



Construction Noise Strategy

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Standard – Applicable to Infrastructure and Services

Quality Management System

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1. Purpose & Scope

The purpose of this document is to provide practical guidance on how to mitigate the impacts of construction noise and vibration (airborne noise, ground-borne noise and vibration) from projects under the authority of Transport for NSW - Infrastructure & Services Division (I&S) on the community through the application of all feasible and reasonable mitigation measures.

2. Scope

This procedure is applicable (targeted audience)

3. Abbreviations and definitions

All terminology in this Standard is taken to mean the generally accepted or dictionary definition with the exception of the following terms which have a specifically defined meaning:

TfNSW	Transport for New South Wales
I&S	Infrastructure & Services division of TfNSW
ICNG	NSW Department of Climate Change <i>Interim Construction Noise Guideline</i> , published July 2009
L_{Amax}	the “Maximum Noise Level” for an event, used in the assessment of potential sleep disturbance during night-time periods. The subscript “A” indicates that the noise levels are filtered to match normal human hearing characteristics (ie A-weighted).
L_{Aeq}(15 minute)	the “Energy Average Noise Level” during construction activities, evaluated over a measurement period of 15 minutes. This is the main parameter used to assess the construction noise impacts
LA90	the “Background Noise Level” in the absence of construction activities. This parameter represents the average minimum noise level during the daytime, evening and night-time periods respectively. The L _{Aeq} (15 minute) construction noise objectives are based on an allowance margin above the LA90 background noise levels.
PPV	“Peak Particle Velocity” evaluated at the building footings and used to assess the risk of damage to structures
Arms	“Root mean squared weighted acceleration”, a vibration parameter used to assess human response to continuous or intermittent vibration
eVDV	“Estimated Vibration Dose Value”, the overall vibration exposure assessed over the daytime or night-time period to assess human response to intermittent vibration
SPL	Sound Pressure Level
SWL	Sound Power Level

4. Process

The document may be used in the development of, or referred to in:

- environmental impact assessment documents;

- design and construction environmental management documents;
- contract documents; and
- approvals and licences (subject to the agreement of the relevant regulatory authority).

This document does not take precedence over approval or licence conditions and will be reviewed as required in response to the release of relevant guidelines, standards and policies dealing with construction noise.

5. Introduction

The construction noise and vibration emissions associated with I&S projects can often cause disturbance to adjacent communities. For many infrastructure projects, construction works are required outside normal construction hours because work during daytime periods would be highly disruptive to commuter services and road traffic on major roads. The potential noise and vibration impacts can often be minimised by informing the community of the potential impacts, the time periods over which these will occur and the proposed mitigation measures that will be employed to minimise the impacts.

This standard addresses the assessment requirements of the NSW Department of Climate Change *Interim Construction Noise Guideline* (ICNG) published July 2009.). The goal of the ICNG is to minimise the impacts of construction noise, rather than focusing only on achieving numeric noise goals, and recognises that some noise from construction sites is inevitable. The ICNG encourages organisations involved with construction, maintenance or upgrading works (such as I&S) to develop their own best-practice techniques for managing construction noise and vibration, through implementing feasible and reasonable mitigation principles. This Strategy is consistent with this recommendation.

In preparing this document, consideration has also been given to guidance contained in the *Australian Standard AS 2436:2010 - Guide to noise and vibration control on construction, demolition and maintenance sites*.

The key elements of the Strategy involve:

- evaluating the construction noise and vibration impacts during the environmental impact assessment stage of a project to identify, in consultation with the community and other stakeholders, project specific construction noise and vibration objectives and possible mitigation measures for them;
- implementing a standard suite of noise and vibration mitigation measures on all projects;
- implementing *additional* mitigation measures when construction noise or vibration is predicted to *exceed* the project's construction noise and vibration objectives;
- verifying the validity of noise assessments undertaken during the environmental impact assessment stage *prior* to construction commencing to ensure that any changes to the project's design, scope, construction method or the mitigation measures proposed in the environmental impact assessment are re-evaluated and any additional (or changes to the) mitigation measures are identified; and
- monitoring the implementation and effectiveness of the project's noise and vibration mitigation measures via a three monthly audit cycle.

6. Assessing the Impacts of Construction Noise and Vibration

As part of the environmental impact assessment process, the impacts on nearby receivers of airborne noise, ground-borne noise and ground-borne vibration generated during the construction of a project are evaluated. This assessment shall be undertaken by an acoustic consultant and shall form part of the environmental impact assessment documentation (eg. Review of Environmental Factors) that is considered by the approval authorities. The noise and vibration construction assessment:

- is based on an initial design, scope and construction methodology for the project;
- identifies sensitive receivers, the existing background noise levels and, in accordance with the ICNG (see Appendix A), the construction noise and vibration objectives; and
- identifies the feasible and reasonable noise and vibration mitigation measures (including any project specific measures¹) that are required to mitigate any predicted exceedance of the construction noise and vibration goals.

A noise and vibration assessment should be included in the project documentation placed on public display. This will include the construction noise and vibration objectives for the project and any accompanying mitigation measures. Comments received from the community and other stakeholders on the proposed mitigation measures for the project shall be considered and if deemed necessary, changes shall be made to the proposed mitigation plan, prior to the project being approved or licensed. Appendix A describes in detail the construction noise and vibration assessment process.

The environmental impact assessment documentation is based on an initial design and construction methodology. Typically, as the design of a project is further developed following its approval, the construction methodology and staging is altered.

To ensure the adequacy of the noise and vibration mitigation measures for the actual design and construction method, a Construction Noise and Vibration Impact Statement (CNIS) must be prepared (for each major construction stage or key activity), prior to the preparation of the Construction Noise and Vibration Management Plan (CNVMP) for that stage/activity. This process is outlined in Figure 1. The CNIS must be prepared in accordance with the requirements of Appendix A. The CNIS should be used as the basis on which to develop the CNVMP² for the project. A separate CNIS must be prepared for each major stage of works or activity and the CNVMP revised as required.

¹ For example: physical structures such as construction noise barriers, acoustic sheds, dwelling treatment, acoustic barriers around noisy plant, operational noise barriers erected early etc or special construction methods such as penetrating cone fracture or controlled blasting in place of conventional rock breaking, etc.

² NB: Any changes to the project must be consistent with the environmental assessment documentation and project approval and cannot cause significant additional impacts on the environment or community.

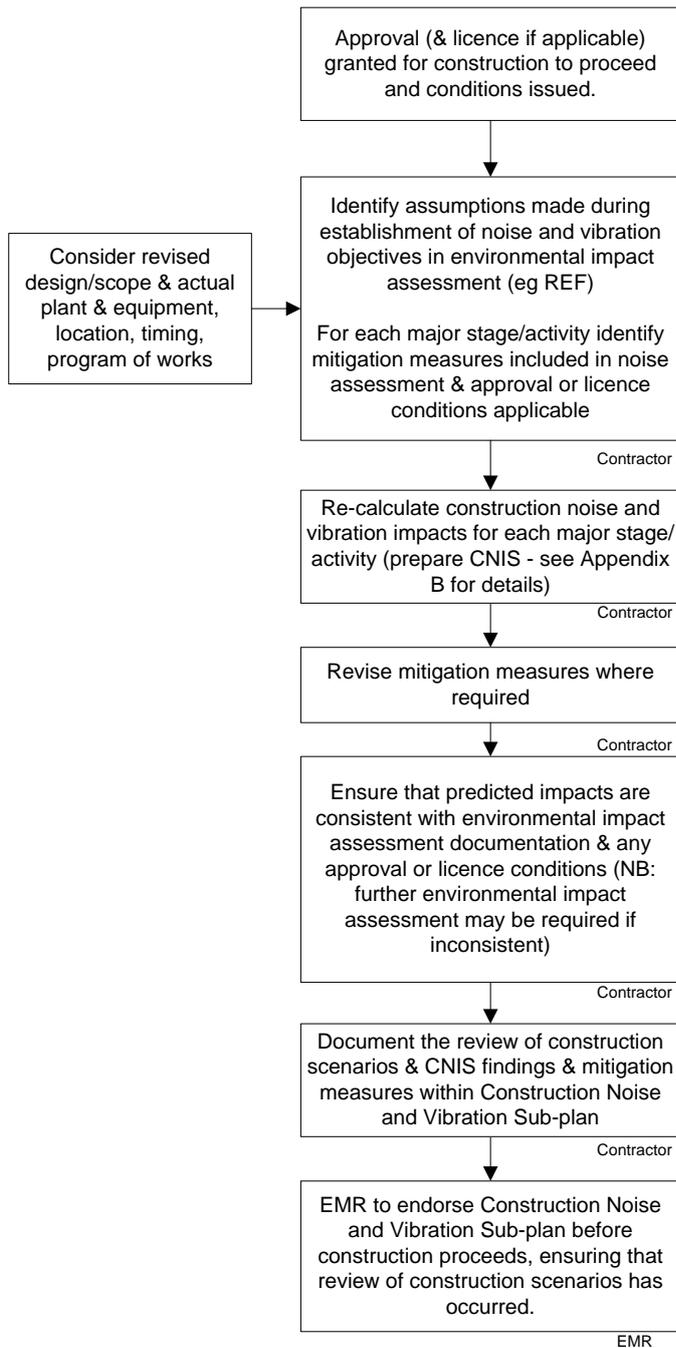


Figure 1: Construction noise and vibration assessment review procedure

7. Standard Mitigation Measures and Monitoring Requirements

This section sets out the *standard* construction noise and vibration mitigation measures to be implemented on all I&S projects and delivered via relevant procedures, systems, environmental impact assessment, construction environmental management and all relevant contract documentation.

For all I&S construction projects, the standard mitigation measures in Table 1 shall be applied to mitigate noise and vibration impacts of the project where reasonable and feasible. Additional information in relation to specific mitigation measures, the assessment process and relevant objectives are provided in the Appendices.

A construction noise and vibration assessment shall be prepared as part of the project environmental impact assessment. This includes monitoring to validate the modelling assumptions and confirm that noise and vibration levels from individual plant and equipment items are not excessive. This section provides guidance in relation to standard monitoring and survey requirements that are expected for construction projects.

Additional information is also provided in relation to satisfactory operating distances to ensure that construction related vibration levels are acceptable.

7.1. Standard Mitigation Measures

The actions set out in the tables below shall be implemented on I&S construction projects where reasonable and feasible.

Table 1: Standard mitigation measures to reduce construction noise and vibration

Action required	Applies to	Details
Management Measures		
Implementation of any project specific mitigation measures required.	Airborne noise Ground-borne noise & vibration	In addition to the measures set out in this table, any project specific mitigation measures identified in the environmental impact assessment documentation (eg REF, submissions or representations report) or approval or licence conditions must be implemented.
Implement community consultation measures (refer to Appendix C for further details of each measure).	Airborne noise. Ground-borne noise & vibration.	periodic notification (monthly letterbox drop or equivalent) ³ website Project Infoline Construction Response Line email distribution list Community and Stakeholder Meetings and Community Based Forums (if required by approval conditions).

³ Detailing all upcoming construction activities at least 14 days prior to commencement of relevant works

Action required	Applies to	Details
Site inductions.	Airborne noise. Ground-borne noise & vibration.	All employees, contractors and subcontractors are to receive an environmental induction. The induction must at least include: all relevant project specific and standard noise and vibration mitigation measures relevant licence and approval conditions permissible hours of work any limitations on high noise generating activities location of nearest sensitive receivers construction employee parking areas designated loading/unloading areas and procedures site opening/closing times (including deliveries) environmental incident procedures.
Behavioural practices.	Airborne noise.	No swearing or unnecessary shouting or loud stereos/radios on site. No dropping of materials from height, throwing of metal items and slamming of doors.
Monitoring.	Airborne noise. Ground-borne noise & vibration.	A noise monitoring program should be carried out for the duration of works in accordance with the Construction Noise and Vibration Management Plan and any approval and licence conditions.
Attended vibration measurements.	Ground-borne vibration.	Attended vibration measurements shall be undertaken at all buildings within 20 m of vibration generating activities when these activities commence to confirm that vibration levels are within the acceptable range to prevent cosmetic building damage.
Source Controls		
Construction hours and scheduling.	Airborne noise. Ground-borne noise & vibration.	Where feasible and reasonable, construction should be carried out during the standard daytime working hours. Work generating high noise and/or vibration levels should be scheduled during less sensitive time periods.
Construction respite period.	Ground-borne noise & vibration. Airborne noise.	High noise and vibration generating activities ⁴ may only be carried out in continuous blocks, not exceeding 3 hours each, with a minimum respite period of one hour between each block ⁵ . No more than four consecutive nights of high noise and/or vibration generating work may be undertaken over any seven day period, unless otherwise approved by the relevant authority.
Equipment selection.	Airborne noise. Ground-borne noise &	Use quieter and less vibration emitting construction methods where feasible and reasonable. For example, when piling is required, bored piles

⁴ Includes jack and rock hammering, sheet and pile driving, rock breaking and vibratory rolling.

⁵ "Continuous" includes any period during which there is less than a 60 minutes respite between ceasing and recommencing any of the work.

Action required	Applies to	Details
	vibration.	rather than impact-driven piles will minimise noise and vibration impacts. Similarly, diaphragm wall construction techniques, in lieu of sheet piling, will have significant noise and vibration benefits.
Maximum noise levels.	Airborne-noise.	The noise levels of plant and equipment must have operating Sound Power or Sound Pressure Levels compliant with the criteria in Table 2.
Rental plant and equipment.	Airborne-noise.	The noise levels of plant and equipment items are to be considered in rental decisions and in any case cannot be used on site unless compliant with the criteria in Table 2.
Use and siting of plant.	Airborne-noise.	<p>Simultaneous operation of noisy plant within discernible range of a sensitive receiver is to be avoided.</p> <p>The offset distance between noisy plant and adjacent sensitive receivers is to be maximised.</p> <p>Plant used intermittently to be throttled down or shut down.</p> <p>Noise-emitting plant to be directed away from sensitive receivers.</p>
Plan worksites and activities to minimise noise and vibration.	Airborne noise. Ground-borne vibration.	Plan traffic flow, parking and loading/unloading areas to minimise reversing movements within the site.
Non-tonal reversing alarms.	Airborne noise.	Non-tonal reversing beepers (or an equivalent mechanism) must be fitted and used on all construction vehicles and mobile plant regularly used on site and for any out of hours work.
Minimise disturbance arising from delivery of goods to construction sites.	Airborne noise.	<p>Loading and unloading of materials/deliveries is to occur as far as possible from sensitive receivers.</p> <p>Select site access points and roads as far as possible away from sensitive receivers.</p> <p>Dedicated loading/unloading areas to be shielded if close to sensitive receivers.</p> <p>Delivery vehicles to be fitted with straps rather than chains for unloading, wherever possible.</p>
Construction Related Traffic	Airborne noise.	<p>Schedule and route vehicle movements away from sensitive receivers and during less sensitive times</p> <p>Limit the speed of vehicles and avoid the use of engine compression brakes</p> <p>Maximise on-site storage capacity to reduce the need for truck movements during sensitive times</p>
Silencers on Mobile Plant	Airborne noise.	<p>Where possible reduce noise from mobile plant through additional fittings including:</p> <p>Residential grade mufflers</p> <p>Damped hammers such as “City” Model Rammer Hammers</p> <p>Air Parking brake engagement is silenced</p>

Action required	Applies to	Details
Path Controls		
Shield stationary noise sources such as pumps, compressors, fans etc.	Airborne noise.	Stationary noise sources should be enclosed or shielded whilst ensuring that the occupational health and safety of workers is maintained. Appendix F of AS 2436: 1981 lists materials suitable for shielding.
Shield sensitive receivers from noisy activities.	Airborne noise.	Use structures to shield residential receivers from noise such as site shed placement; earth bunds; fencing; erection of operational stage noise barriers (where practicable) and consideration of site topography when siting plant.

7.2. Noise & Vibration Auditing

Compliance with the approved construction noise and vibration objectives is to be audited at least every three months. This will involve the measurement of equipment noise levels (on site) and noise and vibration monitoring at the nearest sensitive receivers. A summary of the measurement requirements is provided below and in Appendix A.

The attended measurements shall be carried out by an appropriately trained person in the measurement and assessment of construction noise and vibration, familiar with applicable standards and procedures.

Maximum levels for plant and equipment

All plant and equipment used for construction must have operating Sound Power or Sound Pressure Levels compliant with the criteria in Table 2. Equipment not listed in Table 2, shall be compliance to the most applicable equipment listed in Australian Standard AS 2436-19812010 *Guide to noise and vibration control on construction, demolition and maintenance sites*, British Standard BS 5228-1 *Code of practice for noise and vibration control on construction and open sites* or DEFRA noise database⁶ (2006).

The noise levels in Table 2 can also be used as a guide in the prediction of $L_{Aeq(15\text{minute})}$ construction noise. In doing so, the predicted $L_{Aeq(15\text{minute})}$ noise levels will be dependent on several factors including, but not limited to the duration of the construction activities, the number of plant items and their location on site in relation to the nearest receivers.

Attended measurements shall be undertaken within 14 days of equipment arriving on site. To confirm that the operating noise levels of all plant items comply with the maximum levels in Table 2. Measurements are to be repeated on a three-monthly basis to ensure that noise from individual plant items are still within the acceptable noise range.

Noise and vibration monitoring in the community

Attended measurements are to be undertaken within a period of 14 days from the commencement of construction activities to confirm that the noise and vibration levels in the adjacent community are consistent with the predictions in the CNIS⁷, approval and/or licence conditions.

The attended measurements must be undertaken at the potentially most impacted receivers.

⁶ DEFRA - Department for Environment Food and Rural Affairs (United Kingdom), Update of noise database for prediction of noise on construction and open sites - Phase 3: Noise measurement data for construction plant used on quarries, July 2006.

⁷ Or other relevant acoustic assessment

Noise measurements shall be undertaken consistent with the procedures documented in AS1055.1-1997 *Acoustics - Description and Measurement of Environmental Noise - General Procedures*. Vibration measurements shall be undertaken in accordance with the procedures documented in the OEH's *Assessing Vibration - a technical guideline* (2006) and BS7385 Part 2-1993 *Evaluation and measurement for vibration in buildings*.

For projects with a duration greater than three months, the attended measurements are to be repeated on a three-monthly basis as part of the audit cycle to ensure that noise and vibration levels in the adjacent community remain consistent with the predicted levels in the CNIS, approval and/or licence conditions. Where out of hours works are required, the attended measurements must be undertaken at the time intervals described in the CNIS, out of hours assessment, approval and/or licence conditions.

Noise monitoring should be implemented on all projects where specified by the Additional Mitigation Measures outlined in this document (Section 8.2) or as an on-going mitigation measure during critical periods, such as when noise emissions are expected to be at their highest including piling and hammering activities.

Table 2: Maximum allowable noise levels for construction equipment

Equipment	Maximum Allowable Noise Level (dBA) – L _{Amax1, 2, 3}	
	Sound Power Level	Sound Pressure Level at 7 m
Excavator Hammer	118	93
Excavator (approx. 3 tonne)	90	65
Excavator (approx. 6 tonne)	95	70
Excavator (approx. 10 tonne)	100	75
Excavator (approx. 20 tonne)	105	80
Excavator (approx. 30 tonne)	110	85
Excavator (approx. 40 tonne)	115	90
Skidsteer Loaders (approx. 1/2 tonne)	107	82
Skidsteer Loaders (approx. 1 tonne)	110	85
Dozer (equiv. CAT D8)	118	93
Dozer (equiv. CAT D9)	120	95
Dozer (equiv. CAT D10)	121	96
Backhoe/FE Loader	111	86
Dump Truck (approx. 15 tonne)	108	83
Concrete Truck	112	87
Concrete Pump	109	84
Concrete Vibrator	105	80
Bored Piling Rig	110	85
Scraper	110	85
Grader	110	85
Vibratory Roller (approx. 10 tonne)	114	89
Vibratory Pile Driver	121	96
Impact Piling Rig	134	109
Compressor (approx. 600 CFM)	100	75
Compressor (approx. 1500 CFM)	105	80
Concrete Saw	118	93
Jackhammer	113	88
Generator	104	79
Lighting Tower	80	55
Flood Lights	90	65
Cherry Picker	102	77
Mobile Crane	110	85

Notes:

The Sound Power Level (SWL) represents the total noise output of the plant or equipment. The SWL is normally used in computer noise models to predict the Sound Pressure Levels (SPLs) at nearby receivers. When undertaking site compliance measurements, it is normally the SPL that is measured at a specified distance (typically 7m) from the plant or equipment.

The SWLs presented in the above table have been compiled from a selection of field measurements conducted by Heggies Pty Ltd between 2004 and 2006 of plant and equipment operating on construction projects throughout NSW and are therefore considered to be representative of plant and equipment SWLs which are readily achieved by current plant and equipment normally used in the construction industry.

Plant and equipment with SWLs higher than those presented in the table would be deemed to be emitting an excessive level of noise and should not be permitted to operate on construction sites.

7.3. Ground Vibration – Safe Working Distances for Intensive Activities

As a guide, safe working distances for typical items of vibration intensive plant are listed in Table 3. The safe working distances are quoted for both “cosmetic” damage (refer BS 7385) and human comfort (refer OH&E’s *Assessing Vibration - a technical guideline*). The safe working distances for cosmetic damage must be complied with at all times, unless otherwise approved by the relevant authority.

Table 3: Recommended safe working distances from vibration intensive plant

Plant Item	Rating/Description	Safe Working Distance	
		Cosmetic Damage (BS 7385)	Human Response (OH&E Vibration Guideline)
Vibratory Roller	< 50 kN (Typically 1-2 tonnes)	5 m	15 m to 20 m
	< 100 kN (Typically 2-4 tonnes)	6 m	20 m
	< 200 kN (Typically 4-6 tonnes)	12 m	40 m
	< 300 kN (Typically 7-13 tonnes)	15 m	100 m
	> 300 kN (Typically 13-18 tonnes)	20 m	100 m
	> 300 kN (> 18 tonnes)	25 m	100 m
Small Hydraulic Hammer	(300 kg - 5 to 12t excavator)	2 m	7 m
Medium Hydraulic Hammer	(900 kg – 12 to 18t excavator)	7 m	23 m
Large Hydraulic Hammer	(1600 kg – 18 to 34t excavator)	22 m	73 m
Vibratory Pile Driver	Sheet piles	2 m to 20 m	20 m
Pile Boring	≤ 800 mm	2 m (nominal)	N/A
Jackhammer	Hand held	1 m (nominal)	Avoid contact with structure

Note: More stringent conditions may apply to heritage or other sensitive structures

The safe working distances presented in Table 3 are indicative and will vary depending on the particular item of plant and local geotechnical conditions. They apply to cosmetic damage of typical buildings under typical geotechnical conditions. Vibration monitoring is recommended to confirm the safe working distances at specific sites.

For highly sensitive receivers (eg, high technology facilities, recording studios and cinemas), specific assessment is required to ensure satisfactory operation of the facility and determine if any mitigation or management measures are required to minimise the potential impacts.

In relation to human comfort (response), the safe working distances in Table 3 relate to continuous vibration. For most construction activities, vibration emissions are intermittent in nature and for this reason, higher vibration levels, occurring over shorter periods are allowed (see Appendix A). Where the predicted vibration levels exceed the human comfort objectives, the procedures in Section 5 are to be followed in order to mitigate the potential impacts at sensitive receivers.

7.4. Occupational Health and Safety Considerations

In addition to potential noise and vibration impacts on the community and structures, construction noise and vibration can also have an adverse impact upon the health of workers.

The main adverse impacts of hazardous noise are permanent noise-induced hearing loss and interference with clearly hearing instructions and/or audible warning signals. Excessive vibration from hand-held power tools (such as jack hammers) and whole body vibration (from mobile plant) can lead to adverse impacts such as white-finger disease, damage to tendons and nerves, and lower back pain.

For the above reasons, it is important that contractors adopt noise management strategies to prevent or minimise worker exposure to excessive noise and vibration. Such measures will also assist in reducing noise and vibration impacts on the surrounding community.

The series of Standards, AS/NZS 1269 Parts 0 to 4, sets out procedures to assess, control, manage and review noise hazards, and Regulation 49 of the 'OH&S Regulations 2001' defines the applicable noise limits that are applicable in NSW.

The *National Code of Practice for Prevention of Musculoskeletal Disorders from Performing Manual Tasks at Work (2007)* contains guidance on assessing and controlling vibration risks.

8. Construction Hours

The *standard* construction hours are set out in the approval and licence (if applicable) conditions for each project. The recommended standard hours of construction in NSW are:

- 0700 to 1800 Monday to Friday; 0800 to 1300 Saturday
- No work on Sundays and Public Holidays

Other hours may be worked if approved by the relevant authority.

For blasting, the recommended standard hours of construction in NSW are:

- 0900 to 1700 Monday to Friday; 0900 to 1300 Saturday
- No blasting on Sundays and Public Holidays

Other hours may be worked if approved by the relevant authority.

For rock hammering and breaking, sheet and driven piling and other impulsive/tonal noise generating activities, the typical standard hours of construction in NSW are:

- 0800 to 1200 Monday to Saturday; 1400 to 1700 Monday to Friday
- No work on Sundays and Public Holidays

Blasting and impulsive/tonal noise generating activities may be completed outside of the listed time restrictions if endorsed by the Principal Manager Community Engagement (or nominated delegate) and approved by the PMEM (or nominated delegate) or relevant authority.

All attempts should be made to confine construction activities, including the delivery of plant and equipment to the hours outlined in the ICNG. Working outside these hours should only be conducted when it is not feasible and reasonable, decisions to work outside of these hours shall be supported by documented evidence.

Construction work carried out close to or in operational transport corridors or utilities networks, to maintain a safe work environment and to limit disruptions on commuters, traffic or utilities may warrant work to be carried out outside of ICNG specified hours. This can result in construction activities being undertaken during periods of scheduled track work (such as track possessions), typically during periods of lower commuter use (overnight, weekends and holiday periods).

Box 1 on the following page contains a sample of typical practices under which out of hours work may be permitted.

The procedure for assessing and approving / rejecting proposals for out of hours works is set out in Figure 2 (**NB: out of hours work covered by a licence is subject to a separate application to the EPA by the licence holder**). The key features of the procedure include:

- All applications for out of hours work must be made on the approved form⁸ and accompanied by the required information
- Out of hours work with low or medium risk factors (see Figure 2) may be approved by the Environmental Management Representative (EMR) for the project unless otherwise specified by an approval or licence condition.
- Applications for approval of out of hours work with medium or high risk factors (**including those requiring the EPA's approval**) must be supported by a CNIS or other acoustic assessment prepared in accordance with the guidance in Appendix B and relevant licence conditions
- Out of hours work with a high or extreme risk factor can only be approved by I&S Principal Manager Environmental Management or the Department of Planning & Environment (whichever is applicable) following the endorsement of the EMR.

⁸ This form is not used for applications for out of hours work covered by a licence. The licence holder will have their own procedure covering such applications.

Box 1: Works permitted outside of standard construction hours

- any works which do not cause noise emissions to be more than 5dBA higher than the Rating Background Level (RBL) at any nearby residential property and/or other noise sensitive receivers
- out of hours work identified and assessed in the EIA or the approved out of hours work protocol (OOHWP)
- the delivery of plant, equipment and materials which is required outside these hours as requested by police or other authorities for safety reasons and with suitable notification to the community as agreed by the PMEM/Department of Planning & Environment (whichever is applicable)⁹
- emergency work to avoid loss of life, damage to external property, damage to utilities and infrastructure, prevent immediate harm to the environment, prevent contamination of land or damage to a heritage (indigenous or non-indigenous) item
- any other work as agreed by the SME/Department of Planning & Environment⁹ and considered essential to the Project, or as approved by EPA (where an EPL is in effect) subject to:
 - works which include high noise generating works including sheet piling, pile driving, rock hammering/breaking must be agreed to by the Principal Manager Environmental Management/Department of Planning & Environment (whichever is applicable) or as approved by EPA (where relevant to the issuing of a Licence)
 - notification of the community between 10 and 14 days prior to such activities being undertaken or other period as agreed to by the Director Community Engagement (or nominated delegate) or as approved by EPA (where relevant to the issuing of an Licence). The notification shall include likely times and duration of works

⁹ Depending on whether the project is determined by TfNSW- Infrastructure & Services or approved by the Minister for Planning & Environment.

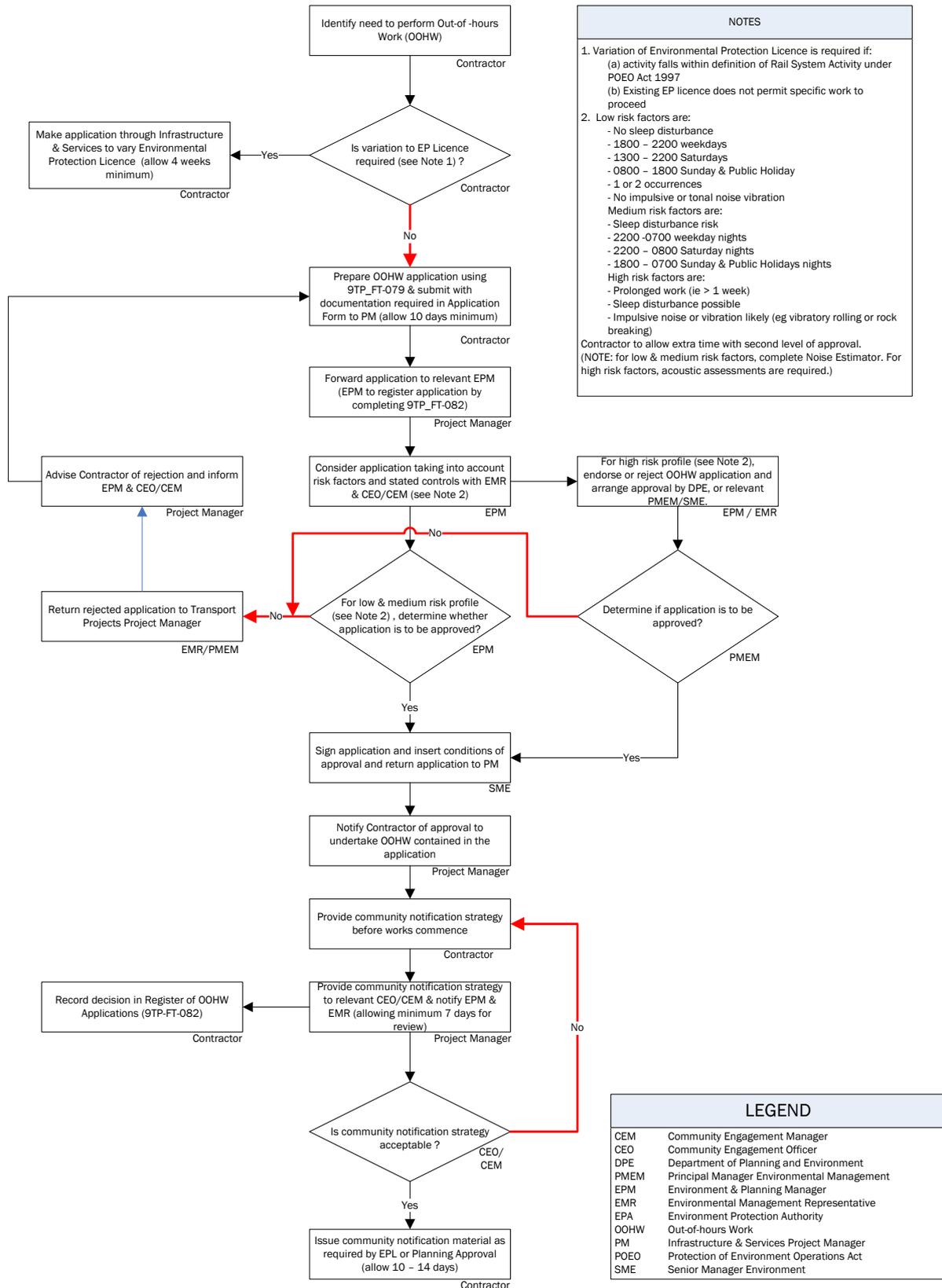


Figure 2: Out-of-hours work assessment and approval procedure

9. Exceedance of Construction Noise and Vibration Objectives

9.1. Approach

As part of the environmental impact assessment process (refer Section 3 and Appendix B), it is necessary to identify feasible and reasonable mitigation measures to minimise noise and vibration levels at the nearest receivers. In accordance with Section 4 of this Strategy, these measures are to be implemented as part of the standard mitigation measures (Table 1).

The implementation of the standard mitigation measures, compliance with maximum sound power levels for plant and equipment, construction hour management and standard community consultation measures in this Strategy should significantly reduce the noise and vibration impacts on nearby sensitive receivers.

Nevertheless, due to the highly variable nature of construction activities and the likelihood of work needing to be undertaken outside the standard construction hours on I&S projects, exceedances of a project's construction noise and vibration objectives are likely to occur.

Where there is a potential for a project's construction noise and vibration objectives to be exceeded, *additional* mitigation measures shall be implemented. These measures should be focused on engagement with affected sensitive receivers. Additional mitigation measures that may be applied are listed in Table 4 below. A full description of each measure is provided in Appendix C.

Table 4: Additional Mitigation Measures

Measure	Abbreviation
Alternative accommodation	AA
Monitoring	M
Individual briefings	IB
Letter box drops ¹⁰	LB
Project specific respite offer	RO
Phone calls	PC
Specific notifications	SN

9.2. Applying Additional Mitigation Measures

Where construction noise and vibration levels are still predicted¹¹ to exceed the noise or vibration objectives after the application of the standard mitigation measures the Additional Mitigation Measures Matrix (AMMM) (see Tables 5 – 7 below) shall be used to determine the additional measures and implement where reasonable and feasible.

Using the relevant AMMM, the following steps need to be carried out to determine the additional mitigation measures:

1. Determine the time period when the work will be undertaken

¹⁰ In certain circumstances, on a case by case basis, media advertising may also be used to supplement letter box drops where considered effective.

¹¹ In the CNIS or other acoustic assessment

2. Determine the level of exceedance
3. From the relevant AMMM table, identify the additional mitigation measures to be implemented where reasonable and feasible (using the abbreviation codes - expanded in Table 4).

Table 5: AMMM – Airborne construction noise

Time period		Mitigation measures			
		LAeq(15minute) noise level above background (RBL)			
		Qualitative assessment of noise levels ¹			
		0 to 10 dBA Noticeable	10 to 20 dBA Clearly audible	20 to 30 dBA Moderately intrusive	> 30 dBA Highly intrusive
Standard	Mon-Fri (7am - 6pm)	-	-	LB, M	LB, M
	Sat (8am - 1pm)				
	Sun/Pub Hol (Nil)				
OOHW Period 1	Mon-Fri (6pm - 10pm)	-	LB	M, LB	M, IB, LB, RO, PC, SN, RO ²
	Sat (7am-8am) & (1pm- 10pm)				
	Sun/Pub Hol (8am - 6pm)				
OOHW Period 2	Mon-Fri (10pm - 7am)	LB	M, LB, RO ²	M, IB, LB, PC, SN, RO ²	AA, M, IB, LB, PC, SN, RO
	Sat (10pm - 8am)				
	Sun/Pub Hol (6pm - 7am)				

Notes:

1. For some types of construction activities (refer Appendix B), a qualitative assessment of the potential noise impacts can be undertaken in lieu of detailed noise modelling. For these activities, noise mitigation measures should be evaluated on the basis of the noise levels being noticeable, clearly audible, moderately intrusive or highly intrusive. The qualitative assessment should consider the type of equipment being used, the character of the noise emissions, time of day, the location of the nearest receivers and the noise sensitivity of the nearest receivers. Where a qualitative assessment is being undertaken, this will need to be approved by the Environmental Management Representative.
2. Respite Offers identified in Period 2 for clearly audible (10 to 20dBA) and moderately intrusive (20 to 30dBA) work shall only apply if works are expected to continue for more than 3 consecutive evenings for Period 1 or more than 2 consecutive nights for Period 2.

Table 6: AMMM - Ground-borne construction noise

Time period		Mitigation measures		
		Predicted LAeq(15minute) noise level exceedance		
		Qualitative assessment of noise levels		
		0 to 10 dBA Clearly audible	10 to 20 dBA Moderately intrusive	> 20 dBA Highly intrusive
Standard	Mon-Fri (7am - 6pm)	LB	LB	M, LB, SN
	Sat (8am - 1pm)			
	Sun/Pub Hol (Nil)			
OOHW Period 1	Mon-Fri (6pm - 10pm)	LB	M, LB, RO, SN	M, IB, LB, PC, SN, RO
	Sat (7am-8am) & (1pm - 10pm)			
	Sun/Pub Hol (8am - 6pm)			
OOHW Period 2	Mon-Fri (10pm - 7am)	M, LB, SN,	AA, M, IB, LB, PC, RP, SN	AA, M, IB, LB, PC, RP, SN
	Sat (10pm - 8am)			
	Sun/Pub Hol (6pm - 7am)			

Table 7: AMMM - Ground-borne vibration

Time period		Mitigation measures
		Predicted vibration levels exceed maximum levels
Standard	Mon-Fri (7am - 6pm)	M, LB, RO
	Sat (8am - 1pm)	
	Sun/Pub Hol (Nil)	
OOHW Period 1	Mon-Fri (6pm - 10pm)	M, IB, LB, RO, PC, RO, SN
	Sat (7am-8am) & (1pm - 10pm)	
	Sun/Pub Hol (8am - 6pm)	
OOHW Period 2	Mon-Fri (10pm - 7am)	AA, M, IB, LB, PC, RO, SN
	Sat (10pm - 8am)	
	Sun/Pub Hol (6pm - 7am)	

9.3. Ground-borne Vibration

If the predicted ground-borne vibration levels exceed the cosmetic damage objectives in Appendix A, a different construction method with lower source vibration levels must be used where feasible and reasonable. Otherwise construction works should not proceed unless attended vibration measurements are undertaken at the commencement of the works to determine if there is risk of exceeding of the cosmetic damage objective, a permanent vibration monitoring system should be installed, to warn plant operators (for example via flashing light, audible alarm, SMS) when vibration levels are approaching the cosmetic damage objective.

10. Documentation

I&S shall maintain a record of all complaints received and the subsequent action taken, in accordance with the approval and licence conditions.

Contractors are to retain records of the following:

- Complaints records (i.e. time and nature of complaint)
- Complaints responses and close out actions
- Correspondence
- Monitoring results
- Mitigation measures
- Construction Environmental Management Plans and associated sub-plans

11. Related Documents and References

Related Documents and References

[Environmental Management System Manual - 1TP-ST-052](#)

[Rion NL-31 Sound Meter Calibration Procedure- 9TP-PR-015](#)

[Out-of-Hours Assessment – 3TP-PR-065](#)

[Out-of-Hours Work Application Form \(EPL Requirements\) - 9TP-FT-080](#)

[Out-of-Hours Work Application Form \(EPL Variation NOT Required\) - 9TP-FT-079](#)

www.transport.nsw.gov.au

NSW Department of Climate Change *Interim Construction Noise Guideline*, (July 2009) *Assessing Vibration - a technical guideline*, (OEH, 2006)

APPENDIX A: Overview of Construction Noise & Vibration Objectives

This appendix provides a brief overview of construction noise and vibration and its potential effects on people, buildings and their contents. It also provides guidance on how to establish construction noise and vibration objectives during the environmental assessment phase.

Construction airborne noise objectives

Where a quantitative noise assessment is to be undertaken, the construction airborne noise objectives are based on the EPA's *Interim Construction Noise Guideline* (2009).

The ICNG contains *noise management* levels for sensitive land uses including commercial and industrial receivers. These are provided in Table A1 and Table A2. At locations where the predicted construction noise levels exceed the noise management levels, the proponent should apply all feasible and reasonable work practices, document these within the environmental impact assessment and implement the proposed work practices as part of the standard mitigation measures (refer Table 1).

Where the predicted construction noise levels remain above the noise management levels after implementation of all feasible and reasonable work practices, the relevant Additional Mitigation Measures Matrix (AMMM) is to be implemented (refer Section 6), based on the predicted $L_{Aeq}(15\text{minute})$ noise levels. These are primarily aimed at pro-active engagement with affected sensitive receivers. When communicating with sensitive receivers impacted by the construction works, the guidelines in the "how to apply" column should be followed.

Table A1: Airborne noise objectives at residences using quantitative assessment

Time of Day	Noise Management Level $L_{Aeq}(15\text{minute})$	How to apply
Recommended standard hours: Monday to Friday 7.00 am to 6.00 pm Saturday 8.00 am to 1.00 pm	Noise affected RBL + 10 dBA	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq}(15\text{minute})$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to minimise noise. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details
No work on Sundays or public holidays	Highly noise affected 75 dBA	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the proponent should consider very carefully if there is any other feasible and reasonable way to reduce noise to below this level. If no quieter work method is feasible and reasonable, and the works proceed, the proponent should communicate with the impacted residents by clearly explaining the duration and noise level of the works, and by describing any respite periods that will be provided.

Time of Day	Noise Management Level L _{Aeq} (15minute)	How to apply
Outside recommended standard hours	Noise affected RBL + 5 dBA	<p>A strong justification would typically be required for works outside the recommended standard hours.</p> <p>The proponent should apply all feasible and reasonable work practices to meet the noise affected level.</p> <p>Where all feasible and reasonable practices have been applied and noise is more than 5 dBA above the noise affected level, the proponent should negotiate with the community.</p> <p>For guidance on negotiating agreements see Section 7.2.2 of the <i>Interim Construction Noise Guideline</i>.</p>

The LA₉₀ Rating Background Levels (RBL's) should be determined using the "tenth percentile method" described in the OEH's *NSW Industrial Noise Policy* during the relevant assessment periods (daytime, evening or night-time).

Table A2: Airborne noise objectives at sensitive land uses (other than residential) using quantitative assessment

Land Use	Management Level, L _{Aeq} (15minute) (Applies When Land Use is being Utilised)
Classrooms at schools and other educational institutions	Internal noise level 45 dBA
Hospital wards and operating theatres	Internal noise level 45 dBA
Places of Worship	Internal noise level 45 dBA
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dBA
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level 60 dBA
Community Centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS2107 for specific uses.

Due to the broad range of sensitivities that commercial or industrial land can have to noise from construction, the process of defining management levels is separated into three categories. The external noise levels should be assessed at the most-affected occupied point of the premises:

- industrial premises: external L_{Aeq}(15 minute) 75 dBA
- offices, retail outlets: external L_{Aeq}(15 minute) 70 dBA
- other businesses that may be very sensitive to noise, where the noise level is project specific as discussed below.

Examples of other noise-sensitive businesses are theatres and child care centres. The proponent should undertake a special investigation to determine suitable noise levels on a project-by-project basis; the recommended 'maximum' internal noise levels in AS 2107 *Acoustics – Recommended design sound levels and reverberation times for building interiors* may assist in determining relevant noise levels.

The proponent should assess construction noise levels for the project, and consult with occupants of commercial and industrial premises prior to lodging an application where required. During construction, the proponent should regularly update the occupants of the commercial and industrial premises regarding noise levels and hours of work.

Ground-borne noise

Construction ground-borne noise objectives are based on the EPA's *Interim Construction Noise Guideline* (2009).

Ground-borne construction noise is usually present on tunnelling projects when equipment such as tunnel boring machines, roadheaders, rockhammers and drilling rigs are operated underground. The ground-borne noise inside buildings initially propagates as ground-borne vibration, before entering the building, which causes floors, walls and ceilings to gently vibrate and hence radiate noise. Sometimes the vibration may be perceptible within the building. For some critical spaces such as recording studios and cinemas, which are designed to reduce airborne noise intrusion, an assessment of ground-borne construction noise for surface construction may also be required.

Ground-borne noise is usually not a significant disturbance to building occupants during daytime periods due to higher ambient levels which mask the audibility of ground-borne noise emissions. During night-time periods however, when ambient noise levels are often much lower, ground-borne noise is more prominent and may result in adverse comment from building occupants.

Table A3 provides a summary of the ground-borne construction noise objectives.

Table A3: Ground-borne noise objectives at residences

Time of Day	Ground-borne noise objectives LAeq(15minute)
Daytime 7.00 am to 6.00 pm	Human comfort vibration objectives only
Evening 6.00 pm to 10.00 pm	40 dBA - Internal
Night-time 10.00 pm to 7.00 am	35 dBA - Internal

Construction vibration objectives

The effects of vibration in buildings can be divided into three main categories; those in which the occupants or users of the building are inconvenienced or possibly disturbed, those where the building contents may be affected and those in which the integrity of the building or the structure itself may be prejudiced.

Human perception of vibration

Guidance in relation to acceptable vibration levels for human comfort is provided in EPA's *Assessing Vibration: a technical guideline* (February 2006). This document is based on the guidelines contained in BS 6472-1992.

The EPA guideline provides three assessment methods, depending on whether the vibration is continuous, impulsive or intermittent. The preferred and maximum values are provided in Table A2.

- **Continuous vibration** would normally be generated by fixed plant items such as generators, fans and the like where the vibration emissions continue uninterrupted (usually throughout the daytime or night-time period).
- **Impulsive vibration** would normally be generated by short duration (ie less than two second) events with no more than three occurrences in an assessment period. A typical example would be ground compaction by dropping a large mass. Higher levels are allowed for impulsive vibration, however if more than three impulsive vibration events occur during the assessment period, the more stringent intermittent objectives are applied.
- **Intermittent vibration** can be defined as interrupted periods of continuous vibration (eg vibratory rolling, heavy truck passbys or rockbreaking) or continuous periods of impulsive vibration (eg impact pile driving). Higher vibration levels are allowed for intermittent vibration compared with continuous vibration on the basis that the higher levels occur over a shorter time period. Hence, for intermittent vibration, human comfort vibration levels are assessed on the basis of the Vibration Dose Value, based on the level and the duration of the vibration events.

Table A4: Preferred and maximum vibration levels for human comfort

Location		Assessment period		Preferred values		Maximum values	
Continuous vibration				z axis	x and y axes	z axis	x and y axes
Critical areas	Day- or night-time	0.005 m/s ²	0.0036 m/s ²	0.010 m/s ²	0.0072 m/s ²		
Residences	Daytime	0.010 m/s ²	0.0071 m/s ²	0.020 m/s ²	0.014 m/s ²		
	Night-time	0.007 m/s ²	0.005 m/s ²	0.014 m/s ²	0.010 m/s ²		
Offices, schools, educational institutions and places of worship	Day- or night-time	0.020 m/s ²	0.014 m/s ²	0.040 m/s ²	0.028 m/s ²		
Workshops	Day- or night-time	0.040 m/s ²	0.029 m/s ²	0.080 m/s ²	0.058 m/s ²		
Impulsive vibration				z axis	x and y axes	z axis	x and y axes
Critical areas	Day- or night-time	0.005 m/s ²	0.0036 m/s ²	0.010 m/s ²	0.0072 m/s ²		
Residences	Daytime	0.30 m/s ²	0.21 m/s ²	0.60 m/s ²	0.42 m/s ²		
	Night-time	0.10 m/s ²	0.071 m/s ²	0.20 m/s ²	0.14 m/s ²		
Offices, schools, educational institutions and places of worship	Day- or night-time	0.64 m/s ²	0.46 m/s ²	1.28 m/s ²	0.92 m/s ²		
Workshops	Day- or night-time	0.64 m/s ²	0.46 m/s ²	1.28 m/s ²	0.92 m/s ²		
Intermittent vibration				x, y and z axes		x, y and z axes	
Critical Areas	Day- or night-time	0.10 m/s ^{1.75}		0.20 m/s ^{1.75}			
Residences	Daytime	0.20 m/s ^{1.75}		0.40 m/s ^{1.75}			
	Night-time	0.13 m/s ^{1.75}		0.26 m/s ^{1.75}			
Offices, schools, educational institutions and places of worship	Day- or night-time	0.40 m/s ^{1.75}		0.80 m/s ^{1.75}			
Workshops	Day- or night-time	0.80 m/s ^{1.75}		1.60 m/s ^{1.75}			

Notes: For continuous and intermittent vibration, the preferred and maximum values are weighted acceleration values (Wg for z axis and Wd for x and y axes).

For intermittent vibration, the preferred and maximum values are Vibration Dose Values (VDVs), based on the weighted acceleration values.

Effects on building contents

People can perceive floor vibration at levels well below those likely to cause damage to building contents or affect their operation. For most receivers, the controlling vibration criterion is therefore the human comfort criterion and separate objectives are not normally required in relation to the effect of construction vibration on building contents.

Some recording studios, high technology facilities and buildings with scientific equipment (eg electron microscopes and microelectronics manufacturing equipment) can require more stringent objectives than those applicable to human comfort. Where appropriate, objectives for the satisfactory operation of critical instruments or manufacturing processes should be sourced from manufacturer's data and/or other published objectives.

Effects of vibration on structures

The levels of vibration required to cause cosmetic damage to buildings tend to be at least an order of magnitude (10 times) higher than those at which people may consider the vibration to be intrusive.

In terms of the most recent relevant vibration damage objectives, Australian Standard AS 2187: Part 2-2006 *Explosives - Storage and Use - Part 2: Use of Explosives* recommends the frequency dependent guideline values and assessment methods given in BS 7385 Part 2-1993 *Evaluation and measurement for vibration in buildings Part 2* as they "are applicable to Australian conditions" BS7385.

The British Standard sets guide values for building vibration based on the lowest vibration levels above which damage has been credibly demonstrated. These levels are judged to give a minimum risk of vibration-induced damage, where minimal risk for a named effect is usually taken as a 95% probability of no effect.

The recommended limits (guide values) from BS7385 for transient vibration to ensure minimal risk of cosmetic damage to residential and industrial buildings are presented numerically in Table A5 and graphically in Figure A1.

Table A5: Transient vibration guide values - minimal risk of cosmetic damage

Line	Type of building	Peak component particle velocity in frequency range of predominant pulse	
		4 Hz to 15 Hz	15 Hz and above
1	Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
2	Unreinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

The standard states that the guide values in Table A5 relate predominantly to transient vibration which does not give rise to resonant responses in structures, and to low-rise buildings. Where the dynamic loading caused by continuous vibration is such as to give rise to dynamic magnification due to resonance, especially at the lower frequencies where lower guide values apply, then the guide values in Table A5 may need to be reduced by up to 50% (as shown by Line 3 of Figure A1 for Residential Buildings).

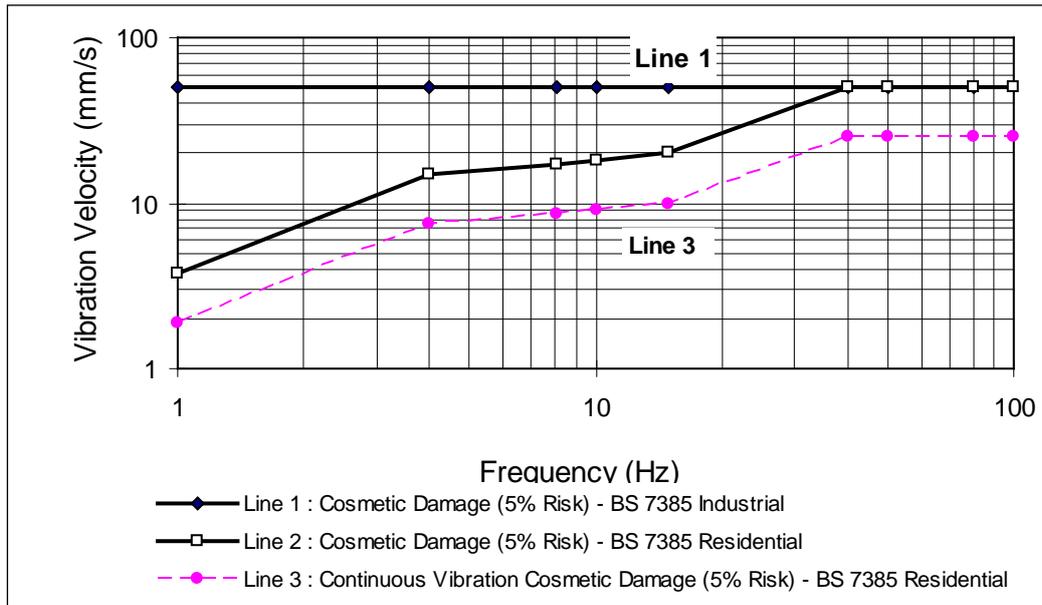


Figure A1: Graph of Transient Vibration Guide Values for Cosmetic Damage

In the lower frequency region where strains associated with a given vibration velocity magnitude are higher, the guide values for building types corresponding to Line 2 are reduced. Below a frequency of 4 Hz where a high displacement is associated with the relatively low peak component particle velocity value, a maximum displacement of 0.6 mm (zero to peak) is recommended. This displacement is equivalent to a vibration velocity of 3.7 mm/s at 1 Hz.

The standard goes on to state that minor damage is possible at vibration magnitudes which are greater than twice those given in Table A3 and major damage to a building structure may occur at values greater than four (4) times the tabulated values.

Fatigue considerations are also addressed in the standard and it is concluded that unless calculation indicates that the magnitude and number of load reversals is significant (in respect of the fatigue life of building materials) then the guide values in Table A5 should not be reduced for fatigue considerations.

It is noteworthy that, extra to the guide values nominated in Table A5, the standard states that:

“Some data suggests that the probability of damage tends towards zero at 12.5 mm/s peak component particle velocity. This is not inconsistent with an extensive review of the case history information available in the UK.”

Also that:

“A building of historical value should not (unless it is structurally unsound) be assumed to be more sensitive.”

Construction-related traffic noise goals

On the roads immediately adjacent to construction sites, the community may associate heavy vehicle movements with the project. Once the heavy vehicles move further from construction sites onto major collector or arterial roads however, the noise may be perceived as part of the general road traffic.

In most situations, it may be sufficient to undertake a qualitative assessment of the potential noise impacts associated with heavy vehicle movements. This assessment should take into consideration the number of heavy vehicle movements per hour or shift, the proximity of sensitive receivers, the duration of the construction works and the time of day. Where a qualitative assessment is being undertaken, this will need to be approved by the Environmental Management Representative.

If a quantitative assessment is required, construction-related traffic noise goals should be based on the guidance contained in the Office of Heritage and Environment's *Environmental Criteria for Road Traffic Noise* (ECRTN). If the heavy vehicle movements occur during the 10pm to 7am night-time period, guidance on the potential for sleep disturbance is contained in the *Application Notes to the NSW Industrial Noise Policy*¹².

¹² <http://www.environment.nsw.gov.au/noise/applicnotesindustnoise.htm>

APPENDIX B: Guidelines for Assessing Noise & Vibration Impacts (including CNIS)

Whenever construction works are proposed as part of a project, a prediction and assessment of the airborne noise, ground-borne noise and ground-borne vibration levels is required to determine the potential impacts on nearby receivers. The determination of the mitigation measures required will depend on the level of impact, the duration of the works and the time at which the noise or vibration activity occurs.

The intention is to minimise the level of site noise and vibration and inconvenience to affected receivers while having regard to the feasibility and reasonableness of any proposed control or mitigation measures.

Type of assessment

The level of detail for a construction assessment will vary depending on the scale of the works and the likely noise and vibration impacts.

For some small projects, involving low-powered plant where sensitive receivers are not located in close proximity to the works, it may be sufficient to undertake a qualitative assessment of the potential noise and vibration impacts. The OEH's *Interim Construction Noise Guideline* indicates that short-term means that the works are not likely to affect an individual or sensitive land use for more than three weeks in total.

For larger projects, involving many plant items and extended periods of construction adjacent to sensitive receivers, a quantitative assessment of the potential noise and vibration impacts is required (although some activities or work stages may still require only a qualitative assessment).

The construction of a chain wire safety fence as part of preparatory works during the daytime or evening period, for example, may require only a qualitative assessment of the potential noise impacts. However, the construction of a new bridge out of hours over a period of 4-weeks would require a quantitative assessment of the potential noise and vibration impacts.

Where a qualitative assessment is being undertaken, this will need to be approved by the Environmental Management Representative.

The noise and vibration impact assessments should be undertaken in accordance with the guidance provided in this Strategy and the relevant Environment Protection Licence conditions.

Qualitative assessment procedure

For qualitative construction assessments, the following minimum requirements would need to be included as part of the assessment report:

- Justification for undertaking a qualitative assessment including endorsement by Environmental Management Representative;
- Duration of the construction works and time periods over which works will be undertaken;
- Equipment expected to be used (during noisiest operations);

- Identification and description of nearest sensitive receivers potentially impacted by the proposed construction works;
- List of standard mitigation measures that will be employed to minimise the potential noise impacts (including management measures, source controls and path controls);
- Discussion of the Qualitative Assessment with reference to the relevant Additional Mitigation Measures Matrix (AMMM) in Tables 5-7;
- List of additional mitigation measures that will be employed to minimise the potential impacts (including monitoring and management measures); and
- Documented complaints management process including a strategy for identifying any additional mitigation measures that may be required.

Quantitative assessment procedure

Quantitative construction assessments are performed by comparing the predicted noise and vibration levels with the appropriate objectives for the receiver types and time of day.

Quantitative assessment reports will need to address the same minimum requirements as per the qualitative assessment procedure above, plus detailed information in relation to the source noise levels, the determination of appropriate noise and vibration objectives, relevant construction scenarios and predicted noise and vibration levels.

The quantitative assessment procedure steps are as follows:

Step 1: Determine noise and vibration objectives

The relevant noise and vibration objectives for the nearest sensitive receivers that may be potentially impacted by the construction works should be determined with reference to Appendix A.

Step 2: Assess construction scenarios

Identify a representative range of construction scenarios.

If the assessment is being carried out for the environmental impact assessment documentation (eg REF) it will be based on a concept design and construction scenarios for the project (usually prepared by a technical advisor and/or planning consultant).

If the assessment is being undertaken prior to construction (eg CNIS) it will be based on a more detailed design and actual construction scenario (usually prepared by the design and/or construction contractors).

The assessment should be conservative and sufficiently detailed to identify any project specific noise or vibration mitigation measures (including, but not limited to: physical structures such as construction noise barriers, acoustic sheds, dwelling treatment, acoustic barriers around noisy plant, operational noise barriers erected early or special construction methods such as penetrating cone fracture or controlled blasting in place of conventional rock breaking) that are both necessary to meet the construction noise or vibration objectives and feasible and reasonable to implement.

In determining feasible and reasonable mitigation measures, proponents are directed to the OEH's *Interim Construction Noise Guideline* which provides several worked examples on how construction noise can be minimised at sensitive receivers (particularly section 6 and Appendix A). Proponents are also directed to Appendix C and Appendix D of Australian

Standard 2436 *Guide to noise and vibration control on construction, demolition and maintenance sites.*

In predicting the level of noise or vibration at nearby sensitive receivers, the assessment (whether based on concept or detailed design) must include the implementation of all relevant mitigation measures in Table 1.

Step 3: Predicting noise and/or vibration impacts

For airborne construction noise

1. Determine the source noise levels (SWLs) of each plant item proposed as part of the construction scenario. Note that the noise levels (SWLs) of each plant or equipment item should be less than the maximum allowable levels in Table 2. If the noise from a particular plant item is tonal or impulsive in nature, a 5 dBA penalty should be added to the noise source level.
2. Determine the location of each plant or equipment item in relation to each receiver.
3. Include the effects of all *project specific* (see above) mitigation measures.
4. Include the effects of all relevant *standard* mitigation measures.
5. Include the effects of noise shielding provided by site offices, noise barriers or natural topographic features.
6. Include the effects of noise reflections and ground attenuation.
7. On the basis of the duration of each activity (over a typical “worst-case” 15-minute period), determine whether any correction between the L_{Amax} and L_{Aeq} (15minute) is required.
8. Calculate the L_{Aeq} (15minute) noise levels from the proposed construction activities at each receiver and compare these with the airborne construction noise objectives.
9. For night-time activities, calculate the maximum (L_{Amax}) noise levels and compare with the OEH’s RBL plus 15 dBA sleep disturbance screening criterion (refer *Application Notes to the NSW Industrial Noise Policy*). Factors that may be important in assessing the extent of impact on sleep include how often high noise events occur at night, the predicted maximum noise levels at night, whether there are times when there is a clear change in the noise environment (such as during early morning shoulder periods), and the degree of maximum noise levels above the background noise level at night.

Notes

The number of receivers would be dependent on the size of the construction site, the time at which the construction noise occurs and the level of potential noise impact. Calculations would normally be undertaken at locations considered to be representative of a group of receivers with a similar level of exposure to the construction works.

For night-time construction works or large construction sites with many nearby receivers, it may be more appropriate to provide noise contour plots in order to illustrate the degree to which each receiver or group of receivers are impacted by the construction works.

For ground-borne construction noise

10. Determine the location of each plant or equipment item in relation to each receiver.
11. On the basis of ground-borne noise levels versus distance prediction curves for each plant item, determine the level of ground-borne noise at each building location. For highly sensitive building occupancies, the assessment may need to incorporate the acoustic properties of the building space and the structural response of the building.
12. Include the effect of all relevant *standard* mitigation measures as part of the construction scenario.
13. Calculate the L_{Aeq} (15minute) noise levels from the proposed construction activities at each receiver and compare these with the ground-borne construction noise objectives.

For ground-borne construction vibration

14. Determine the location of each plant or equipment item in relation to each receiver.
15. On the basis of ground-borne vibration levels versus distance prediction curves for each plant item, determine the level of ground-borne vibration at each building location. For highly sensitive equipment, the assessment may need to incorporate the structural response of the building and particular sensitivities of the equipment.
16. Incorporate all relevant *standard* mitigation measures as part of the construction scenario.
17. Calculate the continuous, intermittent and impulsive vibration levels from the proposed construction activities at each receiver and compare these with the ground-borne construction vibration objectives.

Step 4: Determining *additional* mitigation measures required

18. Consult the relevant Additional Mitigation Measures Matrix (AMMM) in Tables 5-7 to determine, based on the level of exceedance of the background noise or groundborne noise or vibration level, the *additional* mitigation measures to be implemented.

APPENDIX C: Standard and Additional Mitigation Measures

Periodic notification (monthly letterbox drop or advertisement in local papers)

For each I&S project, a newsletter entitled 'Project Update' or 'Construction Update' is produced and distributed to the local community via letterbox drop and the project mailing list or the same information is advertised in the local paper and distributed to the project mailing list. These provide an overview of current and upcoming works across the project and other topics of interest. The objective is to engage, inform and provide project-specific messages. Advanced warning of potential disruptions (eg. traffic changes or noisy works) can assist in reducing the impact on the community. The approval conditions for projects specify requirements for notification to the community about works that may impact on them.

Content and length is determined on a project-by-project basis. Most projects distribute notifications on a monthly basis. Each newsletter or ad is graphically designed within a branded template.

Website

The TfNSW website (www.transport.nsw.gov.au/projects) is a key resource for members of the community to seek further information on projects, noise and vibration management plans, current and upcoming construction activities. It serves to inform on a 24-hour basis and provides a constant and additional layer of information over-and-above the periodic notifications.

The website is reviewed and updated on a monthly basis or in line with construction works.

As the website is a public forum, all information to be uploaded is approved by Transport Projects Principal Manager Community Engagement. The aim is to provide a visually appealing, easy-to-navigate tool for members of the public. Information is provided in plain English with use of illustrative graphics and photos and a minimum of jargon.

Project Infoline and Construction Response Line

The Construction Response Line and Project Infoline are mandatory on all I&S projects to provide a contact point for interested stakeholders. Transport Projects has established two 24 hour free-call telephone numbers:

Construction Response Line, 1800 775 465 – providing a dedicated 24 hour contact point for any complaints regarding construction works.

Project Infoline, 1800 684 490 – providing a dedicated contact point for any project enquiries.

These lines are managed via a professional answering service and are the key mechanism for the receipt of enquiries/complaints to Transport Projects for all projects. These numbers are listed with Telstra and are advertised in all project-related communications materials.

All complaints require a verbal response within 2 hours. All enquiries require a verbal response within 24 hours during standard construction hours, or on the next working day during out of hours work (unless the enquirer agrees otherwise).

The answering service immediately directs any complaints to an on-duty Transport Projects representative via a pager system. Communications team members are scheduled on the pager roster and are on-call 24-hours per day during this period. This ensures that complaints are managed by experienced personnel to facilitate swift resolution.

Email distribution list

Email distribution lists are used on all I&S projects to disseminate project information to interested stakeholders. Advanced warning of audible activities can assist to reduce the impact of projects experienced by the community.

Transport Projects and its contractors maintain mailing lists of stakeholders interested in receiving project information via email.

Signage

Signage is used on all I&S projects to disseminate project information. Signage is provided at each I&S project to notify stakeholders of project details and project emergency and enquiry contact information. Where possible and when appropriate, the full community notification, detailing likely audible construction noise will be on display at the work site.

Specific notifications (SN)

Specific notifications are letterbox dropped or hand distributed to identified stakeholders no later than seven days ahead of construction activities that are likely to exceed the noise objectives. The exact conditions under which specific notifications would proceed are defined in the relevant Additional Mitigation Measures Matrix (Tables 5-7). This form of communication is used to support periodic notifications, or to advertise unscheduled works.

Phone calls (PC)

Phone calls detailing relevant information would be made to identified/affected stakeholders within seven days of proposed work. Phone calls provide affected stakeholders with personalised contact and tailored advice, with the opportunity to provide comments on the proposed work and specific needs etc.

Individual briefings (IB)

Individual briefings are used to inform stakeholders about the impacts of high noise activities and mitigation measures that will be implemented. Communications representatives from the contractor would visit identified stakeholders at least 48 hours ahead of potentially disturbing construction activities. Individual briefings provide affected stakeholders with personalised contact and tailored advice, with the opportunity to comment on the project.

Project specific respite offer (RO)

Residents subjected to lengthy periods of noise or vibration may be eligible for a project specific respite offer. The purpose of such an offer is to provide residents with respite from an ongoing impact. The offer could comprise pre-purchased movie tickets or similar offer. This measure is determined on a project-by-project basis, and may not be applicable to all I&S projects.

Alternative accommodation (AA)

Alternative accommodation options should be provided for residents living in close proximity to construction works that are likely to incur noise levels significantly above the applicable level (Tables 5-7). The value of the offer will be determined on a project-by-project basis.