ENGINE BRAKE NOISE
FINAL PROPOSAL AND
REGULATORY IMPACT
STATEMENT

August 2007

Prepared by
National Transport Commission
National Transport Commission

Engine Brake Noise – Final Proposal and Regulatory Impact Statement

Report Prepared by: National Transport Commission

ISBN: 1 921168 73 0
REPORT OUTLINE

Date: August 2007
ISBN: 1 921168 73 0
Title: Engine Brake Noise – Final Proposal and Regulatory Impact Statement
Address: National Transport Commission
Level 15/628 Bourke Street
MELBOURNE VIC 3000
E-mail: ntc@ntc.gov.au
Website: www.ntc.gov.au

Type of report: Final Proposal and Regulatory Impact Statement
Objectives: To provide an analysis of the engine brake noise regulation.

NTC Programs: Environment


Abstract: This final regulatory impact statement outlines the benefits and costs of adopting a proposal to address engine brake noise. The document discusses background information on the problem of noisy engine brakes, the research undertaken into engine brake noise, and safety and operational considerations in the use of engine brakes. Alternatives to the proposal for reducing the impact of engine brake noise are also presented.

Key words: Engine brake noise, modulation, muffler, noise.
FOREWORD

The National Transport Commission (NTC) is a body established under an inter-governmental agreement with a charter to develop, monitor, and maintain uniform or nationally consistent regulatory and operational reforms relating to road transport, rail transport, and inter-modal transport. The NTC is funded jointly by the Australian Government, States and Territories.

Noise from engine brakes is the greatest source of community complaint against the heavy vehicle industry. This noise problem has the potential to restrict access to roads by heavy vehicle because of demands for curfews and other restrictions from affected populations.

The NTC has been asked to address the situation and has undertaken research to determine the feasibility of a regulatory solution to noise from engine brakes. The NTC has worked with transport agencies, environment agencies and truck manufacturers to propose a solution which represents a breakthrough for the control of noise from engine brakes. Extensive research underpins the proposal. The NTC has investigated a number of ways to control this noise without introducing unfair restrictions on industry or creating a safety issue.


The development of this proposal has been done in partnership with the Department for Transport, Energy and Infrastructure South Australia, the Roads and Traffic Authority New South Wales and VicRoads. I thank these organisations for their support.

The NTC acknowledges the work of Tim Eaton and Neil Wong as the major contributors to this report.

Michael Deegan
Chairman
SUMMARY

Excessive noise from engine brakes is a major source of complaint from the community. This has been the case both in Australia and North America. A limiting factor in addressing this problem has been the lack of data on the cause of the annoyance factor from engine braking.

The National Transport Commission (NTC), in partnership with several transport/road agencies, has undertaken an extensive research program to fill these knowledge gaps and to provide a robust, scientific foundation for the development of actions to address the annoyance from engine brake noise. This research included:

- identifying what is it about engine brake noise that makes it so annoying to the community. This work found the pulsing effect, or modulation, of the noise from engine brakes is the primary cause of this annoyance;

- identifying a suitable noise descriptor for engine brake noise that correlates well with community annoyance. This work included community panel testing. The research concluded that a specific noise descriptor, called modulated Root Mean Square, was best at relating the noise to annoyance;

- roadside testing. Over 24,000 events of roadside noise from heavy vehicles were recorded and analysed. This work found that up to two per cent of heavy vehicles are responsible for modulation that, from the panel testing, the community would find ‘very much’ annoying;

- muffler trials found that current mufflers have variable performance against modulated Root Mean Square;

- an independent analysis of the potential safety impacts, undertaken by a braking expert; and

- an independent analysis of the costs and benefits of the proposal.

This research was used to develop a proposed in-service standard that has a modulated Root Mean Square value of three. Up to two per cent of the heavy vehicle fleet would currently not meet this standard, however, fitting new mufflers that reduced modulation would fix the problem. The NTC anticipates that if this standard is approved, that the muffler industry will respond with more products that will all meet the standard.

Engine brakes are an important safety device. Critically, introducing the proposed standard will have no safety implications, as it does not prevent engine brake use. The standard merely ensures that the noise from engine brakes meets a reasonable level. The proposal can also control engine brake noise without introducing road-network restrictions on industry.

The in-service standard was one of a number of options that was considered for addressing engine brake noise. Other options included both non-regulatory and regulatory approaches. The NTC rejects the non-regulatory options because they have not fixed the problem of engine brake noise to date. From the range of possible regulatory options, two were selected for further analysis; setting a general standard for modulation for engine brakes, and setting a lower standard for modulation that can be applied at jurisdiction
discretion along noise-sensitive routes. The report also discusses the economic impacts of these options.

The NTC’s preferred option is setting a general standard for modulation for engine brakes because it will reduce the impact of noise from engine brakes on the community without compromising safety. The preferred option will address noise for engine brakes in a cost effective way. It allows operators to continue to use engine brakes. For administrative simplicity, the proposed penalty for exceeding the standard is a fine.

The NTC proposes to review the in-service standard within five years of implementation. This review should focus on how effective the in-service standard has been in addressing community annoyance.

The NTC recognises that the proposed standard will not address all community annoyance from engine brake noise because of the subjective nature of noise. However, the NTC believes that the general standard for engine brake noise will address the noise which causes ‘very much’ annoying and ‘extremely’ annoying reactions, and is a major step in fixing the current problem.
# CONTENTS

1. **INTRODUCTION** ....................................................................................................1  
   1.1 Background .............................................................................................................1  
   1.2 Engine Brakes Explained ......................................................................................1  
   1.3 Statement of the Problem ....................................................................................2  
   1.4 Objective of Regulation ......................................................................................4  

2. **BACKGROUND RESEARCH** ................................................................................4  
   2.1 Research Program ..................................................................................................4  
   2.2 Identifying a Noise Descriptor for Noise from Engine Brakes ..............................4  
   2.3 Roadside Testing ...................................................................................................8  
   2.4 Performance of Retrofitted Mufflers ....................................................................12  
   2.5 Safety and Operational Considerations in the Use of Engine Brakes .................14  
   2.6 Setting an In-service Standard for Noise from Engine Brakes ............................15  

3. **PROPOSAL AND ALTERNATIVES CONSIDERED** .........................................16  
   3.1 Options Considered ..............................................................................................16  
   3.2 Regulatory Options ...............................................................................................18  

4. **ANALYSIS OF OPTIONS** ....................................................................................21  
   4.1 Option 1 - Maintain the Status Quo .....................................................................21  
   4.2 Option 2 – A General In-service Standard for Noise from Engine Brakes ..........21  
   4.3 Option 3 – A Lower In-service Standard for Specific Noise-sensitive Routes .........22  
   4.4 Option 4 – A General In-service Engine Brake Noise Standard and a Lower In-service Standard for Specific Noise-sensitive Routes ........................................23  
   4.5 Discussion of Options ..........................................................................................25  

5. **CONSULTATION** ................................................................................................26  
   5.1 Public Consultation during the Review of the Noise Related Australian Design Rules ..........................................................26  
   5.2 Public Consultation on the Draft Proposal and Regulatory Impact Statement Released in June 2006 .................................................................26  
   5.3 Release of Research Reports ................................................................................27  

6. **CONCLUSION AND RECOMMENDED OPTION** .............................................27  
   6.1 Preferred Option ....................................................................................................27  
   6.2 Discussion of Preferred Option .............................................................................27  

7. **IMPLEMENTATION** .............................................................................................28  

8. **REFERENCES** ......................................................................................................29  

APPENDIX A – PROPOSED MODEL LAWS IN RELATION TO THE IN-SERVICE ENGINE BRAKE NOISE STANDARD .................................................................31  

APPENDIX B – THE IN-SERVICE ALGORITHM FOR NOISE FROM ENGINE BRAKES ...................................................................................................................33  

APPENDIX C — SUMMARY OF STAKEHOLDER COMMENTS RECEIVED ON THE DRAFT PROPOSAL AND DRAFT REGULATORY IMPACT STATEMENT RELEASED IN JUNE 2006 ..........35  

APPENDIX D — ENFORCEMENT COSTS FOR OPTION 2 ........................................41
LIST OF TABLES

Table 1. Pacific Highway Data .................................................................10
Table 2. Mt Ousley Data ........................................................................11
Table 3. Monash Freeway Data ..............................................................11
Table 4. Ranges of Heavy Vehicles that Exceed a Modulated Root Mean
         Square Value ..................................................................................12
Table 5. Summary of the Costs and Benefits ..........................................24
Table 6. Stakeholders that made Submissions on the Draft
         Proposal/Regulatory Impact Statement released in June 2006 .......38

LIST OF FIGURES

Figure 1. Noise Graph from Engine Brakes with Minimal Modulation (Root
          Mean Square = 1.74) ........................................................................6
Figure 2. Noise Graph from Engine Brakes with Defined Modulation (Root
          Mean Square = 4.73) ........................................................................6
Figure 3. Correlation of Modulated Root Mean Square with Subjective
          Annoyance from the Panel Testing ....................................................7
Figure 4. Subjective Annoyance with Root Mean Square Values .............8
Figure 5. Pacific Highway Data ...............................................................9
Figure 6. Mt Ousley Data ........................................................................10
Figure 7. Monash Freeway Data .............................................................11
Figure 8. Average Modulated Root Mean Square for Exhaust Systems Trial ..13
1. INTRODUCTION

1.1 Background

The National Transport Commission (NTC) undertook a review of noise issues from Australian vehicles on behalf of the Land Transport Environment Committee. As a result of NTC research, a new Australian Design Rule, ADR 83/00, was gazetted in March 2003. This new standard introduced stringent noise limits for all new vehicles sold in Australia, making the Australian standards largely consistent with international standards. From 1 January 2005, new cars are three decibels quieter than previous standards, while new trucks and buses are between four to seven decibels quieter than previous standards.

However, the new Australian Design Rule does not address noise from engine brakes on heavy vehicles. Excessive noise from engine brakes generates many community complaints, but is largely unregulated. This has been the case both in Australia and overseas due to insufficient information about why noise from engine brakes is annoying.

The NTC has undertaken an extensive research program to fill these knowledge gaps and to provide a robust, scientific foundation for the development of actions to tackle noisy engine brakes. This research has been used to develop a proposal that aims to reduce the impact of noise from engine brakes has on the community.

A draft report with the proposal and regulatory impact statement was released for public consultation in June 2006, with a two month period for submissions. The NTC has prepared this final report which will be submitted to the Australian Transport Council for voting.

1.2 Engine Brakes Explained

An engine brake is a device fitted to the engine of a heavy vehicle to help slow the vehicle down. Engine brakes are often referred to as ‘auxiliary braking devices’ or ‘secondary retarders’. They are generally not capable of stopping the vehicle, but can very effectively slow the vehicle, even on a steep descent. Engine brakes are not the only form of secondary retarder. Others include:

- exhaust brakes – these typically comprise a ‘butterfly valve’ in the exhaust system which momentarily prevent exhaust gases escaping, thereby retarding the engine. They are commonly fitted to light and medium size trucks;
- hydraulic retarders – these typically rely on oil pressure to slow the movement of the drive shaft. They are often fitted to articulated vehicles but are sometimes criticised for adding weight to the vehicle; and
- electromagnetic retarders – these are less common in Australia. They establish a magnetic field around the drive shaft to slow the rotation of the shaft. The copper windings, needed to establish the magnetic field, can add weight to the vehicle.

There are other forms of secondary retarder such as regenerative brakes, where the energy from braking is captured as electrical energy or hydraulic pressure. These brakes have the added advantage of enabling the energy to be re-used on acceleration, thereby reducing fuel use and greenhouse gases. While several major companies are investing in the development of these brakes, they are not currently readily available or regularly used in Australia or elsewhere. It is anticipated that regenerative brakes will become more common over the next decade.
Secondary retarders are not required by any regulation. Most heavy vehicle manufacturers fit such devices to assist in slowing the vehicle without relying on the service brakes. Service brakes of a particular standard are required by the Australian Design Rules and in-service standards. The use of secondary retarders saves wear on service brakes reducing vehicle maintenance costs. There is generally little or no wear associated with use of a secondary retarder, making them a cheap and efficient braking device.

Most forms of braking devices emit some form of noise. There is sometimes a ‘squeal’ associated with the use of service brakes, a ‘rumble’ associated with an exhaust brake and a ‘whine’ with a hydraulic retarder. These noises are often well known to people in the heavy vehicle industry but are rarely a source of community complaint, even when the muffler becomes degraded.

However engine brakes, particularly valve actuated engine brakes commonly used on North American vehicles, are often associated with a characteristic ‘bark’ or ‘crackle’. This distinctive noise is often the source of community complaints and has led to government action, such as signage discouraging the use of engine brakes, in populated areas.

### Key Points

- A range of secondary retadters are available.
- Secondary retarders are not required by law, but are prevalent in the marketplace because they save costs on service brakes.
- Engine brakes are a common secondary retarder on Australian vehicles.
- Noise from engine brakes cause most community complaints about the noise from heavy vehicles.

#### 1.3 Statement of the Problem

Excessive noise from engine brakes has been a community concern for more than a decade. Transport authorities view it as a growing problem that has the potential to adversely affect the movement of goods around the country because communities are demanding that road access to heavy vehicle be restricted due to excessive noise. The problem is being compounded by a range of factors including:

- strong growth in the projected freight task;
- strong growth in the articulated vehicle fleet;
- a desire in the truck industry for greater power in heavy vehicles; and
- population growth combined with limited road infrastructure development, leading to greater numbers of people living in affected areas.

Importantly, the problem is not one solely for people living on main roads in cities. Complaint registers indicate noise from engine brakes affects both urban and rural populations, and people living a considerable distance from main roads.

The desire to resolve the problem has come from ministers, transport agencies, environment agencies, concerned community groups and the truck industry itself. In particular:

- the Australian Transport Council, a council consisting of all transport ministers in Australia, endorsed a National Road Transport Commission (NRTC, the precursor organisation to NTC) reform package that included the issue of noise from engine brakes;
- the Transport Agency Chief Executives (TACE), an advisory group to NTC, supports a national regulatory approach to the problem;
- several community groups have formed to demand ministerial action on truck access to particular roads, due in part to noise from engine brakes; and
- truck manufacturers have assisted with this technical solution because they recognise it is a major community concern and has the potential to limit growth in the industry.

The engine brake remains the favoured form of secondary retarder for heavy vehicles in Australia because it is lightweight, effective and inexpensive. It also reduces wear on normal brake components, thus adding an economic incentive for its use. It is therefore unlikely that other forms of secondary retarder will replace the engine brake in the short term. The company that manufactures most of the engine brakes currently in use in Australia sees the noise problem as a muffler problem, not a problem from the design of the engine brake.¹

The popular brand of engine brake operates by altering the valve sequencing so that the engine is effectively working as a compressor. As each piston reaches ‘top dead centre’ with valves closed, one valve opens, allowing compressed air to be vented at very high speed.² This creates a ‘pulsing’ noise which, on a typical six cylinder truck engine operating around 1500 revolutions per minute, causes the characteristic ‘bark’. Engine brakes can often be switched on or off by the driver, and become engaged when the device is switched on and the acceleration pedal is released.

Not all vehicles fitted with engine brakes produce excessive noise. Heavy vehicles fitted with engine brakes with good muffler systems produce minimal noise impacts on the community. The owners of heavy vehicles with excessive noise from engine brakes externalise the cost of reducing wear and maintenance of the service brakes onto the community in the form of noise.

Existing measures to limit truck noise do not address the noise from engine brakes. The Australian Design Rules and in-service regulations that limit vehicle noise focus on engine noise from a stationary or accelerating vehicle. Therefore, these standards are incapable of addressing noise from engine brakes, which is only audible on deceleration.

Critically, there is no internationally accepted measure of noise from engine brakes. The characteristic ‘bark’ of an engine brake is the source of most complaints. However, the standard A-weighted decibel scale measures volume or loudness, and does not capture the pulses or variation from engine brake noise that makes it annoying. In order to solve the problem of this noise, it is important to understand what it is, and how best to measure the annoyance it causes. Section 2 describes the research program that examined this. This research program resulted in a proposed in-service standard for noise from engine brakes.

¹ Refer www.jake-brake.com
² Refer www.jakebrake.com.au
Key Points

- Noise from engine brakes is recognised by government and industry as a major source of community dissatisfaction.
- Despite current measures to address noise from heavy vehicles, noise from engine brakes is not expected to improve in the near future.
- There is no internationally accepted measure for annoyance caused by engine brakes.
- Gaps in knowledge about what is so annoying about noise from engine brakes have hampered regulatory solutions.
- Operators with trucks with noisy engine brakes externalise the economic cost of reducing wear and maintenance of service brakes onto the community in the form of noise.

1.4 Objective of Regulation

The objective of the regulation is to reduce or eliminate noise from engine brakes and its effect on the community.

2. BACKGROUND RESEARCH

2.1 Research Program

Although noise from engine brakes is a problem in a number of countries, there has been no significant or effective action taken.

Complaints about noise from engine brakes are usually about the ‘bark’ of the noise rather than the overall volume. Given the lack of scientific data on exactly what makes this noise annoying, the NTC has focussed its research to identify and define the factors in noise from engine brakes that cause annoyance. This should lead to a noise descriptor that relates noise from engine brakes with community annoyance.

Once a suitable noise descriptor is found, additional information about the current levels of engine brake noise and the performance of mufflers will lead to the development of a standard for noise from engine brakes.

Because of the potential safety concerns raised by some stakeholders, the safety and operation factors with the use of engine brakes were also explored a part of the research program.

2.2 Identifying a Noise Descriptor for Noise from Engine Brakes

A comprehensive research program was undertaken to identify a noise descriptor that correlates annoyance with noise from engine brakes. This research program is described below.

In 2003, NTC commissioned Sonus Pty Ltd to investigate a suitable noise descriptor that could be used to detect noisy engine brakes by a roadside test. Sonus found there are few reports in the literature that go beyond using a traditional maximum noise level to describe noise from engine brakes. Sonus also discovered that the modulation of engine brake noise was the cause of annoyance, therefore an assessment of the modulation characteristics of the waveform was necessary.
This approach was supported by previous Australian studies (Vipac 1981, 1991). These studies concluded:

- the volume of the noise from engine brakes did not correlate well with annoyance; and
- the annoyance due to engine brakes was the result of a change in the spectral characteristic of the noise emission rather than due to an increase in the overall A-weighted peak noise level.

In another study, Fidell and Horonjeff (1981) conducted psycho-acoustic experiments in which people judged the relative annoyance of noise recordings of engine brakes. Among the authors’ conclusions were:

- effective mufflers can reduce the impulsive effect of engine brake noise; and
- a correction (to the maximum A-weighted sound pressure level) based on crest factor (peak root mean square (Root Mean Square) ratios) greatly reduced the variability of annoyance judgements of engine brake noise.

Sonus also recorded about 600 events of noise from engine brakes. This database of measurements was used to identify good noise descriptors that relate to the annoyance of the noise. From the investigations, Sonus recommended a Rise and Fall criterion for the identification of excessive noise from engine brakes within a traffic stream. The Rise and Fall criterion specified that the noise should not exceed a minimum of five modulations of 7 dBA over a 0.5 second period with each modulation exceeding 80 dBA.

Building on this initial work by Sonus, the NTC engaged Acoustic Technologies Pty Ltd to conduct further work to identify suitable noise descriptors. Acoustic Technologies work included examining whether the noise descriptor could be readily adopted into a roadside test using existing instrumentation and certification procedures. This work was undertaken during 2004.

Acoustic Technologies evaluated 96 recordings against the Sonus Rise and Fall method as well as a range of other noise descriptors, including modulated Root Mean Square, tonal, and harmonic. They concluded that modulated Root Mean Square was best noise descriptor at distinguishing the level of annoyance. The modulated Root Mean Square algorithm also has other advantages in terms of repeatability, certification and the availability of software and instruments.3

Two plots of engine brake noise are presented in Figure 1 and Figure 2. The level of ‘scatter’ with the Figure 2 represents the modulation and is proportional to the amount of annoyance it causes.

---

At this stage, modulated Root Mean Square was identified as the best noise descriptor. However, this noise descriptor was judged the best at correlating with annoyance by selected individuals (staff from Acoustic Technologies, NTC, government agencies and the road transport industry) rather than from any rigorous assessment process. Further
research was undertaken to address this shortcoming, where community members judge their annoyance from recordings of engine brake noise.

The Roads and Traffic Authority NSW commissioned the University of New South Wales Injury Risk Management Centre to determine the best psycho-acoustic descriptor to use for noise from engine brakes. Seven recordings of engine brake noise were selected to representing a range of noise the community may hear. It was recognised that noise volume could influence the overall results, especially if the recording were played at the volume to be expected at roadside. To identify the engine brakes events that have the most annoying characteristics, it was necessary to normalise the noise samples to the same volume. For the panel testing, the seven noise recordings were reproduced at a volume (65 dBA) near to the volume of a truck as heard from inside a house, not as recorded at the roadside. After each noise was played, the panel members were asked to consider “how much would the noise bother, disturb, or annoy you if you heard it regularly inside your home?” The panel was asked to rank to noise into one of the following categories: not at all, slightly, moderately, very much, and extremely. Eight panel sessions were conducted involving 33 panellists. The results of the panel testing for the sounds recordings were then plotted against the various noise descriptors and it was found that modulated Root Mean Square had the best correlation of community annoyance with engine brake noise.

![Correlation of Modulated Root Mean Square with Subjective Annoyance from the Panel Testing](image)

**Figure 3. Correlation of Modulated Root Mean Square with Subjective Annoyance from the Panel Testing**

Figure 3 shows the seven sound recordings used in the panel testing plotted against modulated Root Mean Square and subjective annoyance. Interestingly, most responses from the panel members were centred around ‘very much’ annoying (a subjective mean rating of four). This is better illustrated in Figure 4. Even the noise recording that had the lowest modulated Root Mean Square (of around one) still produced a reaction from the panel that was between ‘moderately’ annoying and ‘very much’ annoying. This is perhaps due to the testing methodology where any instantaneous noise from a quiet background is likely to cause a reaction towards the ‘very much’ annoying end of the scale. It is known from other research (EPA 1999) that 18 per cent of people find traffic noise at a volume of
65 dBA ‘highly’ annoying. Although a recording of noise with a modulated Root Mean Square of close to zero was not played to the panel members, this noise would have probably caused a reaction with subjective rating of 3.1 (extrapolating the panel testing results) which is around ‘moderately’ annoying.

It is interesting to note the practice that has developed for environmental regulations for transport-related noise sources. This sets a point where a percentage of residents are highly annoyed by noise (EPA 1999). For aircraft noise in Australia, the standard applying to new residences is set at a level where 10 per cent of residents would be highly annoyed. For general traffic noise, in Victoria the objective is set for new freeways where 18 percent of residents would find the noise highly annoying.

![Figure 4. Subjective Annoyance with Root Mean Square Values](image)

In summary, the research program found that modulated Root Mean Square was the best psycho-acoustic descriptor for community annoyance from engine brake noise. To understand more about the modulated Root Mean Square levels from heavy vehicle, and hence the noise the community is exposed to, the next section examines the roadside noise monitoring of heavy vehicles conducted as part of this research program.

**Key Points**

The research found:
- the modulation of engine brake noise is the cause of community annoyance; and
- modulated Root Mean Square is the best noise descriptor that correlates community annoyance with noise from engine brakes.

### 2.3 Roadside Testing

This section explores what modulated Root Mean Square levels are produced by heavy vehicles.

The Department for Transport, Energy and Infrastructure in South Australia developed a “noise camera” system that can be set up at the roadside to allow automatic recording of engine brake noise. This system makes it practical to collect large amounts recordings of engine brake noise. Noise camera systems have been set up at a number of locations around NSW, Victoria and South Australia. Additionally, some data was collected using microphones attached to laptop computers. Data from three test sites is presented below.

The recordings capture the noise events by heavy vehicles. These noise events are due not only to engine brakes, but also to the acceleration of heavy vehicles, and loose loads or...
empty trailers that clatter and bang. From this analysis of this roadside data, events of engine brake noise are more typically above a modulated Root Mean Square value of two. As such, some of the analysis is restricted to recordings which have a modulated Root Mean Square of greater than two.

The data for the Pacific Highway was collected at three sites in NSW with over 16,000 recordings made over 22 days. The average daily traffic for the highway is around 12,000 vehicles per day, with heavy vehicles making up 20 per cent of this traffic. Assuming that half of the daily traffic travels in each direction, then around 1,200 heavy vehicles would have passed the noise camera each day.

Figure 5 shows the recordings of noise from heavy vehicles plotted against modulated Root Mean Square. The vehicle recordings are ranked in from lowest value to highest value of modulated Root Mean Square. The plot curves sharply toward vertical at the upper end at a modulated Root Mean Square value of around three. Table 1 shows 22 per cent of the estimated volumes of heavy vehicles have a modulated Root Mean Square of greater than two. Two per cent of the heavy vehicle volume has a modulated Root Mean Square of greater than three, and 0.1 per cent of the volume has a modulated Root Mean Square of greater than four.

The data collected from the roadside testing indicates that there are numbers of heavy vehicles with engine brakes that have no mufflers fitted to the exhaust system. These vehicles are likely to be responsible for many of the data points at the upper end of plots. In addition, heavy vehicles often when past the recording site a number of times during the collection period. Therefore, single vehicles were often responsible for several recordings of high modulation from a test site. This was common at all test sites. Therefore, the reported volume of heavy vehicles exceeding a given Root Mean Square value is likely to be less than reported in Table 1 (and in also Tables 2 to 4).

![Pacific Hwy Modulated RMS](image)

**Figure 5. Pacific Highway Data**
The Southern Freeway is the main road between Sydney and Wollongong. The freeway runs over Mt Ousley near Wollongong, and has a long downhill grade where auxiliary brakes, such as engine brakes, can provide a safety benefit. This road has a high proportion of heavy vehicles, many of them carrying coal to the port at Wollongong. Despite the construction of noise barriers, local residents have consistently complained about the noise from engine brakes for a number of years.

The 3,088 recordings were made over 108 days between the start of November 2006 to the end of February 2007. The daily traffic for this road is around 40,000 vehicles per day, with around 10 per cent of heavy vehicles. Assuming that half of the daily traffic travels in each direction, then around 2,000 heavy vehicles would have passed the noise camera each day.

Figure 6 shows heavy vehicle recordings for Mt Ousley plotted against modulated Root Mean Square. At the upper end, the plot turns sharply towards the vertical at a modulated Root Mean Square of around four, and Table 2 shows 0.1 per cent of the heavy vehicles have a modulated Root Mean Square greater than four. Table 2 shows 1.1 per cent and 0.5 per cent of heavy vehicles have a modulated Root Mean Square of greater than two and three respectively.

### Table 1. Pacific Highway Data

<table>
<thead>
<tr>
<th>Modulated Root Mean Square Value</th>
<th>Number of Recordings</th>
<th>Percentage of Heavy Vehicles¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater than 2</td>
<td>5,807</td>
<td>22%</td>
</tr>
<tr>
<td>Greater than 3</td>
<td>503</td>
<td>2%</td>
</tr>
<tr>
<td>Greater than 4</td>
<td>38</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

¹. Estimated heavy vehicle volume of 26,400.

**Figure 6. Mt Ousley Data**
Table 2. Mt Ousley Data

<table>
<thead>
<tr>
<th>Modulated Root Mean Square Value</th>
<th>Number of Recordings</th>
<th>Percentage of Heavy Vehicles¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater than 2</td>
<td>3,088</td>
<td>1.4%</td>
</tr>
<tr>
<td>Greater than 3</td>
<td>1,120</td>
<td>0.5%</td>
</tr>
<tr>
<td>Greater than 4</td>
<td>241</td>
<td>0.1%</td>
</tr>
</tbody>
</table>

¹. Estimated heavy vehicle volume of 216,000.

The Monash Freeway is located to the south-east of Melbourne and carries large volumes of vehicles. The noise recording was carried out over 55 days across May to July 2006 at two sites. The estimated heavy vehicle volume over this period was 412,000.

The Monash Freeway data (Figure 7 and Table 5) show 0.5, 0.13, and 0.07 per cent of heavy vehicles have a modulated Root Mean Square greater than two, three and four respectively. At the upper end of Figure 8, the plot turns sharply towards the vertical at a modulated Root Mean Square of around 2.5.

![VicRoads Modulated RMS](image)

Figure 7. Monash Freeway Data

Table 3. Monash Freeway Data

<table>
<thead>
<tr>
<th>Modulated Root Mean Square Value</th>
<th>Number of Recordings that exceed this Modulated Root Mean Square Value</th>
<th>Percentage of Heavy Vehicles¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater than 2</td>
<td>1,943</td>
<td>0.5%</td>
</tr>
<tr>
<td>Greater than 3</td>
<td>550</td>
<td>0.13%</td>
</tr>
<tr>
<td>Greater than 4</td>
<td>288</td>
<td>0.07%</td>
</tr>
</tbody>
</table>

¹. Estimated heavy vehicle volume of 412,000.
The data from the three sites show different percentages of heavy vehicles that exceed a given modulated Root Mean Square value. This information is summarised in Table 4.

Now the roadside levels of modulated Root Mean Square from heavy vehicles are known, the next section examines the performance of mufflers to see what modulated Root Mean Square values are achievable through retrofitment of mufflers.

Table 4. Ranges of Heavy Vehicles that Exceed a Modulated Root Mean Square Value

<table>
<thead>
<tr>
<th>Modulated Root Mean Square Value</th>
<th>Ranges of Heavy Vehicles that Exceed this Modulated Root Mean Square Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Greater than 2</td>
<td>0.5% to 22%</td>
</tr>
<tr>
<td>Greater than 3</td>
<td>0.13% to 2%</td>
</tr>
<tr>
<td>Greater than 4</td>
<td>0.07% to 0.1%</td>
</tr>
</tbody>
</table>

Key Points

The research found the roadside performance of heavy vehicles was that:

- 78 to 99.5 per cent can achieve a modulation Root Mean Square value of two;
- 98 – 99.87 per cent can achieve a modulation Root Mean Square value of three; and
- 99.9 per cent can achieve a modulation Root Mean Square value of four.

2.4 Performance of Retrofitted Mufflers

Evidence suggests that degraded, modified or inadequate aftermarket mufflers result in, or at least contribute to, noisy engine brakes. A range of original equipment manufacturer (OEM) mufflers and aftermarket mufflers are available that will reduce the noise from engine brakes. To examine this area further, a trial of retrofitted mufflers was undertaken.

The NSW Roads and Traffic Authority undertook this trial, focusing on the performance of six commercially available mufflers. The test was also performed without a muffler fitted to the exhaust system. A prime mover of US origin was loaded and driven past a test point with the engine brake operating. This test was repeated a number of times and the resulting noises were recorded.

Figure 8 shows the results of the trial. In Figure 8, system 1 is the exhaust system without a muffler. Systems 2 to 7 are commercially available mufflers. System 6 is a muffler designed to minimise noise from engine brakes, and system 7 is a muffler fitted with an oxidation catalyst. As expected, the system with no muffler had the highest modulated Root Mean Square. The six mufflers had variable performance with modulated Root Mean Square values from 2.5 to 4.7.

Most in-service heavy vehicles can meet a modulated Root Mean Square of three or above, as evidenced by the roadside testing where over 98 per cent of heavy vehicles achieved this level. Contrast this result with the muffler trial where only two of the six mufflers achieved a modulated Root Mean Square of three or lower. The roadside testing is more robust as it had many thousand samples of engine brake noise, compared with the muffler

---

4 Refer [www.jakebrake.com](http://www.jakebrake.com), etc
trials where only limited samples where taken. It is speculated that the high modulation values from the muffler trial were a direct result of the test vehicle used, and that if a number of test vehicles were used in the trial, this may have resulted in better modulation results from each muffler. Nonetheless, when compared to the roadside testing data, the muffler test results are possibly the worst performance that might be expected when retrofitting mufflers.

The NTC believes that, if required to meet a standard for engine brake noise, muffler manufacturers would respond with products that would all achieve the modulation level. With the testing procedures for the standard available, the design of mufflers could be tailored specifically to address the modulation of the engine brake.

An in-service standard can be set using the data from the muffler performance, panel testing and roadside trial. This is done in section 2.6. However, before discussing the standard, section 2.5 explores the safety and operation issues with using engine brakes.

![Figure 8. Average Modulated Root Mean Square for Exhaust Systems Trial](image)

**Key Points**

- Degraded, modified or inadequate mufflers do contribute to noisy engine brakes.
- Properly designed mufflers do significantly reduce the annoyance of noise from engine brakes.
- Commercially available mufflers have variable performance with modulated Root Mean Square, with the better performing mufflers able to achieve modulated Root Mean Square values of three or lower.
- If a modulation level is set by regulation, it is expected that better mufflers will be made available.
2.5 Safety and Operational Considerations in the Use of Engine Brakes

During the development of this proposal, there have been stakeholders concerned with the safety implications of limiting the use of engine brakes that produce noise. The NTC commissioned Hartwood Consulting Pty Ltd to undertake an independent review of engine brake safety and operational considerations. This report is available on the NTC website (www.ntc.gov.au). The report found:

- Engine compression brakes are most useful for speed control on downhill descents. They are also useful for ‘trimming’ speed in traffic flow.

- The use of engine brakes will substantially reduce service brake wear by minimising service brake use.

- Engine compression brakes can be used exclusively for speed control in highway driving (e.g. 100 km/h) where slow deceleration is required and provides a benefit for operators in saving on service brake wear.

- Engine compression brakes take the load off the service brakes for downhill speed control. On steep descents with grades greater than around six per cent there is a risk that the service brakes on laden trucks with poor brake balance can fade. Use of engine compression brakes substantially reduces this safety risk.

- The propensity for the service brake to fade on long and steep descents mainly exists when combination vehicles have poor brake balance and poor adjustment. These conditions are relatively common.

- In the absence of an engine compression brake or other secondary braking system, a driver must take additional care when taking a laden truck down a steep descent. This will involve selecting a low gear and stopping the truck at the top so that the speed can be controlled.

- Most braking events on heavy vehicles are slow deceleration events (levels of less than 1 metre per second). Engine compression brakes make the predominant contribution to braking at this level. Therefore, an engine compression brake will substantially reduce service brake wear by minimising service brake use.

- As a guide, a state-of-the-art engine compression brake has a power rating equal to or slightly higher than the engine power rating, and a state-of-the-art exhaust brake has a power rating of about 30 per cent of the engine power rating.

- Both engine compression brakes and exhaust brakes apply retardation via the drive-shaft and the drive wheels. Retardation capacity of engine compression brakes is sufficient to lock-up the drive wheels on slippery surfaces. Because the brake is often applied automatically when the throttle is relaxed, a safety issue exists with the use of engine brakes because the drive wheels may lock-up due to inadvertent action by the driver.

- Engine compression brakes are not a substitute for service brake use during severe and emergency stops. The driver should avoid wheel lock-up, and particularly drive-wheel lock-up, if directional control is to be maintained. As engine compression brakes act through the drive wheels, they can contribute to wheel lock-up during severe braking. For this reason, their use is undesirable during severe braking, particularly when the vehicle is lightly laden.
• Whilst use of an engine compression brake is not essential for safe operation of a heavy vehicle, it is desirable for speed control on a highway because it saves costs on service brake wear, and down long hills because of the safety benefits and cost savings on service brake wear.

**Key Points**

An independent expert has been commissioned to assess the safety implications and he concluded that:

- engine brakes play an important safety role on long, steep descents; and
- engine brakes provide a small proportion of the total braking in low speed and relatively flat environments.

### 2.6 Setting an In-service Standard for Noise from Engine Brakes

This section explains how the information from the research described above was used to set the level for the in-service standard for noise from engine brakes.

The standard aims to reduce noise from engine brakes, not restrict the use of engine brakes. Therefore, there will be no safety implications with setting an in-service standard for noise from engine brakes.

The NTC proposes to set an in-service standard for engine brake noise at a modulated Root Mean Square value of three. Therefore, any heavy vehicle detected with noise above this value will fail the standard. At this level, the standard targets noise from engine brakes that, from the panel testing, are either ‘very much’ annoying or ‘extremely’ annoying. Data indicates that heavy vehicles that exceed the standard can be fixed by fitting a quality muffler.

The alternatives to setting the standard to three are to set the standard higher or lower. The NTC believes that setting the standard at a higher level than three is unreasonable on the community because the level moves more towards the ‘extremely’ annoying end of the annoyance spectrum (Figure 4). Setting the standard at a level of two or below will mean that it will be harder for vehicle owners with modulation above this level to fix the problem by fitting available mufflers, although the community benefit will be higher. As discussed in section 2.4, the current test data on muffler performance may represent worst-case performance. However, without further data, setting the standard lower than a modulated Root Mean Square of three may mean that if vehicle owners cannot fix the problem, they may have to turn off the engine brakes or risk being fined if exceeding the standard. There are possible safety consequences if owners are forced to turn off the engine brakes on their vehicles, and because of this, NTC believes the general standard should not be set at below three at this time.

The NTC anticipates that if a standard with a modulated Root Mean Square of three is approved, the muffler industry will respond with products that are designed to meet the new standard. If this happens, the overall Root Mean Square values from the heavy vehicle fleet will improve. It may be possible to revise the standard downward over time, consistent with improved muffler performance, to further reduce community annoyance from engine brake noise.
This standard does not directly address the volume or loudness of engine brake noise, but the annoyance factor in the noise caused by the modulation. There are already in-service standards that apply to the noise from vehicles. However, fitting of better mufflers to address the modulation from engine brake noise is also expected to reduce the overall volume from noise from heavy vehicles.

Data suggests the standard will have an impact on up to two per cent of heavy vehicles. The owners of these vehicles will need to fix the problem or risk being fined if detected exceeding the standard. The economic impact of the standard is assessed later in this document.

**Key Point**

The NTC recommends an in-service standard with a modulated Root Mean Square of three that takes into account community annoyance and best practice muffler performance.

### 3. PROPOSAL AND ALTERNATIVES CONSIDERED

#### 3.1 Options Considered

The result of this research means that an effective regulatory approach targeting the cause of engine brake noise can be developed. There are a range of options currently available to address the noise problems associated with engine brakes, which include both non-regulatory and regulatory options. These options are discussed in further detail below.

#### 3.1.1 Non-regulatory Options

Over the last decade, most transport regulators in Australia have attempted to deal with the engine brake problem with non-regulatory approaches. These have included:

- education programs;
- advisory signs;
- inclusion in industry alternative compliance schemes; and
- noise abatement treatments along noise-sensitive routes.

#### 3.1.1.1 Education Programs

From time to time, most States and Territories have issued brochures or leaflets to discourage engine brake use at night time, in built up areas or when it is simply unnecessary. In 1999, a national approach was taken whereby a nationally uniform brochure was developed by Austroads and the Australian Trucking Association. The brochure titled “Professional, powerful and pretty quiet” was distributed by every transport agency in Australia and the Australian Trucking Association. The recommendation in the brochure to drivers of vehicles with noisy engine brakes was “whenever you’re driving through a built-up area, either turn off your engine brakes or use them when it’s absolutely necessary.” While its effect was not systematically measured, there is no evidence of any improvement and the noise problem remains.
The brochure noted that some transport companies have policies for drivers to not use engine brakes in built-up areas. This latter point raises the prospect of extending education into some form of industry code of practice. However, there are a number of significant factors that could make a code of practice unworkable:

- the industry is diverse and highly competitive with a relatively small proportion being represented by industry associations. It would be difficult to make all operators and drivers aware of the code, difficult to get them to sign up to a code, and almost impossible to enforce a code; and
- the competitive nature of the industry means that operators will be looking for even a small advantage over their competitors, and there is a possible saving in not maintaining mufflers on heavy vehicles.

3.1.1.2 Advisory Signs

Advisory signs are common along Australian roads. These signs request that drivers of heavy vehicles not use engine brakes as the road is close to residents.

Road authorities are finding it difficult to meet the demand by residents for these signs. In all cases the signs are advisory, not regulatory, since banning the use of engine brakes could lead to potential safety consequences. Therefore the signs advise drivers not to use noisy engine brakes, or not to use engine brakes unless in an emergency.

Road authorities believe the signs have some effect, but this effect diminishes over time. Some residents have reported that noise from engine brakes has increased when a new sign is installed, and they believe it is because drivers have contempt for the signs.

3.1.1.3 Inclusion in Industry Alternative Compliance Schemes

A number of alternative compliance schemes currently in operation allow operators to carry out maintenance practices and have these practices independently audited. These schemes only cover a small percentage of heavy vehicle fleets. Given the small number of heavy vehicles in industry compliance schemes compared to the total number of heavy vehicles, this approach would support, rather than serve as a stand-alone measure, to address noise from engine brakes.

3.1.1.4 Noise Abatement Treatments along Noise-sensitive Routes

Noise from engine brakes is generally low frequency (i.e. less than 200 hertz). However, customary approaches to managing traffic noise, such as constructing roadside noise barriers or sound proofing houses, do not adequately address the low frequency characteristics of the noise from engine brakes. For example, noise of low frequency is largely unaffected by sound barriers.

Noise of low frequency also travels greater distances than higher frequency noise, and so affects a greater number of people. Additionally, noise of low frequency can cause surfaces to vibrate that can cause annoyance inside a structure while being almost inaudible outside.

Noise abatement treatments are ineffective to address engine brake noise. It can be argued that source mitigation is preferable, and is consistent with the polluter pays principle of environmental regulation. Noise abatement treatments, such as noise barriers and sound-

---

5 Personal comments – VicRoads officer.
6 Personal comments – EPA officer.
proofing buildings, are also expensive. Advice from road agencies is that noise walls can be as expensive as the equivalent length of road surface.

**Key Points**

- Non-regulatory approaches to reducing noise from engine brakes have been undertaken for over a decade and have proven inadequate;
- non-regulatory approaches tend to seek to restrict usage of engine brakes rather than to limit noise from engine brakes. Voluntary restrictions on usage are unlikely to be successful because of the economic advantage of non-compliance; and
- abatement measures for noise, including noise barriers, fail due to the characteristics of noise with low frequency.

### 3.2 Regulatory Options

Road authorities have canvassed a number of regulatory options. These options include:

- increased enforcement of existing laws;
- restricting the use of engine brakes with modulation from certain routes;
- introducing an Australian Design Rule;
- banning the use of engine brakes;
- applying access restrictions to heavy vehicles along noise-sensitive routes;
- regulating muffler manufacturers and importers;
- checking muffler performance as part of regular roadworthiness tests; and
- introducing an in-service standard for noise from engine brakes.

These options are discussed in more detail below.

#### 3.2.1 Increased Enforcement of Existing Laws

In-service noise levels are controlled by uniform regulations in each State and Territory. These noise limits are described in the Australian Vehicle Standards Rules and the test is described in the *National Stationary Exhaust Noise Test Procedure*. The test is undertaken when the vehicle is stationary. Importantly, most engine brakes do not operate when the vehicle is stationary so the test is incapable of addressing noise from engine brakes. Some trucks will fail the test because of inadequate muffler performance; and these mufflers will need to be replaced before the stationary test is undertaken again. However, some vehicles, even when fitted with a muffler that allows the vehicle to meet the stationary noise limit, may still have excessive noise from engine brakes. The issue is one of muffler design – a muffler that reduces *engine* noise will not necessarily address noise from the *engine brake*. Therefore, it is unlikely that any increase in roadside enforcement of existing noise levels will reduce the problem of noisy engine brakes.

#### 3.2.2 Restricting the Use of Engine Brakes with Audible Noise

As discussed above, the problem of offensive noise from engine brakes appears to be unique to North American engines. European engines tend to use technologies that are not prone to become offensive even with poor mufflers. Therefore, it is worthwhile examining the approach used by other countries with a large proportion of North American engines.
Both the US and Canada penalise drivers for using engine brakes with audible noise in designated areas. In some cases, these penalties are significant. For example, the city of Banff in Canada has a C$3000 fine for use of an engine brake with audible noise. Many such rules stem from the potential for noisy engine brakes to adversely affect tourism.

This approach could be feasible in Australia. Some States have provision for offensive noise in existing regulations. For example, these provisions can be used to target excessive noise from car stereos. However, there is no definition of what constitutes offensive and it relies on a subjective assessment by individuals authorised under the relevant regulation. To be a credible measure to address noise from engine brakes, criteria about how to undertake the subjective assessment by enforcement officers are needed so it can be consistently applied.

An alternative to subjective assessment is to set a modulated Root Mean Square value for these routes. This is now possible given the research undertaken as part of this proposal. However, setting a modulation Root Mean Square level of, say, one means there will be many events where the use of the engine brake has not occurred, for example, from an accelerating heavy vehicle. The lower the modulated Root Mean Square value used, the more resources for manually processing recorded data is needed. A compromise is to set the modulated Root Mean Square at around two, as the majority of noise events captured will still be from the use of an engine brake.

### 3.2.3 Introducing an Australian Design Rule

Australian Design Rules are instruments made under the *Motor Vehicle Standards Act 1989*. The Australian Design Rules effectively set design standards that all vehicles must meet prior to being sold in Australia. Recently Australia has adopted the Australian Design Rule 83/00 which sets maximum noise levels for vehicles consistent with international standards.

As discussed earlier, the test specified in the Australian Design Rule is an acceleration test and therefore does not address noise generated by engine brakes during deceleration. So, if new standards for heavy vehicles are to address noise from engine brakes, a new standard will need to be developed. However, the Australian Government is part of an international convention that seeks to ensure design rules are consistent throughout the world, proposing a unique requirement through the Australian Design Rules is not consistent with this international convention.

Testing undertaken as part of developing this policy proposal found that new heavy vehicles produced little modulation from engine brakes. In one series of tests at Anglesea in Victoria, only new trucks were used. It was clear that manufacturers were already using high quality mufflers as nearly all of these new trucks showed low modulation characteristics and were not considered offensive by the personnel on-site. There was one exception; the vehicle only had a single exhaust pipe and muffler and a powerful 570 horsepower engine. The manufacturer of this vehicle concluded that the noise from the engine brakes could be significantly lowered if the exhaust was converted to a twin pipe system that would have two mufflers.

This new vehicle testing showed a RMS range between 0.9 to 2.1. This demonstrates that new vehicles are already able to meet an in-service standard of RMS of 3.

The problem of noise from engine brakes is generated when the vehicle is in-service, and not when the vehicle is new. Therefore, it is not effective to address noise from engine brakes through new vehicle standards.
3.2.4 Banning the Use of Engine Brakes

Banning the use of engine brakes along populated areas affected by noise from these devices is an option. However, there are many heavy vehicles with engine brakes that are not noisy and do not become noisy over time. Banning the use of engine brakes would unfairly affect the owners of these vehicles. Given the costs and issues of equity, it would be very difficult to mount a convincing case for a regulation to ban the usage of engine brakes.

3.2.5 Applying Access Restrictions to Heavy Vehicle along Noise-sensitive Routes

From research undertaken as part of this policy proposal, a minority of heavy vehicles have excessive noise from engine brakes. Limiting access to all heavy vehicles because of a small minority is a very inefficient approach to regulation. It is likely to cause high productivity costs and an inability to service businesses located in populated areas. Even sparsely populated areas can be considered noise-sensitive routes, as evidenced by signage seeking to restrict noise from engine brakes around country towns. This approach would prove difficult to implement and have high enforcement costs.

3.2.6 Regulating Muffler Manufacturers and Importers

It may be possible to introduce regulation to limit the sale of mufflers that do not investigate noise from engine brakes.

This approach would require all muffler manufacturers to design mufflers to reduce noise from engine brakes. Not only would this approach be expensive, it would be difficult to enforce and easily subverted by drivers who like noisy engine brakes. Personnel from enforcement agencies have indicated there are some drivers who deliberately damage mufflers to have unrestricted exhaust flow, on the assumption it saves fuel, or to make sure the vehicle produces excessive noise.

There is also the issue of heavy vehicles fitted with other forms of retarder that simply do not need specialised mufflers. This approach would have to be tailored to focus on the mufflers to be fitted to heavy vehicles using engine brakes.

Finally, there is the issue of muffler deterioration – regardless of the quality of the new muffler, it is prone to deteriorate, at which point the noise problem will return.

The NTC concludes that this approach is an ineffective way to address noise from engine brakes.

3.2.7 Checking Muffler Performance as part of Regular Roadworthiness Tests

A vehicle with no muffler, or a muffler that has deteriorated, operates at significantly louder levels and with greater annoyance qualities than a vehicle fitted with a muffler in good condition. Incorporating a check of muffler condition as part of a State’s regular roadworthiness inspection, if the State has such a scheme, would be a useful step in minimising vehicle noise.

However, as noted earlier, there is no reliable international test for noise from engine brakes. Even if such a test were developed, testing and maintenance schemes only cover a
relatively small percentage of heavy vehicles\textsuperscript{7}. Nevertheless, if an appropriate test were to be developed, it may be possible to build it into existing maintenance practices, perhaps in combination with some other approach, to target vehicles outside such schemes.

The NTC concludes that although this approach is feasible, it would be an ineffective way to address noise from engine brakes.

3.2.8 \textit{In-service Standard for Noise from Engine Brake}

Developing a noise test for engine brakes through an in-service standard that can be effectively measured at roadside is the most objective approach and presents a range of enforcement options. This option has been made feasible due to the research undertaken in analysing the noise characteristics of engine brakes and through the development of a measurement procedure.

<table>
<thead>
<tr>
<th>Key Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>• There are many regulatory options to address excessive noise from engine brakes, but many are expensive, inequitable or ineffective; and</td>
</tr>
<tr>
<td>• the more feasible approaches centre on an objectively measurable in-service standard for noise from engine brakes.</td>
</tr>
</tbody>
</table>

4. \textbf{ANALYSIS OF OPTIONS}

From the options presented in the preceding section, two of these options have been selected for their potential to maximise reducing the impact on the community of excessive noise from engine brakes. These are discussed below as both separate options and together, along with the ‘status quo’ option.

Further information has been used to refine the analysis of benefits and costs from the previous draft regulatory impact statement released in June 2006. The main change in this is the estimate that 5 per cent of vehicles with engine brakes produce excessive noise; a figure of 10 per cent was used in the previous draft regulatory impact statement. This revised figure was based on data from the roadside testing discussed in section 2.3. The NTC undertook re-analysis of the cost and benefits by the ARRB (2004). As a result, both the costs and benefits in the analysis have reduced by approximately half.

4.1 \textit{Option 1 - Maintain the Status Quo}

A ‘do nothing’ approach is an option. The costs of $70 million per year of noise from engine brakes for this option will continue to be borne by the community.

The benefits of this option will accrue to part of the trucking industry that has excessive noise from engine brakes. Maintaining the status quo will ensure these operators do not have to internalise the external impact on the community of this excessive noise.

4.2 \textit{Option 2 – A General In-service Standard for Noise from Engine Brakes}

An in-service standard for noise from engine brakes will target noise that is ‘very much’ or is ‘extremely’ annoying, as described by the panel testing in section 2.2. Enforcement

\textsuperscript{7} The NTC estimates about 20,000 vehicles are covered by NHVAS and Trucksafe.
through roadside monitoring would determine which noise events from engine brakes exceed the standard.

Engine brakes are on an estimated 65 percent of the current heavy vehicle fleet. The in-service standard will affect the estimated 5 per cent of heavy vehicles fitted with engine brakes that have high modulation.

A cost-benefit analysis has been undertaken by ARRB Research Ltd and re-analysed by the NTC to determine the economic impacts. The assumption was made that, after a vehicle was detected for exceeding the standard, the vehicle was subsequently repaired. The analysis showed that where adequate lead-time is available, the cost of repair is the price difference between the complying and non-complying muffler. This cost is estimated for a complying single muffler exhaust system as around $350 and for a two muffler exhaust system as double that amount (non-complying mufflers might cost half as much). There may be instances where vehicles fitted with single exhaust pipe need to be modified to be fitted with a twin system, involving two exhaust pipes and two mufflers, and the cost of this modification would be higher than simply replacing mufflers.

The enforcement costs for governments are $11 million over ten years. These costs are presented in Appendix D.

This option produces a net benefit of $55 million over ten years and a cost-benefit ratio of 4.7.

4.3 Option 3 – A Lower In-service Standard for Specific Noise-sensitive Routes

This option seeks to restrict the use of engine brakes with a modulated Root Mean Square of greater than two. However, the restrictions would only apply in noise-sensitive areas that are in relatively flat and low speed routes to ensure there is no safety risk of applying this measure.

There are examples of roads with high volumes of freight in residential areas and the houses may be constructed of materials which do not lend themselves to simple noise insulation techniques. In these areas, it can be argued that even low levels of modulation cause significant annoyance to residents.

If the modulated Root Mean Square of two was set for these signposted routes, then this would affect, depending on the enforcement site, between 1.4 to 22 per cent of heavy vehicles with engine brakes (see Table 4). The operators of these vehicles have two choices to reduce this modulation:

(a) not use engine brakes along these signposted routes; or
(b) improve the muffler system on their vehicles to ensure that no modulation is emitted when an engine brake is engaged.

If operators choose not to use engine brakes along these signposted routes, there will be increased use of the service brake, and additional costs in having to replace brake linings at shorter intervals. The NTC estimates these additional costs are 4.8 cents per kilometre.8

---

8 Renzo Tonin (1997) estimated that brake lining wear with an engine brake was approximately one third of that evidenced without an engine brake, with identical loads over the same route. The NTC has obtained the costs of service brake use on car transporters that have travelled over 2.5 million kilometres. The NTC estimates the additional cost of service brake wear for these car transporters is 2.4 cents per kilometre. These
Operators can also choose to improve the exhaust system on their vehicles to produce engine brakes with no modulation. The rectification costs for fitting a single muffler or twin mufflers will be $350 and $700 respectively. It is expected that jurisdictions will implement restrictions on engine brakes with modulation on targeted and limited sections of the overall road network.

The vehicle owner can determine which of the two choices presented above will be the lower cost option. Using the additional cost of 4.8 cents per kilometre for a truck fitted with engine brakes but not using them along these specific routes, the equivalent number of kilometres for the cost of fixing the muffler comes to approximately 7,300 kms ($350) for a single system and approximately 14,600 kms ($700) for a twin system.

The muffler trials undertaken as part of the research to this policy proposal showed that retrofitting quality mufflers can reduce the exhaust to a modulated Root Mean Square value to three or less. However, it is more difficult to reduce the modulated Root Mean Square value to two; the best muffler from the trial produced a modulated Root Mean Square value of 2.4. If owners of heavy vehicles are considering upgrading the exhaust system, they should investigate the likely level of modulation from the upgraded system.

This option has costs of $3 million for administration and enforcement. This option has net benefits of $10 million over ten years and a benefit-cost ratio of 1.7.

4.4 Option 4 – A General In-service Engine Brake Noise Standard and a Lower In-service Standard for Specific Noise-sensitive Routes

The fourth option is a combination of the general in-service standard (discussed under option 2) and a lower in-service standard for specific noise-sensitive routes (discussed under option 3).

The general in-service standard would apply Australia-wide and reduce a substantial amount of community annoyance with engine brake noise. The specific standard along selected low speed, noise-sensitive routes is focused on addressing this problem in highly populated communities along major transport routes and where the restriction of this type has no adverse safety outcome.

The administration and restriction on enforcement cost of this option will be similar to option 2. This option produces a net benefit of $63 million over ten years and a cost-benefit ratio of 4.7.

A summary of the costs and benefits of the four options is presented in Table 5.
Table 5. Summary of the Costs and Benefits

<table>
<thead>
<tr>
<th>Option</th>
<th>Costs</th>
<th>Benefits</th>
<th>Net benefit over ten years</th>
<th>Benefit/cost ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option 1: Status Quo.</td>
<td>Unacceptable noise impact on the community ($70 million per year).</td>
<td>Truck operators able to use excessively noisy engine brakes and save on service brake costs.</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Option 2: Set a general in-service standard for engine brake noise Australia wide.</td>
<td>Administrative/enforcement costs for jurisdictions ($11 million over ten years). Increased muffler costs to industry ($4 million over ten years).</td>
<td>Reduction in noise events across the whole road network ($70 million over ten years).</td>
<td>$55 million</td>
<td>4.7</td>
</tr>
<tr>
<td>Option 3: Set a lower in-service standard for engine brake noise along specific noise-sensitive routes.</td>
<td>Administration/enforcement costs for jurisdictions ($3 million over ten years). Increased muffler costs for non complying vehicles ($350-700 per vehicle) OR increased service brake maintenance for non-complying vehicles (4.8 cents per kilometre).</td>
<td>Reduction in noise along select routes ($10 million over ten years). Some limited benefits across the road network.</td>
<td>$4 million</td>
<td>1.7</td>
</tr>
<tr>
<td>Option 4: Combine options 2 and 3.</td>
<td>Administration/enforcement costs for jurisdictions ($11 million over ten years). Increased muffler costs for non complying vehicles ($350-700 per vehicle) OR increased service brake maintenance for non-complying vehicles (4.8 cents per kilometre).</td>
<td>Noise reduction in both across the road network and along select routes ($80 million over ten years).</td>
<td>$63 million</td>
<td>4.7</td>
</tr>
</tbody>
</table>
4.5 Discussion of Options

This section discusses the NTC’s analysis and rationale for its preferred option.

Maintaining the status quo, option 1, is unreasonable and unfair to the community as it bears the noise externality generated by a small proportion of heavy vehicles. This option is inconsistent with the environmental principle of polluter pays. On these grounds, the NTC rejects this option.

Several submissions on the draft policy argued that with the new Australian noise standards for heavy vehicles, the problem of noise from engine brakes will reduce over time, especially given the use of diesel particle filters integrated into mufflers. The NTC agrees that these trends will reduce engine brake noise over time for new vehicles, however given the slow fleet turnover, it would take over 20 years to fix the problem.

The choice of viable options is then between options 2, 3 and 4. The options of an in-service standard along selected noise-sensitive routes has lower net benefit and lower benefit-cost ratio compared these other options, because it focuses on limited sections of the road network. Consequently, options 2 and 4 are preferable than option 3.

The choice is then between options 2 and 4. The difference between these options is that option 4 has the restrictions on using engine brakes with a modulated Root Mean Square of above two in flat and low speed noise-sensitive routes.

The NTC proposes option 2 as the preferred option. This is because:

1. while there is a difference in community reaction between setting the Root Mean Square level at two compared to three (see Figure 4), this difference is not large;
2. the majority of the net benefit of option 4 results from the in-service standard component;
3. option 2 alone is simpler to administer and enforce for governments than option 4; and
4. option 2 provides a simple and consistent policy Australia-wide for the owners of heavy vehicles.

Enforcement of the standard along routes that are noise-sensitive (where the modulation level of two was proposed) will provide reduced annoyance from engine brake noise compared to current situation.

It is proposed to review the standard within five years of implementation. There will be further roadside monitoring data to help this review.

During final consultation on the proposal, several government agencies indicated that the costs of option 2 are underestimated. A simple sensitivity analysis was undertaken to examine to impact on the cost-benefit analysis. The costs in option 2 were doubled, and this produces a net benefit of $40 million over 10 years and a benefit-cost ratio of 2.3. Therefore, the proposal still results in a net benefit and a positive benefit-cost ratio if both the enforcement and industry costs are doubled.

A likely consequence of the proposed regulation is to stimulate the demand for better quality mufflers. The availability of better quality mufflers should lead to lower modulation noise across the heavy vehicle fleet over time.
This conclusion is different from that in the draft policy proposal released in 2006, where option 4 was the preferred option. The further data and analysis since 2006 led the NTC to this different conclusion.

The NTC recognises that the proposed standard will not address all community annoyance from engine brake noise. The approach taken with developing this standard is consistent with developing noise policy. As discussed in section 2.2, setting road traffic noise limits or aircraft noise limits recognises that there will still be people that are highly annoyed by these limits. The NTC believes that a standard for engine brake noise addresses the noise which causes ‘very much’ annoying and ‘extremely’ annoying reactions, and is a major step in addressing the current problem.

In conclusion, the proposed standard targets the most annoying engine brake noise and will reduce the impact on the community. The proposed regulation will mean, for the first time, owners of heavy vehicles that have excessive modulation from engine brakes will need to internalise this cost by fixing the problem. This cost is an externality currently being borne by the community.

**Key Points**

- The proposed option is to set an in-service standard for noise from engine brakes; and
- a review of the proposed reform is to be undertaken within five years of implementation.

### 5. CONSULTATION

#### 5.1 Public Consultation during the Review of the Noise Related Australian Design Rules

The community’s concern with noise from engine brakes is long standing and has been the subject of numerous complaints to government agencies. The lack of understanding of the nature of the noise from engine brakes has meant that an appropriate and effective strategy has been unavailable to date.

This policy proposal was preceded by a review of the noise related Australian Design Rules and engine brake noise in 2001. This earlier process provided the opportunity for stakeholders to discuss noise from engine brakes. Stakeholder comments from this earlier review included:

- Federal Chamber of Automotive Industries: engine brake measures should focus on in-service initiatives not manufacturing ones;
- community representatives: current enforcement of vehicle noise is inadequate; and
- manufacturers: modifications to vehicles occurred once in the market which altered the noise profile of vehicles. Consequently, enforcement of in-service limits strongly recommended.

#### 5.2 Public Consultation on the Draft Proposal and Regulatory Impact Statement Released in June 2006

The draft proposal and regulatory impact statement was released for a two month consultation period in June 2006. Forty two submissions were received on the proposal.
Appendix C contains a summary of issues raised in these submissions. These comments were considered in finalising this policy proposal.

Public consultation included:

- convening panels drawn from the community to listen to and assign ‘annoyance’ values to a range of engine brake recordings;
- making recordings of noise from engine brakes available, by compact disc and the NTC’s website, for anybody to decide if the noise is acceptable or is unacceptable;
- running a series of seminars that included listening these recordings of noise from engine brakes around the level of the proposed in-service standard;
- holding a meeting of acoustics experts to peer review the analysis undertaken; and
- meetings and discussions with stakeholders to explain the reform and listen to stakeholder views.

5.3 Release of Research Reports

The research that underpins the proposal and regulatory impact statement has been extensive and has sought to address excessive noise from engine brakes without introducing unfair restrictions on industry or creating a safety issue.

A series of research projects have been undertaken and the findings have been made publicly available. The reports have been available on the NTC’s website. These reports are:

- Engine Brake Noise: Development of a Roadside Test Procedure; August 2003;
- Economic Evaluation of Vehicle Based Engine Brake Noise Countermeasures by ARRB Transport Research, 2004; and

6. CONCLUSION AND RECOMMENDED OPTION

6.1 Preferred Option

The preferred option is to set an in-service standard for engine brake noise.

6.2 Discussion of Preferred Option

The preferred option is an in-service standard for noise from engine brakes. This is now feasible due to an understanding of the annoying characteristic of noise from engine brakes.

The preferred option would address noise from engine brakes in a cost effective way. It allows operators to continue to use engine brakes, and it targets modulation from engine brakes which causes community annoyance.

Costs for enforcement agencies are $11 million over ten years for this option. The costs for the heavy vehicle industry for new mufflers are $4 million over ten years.
For administrative simplicity, the proposed penalty for exceeding the standard is a fine.

It is proposed to review the in-service standard within five years of implementation. This review should focus on how effective the in-service standard has been in addressing community annoyance.

7. IMPLEMENTATION

It is proposed that an in-service standard for engine brake noise will be made under Australian Vehicle Standards Rules 1999 and the Vehicle Standards regulations. These proposed amendments are presented in Appendix A.

The NTC recommends that States and Territories phase in the introduction of the in-service standard with a period of where heavy vehicle owners receive a letter informing them that their vehicle has failed the standard. In this way, these vehicle owners can take action to fix the problem or face fines when the introduction period is completed.

To further the awareness of the heavy vehicle industry of this reform, the NTC will release an information bulletin. This bulletin will include information about how owners can identify if their vehicles are likely to fail the standard. Information collected as part of the research program (Marshall Day Acoustics 2006) shows that particular heavy vehicle makes and models of US origin are more likely to fail the standard than other heavy vehicles.

In parallel with the development of the acoustic measurement methodology, the Department for Transport, Energy and Infrastructure in South Australia has developed camera technology that can be linked with the measurement software. The combination of these systems offers the potential for the incidents of noisy engine brakes to be identified and recorded, which will provide a useful tool for enforcement agencies.
8. REFERENCES


Detroit Diesel (2004). *Unit Costs of Silent Partner Mufflers*, MTU Detroit Diesel-Allison Australia Pty Ltd.


APPENDIX A – PROPOSED MODEL LAWS IN RELATION TO THE IN-SERVICE ENGINE BRAKE NOISE STANDARD

A. Proposed amendment to the Australian Vehicle Standards Rules

After rule 153 of the Australian Vehicle Standards Rules insert:

"153A Limits on engine brake noise

(1) In this rule:

approved engine brake noise measuring and recording device means a device that measures and records the engine brake noise emitted by a vehicle and that is of a type that has been approved by the [relevant jurisdictional authority] as suitable for the enforcement of engine brake noise limits;

modulated Root Mean Square means the figure that results from applying the method set out in National In-Service Engine Brake Noise Test Procedures for Heavy Vehicles published on xx xxxx 2007 by the National Transport Commission, as amended from time to time, to a heavy vehicle’s engine brake noise as measured and recorded by an approved engine brake noise measuring and recording device in accordance with the procedures set out in that document.

(2) An engine brake device fitted to a motor vehicle must not emit noise that has a modulated RMS of more than 3.0.

(3) For the purposes of sub-rule (2), an engine brake device includes any exhaust outlets of the device, and anything attached to such outlets, including mufflers."

B. Proposed amendment to the Vehicle Standards Regulations

After regulation 14 of the Road Transport Reform (Vehicle Standards) Regulations insert:

"14A. Engine brake devices not complying with Vehicle Standards

If an engine brake device contravenes rule 153A of the Vehicle Standards, the operator of the vehicle to which the device is fitted commits an offence.

Penalty: [local variations]."

[Implementation note: As these provisions are new, it is intended that the amendments will only be introduced after the intention to introduce them has been well-publicised.]

C. Provisions that it would be desirable to include to assist in the enforcement of engine brake noise limits

[Drafting note: In most, if not all, jurisdictions, these provisions will need to be enacted as primary legislation.]
x. **Evidence of engine brake noise**

A document that has been produced by either an approved engine brake noise measuring and recording device or an approved camera recording device and that shows one or more images of a vehicle together with details purporting to be a modulated RMS and the date, time and place at which the modulated RMS was measured and recorded –

(a) is admissible in any proceedings; and

(b) is evidence that the engine brake noise emitted from the engine brake device fitted to that vehicle had that modulated RMS at that date, time and place.

y. **Evidence of engine brake noise**

A statement in a certificate purporting to have been issued by [relevant jurisdictional authorities/officers] that, at a specified time or during a specified period –

(a) a specified device is, or was, an approved engine brake noise measuring and recording device or an approved camera recording device;

(b) a specified approved engine brake noise measuring and recording device or approved camera recording device was tested or sealed in a specified way;

(c) a specified approved engine brake noise measuring and recording device or an approved camera recording device was operated in a specified way;

(d) a specified modulated RMS relates to a specified vehicle –

    is admissible in any proceedings and is evidence of the matters stated."

[Drafting note: These provisions will need to be supported by definitions of "approved engine brake noise measuring and recording device", "modulated RMS" and the following:

**approved camera recording device** means a device approved by [relevant jurisdictional authority] as suitable for the enforcement of engine brake noise limits that is designed to be attached to an approved engine brake noise measuring and recording device for the purpose of producing, in respect of any vehicle that has any noise that it emits measured and recorded by that device, a document containing one or more images of the vehicle together with details of –

(a) the modulated RMS of that noise as recorded by that device; and

(b) the date, time and place the measurement was taken and recorded;

**engine brake device** includes any exhaust outlets of the device, and anything attached to such outlets, including mufflers.
APPENDIX B – THE IN-SERVICE ALGORITHM FOR NOISE FROM ENGINE BRAKES

The captured wave file is scaled to Pascals, by comparison with a calibration signal.

The signal is A- weighted, as described in Australian Standard 61672.1-2004.

The 5 ms time averaged signal is also calculated, resampled to 5 ms, converted to a decibel scale, and band-pass filtered.

- The signal is squared.
- The weighting factor is calculated \( w = e^{-\frac{1}{\tau}} \), where \( s \) is the sampling frequency of the data, and \( \tau \) is the averaging period, which is in this case 0.005 s.
- Calculate \( G \), the 5 ms averaged signal with \( G(n) = (1 - w)S(n) + w \cdot G(n - 1) \), where \( G(n) \) is the \( n \)th element of the 5 ms time averaged signal, and \( S(n) \) is the \( n \)th element of the squared A-weighted signal.
- \( G \) is resampled to 200 Hz. Where the original sample rate is a multiple of 200 Hz, this can be calculated by electing only every \( \left(\frac{\text{sample rate}}{200}\right)^{th} \) data point. The exponential averaging shall be taken to be provide sufficient low pass filtering to minimise aliasing.
- \( G \) is converted to decibels using:

\[
L_{(A),\tau=5\text{ms}} = 10 \log_{10}\left( \frac{G}{(2 \times 10^{-5})^2} \right) \text{dB}, \text{ for each element, yielding } L_{(A),\tau=5\text{ms}} ,
\]
the 5 ms sound pressure level.

- \( L_{(A),\tau=5\text{ms BAND-PASS}} \) is calculated by band-pass filtering \( L_G \) between 5 and 80 Hz, using a sixth order (roll-off of -120 dB per decade) Butterworth (maximally flat magnitude) band-pass filter.

- The Modulated Root Mean Square metric is calculated as the time averaged 300 ms Root Mean Square of \( L_{(A),\tau=5\text{ms BAND-PASS}} \).
  - Modulation\(_{\text{squared}}(n) = L_{(A),\tau=5\text{ms BAND-PASS}}(n)^2 \)
  - The weighting factor is calculated \( w = e^{-\frac{1}{\tau}} \), where \( s \) is 200 Hz, and \( \tau \) is the averaging period, which is in this case 0.3 s.
  - Calculate modulated Root Mean Square of the 0.3s time averaged signal with:

\[
\text{MS}(n) = (1 - w)\text{Modulation}_{\text{squared}}(n) + w \cdot \text{MS}(n - 1) ;
\]
where \( \text{MS}(n) \) is the \( n \)th element of the 0.3 s time averaged signal.
  - \( \text{RMS}(n) = \sqrt{\text{MS}(n)} \)

The measured modulated Root Mean Square for the signal is the maximum of this Root Mean Square over the duration of the drive by of the vehicle. This maximum should not include data from at least the first 0.5 s after the start of measurement since:
a) The time averaging takes time to stabilise, and
b) The early part of the Modulated Root Mean Square can be dominated by the step response of the Butterworth filter.
APPENDIX C — SUMMARY OF STAKEHOLDER COMMENTS RECEIVED ON THE DRAFT PROPOSAL AND DRAFT REGULATORY IMPACT STATEMENT RELEASED IN JUNE 2006

The NTC received forty-two submissions on the draft engine brake noise proposal and draft regulatory impact statement released in June 2006.

The majority of submissions agreed that there is a problem with noisy engine brakes. Some of these submissions said that noise from engine brakes is a problem at all times of the day in some locations, and it was acknowledged by several that the noise was more noticeable and more irritating at night.

One submission said the truck industry suffers from perception issues and that a resolution of noise from engine brakes will go a long way to improving the public’s perception of this industry, which is particularly important given the projected growth of freight in the future.

The Australian Trucking Association has some significant concerns with the proposed option. The Australian Trucking Association said excessive noise from engine brakes is a problem in some areas but that this is largely confined to a particular group of older, poorly maintained trucks. The Australian Trucking Association was supportive of establishing an in-service standard although it believes that the follow-up enforcement action needs further development, for example, give a first warning to the vehicle owner before harder penalties.

Similar issues were raised by submissions and these are discussed below.

**Engine Brakes and Safety**

A key concern in many submissions was if there was a safety risk of not using engine brakes. The draft proposal discusses independent research that argues that engine brakes provide additional braking for long slow descents where heavy vehicles are prone to the brakes fading.

A number of submissions supported this view and advised that any measures taken against engine brake noise should consider the safety consequences of restrictions in downhill areas. This included the option to introduce no modulation routes or zones.

The submission from Ararat Rural City supported the introduction of no modulation routes but notes that these routes should not be applied where engine brakes are required for assistance, for example in the descent of hills.

The submission from the Australian Trucking Association asserts that even though engine brakes are often referred to as ‘auxiliary’ or ‘secondary retarders’ they are in fact an integral part of the braking and speed management system on a heavy vehicle. Furthermore, to prohibit the use of engine brakes at any time, irrespective of the gradient, can pose a safety risk because engine brakes act in tandem with service brakes in emergency stopping situations.

Additionally, the Australian Trucking Association is not supportive of any proposal that may hamper a driver’s ability to legally apply maximum retardation during an emergency stop in any area. The Australian Trucking Association argues that education and incentives to upgrade the fleet are a more appropriate response and that the proposed
option adds unnecessary regulatory burden to the industry without acknowledging significant parts of it that do not contribute to the problem.

The submission from the Department of Environment and Conservation NSW suggests that in an emergency braking situation, service brakes should apply enough pressure to the extent where a vehicle will start to skid, and that in this situation, engine brakes are unlikely to have any additional effect on stopping. The Department of Environment and Conservation submission supports the need for engine brakes on long, steep descents based on reducing the safety risk.

Another submission questions the legitimacy of the need for engine brakes for safety purposes citing a company that purposefully disengaged the engine brakes on their trucks because drivers may be become lazy and complacent, relying unduly on engine brakes, which may lead to bad driving.

There was also comment that the fitment of disc brakes and on trucks and trailers would give improved braking performance, fade resistance and stability.

**Education**

A number of submissions commented that effective education, both to the community and truck drivers, could contribute to raising awareness about what is an acceptable level of noise, and how this can be reached through better maintenance and driving practices.

A number of submissions commented that not all trucks emit the same noise from the engine brakes. One submission commented that it might be more helpful for residents of hills to have a better understanding about why engine brakes are used, but at the same time drivers need to be educated about correct gear selection which can lead to minimising noise. Another submission suggested that trucks that are not fully laden and travelling quite fast appear to not slow down early enough and often emit more noise than other trucks. It was suggested that smoother driving practices in this situation would help improve the overall noise emission.

The draft proposal discusses noise from engine brakes becoming worse if mufflers degrade, become modified, or are simply inadequate. The Australian Trucking Association believes that industry could benefit from education about how this can lead to an increase in noise emissions. The Australian Trucking Association cites the example of an ‘engine brake exclusion zone’ in South Australia where education for drivers was part of a measure that has successfully reduced noise complaints in this area.

The Australian Trucking Association’s submission argued significant gains have been made through voluntary actions and signage in sensitive areas and notes a study in South Australia where a 50 per cent reduction in noise from engine brakes was reported since the erection of signs. The Australian Trucking Association also claims that the introduction of no modulation routes will result in misuse as they will proliferate as a quick fix to stop public complaints and could adversely affect productivity.

The Department of Environment and Conservation notes that in NSW, some educational initiatives including brochures, advertisements, and advisory signs have been used for some time and there is no evidence that these have had any real impact on reducing noise from engine brakes.

The Ararat Rural City said that engine brake advisory signs for engine brakes in numerous locations within the municipality have been ineffectual.
No Modulation Routes or Zones

Many submissions commented on the proposal for no modulation routes or zones. A number of submissions supported the introduction of no modulation routes or zones as long as the safety aspect was considered. Generally, the submission agreed no modulation zones would only be effective if adequately policed, as the ‘voluntary’ examples currently in place did not appear to be effective. Noise cameras are seen as key to success of the no modulation zones.

The Ararat Rural City supports that no modulation routes should be used where safe to do so, and notes that they could be applied during specific hours of operation.

The Westlink Motorway Limited supports a mechanism for prohibiting engine brakes with modulation in specified zones or routes, although notes that the proposal is for restricted areas to be relatively low speed and relatively flat, which would rule out motorways. This submission pointed to particular problem areas on motorways that could benefit from being a no modulation route. They argued that modern high-grade motorways provide a very safety driving environment and could benefit from a reduction in modulation without adversely affecting safety.

The Department of Environment and Conservation NSW notes that the Roads and Traffic Authority NSW has erected about forty advisory signs around Sydney and that there was no discernable change in noise. This submission also cites a study undertaken in Western Australia in 2003 that showed no discernible change due to the introduction of advisory signs.

One submission suggested that engine brakes should only be allowed on gradients over a designated steepness with a 4.5 per cent gradient suggested.

Setting a ‘Limit’ for the In-service Engine Brake Noise Standard

A submission from the Exhaust System Professional Association Limited believed the introduction of an in-service standard for engine brake noise might result in better exhaust systems design and maintenance practices.

One submission said enforcement should be left to the discretion of police or the State transport authorities.

In-service Maintenance

Comments were made about in-service maintenance practices. One submission suggested that vehicles with modified, non-compliant exhaust systems could be identified at weight stations and then marked with a red sticker.

Another submission said there should be a mechanism in place to police defective mufflers, and that the in-service standard for noise from engine brakes would assist in this.

Acknowledgement of Responsible Drivers and Operators who are ‘Already Doing the Right Thing’

A number of submissions said there are many responsible operators and drivers who already take steps to minimise noise from engine brakes, through choosing quiet technology and also optimising the driving habits. One submission suggested incentives should be given to drivers who do the right thing regarding noise from engine brakes.
Other Comments

Some other comments included:

- The Ararat Rural City Council recommended allowing a lead-in time, to give industry the opportunity to bring vehicles up to compliance level, and recommends six months for this. A lead-in time would also allow local governments to run implementation trials.

- The Environment Protection Authority Victoria notes new vehicle design standards have been very effective in delivering reductions across the fleet to date and while a combination of this with an in-service approach may deliver the best outcomes, in-service programs tend to be more costly.

- Several submissions noted that engine brake noise is not a problem in Europe or Japan and suggested that trucks should meet the European Standards as a way of minimising noise emissions.


<table>
<thead>
<tr>
<th>Submission Number</th>
<th>Name</th>
<th>Organisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>N Blatch</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>2</td>
<td>S W Schultz</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>3</td>
<td>Flan Clearly</td>
<td>Westlink Motorway Limited</td>
</tr>
<tr>
<td>4</td>
<td>Robert Johnston</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>5</td>
<td>Brian Collin</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>6</td>
<td>D Nugent</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>7</td>
<td>Siraj Haq and Andrew Dyson</td>
<td>Kensington Residents Association Incorporated</td>
</tr>
<tr>
<td>8</td>
<td>John and Barbara Coleman</td>
<td>Private Citizens</td>
</tr>
<tr>
<td>9</td>
<td>Dallas Quinn</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>10</td>
<td>Stuart St Clair</td>
<td>Australian Trucking Association</td>
</tr>
<tr>
<td>11</td>
<td>Bernard Grinberg</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>12</td>
<td>Ian Mitchell</td>
<td>Ararat Rural City</td>
</tr>
<tr>
<td>13</td>
<td>Ian Butterworth</td>
<td>Maribyrnong City Council</td>
</tr>
<tr>
<td>14</td>
<td>George Houen</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>15</td>
<td>Chris Shevellar</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>16</td>
<td>Con Efremidis</td>
<td>Frankston City Council</td>
</tr>
<tr>
<td>17</td>
<td>Christa Sams</td>
<td>Sydney Ports</td>
</tr>
<tr>
<td>18</td>
<td>Carol Darroch</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>19</td>
<td>Mick Bourke</td>
<td>Environment Protection Authority Victoria</td>
</tr>
<tr>
<td>Submission Number</td>
<td>Name</td>
<td>Organisation</td>
</tr>
<tr>
<td>-------------------</td>
<td>-------------------------------</td>
<td>---------------------------------------</td>
</tr>
<tr>
<td>20</td>
<td>Barry Houghton</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>21</td>
<td>Thomas Connor</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>22</td>
<td>Martin Gell</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>23</td>
<td>Milton and Theresa Scaysbrook</td>
<td>Private Citizens</td>
</tr>
<tr>
<td>24</td>
<td>Alan Bond</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>25</td>
<td>John Cunningham</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>26</td>
<td>Bob Johnston</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>27</td>
<td>Tim Nott</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>28</td>
<td>Peter Knight</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>29</td>
<td>Noel Wynn</td>
<td>Exhaust Systems Professional Association Limited</td>
</tr>
<tr>
<td>30</td>
<td>Andrew Bullen</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>31</td>
<td>Dennis Gellert</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>32</td>
<td>Robyn Green</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>33</td>
<td>Arthur Mason</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>34</td>
<td>Rhonda Cooper</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>35</td>
<td>Nigel Nicol</td>
<td>Owner/Operator</td>
</tr>
<tr>
<td>36</td>
<td>Cliff Beazley</td>
<td>Port Ash Ship Handling Centre</td>
</tr>
<tr>
<td>37</td>
<td>Graeme Marshall</td>
<td>Department of the Environment and Heritage</td>
</tr>
<tr>
<td>38</td>
<td>Sally Barnes</td>
<td>Department of Environment and Conservation</td>
</tr>
<tr>
<td>39</td>
<td>Alan Barrett</td>
<td>Private Citizen</td>
</tr>
<tr>
<td>40</td>
<td>Les Wielinga</td>
<td>Roads and Traffic Authority NSW</td>
</tr>
<tr>
<td>41</td>
<td>David Anderson</td>
<td>VicRoads</td>
</tr>
<tr>
<td>42</td>
<td>Dan Hunt</td>
<td>Queensland Transport</td>
</tr>
</tbody>
</table>
## APPENDIX D – ENFORCEMENT COSTS FOR OPTION 2

<table>
<thead>
<tr>
<th></th>
<th>N.S.W</th>
<th>Vic</th>
<th>Qld</th>
<th>S.A.</th>
<th>W.A.</th>
<th>Tas</th>
<th>A.C.T</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>No. of cameras</strong></td>
<td>9</td>
<td>8</td>
<td>9</td>
<td>6</td>
<td>8</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td><strong>No. of sites</strong></td>
<td>27</td>
<td>22</td>
<td>25</td>
<td>22</td>
<td>22</td>
<td>12</td>
<td>6</td>
</tr>
<tr>
<td><strong>Total set up costs</strong></td>
<td>$621,000</td>
<td>$556,000</td>
<td>$615,000</td>
<td>$456,000</td>
<td>$556,000</td>
<td>$326,000</td>
<td>$191,000</td>
</tr>
<tr>
<td><strong>Total operating costs over 10 years</strong></td>
<td>$1,402,000</td>
<td>$1,074,000</td>
<td>$1,306,000</td>
<td>$1,119,800</td>
<td>$1,358,000</td>
<td>$925,600</td>
<td>$494,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>$2,023,000</td>
<td>$1,630,000</td>
<td>$1,921,000</td>
<td>$1,575,800</td>
<td>$1,914,000</td>
<td>$1,251,600</td>
<td>$685,000</td>
</tr>
</tbody>
</table>