Amax} noise measurement measures for noise sensitive land uses along the Fremantle Freight Rail Line (see box). The study indicated that the L_{Amax} criteria is not adequately addressed for freight rail.

The case study also demonstrates that if a L_{Amax} criteria were introduced, the packages would also be insufficient in achieving reasonable internal noise levels.

FLCWA Bulletin No 7 provides a response to these concerns by setting out a methodology that specifically considers the impacts of freight rail noise along freight rail lines. The approach is based on L_{Amax} for up to two freight rail trains per hour as follows:

1. An alternate table to the SPP 5.4 Screening Assessment Worksheet - *Table 4: Freight Rail Noise Guideline* above; and
2. Targeted treatment packages for residential development along freight rail routes - *Tables 5: Recommended Acceptable Treatment Packages for Freight Rail* and *Table 6: Example Construction for Freight Rail*.

Otherwise, a detailed assessment should be undertaken by a suitably qualified and experienced professional acoustics engineer or consultant where:

1. More than two rail freight trains per hour are forecast; or
2. Development is proposed in the vicinity of a rail freight handling facility; or
3. An alternative to the "Acceptable Treatment' packages is sought.

Freight Rail Noise Guideline

Standards in Table 5 have been developed for the planning and development of sensitive land uses within 135 metres from the edge of a freight rail track[3] for up to two freight rail trains per hour as follows:

1. Within 20 metres of a freight rail line edge, the L_{Amax} is above 85 db and the following measures should be instituted:
   - Proposed noise sensitive land use and development should be reviewed for land use compatibility and the earliest stage of the planning process, being at the region or local planning scheme amendment stage;

3 *The SPP 5.4 guidelines refer to distances from the rail centreline. The edge of the freight rail track has been used in Bulletin No. 7 to correspond with noise monitoring undertaken by local government and the private sector.*

- If a noise sensitive land use or development be progressed, then as per SPP 5.4 Guidelines (Section 4.5):
  - Arrange for notification on each title of property affected.
  - Undertake a detailed noise assessment required by competent professional to the satisfaction of authorities. The assessment must include acceptable treatment provisions.
  - Confirm proponent is committed to implementing the recommendations of the noise assessment or separate noise management plan, and seek evidence of installation as deemed necessary.

2. From 20 to 135 metres of a freight rail line edge, where L_{Amax} is between 75 and 85 db the following measures should be instituted:
   - 'Mitigation measures' need to be implemented through Table 5 (Package CF: 20-30 m; Package BF: 30-75 metres; and AF: 75-135 metres), or engage specialist advice.
   - As per SPP 5.4 Guidelines (Section 4.5)
     - Arrange for notification on each title of property affected according to SPP Guidelines Section 4.5.
     - Seek evidence of implementation/ compliance as deemed necessary.
3. Compliance will be achieved beyond 135 metres where L_{Amax} is less than 75 dB, and no further measures are required.

Acceptable Treatment Packages for Freight Rail

Roof/ceiling can dramatically increase noise levels. However, the SPP Guidelines do not specify the type of roof materials, so either Colorbond or clay tiles could be used.

From the research, refined packages that include roof/ceiling materials as set out in Table 6 have been developed to help address noise impacts from freight trains. The table is provided as information on appropriate standards that will maintain an adequate level of amenity within residential buildings along freight rail lines.

Alternative treatments offered by proponents may also achieve an acceptable noise level.

Area	Orientation to Road or Rail Corridor	Freight Rail Package CF (up to 92 dB L_{Amax})	Freight Rail Package BF (up to 88 dB L_{Amax})	Freight Rail Package AF (up to 80 dB L_{Amax})
All Habitable Rooms (including Kitchens)	Facing	• Walls to $R_W + C_{tr}$ 50 • Windows and external door systems: Minimum $R_W + C_{tr}$ 34 total glazing up to 40% of room floor area. $R_W + C_{tr}$ 37 if 60%. • Roof and ceiling to achieve minimum transmission loss of 22dB at 63 Hz and overall $R_W + C_{tr}$ 35 (e.g. clay roof tiles). • Mechanical ventilation.	• Walls to $R_W + C_{tr}$ 45 • Windows and external door systems: Minimum $R_W + C_{tr}$ 30 total glazing up to 40% of room floor area. $R_W + C_{tr}$ 33 if 60%. • Roof and ceiling to achieve minimum transmission loss of 22dB at 63 Hz and overall $R_W + C_{tr}$ 35 (e.g. clay roof tiles). • Mechanical ventilation.	• Walls to $R_W + C_{tr}$ 45 • Windows and external door systems: Minimum $R_W + C_{tr}$ 28 total glazing up to 40% of room floor area. $R_W + C_{tr}$ 31 if 60%. • Roof and ceiling to $R_W + C_{tr}$ 35. • Mechanical ventilation.
	Side	• As above.	• As above.	• As above.
	Opposite	• As above, except glazing may be 3dB less, or % increased by 20% (i.e. $R_W + C_{tr}$ 34 for 60%).	• As above, except glazing may be 3dB less, or % increased by 20% (i.e. $R_W + C_{tr}$ 29 for 60%).	• As above, except glazing may be 3dB less, or % increased by 20% (i.e. $R_W + C_{tr}$ 28 for 60% or $R_W + C_{tr}$ 31 for 80%).

Table 5: Recommended Acceptable Treatment Packages for Freight Rail

Table 6 sets out some typical examples of construction materials for freight rail for the recommended range of acceptable treatment packages in Table 5.

Area	Orientation to Road or Rail Corridor	Freight Rail Package CF (up to 92 dB L_{Amax})	Freight Rail Package BF (up to 88 dB L_{Amax})	Freight Rail Package AF (up to 80 dB L_{Amax})
All Habitable Rooms (including Kitchens)	Facing	• Walls: 2 x 110mm double brick wall with 50mm cavity and 50mm fibreglass insulation within the cavity. • Windows: 10.5mm VLam Hush awning windows (up to 40% of room floor area). • External Doors: 10mm fully glazed hinged door (up to 20% of room floor area). • External doors to bedrooms are not recommended. • Roof and ceiling: Clay roof tiles with sarking and 10mm plasterboard ceiling, or, Colorbond roof sheeting with sarking, 4mm fibre cement sheeting fixed to the roof purlins and 2 x 10mm plasterboard ceiling. • Mechanical ventilation.	• Walls: 2 x 90mm double brick wall with 20mm cavity. • Windows: 6mm awning windows (up to 40% of room floor area); or, 10mm awning windows (up to 60% of room floor area). • External Doors: 10mm sliding glass doors (up tp 20% of room floor area). • External doors to bedrooms are not recommended. • Roof and ceiling: Clay roof tiles with sarking and 10mm plasterboard ceiling, or, Colorbond roof sheeting with sarking, 4mm fibre cement sheeting fixed to the roof purlins and 2 x 10mm plasterboard ceiling. • Mechanical ventilation.	• Walls: 2 x 90mm double brick wall with 20mm cavity. • Windows: 6mm awning or 10mm sliding windows (up to 40% of room floor area); or, 6mm awning windows (up to 60% of room floor area). • External Doors: 6mm sliding glass doors (up to 20% of room floor area). • Roof and ceiling: Colorbond roof sheeting with 10mm plasterboard ceiling. • Mechanical ventilation.
	Side	• As above.	• As above.	• As above.
	Opposite	• As above, except - • Windows: 6mm awning windows (up to 40% of room floor area); or, 10mm awning windows (up to 60% of room floor area). • External Doors: 6mm fully glazed hinged door (up to 20% of room floor area).	• As above, except - • Windows: 6mm awning or 10mm sliding windows (up to 40% of room floor area); or, 6mm awning windows (up to 60% of room floor area). • External Doors: 6mm sliding glass doors (up to 20% of room floor area).	• As above, except - • Windows: 4mm awning or 6mm sliding windows (up to 40% of room floor area); or, 6mm awning or 10mm sliding windows (up to 60% of room floor area).
Outdoor Living Area		• Where practicable, locate an outdoor living area on the opposite side of the rail corridor or in an alcove on the side of the house.	• Where practicable, locate an outdoor living area on the opposite side of the rail corridor or in an alcove on the side of the house.	• Where practicable, locate an outdoor living area on the opposite side of the rail corridor or in an alcove on the side of the house.

Table 6: Example Construction for Freight Rail

CONCLUSION

This Bulletin from the Freight and Logistics Council of Western Australia discusses the measurement of freight rail noise impacts and their treatment based on Council research into the issue. The work will form the basis of a Council submission into a current Government review of related policy and practice.

TERMS

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.

Hertz (Hz)

Hertz is the unit of frequency or pitch of a sound. One hertz equals one cycle per second.

L_{eq}

The L_{eq} level represents the average noise energy during a measurement period.

L_{Aeq}(Day)

the L_{Aeq}(16 hour) for the time period 6 am to 10 pm;

L_{Aeq}(Night)

the L_{Aeq}(8 hour) for the time period 10 pm to 6 am;

Lmax

The L_{max} level represents the maximum energy during a measurement period.

Noise-sensitive land use

Includes land used for noise-sensitive premises (as defined in the *Environmental Protection (Noise) Regulations 1997*) occupied solely or mainly for residential or accommodation purposes, rural premises and premises used for the purpose of:

- a caravan park or camping ground;
- a hospital;
- a sanatorium, home or institution for the care of persons, a rehabilitation centre, home or institution for persons requiring medical or rehabilitative treatments;
- education (school, college, university, technical institute, academy or other educational centre, lecture hall or other premises used for the purpose of instruction);
- public worship;
- a tavern, hotel, club premises, reception lodge or other premises that provide accommodation for the public;
- aged care;
- child care; and
- prison or detention centre;

R_w

This is the weighted sound reduction index and is similar to the previously used STC (Sound Transmission Class) value. It is a single number rating determined by moving a grading curve in integral steps against the laboratory measured transmission loss until the sum of the deficiencies at each one-third-octave band, between 100 Hz and 3.15 kHz, does not exceed 32 dB. The higher the R_w value, the better the acoustic performance.

Further information:

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Published by TPG Town Planning, Urban Design and Heritage

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