Review

of the

National Environment Protection (Diesel Vehicle Emissions) Measure

Discussion Paper

October 2006

TABLE OF CONTENTS

1 BACKGROUND

1.1 NATIONAL ENVIRONMENT PROTECTION COUNCIL

The National Environment Protection Council (NEPC) is a national body established by State, Territory and Commonwealth Governments. The objective of the NEPC is to work cooperatively to ensure that all Australians enjoy the benefits of equivalent protection from air, water, soil and noise pollution and that business decisions are not distorted nor markets fragmented by variations in major environment protection measures between member Governments. The NEPC stems from the Inter-Governmental Agreement on the Environment (IGAE) 1992, which agreed to establish a national body with responsibility for making National Environment Protection Measures (NEPMs). The NEPC and its operations are established by the National Environment Protection Council Act 1994 (Commonwealth) and corresponding State and Territory Acts. Since May 2002, NEPC has met in conjunction with the Environment Protection and Heritage Council (EPHC). NEPC remains the legal entity for developing and making NEPMs.

NEPMs are broad framework-setting statutory instruments, which, through a process of inter-governmental and community/industry consultation, reflect agreed national objectives for protecting particular aspects of the environment. NEPMs may consist of any combination of goals, standards, protocols, and guidelines.

Implementation of NEPMs is the responsibility of each participating jurisdiction. A NEPM will take effect in each participating jurisdiction once it is notified in the Commonwealth of Australia Gazette, but is subject to disallowance by either House of the Commonwealth Parliament. Any supporting regulatory or legislative mechanisms that jurisdictions might choose to develop to assist in implementation of proposed NEPMs go through appropriate processes in those jurisdictions.

1.2 DIESEL NEPM

The National Environment Protection (Diesel Vehicle Emissions) Measure (Diesel NEPM) was made by Council on 29 June 2001 and gazetted on 18 July 2001. The NEPM forms part of an integrated suite of approaches to manage emissions from diesel vehicles which includes: emission standards for new vehicles; clean fuels; ensuring compliance of in-service vehicles with emission standards; and reducing vehicle use and encouraging efficient driving behaviour.

The scope of the NEPM is to provide guidelines for developing programs to minimise the deterioration in exhaust emissions performance, or improve exhaust emissions performance, from diesel vehicles while they are in service.

The Goal of the NEPM is to reduce exhaust emissions from diesel vehicles, by facilitating compliance with in-service emissions standards for diesel vehicles.

The Desired Environmental Outcome of this NEPM is to reduce pollution from in-service diesel vehicles.

Clause 16 of the NEPM sets out the need for review after five years and the scope for the Review which is discussed below.

2 PROCESS FOR THE REVIEW

2.1 REVIEW TEAM

The review is being conducted by a Review Team comprising a chairperson representing the Australian Government on NEPC Committee, and members from the Australian Government Department of the Environment and Heritage and Department of Transport and Regional Services (DOTARS), New South Wales Department of Environment and Conservation (DEC) and Roads and Traffic Authority (RTA), Western Australian Department of Environment and Conservation, EPA Victoria, the National Transport Commission (NTC), the Northern Territory Department of Planning and Infrastructure and South Australian Department for Transport, Energy and Infrastructure. The NEPC Service Corporation provides project management. The Review Team is accountable to the NEPC through the NEPC Committee and will prepare a report and recommendations to NEPC Committee and Council.

2.2 CONSULTATION

Consultation for this review is being undertaken via this Discussion Paper. The Paper is available on the EPHC website and you are invited to make submissions (see Section 2.6 below).

2.3 PROCESS

The review process will comprise the following components:

- Establishment of Review Team
- Development of a draft Discussion Paper
- Release of the Discussion Paper and call for submissions
- Assessment of submissions and preparation of a review report
- Submission of the review report and recommendations to NEPC Committee
- Transmission of the review report and recommendations to the NEPC.

2.4 TIMEFRAME

The review commenced in June 2006. This Discussion Paper was released on 19 October 2006, for an eight week consultation period, with comments closing on 15 December 2006. The Review Team will report back to NEPC in April 2007. If Council decides to vary the NEPM as a result of the Review, this process will begin in 2007.

2.5 TERMS OF REFERENCE FOR THE REVIEW

Clause 16 of the NEPM sets out the scope for the Review as follows:

> *(1) The effectiveness of the Measure in achieving the Goal and Desired Environmental Outcome set out within it.*
>
> - *The Goal of the Measure is to reduce exhaust emissions from diesel vehicles, by facilitating compliance with in-service emission standards for vehicles.*
> - *The Desired Environmental Outcome of the Measure is to reduce pollution from in-service vehicles*
>
> *(2) The resources available for implementing the Measure; and*
>
> *(3) The need, if any, for amending the Measure (in accordance with the Act), including:*
>
> - *whether any changes should be made to Schedule A*
> - *whether any changes should be made to improve the effectiveness of the Measure in achieving the Goal and Desired Environmental Outcome set out within it".*

2.6 PURPOSE OF DISCUSSION PAPER

The purpose of this Discussion Paper is to seek stakeholder input on the effectiveness of the Diesel NEPM, identify issues, and, where possible, make recommendations for NEPC to consider.

Throughout the Paper, questions are posed to assist stakeholders provide comment. These questions are for guidance only and are not intended to limit comment on issues relevant to the review of the Diesel NEPM. A template for submissions is available from the EPHC website at www.ephc.gov.au The Review Team requests that you use this template to assist the collation of responses.

It is important to note that in developing this discussion paper the project team considered at some length alternative fuels and vehicle conversions that enable use of alternative fuels. Whilst it is acknowledged that alternative fuels and conversions may offer potentially significant emissions benefits relating to the performance of in-service diesel vehicles, they are not referenced within this discussion paper for the following reasons:

- the preamble to the NEPM specifies that the scope of the NEPM is to provide a framework for the management of in-service emissions from diesel vehicles
- alternative fuels and conversions are the subject of a significant volume of work outside of the Diesel NEPM activities, and on this basis it is not thought useful to duplicate this work within the scope of the NEPM, and
- the Diesel NEPM has little capacity to influence the choice of fuel made by the operator for use in their vehicle.

Submissions addressing the issues raised in this paper or any other issues related to the Diesel NEPM should be sent to:

Mr Haemish Middleton
Project Officer
NEPC Service Corporation
Level 5, 81 Flinders St
Adelaide 5000
08 8419 1209
hmiddleton@ephc.gov.au

COMMENTS CLOSE ON 15 DECEMBER 2006

3 CONTEXT

3.1 THE DIESEL NEPM

The purpose of the Diesel NEPM is to provide a framework for the management of in-service emissions from diesel vehicles that complements and protects the emissions improvement obtained from other regimes such as new vehicle standards and fuel quality standards.

The NEPM is structured with a mandatory requirement for jurisdictions to assess and report on the need to address in-service emissions in their jurisdiction. The NEPM sets out criteria to consider in making that assessment.

The Schedule to the NEPM sets out five guidelines that provide approaches for improving the maintenance and operation of diesel vehicles. Implementation of the guidelines is voluntary and they can be adapted to suit the specific circumstances of the jurisdiction.

The guidelines cover:

- smoky vehicle management;
- emission testing and repair programs that identify high polluting vehicles using a specified test, and repairing vehicles identified as high polluters;
- audited vehicle maintenance programs that would allow vehicle operators to demonstrate that they meet the standards through their own good maintenance practices;
- retrofit programs for use of advanced technologies for reducing vehicle emissions; and
- engine rebuild programs for improving the emissions performance of in-service diesel vehicles.

The NEPM is complemented by standards for the emissions of particles, oxides of nitrogen (NO_x) and smoke opacity for in-service diesel vehicles set out in Australian Vehicle Standards Rule (AVSR) 147A. The in-service Standards take into account the emission standard to which a vehicle was originally constructed, normal deterioration of engine components under adequate maintenance regimes and the emissions level at which vehicle repair invariably produces an improvement in emission performance.

Implementation of the Diesel NEPM by jurisdictions is discussed throughout this paper. For detailed reports on implementation of the Diesel NEPM, see NEPC Annual Reports at http://www.ephc.gov.au/nepc/annual_reports.html

3.2 DEVELOPMENTS SINCE THE NEPM WAS INTRODUCED

The Diesel NEPM was made because of concern of about the impact of air pollution on the community, in particular its adverse affect on the health of the community, the disproportionate contribution of diesel vehicles to urban air pollution and the forecast increased proportion of the transport load to be undertaken by diesel vehicles. The sections below consider the current situation with regard to these issues.

3.3 AIR POLLUTANTS FROM DIESEL VEHICLES

Motor vehicles are the major source category of air pollution in Australian cities. Diesel vehicle exhaust is a complex mixture of gases, including oxides of nitrogen (NO_x), carbon

dioxide (CO_2) and hydrocarbons (HC), and particles. The pollutants of most concern from diesel vehicles are particles and NO_x.

3.3.1 Particles (PM_{10} and $PM_{2.5}$)

Respirable particles, those with a diameter of less than 10 microns (μm) (commonly referred to as PM_{10}) are a particular health concern as they are easily inhaled and retained in the lung. While particles are emitted by both diesel and spark ignition engines, diesel sources dominate. The particles may also adsorb potentially health threatening organic "air toxics" (such as benzene, 1,3-butadiene, acetaldehyde and formaldehyde) found in engine exhaust.

Long and short-term exposure to PM_{10} is associated with a wide range of respiratory symptoms, hospital admissions and increased deaths from heart and lung disease. No threshold for the health effects of particles has been identified. The elderly, children, and people with respiratory infections or pre-existing health or lung disease are particularly susceptible to the effects of particles.

There is increasing evidence that the adverse health effects of particles are more closely associated with the $PM_{2.5}$ size fraction. Their combination of extremely small size and chemical composition creates strong concerns about their effects on human health. Their small size increases the likelihood that the particles will carry irritants and toxic compounds into the deepest and most sensitive areas of the human lungs.

3.3.2 Ozone (O_3)

Ozone, as the main component of photochemical smog, is a secondary pollutant formed when emissions of volatile organic compounds and oxides of nitrogen react in the presence of sunlight. It is a highly irritating substance that has effects on various parts of the respiratory tract.

Epidemiological studies show an association between ozone levels and increased hospital admissions for respiratory disease and cardiac conditions, increased emergency room visits for respiratory disease (including asthma) and with increases in respiratory symptoms, airway responsiveness and decreases in lung function. Studies have also shown an association between ozone and mortality (especially from respiratory and cardiovascular causes).

3.3.3 Nitrogen Dioxide (NO_2)

NO_2 is an oxidising agent that can cause both short and medium term impacts. It is one of the several oxides of nitrogen which are largely produced by human activities such as combustion processes. Around 80% of ambient NO_2 in urban areas comes from motor vehicles.

NO_2 impairs the immune defence mechanisms of the lung, resulting in increased susceptibility to respiratory infections, especially in children and asthmatics, and reduces lung function at high levels. NO_2 enhances the effects of exposure to other known irritants such as ozone, sulfur dioxide, and particles. Asthmatics and people with pre-existing respiratory disease are particularly susceptible to NO_2 exposure. Epidemiological studies have found associations between nitrogen dioxide and hospital admissions.

The health costs of these pollutants are substantial. For example the Fuel Quality and Vehicle Emission Standards Cost Benefit Analysis Review prepared for the national Review of

Vehicle Emission and Fuel Standards Post 2006 (released October 2003) provided the following guide to the health costs of these pollutants.

Average capital city health cost saving per tonne of emission

Emission Type	Air Quality Impact	Health Savings ($/tonne of pollutant)
Oxides of Nitrogen	Nitrogen Dioxide	$60
Oxides of Nitrogen	Ozone	$8,500
Particles (PM_{10})	Particles (PM_{10})	$232,000

Note: These figures are estimates only and will vary according to the degree of population exposure.

3.4 DIESEL VEHICLE TRENDS

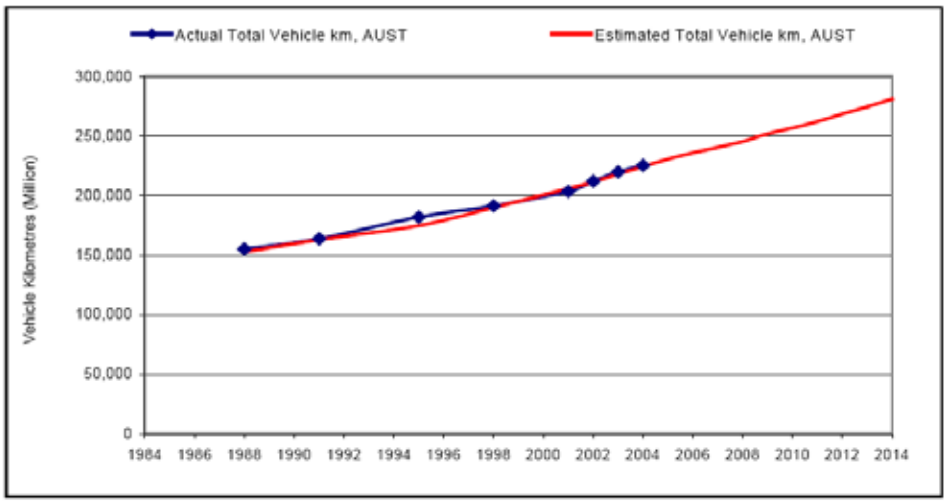
Diesel fuelled vehicles are the dominant vehicle type used in heavy commercial transport activities, with 86% of trucks and buses over 3.5 tonnes operating on diesel (ABS, 2005). They are also widely used in light commercial vehicles making up almost 30% of the fleet. The recent *Twice the Task* report published by the National Transport Commission highlights significant growth forecasts in freight transport activity over the next 10-15 years. While there are differing views as to the magnitude, timing and location of the increase, there is broad agreement on the general trend.

In the Diesel NEPM context, emissions in urban areas are of most concern. The NTC report concludes that "adverse impacts {from the increase in freight transport} will be greatest in urban areas", with the Bureau of Transport and Regional Economics (Report 112) estimating that freight in Australia's cities will increase by 80% in the 17 years between 2003 and 2020. The estimated growth rates vary from city to city, with the highest annual growth expected in Darwin, Brisbane and Perth (3.7%, 3.6% and 3.3% respectively) and the lowest in Adelaide and Hobart (2.4% and 2.3%).

Road transport is the dominant freight mode in urban areas, with very little urban freight travelling by rail. Forecasts also indicate that most of the freight growth will be in road transport, with most modal shift to rail or shipping occurring on longer transport corridors. In urban areas, the rate of growth in vehicle travel of commercial vehicles is anticipated to be highest in light commercial vehicles, even though they carry only a small proportion of the freight (see Figure 2 below). Thus, whether considered in freight or traffic growth terms, road transport will continue to be the major source of emissions to the urban airshed from the transport sector.

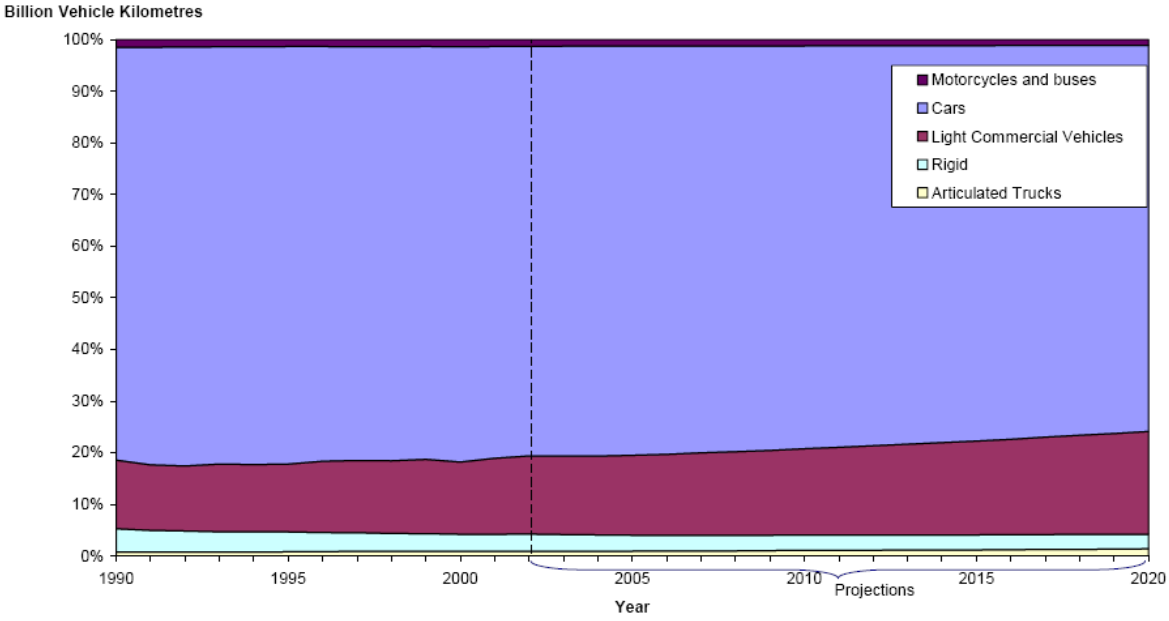
Figure 1 below demonstrates that vehicle use, as measured by vehicle kilometres travelled, will continue to increase and Figure 2 demonstrates that an increasing proportion of that will be by diesel vehicles. The trends forecast in the Impact Statement for the Diesel NEPM are being borne out in practice and this suggests an ongoing need to ensure that diesel vehicles are maintaining their emissions performance in service.

Figure 1 Projected and Actual Vehicle Use in Australia



Source:
Apelbaum Consulting Group.

Figure 2 Metropolitan Vehicle Kilometres Travelled by Vehicle Type 1990-2020



Source: Gargett, D. and Cosgrove, D (2004) Predicting Traffic Growth in Australian Cities: BTRE Staff Paper presented at Australasian Transport Research Forum, 29 September – 1 October, Adelaide.

3.5 IMPACT OF NEW VEHICLE STANDARDS

3.5.1 Status of Standards[1]

Since the finalisation of the Diesel NEPM, there have been significant improvements in diesel vehicle emission standards, as well as complementary improvements in diesel fuel standards. In 2002, sulfur in diesel was capped at 500 parts per million (ppm) under the *Fuel Quality Standards Act 2000* (Commonwealth). In January 2006, the permissible sulfur limit decreased to 50 ppm and will further decrease to 10 ppm in 2009.

The data used to underpin the measures set out in the schedules to the NEPM were derived from diesel vehicles certified, at best, to Australian Design Rule (ADR) 70/00. ADR70/00 adopted Euro 1 emission standards, and accepted US 1991 and Japan 1993 standards as alternatives. Many pre-1996 model vehicles met basic smoke standards only.

In 2002, ADR80/00 was introduced and applied the Euro 3 standards and accepted the US 1998 standards (for model year 2000 or later) as alternatives. From 2007, Euro 4 (or US 2004) will become the minimum standard, with Euro 5 (or US 2007 or Japan JE05 Long Term) taking effect from 2010.

Similarly, there have been changes for light diesel vehicles. ADR79/00 adopted Euro 2 for diesels from 2002, and ADR79/01 adopted Euro 4 for diesels from 2006.

ADR30/00 which dealt with smoke emissions has been replaced by ADR30/01. This was largely an editorial process to remove redundant standards and had little impact on the effective smoke standards, which have changed little over the past decade or more.

3.5.2 Impact on Diesel NEPM

The introduction of ADR79/00, ADR80/00 and later standards will significantly reduce the emission levels from diesel vehicles. The later standards in particular will lead to the introduction of external emission control devices such as oxidation catalysts and particle traps, and in some vehicles (mainly European), the use of selective catalyst reduction equipment which utilises reagents such as urea to maintain emissions compliance.

4 ASSESSMENT OF THE EFFECTIVENESS OF THE NEPM

4.1 OVERALL EFFECTIVENESS OF THE NEPM

The effectiveness of the specific guidelines contained in the Diesel NEPM is discussed below. The Review Team seeks feedback from stakeholders on their assessment of the overall effectiveness of the NEPM. Indicators of the effectiveness of the NEPM may include its capacity to provide:

- a framework to undertake activities to reduce diesel vehicle emissions and maximise the benefit of other measures, such as new vehicle standards, by ensuring that vehicles perform as intended
- information on the changed profile of the fleet

[1] The applicability dates quoted for the ADRs reflect the year in which the new standard took effect – typically new models introduced on or after 1 Jan of the given year had to comply with the new ADR, while existing models had until the end of the year to either be re-certified to the new ADR or be withdrawn from the market.

- estimates of diesel vehicle emissions improvement based on data from implementation of programs
- improved training and knowledge of the diesel vehicle repair industry, operators and regulators.

Comment is invited on the following:
What is your assessment of the overall effectiveness of the Diesel NEPM in achieving its goal and desired environmental outcome?

4.2 SCHEDULE A1: GUIDELINE ON SMOKY VEHICLE PROGRAMS

4.2.1 Description of Schedule

The objectives of the guideline on smoky vehicle programs are to improve the emissions performance of in-service diesel vehicles by:

- providing a means of detecting vehicles emitting excess smoke;
- requiring the repair of vehicles emitting excessive smoke; and / or
- encouraging vehicle owners to regularly tune and maintain their vehicles.

Most jurisdictions have some form of smoky vehicle program in operation, be it public or authorised officer reporting. Most jurisdictions utilise the 10 second rule as the legislative backing for their programs.

4.2.2 Status of Implementation

Jurisdictions have implemented smoky vehicle programs in a number of ways. This is due to different legislative powers and education and enforcement models. The legislation available and programs implemented are detailed below.

4.2.3 The 10 second rule

The AVSR require a vehicle that is subject to an ADR when built or imported to continue to comply with the ADR. The 10 second rule for visible emissions is introduced under the AVSR. This rule stipulates that a vehicle must not emit visible emissions for a continuous period of at least 10 seconds.

4.2.4 Public (community) reporting programs

Most jurisdictions operate a public reporting program for reporting smoky vehicles. A smoky vehicle is deemed to be one that emits smoke continuously for more than 10 seconds. These programs are designed to allow the public to report vehicles which have excessive smoke emissions and encourage their repair by providing some form of follow-up. Reporting of a smoky vehicle may result in a warning letter to the owner of the vehicle to indicate that there may be problem with the vehicle.

Public reporting programs use a variety of methods for reporting including phone hotlines, internet, email and vouchers, booklets or reporting cards that can be filled out and sent in. Using one or more of the above increases the ease with which reports can be made, increasing the number of reports and the likelihood of detecting those vehicles emitting excessive smoke.

The registering of reporters, including simple training, can be used to reduce the number of false or vexatious reports.

A review of the WA reporting program in 2005 found the program effective in educating the owners of smoky vehicles on the need for repair. However, without an enforcement provision, the program was seen to be less effective. In response, the WA program will be improved to include active follow up on repeat reports.

4.2.5 Authorised Officer reporting programs

Several jurisdictions, including NSW and Victoria, have in place Regulations for smoky vehicles which allow enforcement of the requirements of the 10 second rule. In NSW, the Protection of the Environment Operations (Clean Air) Regulation 2002 provides the regulatory basis for action to address emissions from the in-service diesel fleet. Specifically, the Regulation prohibits excessive visible smoke emissions from vehicles and tampering with emission control equipment.

Similarly, in Victoria, compliance is required with the Environment Protection (Vehicle Emissions) Regulations 2003 which recognise the 10 second rule. Reports are submitted from EPA or Police officers in writing using a standard spotting form.

The registered owners of these vehicles are sent a warning letter requesting they fix their vehicle. The letter contains the date, time and location of the offence. They are warned of potential fines should they be reported again. They are not required to reply or submit evidence of compliance.

Experience has shown that only a very small number are repeat or serial offenders. These offenders can be issued with further warnings requiring evidence of compliance, infringement notices, attendance for an inspection by EPA officers or court prosecution. Officers reporting vehicles are aware that the report may result in a fine being issued or a court prosecution.

NSW DEC, RTA and Police officers are able to issue warning notices, fines, inspection notices and defective vehicle notices to owners of excessively smoky vehicles. In some serious cases, and for some repeat offenders, prosecutions are launched.

In a number of other jurisdictions Transport Inspectors, Authorised Inspectors and Police, involved in the inspection of motor vehicles for roadworthy purposes are able to defect or not pass a vehicle for registration for vehicles which fail the 10 second rule.

4.2.6 Issues

The effectiveness of smoky vehicle programs depends on both education and enforcement. Smoky vehicle programs lacking one of these aspects are likely to be less effective. The current guidelines under Schedule A1 recognise this.

Effectiveness is also determined by whether a program is supported by legislative instruments, the level of resourcing and the manner of operation of reporting programs.

Victoria is considering requiring that any diesel engine heavy vehicles reported under the program must attend a DT80 test facility to obtain a “certificate of compliance”. This legal mechanism is available under existing legislation and is currently used for vehicles reported for excessive noise (Environment Protection Act 1970 Section 55AC).

The relationship between smoke (observed by the 10 second rule) and particles is described 'as not showing a strong correlation' in the NEPM schedule. However, indications based on vehicle testing to date are that there may be a stronger correlation between smoke and particle emissions. The schedule may require changing to reflect this.

Emerging technologies may be useful for the detection of smoky vehicles. The use of cameras in conjunction with remote sensing equipment may allow the detection of smoky vehicles, which may be used as a trigger for follow-up.

NSW RTA has successfully trialled the use of remote sensing in conjunction with cameras in a road tunnel to identify smoky vehicles. This allowed follow up action to seek repair to the vehicles and also improved the local air quality within the tunnel.

An emerging issue is the appropriateness of the 10 second smoke rule for newer (post ADR 70/00) vehicles. Any smoke is an indication of possible mechanical fault. Although a vehicle may emit smoke for less than 10 seconds, it may still be appropriate for such vehicles to be reported as a 'smoky vehicle'.

Comment is invited on the following:

- Does the current guideline for smoky vehicle programs provide an effective means of reducing pollution from diesel vehicles?
- Are smoky vehicle programs an effective means of reducing pollution from diesel vehicles?
- Can you suggest changes to improve the effectiveness of the guideline for smoky vehicle programs?

4.3 SCHEDULE A2: GUIDELINE ON EMISSION TESTING AND REPAIR PROGRAMS

4.3.1 Description of Schedule

The schedule outlines the requirements for a program intended to minimise the deterioration in emission performance of diesel vehicles by:

- testing vehicles on a standardised test;
- assessing their emissions performance against a pass/fail level;
- requiring vehicles that fail to be repaired;
- re-testing the repaired vehicle against the standardised test.

AVSR Rule 147A specifies the DT80 test as the standardised test for test and repair programs.

4.3.2 Status of implementation

To date no jurisdiction has fully implemented a test and repair program. NSW has tested almost 3,000 vehicles and has repaired and retested a proportion of these vehicles, but has not introduced a comprehensive test and repair program. Victoria has introduced the DT80 test and test standards into legislation and has completed some testing and repair of vehicles but has not yet implemented a formal test and repair program. In Queensland, the Brisbane City Council provides testing in accordance with the DT80 test at a vehicle emission testing facility based at its CityFleet depot. To date, more than 400 diesel vehicles have been tested. South Australia is currently building a facility to undertake DT80 testing. Establishing facilities is an infrastructure project that can take two to three years to complete.

4.3.3 Issues

Test standards

The DT80 test is the linchpin of the Diesel NEPM. Passing a DT80 test is taken as evidence that a vehicle is in a satisfactory state of maintenance.

The data used to develop the DT80 test standards were derived from diesel vehicles certified, at best, to ADR70/00 which was implemented in 1996. ADR70/00 adopted Euro 1 emission standards, and accepted US 1991 and Japan 1993 standards as alternatives. Many pre-1996 model vehicles were also tested that only met basic smoke standards when new. This testing was conducted using high (over 1,000 ppm) sulfur content fuel. Current fuel standards specify less than 50 ppm sulfur in diesel fuel. It is known that reducing the sulfur content reduces exhaust PM emissions.

Although no formal test and repair programs have been started there has been substantial testing done using the DT80 test since the Diesel NEPM was introduced. The data from this testing were analysed and show that with the present test standards the failure rate is zero for some criteria. The limit allowed in the standard is sometimes well above the actual emissions of all of the vehicles tested. The opacity limit for late model vehicles is a particular example.

Results of DT80 testing has shown that increasing the stringency of new vehicle standards reduces in-service emissions. There is no DT80 test standard for the vehicles affected by emission ADRs introduced after the Diesel NEPM was finalised. In 2002 ADR80/00 was introduced for heavy vehicles and applied the Euro 3 standards (US 1998 standards (for model year 2000 or later) an alternative) and Euro 4 (or US 2004) will take effect from 2007 and Euro 5 (or US 2007 or Japan JE05 Long Term) from 2010. Similarly, there have been changes for light diesel vehicles. ADR79/00 adopted Euro 2 for diesels from 2002, and ADR79/01 adopted Euro 4 for diesels from 2006.

Standards for late model vehicles (post 2001) can only be determined by subjecting a representative sample of ADR80/00 and ADR79/00 compliant vehicles to the DT80 test. One question to consider is whether enough time has elapsed since 2002 to consider testing such vehicles in the near future, or whether more time is needed before pursuing an assessment of a reasonable level of emissions performance from in-service ADR79/00 or ADR80/00 vehicles.

Test equipment and procedure

Since the Diesel NEPM was developed almost 3,000 tests have been conducted.

The test procedure has proved to be relatively simple and reliable to conduct, however experience has demonstrated that often the first test is not a reliable indicator of performance and that test repeatability is only obtained from a 2nd and subsequent test. This suggests that perhaps the test procedure should be amended so that the test result is determined from the average of a 2nd and 3rd test run.

In addition, some vehicles fitted with speed limiting or governing devices, particularly buses, have been unable to reach the designated maximum speed of 80km/hr specified in the test procedure. It would be desirable to consider suitable amendments to the test procedure to accommodate such vehicles.

The test equipment has proven to be reliable in an industrial environment and to be capable of providing repeatable test results.

A key element of the test equipment has been the use of laser light scattering photometry (LLSP) to measure particles. Research in the Diesel NEPM preparatory projects showed that the LLSP method could provide an accurate real time measure of particle mass. The LLSP system has subsequently been used in Diesel NEPM related laboratory testing of alternative fuels and after-treatment systems. This testing has confirmed that the system can provide an accurate measure of particle mass.

Several DT80 test systems have now been purchased and there has been a continual refinement of the test system specifications. Further refinement may be necessary to ensure consistency of test results between systems, however this must be pursued within the constraints imposed by the intellectual property rights of different test equipment suppliers.

NATA Accreditation

Schedule 3 requires NATA accreditation for test systems. Consideration needs to be given to the need for this requirement, or whether alternative quality assurance requirements are acceptable. For example AS ISO/IEC 17025 contains the necessary elements for operation of a robust and legally-binding test system.

4.3.4 New developments

Particle Measurement

Because of their impact on health, extensive research is being undertaken to identify the nature of particle emissions involving considerable debate about how particles should be measured. This debate raises a question about the selection of PM_{10} mass as the standard for the DT80 test.

Particle emissions from vehicles are essentially all fine particles ($PM_{2.5}$) and have a bimodal size distribution, consisting of accumulation mode and ultrafine components.

The larger accumulation mode particles are mostly carbon agglomerates with adsorbed nanoparticles. The numbers of these particles are not sensitive to changes in measurement conditions and are easier to measure as mass than number.

Nanoparticles consist largely of “nuclei” mode particles comprising mostly volatiles. The measurement of these ultrafine particle emissions is very sensitive to measurement conditions, particularly the dilution ratio used in test equipment. The numbers of nanoparticles can vary by orders of magnitude as a result of changes to the measurement system, although there is little change in their total mass because of their small size. The numbers of these particles are also very sensitive to ambient temperature conditions in real life. They are essentially compounds in liquid form which become vapour as temperature rises.

There has been considerable debate about the merits of using particle number counts as a substitute for or complement to mass measurements. For the reasons outlined above it is difficult to use particle numbers in compliance testing of engines or as a measure of air quality. PM_{10} mass is still used to measure particles in ADR testing.

It is therefore concluded that it is reasonable to continue to measure PM_{10} mass for DT80 testing.

Second tier test

The DT80 test requires the use of a dynamometer and a collection of sample handling and measurement equipment. Although this equipment is significantly smaller and less complex than equipment previously needed for diesel emission testing, it is still bulky and relatively expensive. The development of a test that did not require a dynamometer and that could be done on the road with measurement equipment mounted in the vehicle would greatly assist in the extension of emission testing programs.

Consideration could be given to the introduction of a second tier test that could be used in place of the DT80 test in some circumstances or as a screening test for the DT80 test.

New technology (available and arising)

NSW has done some correlation testing between the DT80 test and a range of simpler, lower speed tests. Initial indications are that it will be possible to develop a simplified test that can be done on-road but which still has acceptable correlation with the DT80 test standard.

In conjunction with the simplification of the DT80 test, NSW has been examining the feasibility of simplifying the test equipment. Prototype "briefcase" size analysis units have been commissioned and are being tested to establish the correlation of their results with the analysis equipment currently used for the DT80 test. If this equipment is proven, it opens up the possibility of low cost equipment being made available to operators such that they are able to conduct testing as part of their routine maintenance. It may also provide an "on-road" option for jurisdictions to monitor diesel vehicles emissions performance

Link to other initiatives

It is noted that the DT80 test has been accepted in the environmental criteria which impact on eligibility for the fuel tax credit under the *Fuel Tax Act 2006* (Commonwealth). This Act is administered by the Australian Taxation Office (ATO), but the ATO has indicated it will recognise test reports from test facilities assessed by DOTARS as meeting minimum requirements. These requirements are specified on the DOTARS website at: http://www.dotars.gov.au/roads/environment/fuel_tax_credit/dt80.aspx. It may be beneficial to incorporate the elements of the DOTARS document into the Diesel NEPM Schedule A (2) guideline.

Comment is invited on the following

- Does the current guideline on diesel vehicle emission testing and repair programs provide an effective means of reducing pollution from diesel vehicles?
- Is there a need to review the DT80 test standards in the AVSR?
- Should the DT80 test equipment specifications in the AVSRs be updated?
- Should test equipment be NATA accredited?
- Would a simplified second tier test and test equipment assist the implementation of test and repair programs?

4.4 SCHEDULE A3: AUDITED MAINTENANCE PROGRAMS

4.4.1 Description of Schedule

The objective of this schedule is to improve the emissions performance of in-service diesel vehicles by ensuring they are maintained in a manner that can be shown to minimise excess emissions.

This schedule is based on the premise that a vehicle that has been maintained to the specifications of the manufacturer should not become a polluting vehicle. Audits of the maintenance regime ensure that vehicles are being maintained properly and ensure the credibility of the program.

4.4.2 Status of implementation

Progress has been made in developing and implementing audited maintenance programs. Considerable impetus has been given to these programs with the introduction from 1 July 2006 of the fuel tax credit. Membership of an audited maintenance program accredited by the Department of Transport and Regional Services (DOTARS) is one of the criteria for obtaining a fuel tax credit.

Below is a list of accreditation schemes available that can help reduce in-service emissions and discussion of the incentives for transport operators who become accredited.

National Heavy Vehicle Accreditation Scheme

The National Heavy Vehicle Accreditation Scheme (NHVAS) is a government scheme offered in South Australia, Victoria, New South Wales and Queensland. It is a voluntary scheme which currently offers mass and maintenance management modules. Becoming accredited means operators need to develop management systems to address the standards for the modules and undergo third-party audits.

The current incentive for heavy vehicle operators to be accredited under the NHVAS maintenance module is that they are not required to have the annual vehicle inspection which is required in some jurisdictions (Queensland and New South Wales for all vehicles, South Australia for restricted-access vehicles such as road trains and B-doubles).

The NTC is currently seeking accreditation of NHVAS for the purposes of the fuel tax credit. This will require some changes to the maintenance standards to bring them in line with the environmental guidelines issued by DOTARS.

Truck Safe maintenance module

TruckSafe Pty Ltd is a wholly owned subsidiary company of the Australian Trucking Association. TruckSafe is a business and risk management system, which is aimed at improving the safety and professionalism of trucking operator's nation wide. The modules offered by TruckSafe include:

- **Management** - Aimed at ensuring that a trucking operator has a documented business system that covers each of the standards.
- **Maintenance** - Aimed at ensuring vehicles and trailers are kept in a safe and roadworthy condition. This standard covers the requirements for daily checks, fault reporting and recording, fault repair, scheduled maintenance, maintenance records and documentation, maintenance responsibilities, internal review, and maintenance

training and education. TruckSafe maintenance also complies with NHVAS maintenance standards.

- **Workplace and Driver Health** - Aimed at ensuring that drivers are fit and healthy and Occupational Health and Safety requirements are met. This standard covers requirements for Workplace Health and Safety, Driver Health Screening (including medicals), the role of the medical practitioner, rehabilitation and fatigue management.
- **Training** - Aimed at ensuring that drivers are licensed, authorised and trained for the tasks, which they are undertaking.

Currently, only Queensland Transport offer TruckSafe-accredited operators in the maintenance scheme the regulatory concession of not requiring an annual inspection of vehicles (the same incentive as being accredited under NHVAS maintenance module.

Truck Safe is accredited by DOTARS as an audited maintenance program for the purposes of the fuel tax credit. Some changes were made to the maintenance modules to bring them in line with the environmental guidelines issued by DOTARS.

Clean Fleet

Clean Fleet is a voluntary audited maintenance program run by NSW RTA, designed to improve air quality by reducing vehicle emissions. Through the implementation of best practice fleet management and maintenance strategies, fleet owners and operators can establish themselves as being environmentally responsible.

Clean Fleet members need to comply with four Emission Management Standards:

- Standard 1 – Clean fuel. Fuel must be free of contamination and meet fuel quality standards.

- Standard 2 – Engine settings. Engines must meet manufacturer's specifications, particularly fuel pumps and injection timing.

- Standard 3 – Maintenance schedules and methods. Periodic Maintenance Schedules must define identified service periods and the tasks to be completed.

- Standard 4 – Fault identification and repair. Systems must be in place for the identification, assessment and action on reported emission contributing faults.

Membership of Clean Fleet is a requirement for operators contracted to the NSW Government for metropolitan bus service contracts. It is also a requirement for transport operators (e.g. waste management) entering new contracts with NSW Councils.

Clean Fleet is accredited by DOTARS as an audited maintenance program for the purposes of the fuel tax credit. Some changes were made to the maintenance standards to bring them in line with the environmental guidelines issued by DOTARS.

4.4.3 Issues

Experience from implementation

Implementation of these programs has shown that there is considerable operator interest provided the operators feel that they are entering a credible program and that they will obtain adequate public recognition for their participation. Financial incentives are an extra

bonus. Many operators are looking for programs such as Clean Fleet so that they can report their participation under "triple bottom line" reporting systems.

Communications

Communications with operators and repairers need to be undertaken on many levels. For example, the Diesel Emissions Awareness Program that has been run in NSW and Tasmania explains to operators the reasons for good maintenance. The feedback from operators and repairers regarding this program has been almost universally positive. The program has been run since late 2003 by NSW TAFE and is attracting around 300 to 400 people per annum. Elements of this course are available in an electronic version for distance education.

An eco-maintenance module has been developed jointly by EPA Victoria and Kangan Batman TAFE. This module provides specific training for diesel mechanic apprentices on maintaining emissions performance and is being used by other TAFEs in other states.

Foundation for other programs

Audited maintenance provides a good foundation for other programs. The communication around the development and implementation of audited maintenance programs raises operators' awareness of vehicle environment issues. Adequate maintenance also allows for retrofit devices to be fitted.

New developments

The successful development of a "briefcase" emissions analysis unit and a simplified second tier DT80 test will create the possibility of low cost equipment being made available to operators so that they can conduct their own emission tests as part of audited maintenance regimes.

Link to other initiatives

It is noted that the concept of audited maintenance programs has been reflected in the environmental criteria which impact on eligibility for the fuel tax credit under the Fuel Tax Act 2006. In order for a vehicle operator to use membership of an audited maintenance program as a means of demonstrating eligibility for the fuel tax credit, the program must be accredited by the DOTARS and meet a number of elements which are specified on the DOTARS website at: http://www.dotars.gov.au/roads/environment/fuel_tax_credit/accreditation.aspx. It may be beneficial to incorporate the elements of the DOTARS document into the Diesel NEPM Schedule A (3) guideline.

Comment is invited on the following

- Does the current guideline on audited maintenance programs provide an effective means of reducing pollution from diesel vehicles?
- What incentives could be introduced to improve participation?
- Is there a need to review the DT80 test standards in the AVSR?
- Would a simplified second tier test and test equipment assist the implementation of audited maintenance programs?

4.5 SCHEDULE A4: GUIDELINE ON DIESEL VEHICLE RETROFIT PROGRAMS

4.5.1 Description of Schedule

Significant air pollution reductions from the existing fleet of diesel vehicles can be obtained with currently available pollution after-treatment technologies developed to reduce vehicle emissions. This schedule provides guidelines to assist the development of programs to improve the emissions performance of in-service diesel vehicles by the fitment of exhaust after-treatment devices.

Progressively stricter national vehicle emission limits and fuel standards are reducing emissions from new diesel vehicles. Air pollutant emissions from the diesel fleet are expected to reduce in the future as the numbers of new vehicles that meet these tougher standards increase. However, diesel fleet turnover is slow due to the long lasting nature of diesel engines. Many diesel engines, that did not have to comply with emissions standards when new, will continue to operate for years into the future. In these circumstances refitting existing diesel vehicles with exhaust after-treatment devices designed to cost effectively reduce air pollutant emissions can be a viable strategy.

4.5.2 Status of Implementation

To date two jurisdictions, NSW and Victoria, are involved in implementation of diesel retrofit programs.

<u>NSW Diesel Retrofit Pilot Program</u>

The NSW Government is undertaking a Diesel Retrofit Pilot Program to improve the emissions performance of in-service diesel vehicles by fitting emission reduction devices to their exhausts. The pilot project was designed to assess the feasibility of implementing a broader diesel retrofit program in NSW, and to establish the benefits and costs of implementing such a program. The program was announced by the Premier in November 2004 and is funded by the NSW Environmental Trust and the Australian Government Diesel NEPM Implementation Program.

The final phase of the pilot is an operational trial of the after-treatment devices involving fitment to a number of different vehicles and evaluating their effect on engine emissions and operations. Under the current program funds are used to purchase and fit after-treatment devices; the RTA provides project management, technical support and the purchase and fitting of data logging equipment and operators provide the vehicles. To date around 60 after-treatment devices have been installed without any operational issues.

Performance indicator: Under the $1.5M program it is expected to be able to purchase and fit after treatment devices to around 450 older heavy duty diesel vehicles and reduce particle emissions by around 8 tonnes over the life of these vehicles.

<u>Victorian Program</u>

EPA Victoria has initiated a retrofit program in pursuing a formal agreement with Moreland City Council for fitment of Diesel Oxidation Catalysts to approximately 10 of their fleet of street-sweepers and waste-collection vehicles. A letter of nomination was issued in August 2006 as a stepping-stone towards a formal agreement for implementation of the program early-2006 / start-2007.

It is an aim of the program that, not only a quantified volume of pollutants be avoided from entering the atmosphere, but a project management framework will be established for continued implementation beyond the EPA/Commonwealth funded program. To this end novel means of securing uptake of the project management framework are being sought to overcome the present need for direct funding by government agencies.

4.5.3 Issues

Experience from implementation

The effectiveness of diesel retrofit programs in reducing emissions is broadly acknowledged. Such programs are now being implemented in a number of countries. In Australia, the NSW retrofit program has demonstrated particle emissions reductions of between 30 and 90% without any operational issues arising. However, there are few incentives for vehicle fleet managers or owner operators to retrofit in-service diesel vehicles, apart from reduced brake noise. Allocating further resources to diesel retrofit programs could contribute significantly in reducing particle emissions and their associated health costs. For example, under the 2007 budget for the US Environmental Protection Agency (US EPA), $50 million is allocated for a Diesel Emissions Reduction Program to support diesel retrofits. The US EPA estimates this amount will attract at least $100 million in funding assistance and reduce particle emissions by approximately 7,000 tons, achieving an estimated $2 billion in health benefits.

The goodwill and commitment of heavy vehicle fleet operators is a key factor in the success of retrofit programs. Accordingly, current Australian retrofit programs are designed to make the fitting and operation of devices as simple as possible, so that fleet operators then have confidence that there is no risk to their commercial operations. Based on the success of these initial programs further Government commitment could broaden the application of the programs. For example, possible next steps could include requesting Councils to adopt diesel vehicle fleet contracts that specify that older vehicles that do not meet in-service emission standards must be retrofitted. This would allow the costs of complying with the requirement to be spread over the life of the contract.

To date diesel vehicle retrofit programs have largely focused on the use of Diesel Oxidation Catalysts (DOCs). DOCs are well proven technology widely used in retrofit programs. DOCs convert pollutants into harmless gases by means of oxidation. In addition to oxidizing compounds such as carbon monoxide (CO) and gaseous HC, DOCs can reduce the mass of unburned fuel and oil by 90 percent under some operating conditions. These gaseous HC contribute on average around 30 percent of the total PM mass. DOCs are effective in reducing HC, CO and PM emissions and require no maintenance.

New developments

Since development of the Diesel NEPM in 2001 new diesel vehicle exhaust after-treatment technology has been commercialised as well as techniques to assist selection of the appropriate retrofit technology. Mandated cleaner fuel quality standards have also reduced the sulfur content from diesel allowing the introduction of more effective emissions control equipment.

New technology (available and arising)

Commercial retrofit technologies

The NSW Diesel Exhaust Retrofit Demonstration Program identified Diesel Particle Filters (DPFs) as well as DOCs as the preferred retrofit technologies following a review of the literature and discussions with vehicle manufacturers.

DPFs consist of a porous substrate that permits gases in the exhaust to pass through but at the same time traps particulate matter. DPFs are very efficient in reducing PM emissions typically achieving reductions in excess of 90 percent. Most DPFs employ some means to periodically regenerate the filter (i.e. burn off the accumulated PM) through either passive or active systems.

Selection of appropriate retrofit technology

Diesel engine exhaust temperature can be used to determine the PM reduction efficiency of DOCs. The NSW Diesel Exhaust Retrofit Demonstration Program indicates that PM reduction efficiency improves as temperature increases, up to about 300 C. Above 300 C the efficiency decreases.

For DPFs typically, exhaust temperature should exceed 260 C for at least 40 percent of the duty cycle. DPF periodically require high exhaust temperatures, so that the carbon trapped in the filter can be burnt off. Failure to burn off the carbon will cause the filter to become blocked and will affect engine performance.

Neither DPF nor DOC should be fitted to vehicles burning excessive amounts of oil. Factors that affect the DPF, including the need for extra maintenance should be considered. Note that while DPFs can potentially plug up, operators can avoid this problem by using backpressure monitors to alert the operator if the backpressure exceeds the manufacturer's specified limits.

Information in the guideline

Guidance on the use of DPFs could now be usefully included in the Diesel NEPM. DPFs are being successfully incorporated into overseas diesel retrofit programs and warrant active assessment within Australian diesel retrofit programs. While the costs and maintenance associated with the use of DPFs can limit their application, they have the capacity to deliver substantial reductions in PM emissions, and should be considered a viable option where particular engine operating conditions can be achieved. Importantly, in Australia the introduction of ultra low sulfur diesel in 2006 means the provision of low sulfur fuel necessary for DPFs is no longer an issue.

The overall cost effectiveness of DPFs compared to DOCs in reducing vehicle emissions appears to be similar. DPFs are around three times more efficient than DOCs in terms of PM reduction but also cost around three times more. Under the NSW Diesel Exhaust Retrofit Demonstration Program, PM reduction efficiencies of around 30% for DOCs and over 90% for DPFs have been demonstrated. Purchase and installation costs for DOCs averaged $3,000 and $9,000 for DPFs.

Guidance could usefully be provided in the Diesel NEPM on how to select the appropriate after-treatment emission reduction technology. One easy means to achieve this is through a better understanding of vehicle engine exhaust temperature (as detailed above).

In practice it could be recommended that due to the importance of duty cycle and exhaust temperature, the exhaust temperatures of candidate retrofit vehicles should be logged, before deciding on a suitable after-treatment device. Data loggers can be fitted to candidate vehicles to record and store exhaust temperature data over a period to establish the exhaust temperature profile for a vehicle's typical duty cycle. For example, a DPF should be fitted to a truck engine that exceeds 260 C for 50 percent of the time (or to similar trucks working

similar duty cycles). A DOC fitted to such a vehicle would always reduce PM to some extent, but less than that achieved by a DPF.

As exhaust temperature rises, PM emissions rise. Given this, there is also the potential to use exhaust temperature to estimate likely percentage PM emission reductions from installation of DOC or PDF based on the relationship between exhaust temperature, power and PM emissions.

Priority candidate vehicles for retrofitting tend to be on-road heavy vehicles (trucks, prime movers and buses), manufactured after 1990 and before 2000, and off-road plant vehicles. (Based on a NSW RTA analysis of emissions performance, the average distance travelled each year and anticipated economic life of the vehicle). Nevertheless, a considerable number of ADR80/00 vehicles (introduced in 2002/03) are likely to have met the ADR80/00 without the use of oxidation catalyst, so when these vehicles have been in service for some time they may benefit from retrofit with a DOC or DPF. In the medium term it is likely some work will be required to evaluate the net benefits of retrofitting ADR80/00 compliant vehicles.

Baseline data

Under the NEPM a means to calculate the cost effectiveness of a retrofit project is provided. Another means of estimating the worth of a retrofit program is to compare its cost against the dollar value of the estimated tonnes of PM that will be offset in terms of known health impacts. Monetary values on the health impacts per tonne of particles are publicly available (see example within section 3.3). Calculation of such health benefits may provide another means to support a retrofit program proposal.

Comment is invited on the following:

- Does the current guideline for diesel retrofit programs provide an effective means of reducing pollution from diesel vehicles?
- Can you suggest changes to improve the effectiveness of the guideline?
- Should the Diesel NEPM provide guidance on more recently commercialised exhaust retrofit technologies (such as diesel particle filters) that are able to be incorporated into retrofit programs?
- Should the Diesel NEPM provide guidance to assist selection of the appropriate retrofit technology through mechanisms such as knowledge of engine exhaust temperature and duty cycle?
- Should the Diesel NEPM suggest calculation of health benefits be included as part of the program evaluation to provide another means to support a retrofit program proposals?

4.6 SCHEDULE A5: GUIDELINE ON ENGINE REBUILD PROGRAMS

4.6.1 Description

Schedule A5 relating to engine rebuild programs is aimed at realising emissions reductions through the application of either retrofit technologies or low NO_x rebuild kits to vehicles at the time of engine rebuild.

The Schedule effectively utilises hardware / methods developed at the behest of the US EPA in response to legislation relating to urban buses, or as a result of a 1998 civil court finding against 6 major engine manufacturers entailing the creation of low NOx engine rebuild kits for a range of vehicles manufactured during the 1990's. The methods within the Schedule are by implication highly targeted, in that they would only apply to that segment of the Australian vehicle fleet that also existed for sale within the US marketplace.

4.6.2 Status of implementation

To date there has been no instances of this Schedule being implemented.

The US EPA has overseen only a moderately successful implementation of the initiatives captured by this Schedule in spite of there being mandatory compliance requirements. The urban bus retrofit program was initiated in 1993 and in the 6 years following a total of 10,000 out of an eligible 42,000 vehicles (= 24%) had been addressed with low emissions equipment at the time of engine overhaul.

4.6.3 Issues

The reasons for the lack of implementation of this Schedule of the NEPM include:

- difficulty in coordinating with vehicle operators to take advantage of scheduled engine rebuilds
- difficulty in matching specific vehicles to the relevant certified low emissions hardware as prescribed by the US EPA
- difficulty in ensuring the availability of the range of certified low emissions hardware as prescribed by the US EPA
- the limited range of vehicles as a proportion of the overall Australian fleet for which the certified emissions reduction hardware is available
- a lack of means to compel vehicle operators to submit vehicles to programs such as these
- little incentive existing for vehicle operators to voluntarily submit vehicles to programs such as these
- higher perceived / actual obstacles to implementation of this Schedule relative to the other Schedules within the Diesel NEPM.

Furthermore as the certified low emissions hardware was developed by engine manufacturers as a result of a US civil court penalty, this equipment must be made available to vehicle operators free of charge in the US. This finding does not extend to the Australian market and on this basis the service departments of the associated vehicle manufacturers are not required to carry the equipment.

Comment is invited on the following:

- Does the current guideline on engine rebuild programs provide an effective means of reducing pollution from diesel vehicles?
- Can you suggest changes to improve the effectiveness of the guideline?
- Should this Schedule be deleted from the Diesel NEPM?

REFERENCES

Australian Bureau of Statistics (2005) *Motor Vehicle Census* Cat no 9309.0, Canberra.

Bureau of Transport and Regional Economics (BTRE) 2006, *Freight Measurement and Modelling in Australia*. Report 112, BTRE, Canberra ACT.

Coffey Geosciences (2003) *Fuel Quality And Vehicle Emissions Standards Cost Benefit Analysis*, report prepared for MVEC Review of Vehicle Emissions and Fuel Standards Post 2006, October 2003.

NEPC (2001) *Impact Statement for the Draft National Environment Protection (Diesel Vehicle Emissions)*, National Environment Protection Council Paper, February 2001.

National Transport Commission (2006), *"Twice the Task" A Review of Australia's Freight Transport Tasks*, Report prepared by Sinclair Knight Merz and Meyrick & Associates, February 2006.