NEPC
NATIONAL ENVIRONMENT PROTECTION COUNCIL

DIESEL VEHICLE EMISSIONS

Impact Statement
for the
Draft
National Environment Protection (Diesel Vehicle Emissions) Measure

Public Consultation
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CONTENTS

GLOSSARY

Airshed	An area in which air quality is subject to common influences from emissions, meteorology and topography
Ambient Air NEPM	National Environment Protection Measure for Ambient Air Quality
Ambient air	The external air environment (does not include the air environment inside buildings or structures)
Australian Design Rule	Design standards applying to motor vehicles before they enter the market.
Australian Vehicle Standards Rules	Standards applying to in-service vehicles.
Combined Urban Emissions Drive Cycle	A transient test cycle that simulates a range of driving conditions from congested to open road.
Diesel vehicle	A vehicle registered for use on public roads and powered by a diesel fuelled engine.
DT80	A prescribed short transient test cycle for in-service emissions testing
In-service emissions	Exhaust emissions, excluding emissions of noise, from diesel vehicles in use.
In-service Emissions Standards	The in-service emissions standards for diesel vehicles specified in Australian Vehicle Standards Rules 1999, Rules 147A and 147B.

ACRONYMS

ATA	Australian Trucking Association
ADR	Design standards applying to motor vehicles before they enter the market.
CARB	California Air Resources Board
CUEDC	A transient test cycle that simulates a range of driving conditions from Congested to open road.
DEP	Department of Environmental Protection (Western Australia)
EPA	Environmental Protection Authority (Agency)
GVM	Gross vehicle mass
LCVs	Light commercial vehicles under 3.5 tonnes gross vehicle mass
NATA	National Association of Testing Authorities
NEPC	National Environment Protection Council
NEPM	National Environment Protection Measure
NHVAS	National Heavy Vehicle Accreditation Scheme
NRTC	National Road Transport Commission.
SEPP	State Environment Protection Policy

POLLUTANTS

NO	Nitric oxide
CO	Carbon monoxide
HC	Hydrocarbons
NMHC	Non-methane hydrocarbons
NO_2	Nitrogen dioxide
NO_x	Oxides of nitrogen
O_3	Ozone
PM_{10}	Particles which have an aerodynamic diameter less than or equal to 10 µm
$PM_{2.5}$	Particles which have an aerodynamic diameter less than or equal to 2.5 µm
ppb	Parts per billion
ppm	Parts per million
SO_2	Sulfur dioxide
VOC	Volatile organic compounds
$\mu g/m^3$	Microgram (1 millionth of 1 gram) per cubic metre

EXECUTIVE SUMMARY

Introduction

This document seeks to explain the likely impacts associated with the introduction of a National Environment Protection Measure for Diesel Vehicle Emissions (Diesel NEPM) and In-service Standards for diesel vehicles.

The Diesel NEPM will be a statutory instrument setting out a range of strategies for improving emissions from in-service diesel vehicles. It will be made by the National Environment Protection Council (NEPC) consistent with the process set down in legislation.

In-service emission standards for diesel vehicles will be made by the National Road Transport Commission (NRTC) following endorsement by the Australian Transport Council (comprising Transport Ministers).

Both instruments will be developed with input from public and private sector stakeholders.

This Impact Statement is intended to meet relevant legal requirements for making a NEPM under NEPC legislation and for making regulations under the NRTC legislation. These requirements generally relate to impact analysis, consultation and public input. It is therefore important that stakeholders take this opportunity to provide feedback on the draft Diesel NEPM and Impact Statement.

The analysis contained in this document has been informed by extensive research including approximately 700 vehicle tests in regard to maintenance practices, average emission levels, testing protocols, fault finding and appropriate levels for standards. In addition, extensive research into the size and nature of the Australian fleet, its impact on air quality and the success or failure of overseas approaches has created a wealth of data and analysis that cannot be comprehensively covered in this document. Reports commissioned for these projects are available on the NEPC website at www.nepc.gov.au.

Statement of the Problem

Diesel vehicles contribute disproportionately to urban air pollution. Although diesel vehicles comprise less than 10% of the total Australian fleet and approximately 13% of vehicle kilometres travelled, they contribute about 40% of the oxides of nitrogen (NO_x) emissions and about 60-80% of particle emissions by the road transport sector. NO_x is a precursor to the formation of smog. Particles have been identified as a major health risk. National standards for ambient air quality, including standards for NO_x and particles were set by the NEPC in 1998.

Ambient particle and NO_x levels have an adverse effect on community health. Health effects include respiratory problems ranging in severity from coughs, chest congestion, and asthma to chronic illness and possible premature death in susceptible people.

Recent research has confirmed earlier studies that the particles of most concern are the fine particles less than 2.5 µm, and almost all diesel particles fall within this group (in fact less than 1 µm) and that there is an association between fine particles and increased daily mortality and decreased life expectancy. Recent research has also reported health effects at levels well below current guidelines and point to no safe threshold level for particle exposure.

The lack of an identifiable safe threshold level for particle exposure points to the need to reduce ambient particulate concentrations to as low a level as practical. This means that there is a need to examine significant emission sources of particulates and determine whether reduction measures are feasible, practicable and warranted.

Black smoke and odour from diesel exhaust is also a significant urban amenity issue with thousands of public complaints about smoky exhausts received annually by environmental agencies.

In order to overcome these health and amenity issues, governments have sought to control diesel emissions through a range of measures including new vehicle emission design standards, improved fuel quality and a range of traffic management strategies. While research shows that the combined effects of these measures will lead to improvements in emissions from the diesel fleet, none address the issue of deterioration in emission performance while vehicles are in use. Sources of deterioration include lack of vehicle maintenance, poor maintenance, poor fuel quality and tampering.

The problem then, is how best to control emissions from the in-service diesel fleet in order to protect the emission reduction gains anticipated from existing measures, achieve further emission reductions, help achieve national air quality standards and reduce the impact of diesel emissions on the health and amenity of Australians. Preparatory projects carried out for the proposed Diesel NEPM have examined on-road diesel vehicles in some detail, with a view to determining the most appropriate strategies for managing emissions from diesel vehicles.

Objectives

The objectives of National Environment Protection Measures are expressed in terms of National Environment Protection Goals and Desired Environmental Outcomes.

The proposed Goal for this NEPM is *to reduce exhaust emissions from diesel road vehicles, by facilitating compliance with emissions standards for in-service diesel vehicles*.

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

The objective of setting in-service standards is to ensure that all owners and operators of diesel vehicles have a standard against which the performance of their vehicle(s) can be objectively measured.

The Proposed Approach

The proposed approach to controlling emissions from the in-service fleet is to develop in-service standards for diesel vehicle emissions and provide guidelines for strategies to facilitate achievement of the standards.

Several mechanisms to reducing emissions from in-service diesel vehicles were considered, ie:

- Business as usual. It was considered that while this option addresses emissions from new vehicles, given the existing level of vehicle faults and tampering, it would not effectively reduce in-service diesel vehicle emissions and would not lead to a national approach to reducing in-service emissions.
- Industry agreements. This approach would be unlikely to involve all diesel vehicle owners and the voluntary approach could again lead to national inconsistency.
- State regulation. State regulation is likely to lead to different standards and different strategies across Australia. This would create inefficiencies for industry.
- Commonwealth regulation. Management of in-service motor vehicles has traditionally been the role of the States and in-service standards for all other aspects of vehicle performance are regulated by the States based on NRTC model legislation. While it may be possible for the Commonwealth to use its constitutional powers to regulate in this area, other effective national approaches are available, particularly the option of a National Environment Protection Measure and the development of standards through the National Road Transport Commission.

The recommended approach to reducing in-service emissions from diesel vehicles is through the development of a National Environment Protection Measure in conjunction with in-service emissions standards developed by the NRTC. This approach will set national in-service emissions standards, and provide guidelines for strategies for reducing in-service emissions in order to achieve these standards. A NEPM offers both a national approach and flexibility of implementation. Where jurisdictions choose to implement the same strategy, by following the guidelines they will do so in a nationally consistent way.

The proposed NEPM will include guidelines on the following:

- 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.

It is proposed that the National Road Transport Commission will develop standards for the emissions of particulates, NO_x and smoke opacity for in-service diesel vehicles. The proposed 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.

Costs and Benefits

As the proposed solution allows jurisdictions flexibility in attaining the proposed in-service emissions standards, it is difficult to estimate the costs and benefits of this NEPM.

The reduction in particle emissions to be achieved from repair of individual vehicles is potentially 53%. The percentage of vehicles with emissions related faults which will benefit from repair can vary between 8% and 32% of the diesel fleet, depending on the size of the vehicle and the emissions standard to which it was constructed.

The costs of achieving the standard vary with the strategy implemented but can include maintenance and repair of vehicles, administrative and operational costs, vehicle off road time, the cost of vehicle testing facilities and fees.

An extensive analysis of costs and benefits is presented in Section 7 of the Impact Statement.

The benefits, some of which are substantial but not easily quantified, include improved health and well being, improved roadside amenity, improved recreational and tourist amenity, potential behavioural change in favour of vehicle maintenance and benefits to diesel vehicle owners such as potential improved fuel economy and vehicle performance, reduction in unscheduled breakdowns and improved resale value.

Jurisdictions will need to determine the strategy or mix of strategies which are most appropriate in their own circumstances. The actual cost-benefit outcome for reduction of in-service diesel emissions is dependent on the strategies implemented.

Consultation

The results of the research projects underpinning the proposed NEPM have been made available on the NEPC website as the projects were completed. This has led to a increasing amount of information being publicly available since December 1999.

In September 2000 the NEPC announced that it would commence the development of the NEPM. In November 2000, NEPC released a discussion paper which sought input from informed key stakeholders of the proposed process for the development of the NEPM and in-service standards. It raised a number of specific issues to help shape a first draft of the NEPM and the standards.

The release of the draft Diesel NEPM and this Impact Statement is the second major opportunity for stakeholders to provide input. Comments will be sought over a two month period and jurisdictions will hold public meetings to help explain the process and seek feedback on the proposals. Once comments are received they will be collated and analysed. A summary of responses to the issues raised will be developed, and taken into account when finalising the NEPM and standards.

Evaluation

A wide range of studies conclude that it is beneficial to reduce emissions of fine particles since there is no acceptable exposure threshold for health effects. Diesel vehicles are one of the significant sources of fine particle emissions.

Governments have recently taken significant initiatives to reduce emissions from diesel vehicles through the introduction of improved vehicle standards and improved fuel quality. Many jurisdictions apply traffic management strategies to reduce the concentration of vehicles and improve their emission performance through improving road flow conditions.

Achievement of the full benefits envisaged from these initiatives will not be fully realised if there is significant deterioration in the emission performance of diesel vehicles during their useful life. Investigation of the emission performance of in-service vehicles by NEPC has shown that the emission performance of many vehicles has deteriorated. Up to 32% of some classes of diesel vehicles have excessive levels of emissions and readily identifiable faults. It has been shown that moderate costs of repair of high emitting vehicles can result in significant reductions in emissions of fine particles.

Development of standards for the emission performance of in-service diesel vehicles, and implementation of strategies to achieve them, is an effective means of reducing emissions.

A NEPM combined with in-service standards allows national action, resulting in consistency and certainty to vehicle operators. Implementation can provide a legislative basis for actions by government, whether through the strategies outlined in the NEPM or other mechanisms.

The proposed approach offers effective options that can be implemented in a manner that best addresses the emissions reduction needs of each jurisdiction.

Review

As new vehicles enter the market there will be a need for in-service standards to be updated to ensure the anticipated benefits of the new vehicle design standards are realised.

New vehicle technology brings with it new options for addressing in-service emissions performance. On-board diagnostics are increasingly a feature of new vehicles and may have the potential for vehicles to self diagnose emissions problems and possibly manage the in-service emissions of future vehicles. Emissions monitoring technology such as remote sensing offers potential as a method of identifying high polluting vehicles to which should be submitted to test and repair or other programs.

The NEPM has a provision for review after five years to ensure that any further need to regulate can be comprehensively addressed in light of the extent of emissions reductions, and the advent of new technologies.

YOUR VIEWS ARE IMPORTANT

Your views are sought regarding the draft NEPM, in-service standards and Impact Statement for diesel vehicle emissions. Issues raised in submissions will be considered by the project team and communicated to the NRTC and the NEPC.

It is important to note that the processes for the development of the NEPM and in-service standards is open to the views of all governments and stakeholders. The final draft NEPM and in-service standards will be developed taking into account the input received during the public consultation process.

Written submissions on the draft NEPM, the in-service standards, and the Impact Statement should be sent to**:**

Mr Marc Thompson – Diesel Emissions Project Manager
NEPC Service Corporation
Level 5, 81 Flinders Street
ADELAIDE SA 5000
Tel (08) 8419 1207
Fax (08) 8224 0912

To allow ease of photocopying, submissions should be unbound. Should you wish to provide extensive comment, consideration of your submission will be facilitated if it is provided, if possible, in one of the following electronic forms:

- on a 3.5 inch floppy disk, or
- email: exec@nepc.gov.au

preferably as a Word for Windows file by **27 April 2001**.

Please note: subject to Freedom of Information Act (FOI) provisions, public submissions are considered public documents unless clearly marked "confidential".

For details of meetings in your jurisdiction, please contact your respective Jurisdictional Reference Network Member.

Australian Capital Territory	Mr Geoff Wells Environment ACT 12 Wattle Street LYNEHAM ACT 2601	Tel: (02) 6207 2147 Fax: (02) 6207 6610 geoff.wells@act.gov.au
Commonwealth	Ms Christine Schweizer Environment Australia John Gorton Building King Edward Terrace PARKES ACT 2600	Tel: (02) 6274 1581 Fax: (02) 6274 1172 christine.schweizer@ea.gov.au
New South Wales	Ms Suzanne Quigley Environment Protection Agency 59-61 Goulburn Street SYDNEY NSW 2000	Tel: (02) 9995 5829 Fax: (02) 9995 5938 quigleys@epa.nsw.gov.au

Northern Territory	Mr Randall Scott Department of Lands Planning and Environment GPO Box 1680 DARWIN NT 0801	Tel: (08) 8924 4136 Fax: (08) 8924 4053 Randall.Scott@lpe.nt.gov.au
Queensland	Mr Scott McDowall Environmental Protection Agency 12th Floor 160 Ann St BRISBANE QLD 4000	Tel: (07) 3227 8565 Fax: (07) 3227 8341 scott.mcdowall@env.qld.gov.au
South Australia	Mr Tony Circelli Environment Protection Agency Level 6 Chesser House 91-97 Grenfell Street ADELAIDE SA 5000	Tel: (08) 8204 2047 Fax: (08) 8204 2025 tcircelli@dehaa.sa.gov.au
Tasmania	Dr Frank Carnovale Dept of Primary Industries Water & Environment 6th Floor Lands Building 134 Macquarie Street HOBART TAS 7000	Tel: (03) 6233 6384 Fax: (03) 6233 6800 frankc@dpiwe.tas.gov.au
Victoria	Tracey Mitchell Environment Protection Authority Level 1 HWT Tower 40 City Road SOUTHBANK VIC 3006	Tel: (03) 9695 2540 Fax: (03) 9695 2578 tracey.mitchell@epa.vic.gov.au
Western Australia	Mr Anthony Stuart Department Environmental Protection 141 St Georges Terrace PERTH WA 6000	Tel: (08) 9222 7167 Fax: (08) 9321 5184 Anthony_Stuart@environ.wa.gov.au
National Road Transport Commission	Mr Tim Eaton National Road Transport Commission Level 5 326 William Street MELBOURNE VIC 3002	Tel: (03) 9321 8444 Fax: (03) 9326 8964 Eatont@nrtc.gov.au

1 INTRODUCTION

The National Road Transport Commission (NRTC) is developing emission standards for in-service diesel vehicles. The National Environment Protection Council (NEPC) is developing a National Environment Protection Measure (NEPM) for diesel vehicle emissions. The proposed NEPM will outline strategies for the management of emissions from in-service diesel vehicles, which will facilitate compliance with the in-service emissions standards.

This Impact Statement is designed to assist stakeholders in understanding the key impacts associated with a National Environment Protection Measure for Diesel Vehicle Emissions (Diesel NEPM) and the setting of national in-service diesel vehicle emission standards.

The Impact Statement should be read in conjunction with:

- the draft Diesel NEPM, which outlines a range of in-service strategies that jurisdictions may use to achieve improved emissions performance from the diesel fleet and;
- the draft in-service standards, which set maximum emission levels for the key diesel pollutants and specify a test for measuring those levels.

Any future NEPM and in-service standards are inter-dependent and would come into force at the same time. This document examines the impacts of both the draft Diesel NEPM and the draft in-service standards. This Impact Statement also fulfils the requirements of a Regulatory Impact Statement for the National Road Transport Commission standard setting process.

1.1 National Environment Protection Council

The National Environment Protection Council is a body established by each State and Territory and the Commonwealth Government to work cooperatively at a national level. The NEPC aims 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 (1992), under which it was agreed to establish a national body with responsibility for making National Environment Protection Measures.

The operation of the NEPC is covered by the National Environment Protection Council Act 1994. Section 14(2) of the Act requires that in developing vehicle emission standards, the NEPC must work in conjunction with the National Road Transport Commission. Section 10B of the National Road Transport Commission Act 1991 (as amended) has a corresponding requirement for the NRTC to work in conjunction with the NEPC.

1.2 National Environment Protection Measures

NEPMs are broad framework-setting statutory instruments, which, through an extensive process of inter-government 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.

It should be noted that any supporting regulatory or legislative mechanisms which jurisdictions may choose to develop to assist in implementation of the proposed NEPM will need to be made under appropriate processes in those jurisdictions.

1.3 Purpose Of Impact Statement

This Impact Statement is intended to:

- enable stakeholders to provide input on the scope and development of a potential Diesel NEPM and in-service standards; and
- ensure the process of NEPM development and standard setting is open and transparent.

This Impact Statement will therefore assist in the process of public consultation over the proposals contained in the draft NEPM.

This Impact Statement is designed to meet the statutory requirements of the NEPC and the NRTC. Both organisations require analysis of regulatory options and a transparent process. In particular, in making NEPMs, the NEPC must have regard to a number of considerations, detailed in section 15 of the National Environment Protection Council Act. They include:

- consistency with the Inter-Governmental Agreement on the Environment ;
- environmental, economic, and social impacts;
- relevant international agreements; and
- any regional environmental differences.

An analysis of the means by which the draft NEPM and Impact Statement meet the relevant requirements of the NEPC Act is given in Appendix 3. The same Appendix also outlines a competition policy assessment as part of the process of making subordinate legislation under the COAG Competition Principles Agreement.

Similarly, the NRTC legislation requires rigorous analysis in the preparation of regulatory impact statements, as well as extensive consultation.

The NEPC legislation requires that both the draft NEPM and the Impact Statement be made available for public consultation for a period of at least two months. The NEPC must also have regard to the Impact Statement and submissions received from the public in deciding whether to adopt a proposed NEPM.

1.4 Policy Framework

The need to address emissions from diesel vehicles is recognised by Governments in existing programs and policy commitments.

Regulations seeking to control emissions from the diesel fleet, including smoke emissions limits (the 'ten second smoke rule') based on the Australian Vehicle Standards Rules, are common in state legislation. Some states (NSW, Victoria and Tasmania) have sought to reduce local impacts by introducing vertical exhaust requirements to aid dispersion of pollutants from larger diesel vehicles.

It has been recognised that more needs to be done to effectively manage transport emissions, including diesel vehicle emissions.

Urban Air Pollution in Australia, the report of an independent inquiry (AATSE, 1997) recommended that emission limits based on Australian Design Rule standards be set for in-service vehicles, backed by effective inspection and maintenance programs in the major urban airsheds (to ensure that compliance with these standards is maintained over the life of the vehicle).

In *Action for Air* (1998), the NSW Government identified the need to reduce diesel vehicle emissions and identified the introduction of tighter national emission standards, the development of a diesel NEPM and the design of an inspection and maintenance program for diesel vehicles as key mechanisms to achieve reductions.

The Draft South-East Queensland Regional Air Quality Strategy (1998) and the Perth Air Quality Management Plan (2000) also identify a series of approaches to reduce emissions from the in-service fleet. These include improved vehicle tuning and maintenance regimes, consideration of a vehicle test and repair programs, improved fuel quality, roadside emissions testing and other measures.

As part of its 1999 tax package, the Commonwealth Government agreed to deliver a number of environmental initiatives which were outlined in a package entitled *Measures for a Better Environment.*

Measures for a Better Environment includes the following initiatives relating to the management of emissions from Australia's diesel fleet:

- progressive reduction of the sulfur content of diesel fuels (fuel standards will be regulated in 2001);
- introduction of tighter emissions control standards for new vehicles (new standards were gazetted in December 1999);
- development of a diesel NEPM to be introduced as soon as possible and specifically address the issue of emissions from the in-service fleet; and
- provide resources with the view to ensuring that the NEPM can be finalised over two years and establish:
  - in service emission tests/inspection protocols and programs for diesel vehicles;
  - a minimum performance standard for all in-service diesel vehicles which were not certified to an agreed international standard at the time they entered the market; and
  - in-service emission standards, based on compliance with original certification standards, for all diesel vehicles certified to international standards (eg Euro 2, Euro 3).

Through the 'Third Heavy Vehicle Reform Package' approved by the Australian Transport Council in May 2000, Transport Ministers and the road transport industry are committed to reducing in-service emissions from diesel vehicles by supporting the development of a diesel vehicle emissions NEPM.

1.5 Work to Date on a Diesel NEPM

In November 1999, the NEPC commenced work on a proposal to develop a NEPM to reduce the impact of diesel emissions.

At that time, little was known about the Australian diesel fleet, its likely growth trends and the potential for improvements in emissions from in-service vehicles.

To fill identified knowledge gaps a series of preparatory projects was developed. The preparatory work was structured to provide data that would assist jurisdictions to evaluate:

- the scope and dynamics of emissions to urban airsheds by the Australian diesel fleet;
- options for reducing emissions from in-service diesel vehicles; and
- potential environmental benefits and associated costs related to managing emissions from the in-service diesel fleet.

The final reports for all projects are available on the NEPC website (www.nepc.gov.au). A summary description and key outcomes of the preparatory projects are provided in Appendix 2.

On 19 September 2000 the NEPC resolved to develop a draft National Environment Protection Measure for Diesel Emissions. NEPC Committee released a Discussion Paper in November 2000 as a first step in developing the NEPM and in-service standards.

This Impact Statement and the accompanying draft NEPM and draft in-service standards represent the second step in that process and reflect the history of policy commitments discussed above. It is intended that NEPC will consider making the NEPM in June 2001.

Key Points

- **A Diesel NEPM is being developed by the NEPC and emissions standards for in-service diesel vehicles are being developed by the NRTC**
- **This document explains the potential impacts of both a Diesel NEPM and In-Service Diesel Emission Standards**
- **The NEPC and the NRTC have been working together and have undertaken extensive research**
- **The research findings provide valuable information for estimating the likely environmental improvements and associated costs of setting standards and developing strategies to meet those standards**

2 STATEMENT OF THE PROBLEM

The community generally perceives air quality to be the main environmental issue which needs to be addressed, as shown by Australian Bureau of Statistics research (ABS, 1998). Although Australia's urban air quality is considered to be quite good by international standards, relatively high concentrations of pollutants are experienced on occasions in the larger cities, and it is urban air quality in particular that most people regard as needing attention (NRMA, 1996; NSW EPA, 1994; Clean Air 2000, 1997).

In 1998 NEPC set ambient air quality standards to protect the more susceptible members of society. Breaches of the standards represent undesirable impacts on community health. Emissions from motor vehicles are the major source of urban air pollution. Concentrated vehicle activity in areas such as transport corridors, tunnels, and freight and transport depots has the potential to produce high concentrations of pollutants. In addition, confined areas such as urban transport hubs, parking areas and street canyons between tall buildings in urban centres and even busy roads can lead to undesirable levels of pollutants.

Diesel vehicles are major contributors to urban air pollution. Thus diesel vehicles, though comprising less than 10% of the total vehicle fleet, contribute approximately 40% of oxides of nitrogen emissions and about 60-80% of particle emissions from the road transport sector. Whilst diesel vehicles currently comprise a small part of the vehicle fleet, their proportion is increasing rapidly. In 1995 diesel vehicles comprised 8.3% of the fleet, and are projected to increase to 15% by 2015. Over this time diesel vehicle travel in metropolitan areas is anticipated to increase by 146%. Despite improvements to emission standards for new vehicles, and a consequent reduction in total emissions, continued annual growth in vehicle kilometres travelled and fuel consumption mean that the diesel fleet will continue to be a significant source of pollutants.

The emissions of most concern in relation to diesel vehicles are particulates, visible smoke and oxides of nitrogen. Oxides of nitrogen are a precursor to the formation of photochemical smog and react with other pollutants to form particles. Hydrocarbons and secondary pollutants such as ozone are also of concern.

Pollutants sourced from diesel vehicles impair amenity, the environment and human health. These impairments include:

- nuisance effects (eg odour and decreased visibility);
- environmental effects (eg material soiling, vegetation damage and corrosion);
- acute toxic effects (eg eye irritation, increased susceptibility to infection, chest congestion and asthma); and
- chronic health effects (eg mutagenic and carcinogenic actions and the possibility of premature death).

According to Denison and Chiodo (1996), "although respirable particle levels in Australia are low, there are still strong associations with adverse health effects". Recent research has confirmed earlier studies that the particles of most concern are the fine particles less than 2.5 µm, and almost all diesel particles fall within this group (in fact less than 1 µm). Dockery (2000) concludes that re-analysis of earlier data confirms the association between fine particles and increased daily mortality and decreased life expectancy.

Denison and Chiodo also reported that "for mortality, at least, there does not appear to be a threshold particle level". Recent research has reported health effects at levels well below current guidelines (Pope *et al,* 1995, cited in Denison and Chiodo, 1996). Other sources (NEPC, 1997; NSW EPA, 1998; WA DEP, 1996) also conclude that research findings point to no safe threshold level for particle exposure.

The lack of an identifiable safe threshold level for particle exposure points to the need to reduce ambient particulate concentrations to as low a level as practical. This means that there is a need to examine significant emission sources of particulates and determine whether reduction measures are feasible, practicable and warranted.

The preparatory projects carried out for the proposed Diesel NEPM examined the contribution to pollution by diesel vehicles of different ages, types and by kilometres travelled, with a view to determining the most appropriate strategies for managing such sources. These projects showed that certain classes of vehicles produce excessive emissions and that significant improvements in emissions performance can be achieved from these vehicles. Research suggests that for some classes of diesel vehicles, up to 32% of vehicles are operating well below their optimum emissions performance (due to lack of maintenance or tampering) and significant emission reductions could be achieved from moderate improvements in maintenance.

2.1 Air Quality Impacts

High levels of diesel pollutants can result in a wide range of adverse health and visual impacts. The emissions of most concern in relation to diesel vehicles are particles, oxides of nitrogen (NO_x) and visible smoke. NO_x is a problem in its own right, and as a precursor to the formation of photochemical smog and as a reactive agent with other pollutants to form particles. Particles have been identified as a major health risk. Visible smoke is a major public amenity issue.

2.1.1 Amenity

Smoke

Possibly the issue of most immediate concern to the general public in relation to diesel vehicles emissions is that of visible smoke. Diesel smoke emissions are odorous and visibly offensive. They contribute to haze levels and are unpleasant for pedestrians, cyclists and other road users.

Australia has a national standard for the emissions of on-road smoke. The standard requires that vehicles should not emit smoke continuously for more than 10 seconds. Most states have programs or strategies for identifying and rectifying smoky vehicles. A measure of the public concern regarding smoky vehicles is the number of complaints received by environmental protection agencies. For example, annual complaints from the general public number approximately 4800 in WA and 12000 in NSW. In Victoria 9,000 smoky vehicle complaints were received in 1995, increasing to 12,000 in 2000.

2.1.2 Health impacts and trends in air quality

Particles

Respirable particles, those with a diameter of less than 10 µm (PM_{10}), are a particular health concern because they are easily inhaled and retained in the lung. Almost all of the particles in diesel exhaust are less than 1 μm in diameter (Concawe, 1998), and diesel particles also adsorb unburnt hydrocarbons and other potentially carcinogenic organic compounds such as polycyclic aromatic hydrocarbons. The International Agency for Research on Cancer has concluded that diesel exhaust is a probable human carcinogen (California Air Resources Board 1994), and the California Air Resources Board has identified diesel exhaust as a toxic air contaminant (California Air Resources Board 1998). In October 2000 the US Clean Air Scientific Advisory Committee agreed with the US EPA's assessment that diesel exhaust is a 'likely' carcinogen.

Although the mechanisms are not clear, epidemiological studies in the US and elsewhere consistently show a relationship between particles and a range of respiratory, cardiovascular and cancer related morbidity and mortality (Concawe, 1996; Ballantyne, 1995; NEPC, 1997). The NSW Health and Air Research Program (HARP) study estimated that particle pollution contributed to nearly 400 (2%) premature deaths in Sydney each year between 1989 and 1993 (Hensley, 1996). The study also estimated that days of high particle concentrations were associated with:

- 3.5% increase in hospital emissions for cardiovascular disease;
- 3% increase in chronic obstructive pulmonary disease hospital admissions; and
- 3% increase in heart disease admissions in the elderly.

The study also suggests that there is a 1% increase in daily deaths for every 10μg/m^3 increase in the level of daily particles in Sydney. This is consistent with the findings of studies conducted in Brisbane and in the US.

According to Denison and Chiodo (1996), "although respirable particle levels in Australia are low, there are still strong associations with adverse health effects", and "for mortality, at least, there does not appear to be a threshold particle level". Recent research has reported health effects at levels well below current guidelines (Pope *et al* (1995) cited in Denison and Chiodo, 1996). Other sources (NEPC, 1997; NSW EPA, 1998; WA DEP, 1996) also conclude that research findings point to no safe threshold level for particle exposure.

Recent research has confirmed earlier studies that the particles of most concern are the fine particles less than 2.5 μm (in fact less than 1 μm), and as indicated above almost all diesel particles fall within this group. In reporting on these recent studies, Dockery (2000) concludes that re-analysis of the earlier data confirms the associations between fine particles and increased daily mortality and decreased life expectancy, and supports the recent US EPA proposal to set an ambient air quality standard for particles less than 2.5 μm.

<u>Trends in particle concentrations</u>

Measurements of PM_{10} in urban areas show annual average levels of 25 to 40 μg/m^3 and peak 24-hour average levels of 90 to 110 μg/m^3 (NEPC 1998b). Particle concentrations vary with season, higher values occurring in the autumn/winter months. The main sources of PM_{10} are motor vehicles in summer, along with wood heating and fuel reduction burning in autumn and winter (EPA Victoria 2000a).

The Ambient Air Quality NEPM standard for PM_{10} is 50 μg/m^3 24 hour average, not to be exceeded more than 5 times per year. In Perth, PM_{10} levels greater than 50 μg/m^3 24 hour average occurred 22 times between 1990 and 1998, but no more than 4 times per year (Perth Air Quality Management Plan 2000). In South-East Queensland, this level was exceeded 76 times in the same period. The Ambient Air NEPM standard was exceeded for 6 years in that period, with no obvious upward or downward trend (A Strategy for Improving Air Quality in South-East Queensland 1999).

Oxides of Nitrogen

Nitrogen dioxide (NO_2) and nitric oxide (NO) together are referred to as oxides of nitrogen (NO_x). Diesel engines emit NO_x in the normal course of operation. NO_x reacts in the atmosphere with reactive volatile organic compounds to form secondary air pollutants , which include ozone (a principal constituent of photochemical air pollution, or smog), and nitrate aerosols (which add to atmospheric particle loading). Nitrogen dioxide is associated with adverse effects on human health.

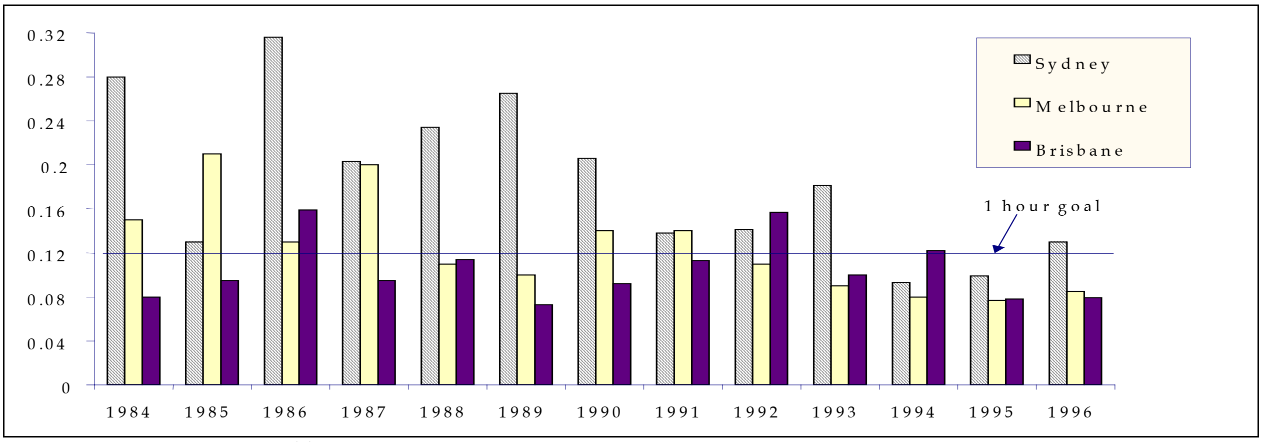
Increases in ambient nitrogen dioxide levels are associated with increases in cardiovascular and obstructive pulmonary diseases. The NSW HARP Study identified associations between nitrogen dioxide (NO_2) and hospital admissions (Hensley, 1996; Morgan *et al*, 1998a). The study estimated that days of high NO_2 levels were associated with a 7% increase in hospital admissions for cardiovascular disease, a 5% increase in childhood asthma admissions, a 3% increase in adult asthma admissions, and a 5% increase in chronic obstructive pulmonary disease admissions.

A study carried out in Sydney between 1989-93 also found an association between an increase in NO_2 concentration and a 2.9% increase in all deaths (the association with respiratory and cardiovascular deaths being the strongest) (Morgan, 1998b).

<u>Trends in NO_2 concentrations</u>

The number of breaches of the current NEPM standard for ambient NO_2 have been low in recent years, with only Sydney and Brisbane having exceedences in the past 10 years. However, the formation of nitrogen dioxide in the atmosphere (from nitric oxide in vehicle exhaust) is strongly affected by seasonal weather conditions. This has lead to a number of reports concluding that there are no clear trends in the levels of nitrogen dioxide (NSW EPA, 1996b, Coffey Partners, 1996).

Figure 2-1 Nitrogen dioxide peak 1 hour values



Source: NSW EPA, Vic EPA, Qld DOE

Ozone

Ozone is an indicator of the level of photochemical smog in the atmosphere. It is a secondary pollutant, formed from the reaction of a mixture of hydrocarbons and NO_x in the presence of sunlight.

Epidemiological studies have shown that ambient ozone levels are associated with hospital admissions and emergency room visits for respiratory disease (including asthma) and with increases in respiratory symptoms, airway responsiveness and decreases in lung function. A study in Sydney has found an association between daily ozone levels and reductions in lung function in children with a history of respiratory symptoms (Jalaludin *et al*, 2000).

Ozone may be associated with an increase in daily mortality, mainly in the elderly and in people with existing cardiovascular or respiratory disease (Kinney & Ozkaynak, 1991; Kinney & Ozkaynak, 1992; Anderson *et al*, 1996; Touloumi *et al*, 1997; Sartor *et al*, 1997; Borja-Arbuto *et al,* 1997; Loomis *et al*, 1996; Simpson *et al,* 1997; Morgan *et al*, 1998a; EPA Victoria, 2000b).

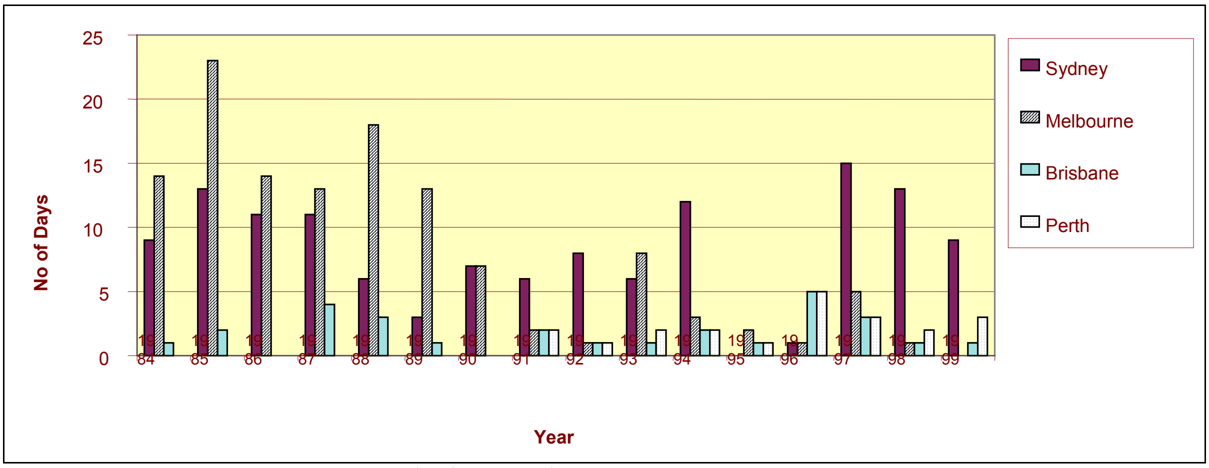
A 1ppb increase in the same-day 8-hour concentration of ozone was associated with a 0.5% increase in the risk of respiratory death in the elderly. The results of epidemiological studies have not shown any clear evidence of a safe threshold level for ozone (EPA Victoria 2000b).

<u>Trends in ozone concentrations</u>

The Ambient Air NEPM sets an ambient ozone standard of 0.10ppm (1 hour value). This standard is exceeded on an annual basis in Melbourne, Sydney, Brisbane and Perth. (Figure 2-2). Adelaide experiences less frequent exceedences of the standard.

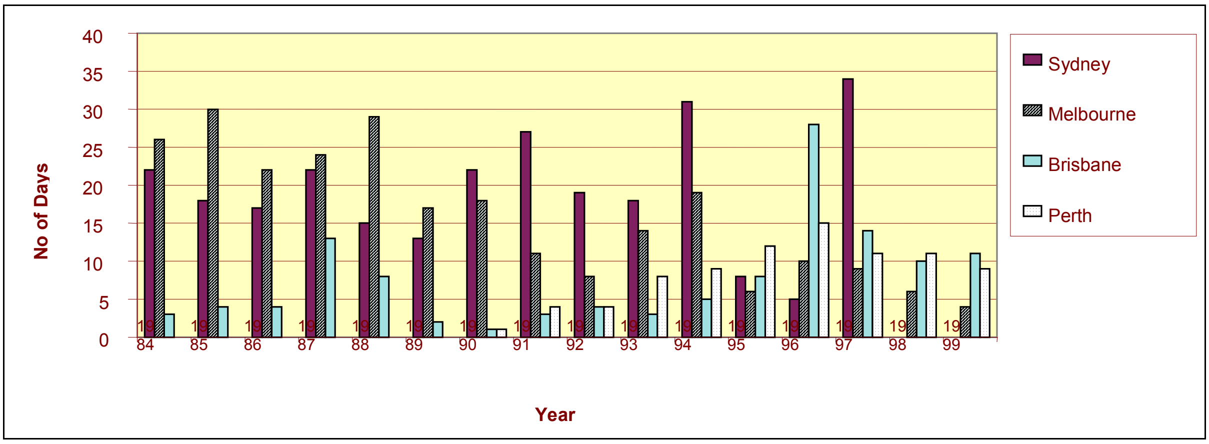
The World Health Organisation has set a stricter goal of 0.08ppm. WA has adopted and NSW intends to adopt this more stringent goal. Such a goal will result in a significantly higher number of recorded exceedences (Figure 2-3). Thus, in Sydney the number of exceedences in 1994, based on 0.12ppm, 0.10ppm and 0.08ppm goals, were 2, 12 and 32 days respectively (NSW EPA, 1996a).

Figure 2-2 Ozone exceedences, 1 hour 0.10ppm



Source: NSW EPA, EPA Victoria, Queensland DOE, and WA DEP.

Figure 2-3 Ozone exceedences, 1 hour 0.08ppm



Source: NSW EPA, EPA Victoria, Queensland DOE, and WA DEP.
Note: 1998 and 1999 Sydney data not yet available.

Hydrocarbons

Reactive organic compounds comprising mainly hydrocarbons contribute to formation of photochemical air pollutants (including Ozone) and organic aerosols (which add to atmospheric particle loading). Vehicle emissions include unburnt hydrocarbons.

In addition to their role in the eventual formation of ozone, hydrocarbons are of concern because they include air toxics such as 1,3-butadiene and benzene which are known to cause cancer. Motor vehicle usage accounts for most of the benzene in ambient air, which is the primary source of benzene exposure for the general population.

Key Points

- **The principal emissions of concern from diesel vehicles are smoke, particles, and oxides of nitrogen**
- **Hydrocarbons and secondary pollutants such as ozone are also of concern**
- **The adverse health effects of these air pollutants are well documented**

3 EMISSIONS FROM DIESEL VEHICLES

The relative contribution of emissions by diesel vehicles to airsheds depends on many factors:

- total distance travelled by diesel vehicles in urban areas;
- vehicle design (since 1996 diesel vehicle emission standards in the Australian Design Rules have placed limits on the emission of particles and gaseous pollutants for new vehicles. Prior to 1996 diesel vehicles sold in Australia were required to meet a smoke opacity standard only);
- the state of tune and repair of vehicles (a vehicle in good repair will operate more efficiently, with lower fuel consumption and fewer emissions); and
- fuel quality (lower diesel sulfur content is likely to produce lower emissions of particles).

The NEPC carried out a series of preparatory projects to determine the characteristics and emission performance of the Australian diesel fleet (Appendix 2). The results of those projects are utilised in this and subsequent chapters.

Current estimates of total emissions from the Australian diesel fleet in capital cities are provided in Table 3-1.

Table 3-1 Total emissions from diesel road vehicles for capital cities for 2000

City	Particles (PM_{10})	Oxides of Nitrogen	Total Hydrocarbons	Carbon Monoxide
	Tonnes			
Adelaide	322	3,432	1,117	2,397
Brisbane	676	8,569	2,264	5,092
Canberra	72	937	268	551
Darwin	48	517	158	352
Hobart	83	1,085	294	653
Melbourne	1,377	15,986	4,452	10,387
Perth	490	5,760	1,635	3,597
Sydney	1,325	16,315	5,086	10,229

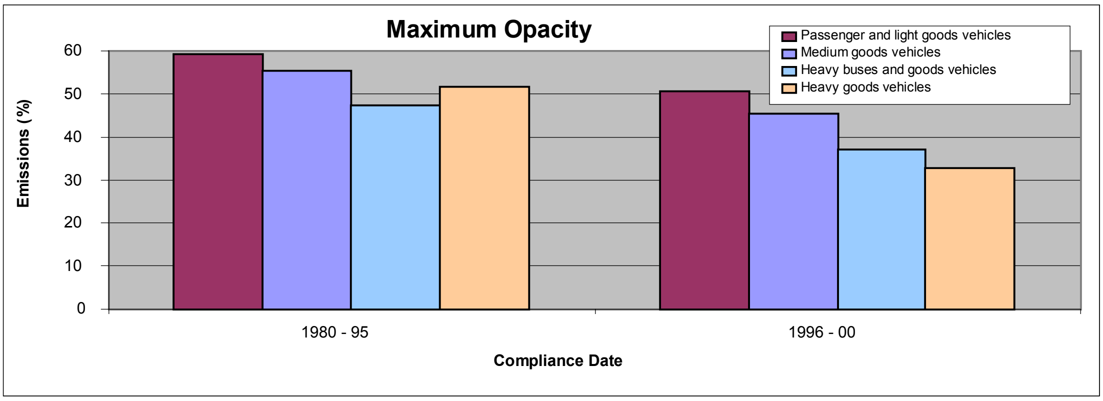
Source: NEPC Project 1

3.1.1 Smoke

The preparatory projects examined the emission performance of the diesel fleet for smoke under typical driving conditions. Maximum opacity gives a picture of the worst levels of smoke that a vehicle may emit over a short time period ie the highly visible blasts of smoke. Average opacity provides a more reliable measure of a vehicle's performance over a range of driving conditions.

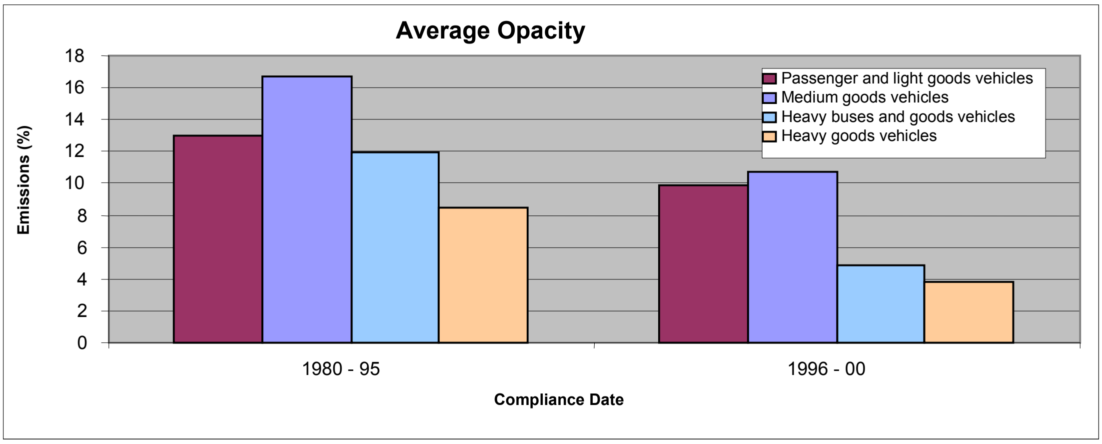
Figure 3-1 and Figure 3-2 indicate that generally, emissions of smoke are improving in newer vehicles, and that light duty vehicles are smokier than larger vehicles.

Figure 3-1 Maximum opacity of smoke emissions for 1980-1999 diesel vehicles



Source: NEPC Project 7

Figure 3-2 Average opacity of smoke emissions for 1980-1999 diesel vehicles

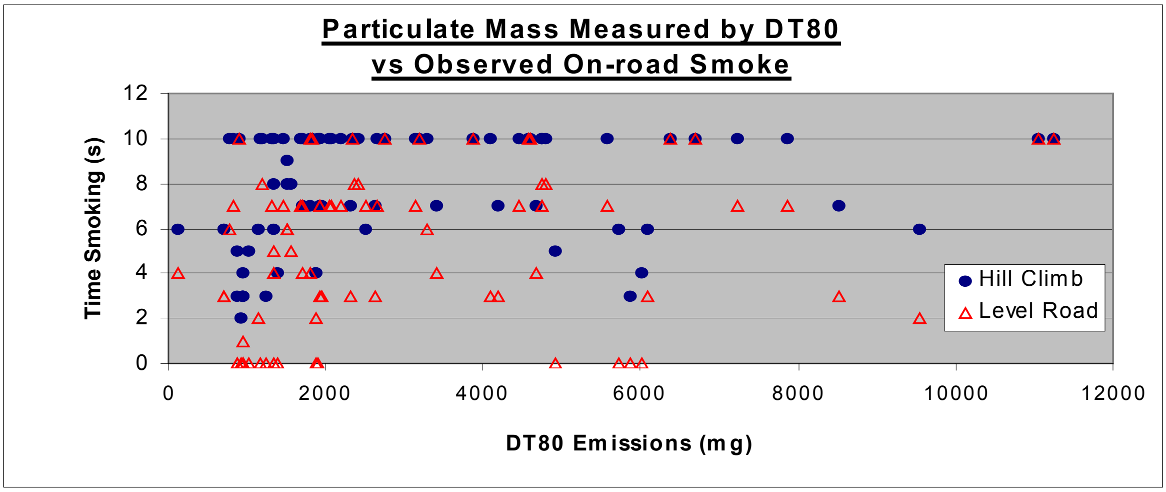


Source: NEPC Project 7

Results of NEPC Project 7 indicate that, given the emissions levels illustrated above, up to 14% of the vehicles in some classes would fail the proposed in-service emissions standards for opacity given in Section 6.1.3.

Figure 3-3 compares the amount of time a vehicle on the road emitted visible smoke to the recommended laboratory test for particle mass. While those vehicles which emitted visible smoke for more than 10 seconds are not included, this figure demonstrates a poor correlation between visible smoke and laboratory tested particles. For example, for vehicles that emit visible smoke for 10 seconds, the mass of particles emitted by those vehicles in an in-service test cycle ranges from 800mg to 11,500mg. Similar ranges in particle mass emitted for a given smoke emission time are also observed.

Figure 3-3 Observed on-road smoke vs in-service test for particle emissions



Source: NEPC Project 7

NEPC Project 2.2 identified that, of the vehicles identified as smoky vehicles by "on road" observation, only between 24% and 50% of these vehicles also failed the laboratory particle test. This is because the laboratory test only measures the mass of particles emitted and does not necessarily account for how visible the exhaust may be to the naked eye.

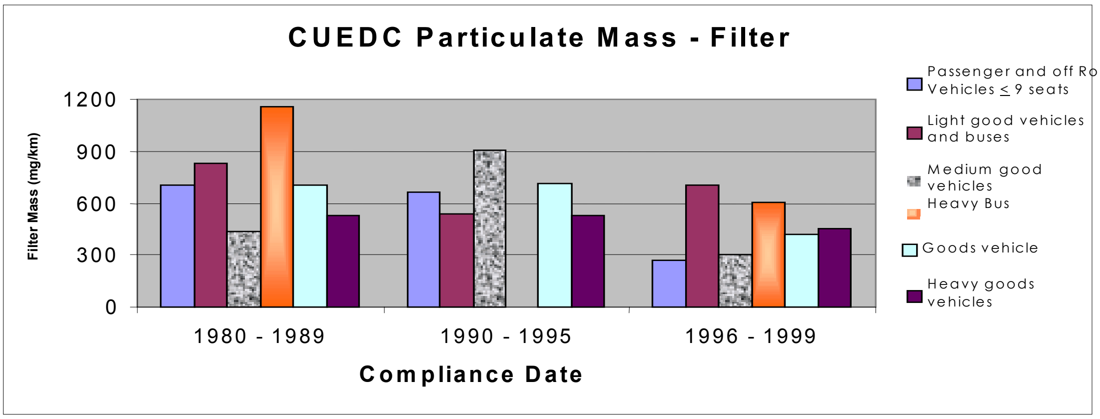
The large range in vehicles failing the smoke test and failing the particle test is dependent on where they were observed. Some vehicles will smoke on both level ground and on a hill while others will only smoke when going up a hill. Vehicles that smoke excessively on level ground, where the going is easier, can be expected to be the poorer performing vehicles and so more of these vehicles will smoke <u>and</u> fail the laboratory test (up to 50%). The extra effort required to climb a hill may see generally good vehicles smoke, even when they do not smoke on level ground or do not fail a particle test. Therefore a smaller proportion of vehicles smoking excessively on a hill (24%) will also fail the laboratory particle test.

3.1.2 Particles

A NSW study estimated that road transport is responsible for about 30% of particle emissions, with commercial diesel vehicles being the most significant contributor (NSW EPA, 1996c). The estimate of the contribution of vehicles to anthropogenic particle emissions in Victoria was between 10% (in Winter) and 46% (in Summer). Diesel vehicles are estimated to be responsible for 70-80% of these vehicle particle emissions (Carnovale et al, 1991; WA DEP, 1996; NSW EPA, 1998; Q DOE, 1998).

Figures 3-4 and 3-5 provide snapshots of the emission performance of the Australian diesel fleet with respect to particle emissions. The vehicles were tested using the Composite Urban Emission Drive Cycle (CUEDC) developed during NEPC Projects 2.2 and 7.

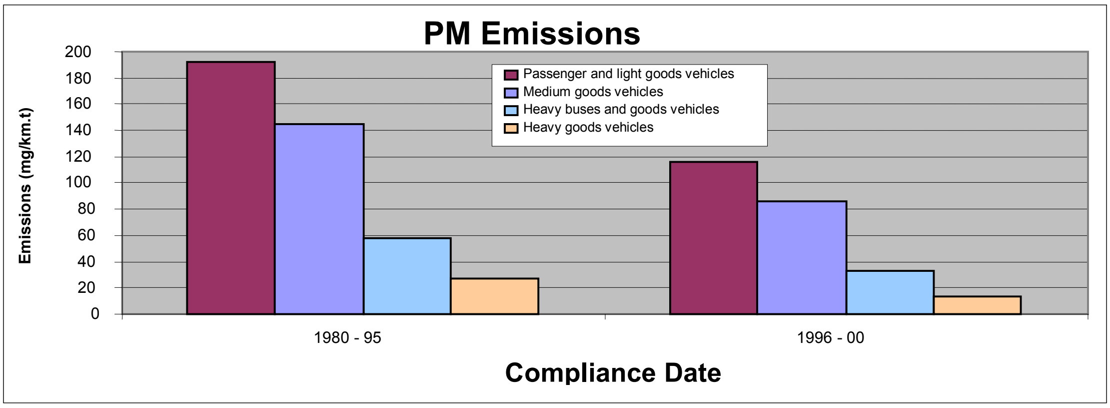
Figure 3-4 Total particle emissions for 1980-1999 diesel vehicles



Source: NEPC Project 2.2

Results of NEPC Projects 2.2 and 7 show a general trend toward lower particles emissions for new vehicles. On a mass normalised basis it also demonstrates that larger vehicles emit lower amounts of particles per tonne of vehicle mass. However, it should be noted that pre-ADR 70 light duty vehicles and light duty vehicles of 2.7-3.5 t GVM certified to the Euro 1 standard under ADR 70 were not required to meet a particle emissions standard.

Figure 3-5 Total particle emissions for 1980-2000 diesel vehicles (mass normalised)

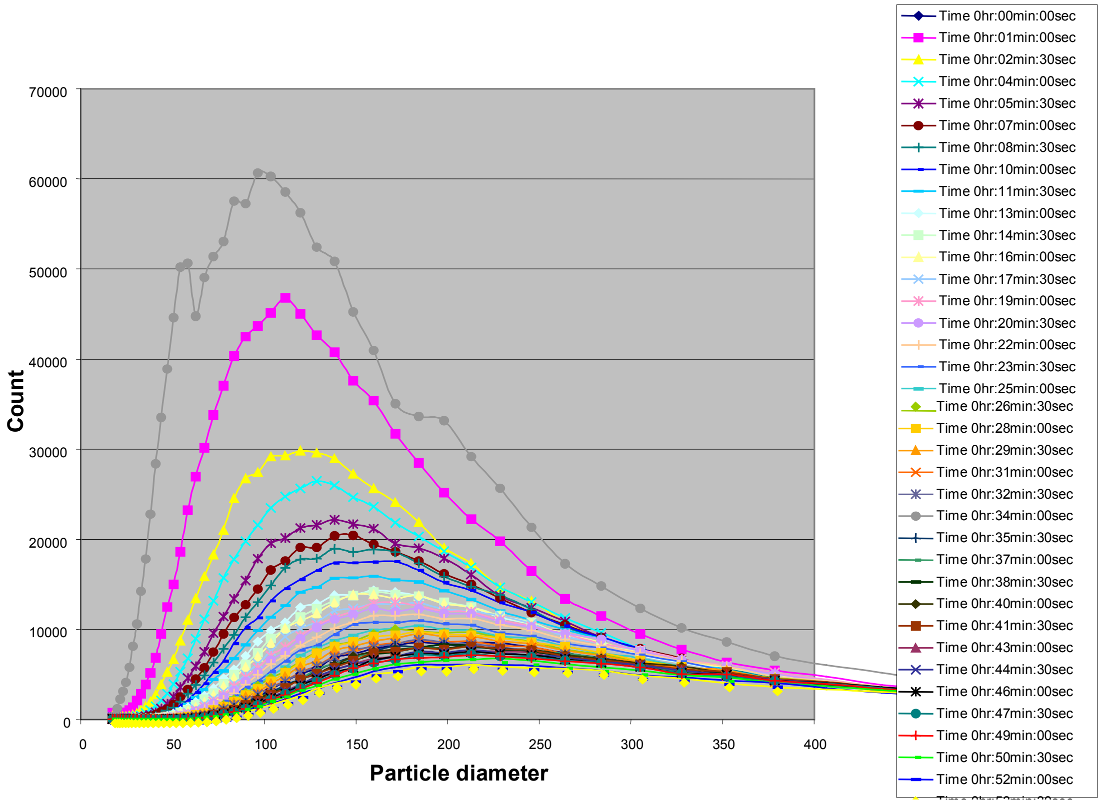


Source: NEPC Project 7

The level of particle emissions is not uniform across the Australian diesel fleet. For some vehicles, particle emissions are up to 600 per cent higher than the fleet average. NEPC Project 7 data shows that there is the potential to achieve a 53 per cent particulate emission reduction from vehicles with identifiable faults within certain classes. The results of Project 7 indicate that, given the particle emission levels illustrated above, up to 32% of some vehicle classes within the current diesel fleet would fail the proposed in-service emissions standards for PM_{10} given in Section 6.1.3.

According to the California Air Resources Board, 92% of diesel particles are less than 1 µm diameter (PM_1) (CARB 1998). The results of particle size analysis from NEPC Project 2.2 confirm a similar distribution for the Australian fleet. Figure 3-6 shows the number and size of particles emitted from a light duty vehicle and how they appear to form into fewer, larger particles over time but nevertheless remain considerably smaller than 1 µm after 1 hour (the maximum particle diameter on x-axis of the figure is 400nm (ie 0.4 µm)).

Figure 3-6 Growth in particle size with time after sampling – 1995 Vehicle <3.5 tonnes (Particle size in nanometres)



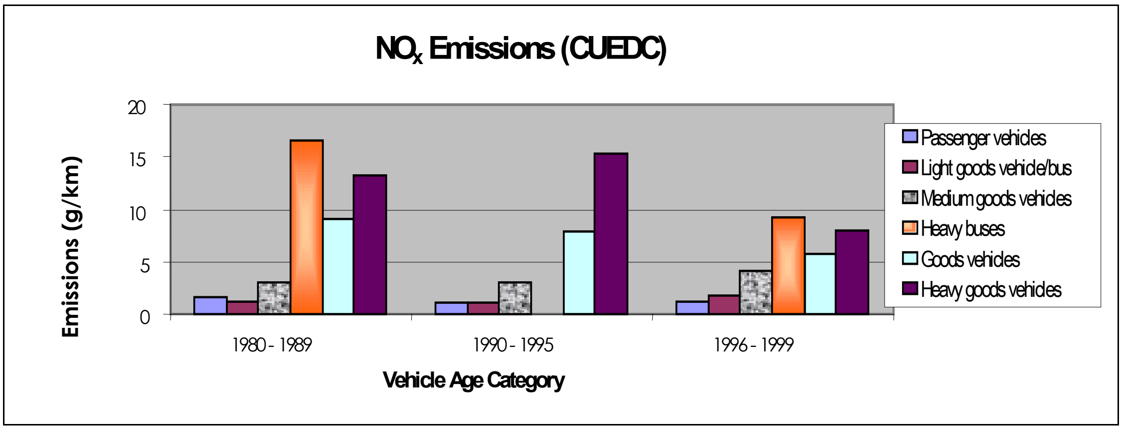
Source: NEPC Project 2.2

3.1.3 Oxides of Nitrogen

Diesel fuelled road vehicles make a disproportionate contribution to emissions of oxides of nitrogen. Data from Sydney, Melbourne and Brisbane indicate that motor vehicles are responsible for around 80% of total NO_x emissions, with diesel trucks and buses contributing about 40% of these vehicle emissions (NSW EPA, 1996c; Coffey Partners, 1996; Carnovale et al, 1991).

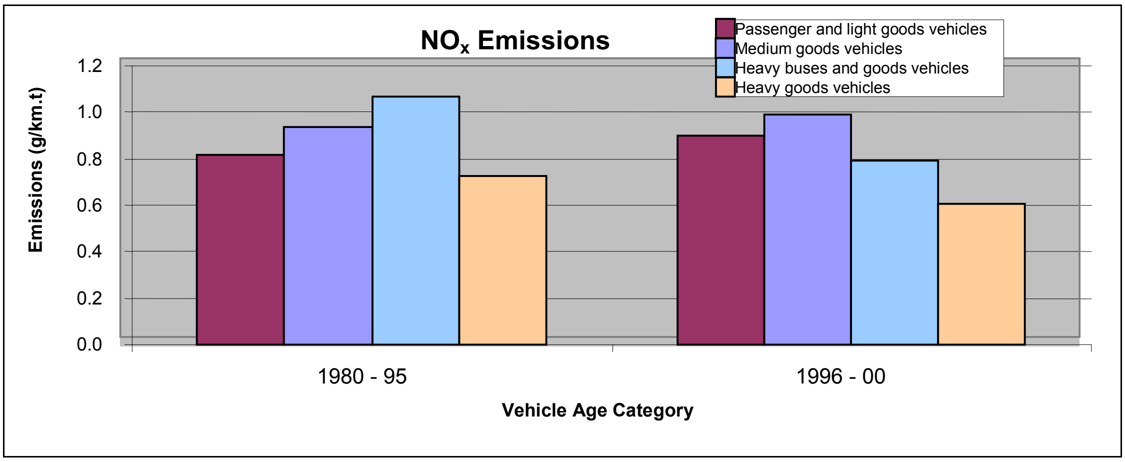
Figures 3.7 and 3.8 show current NO_x emission levels for diesel vehicles as determined by NEPC Projects 2.2 and 7 respectively. The results show increasing NO_x emissions with increasing vehicle mass, and overall emissions improving slightly for newer vehicles.

Figure 3-7 Oxides of nitrogen emissions for 1980-1999 diesel vehicles



Source: NEPC Project 2.2

Figure 3-8 Oxides of nitrogen emissions for 1980 – 2000 diesel vehicles (mass normalised)



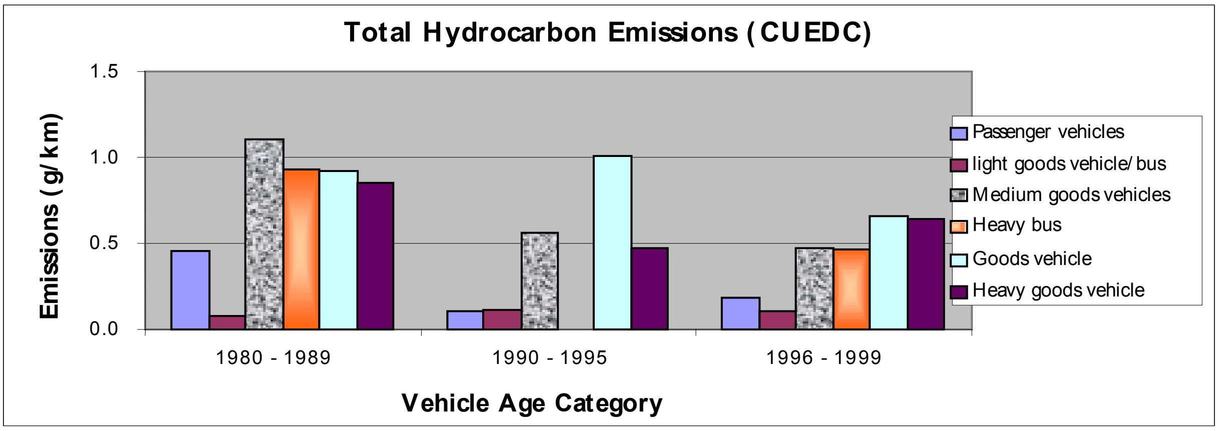
Source: NEPC Project 7

Results of NEPC Project 7 indicate that, given the emissions levels illustrated above, up to 5% of some vehicle classes within the current diesel fleet would fail the proposed in-service standards for NO_x given in Section 6.1.3.

3.1.4 Hydrocarbons

Emission results from Project 2.2 suggest that diesel vehicles are relatively low emitters of hydrocarbons. Figure 3-9 indicates that hydrocarbon emissions increase with vehicle mass but improve for newer vehicles.

Figure 3-9 Total hydrocarbon emissions for 1980-1999 diesel vehicles



Source: NEPC Project 2.2

Key Points

- **Diesel vehicles make a significant contribution to ambient levels of urban air pollutants, including particles, NO2 and ozone**
- **Extensive testing of diesel vehicles shows that:**
  - **emissions of NO_x have only improved marginally despite the introduction of new vehicle emission standards**
  - **lighter diesel vehicles tend to have very high particle emissions and average opacity levels per tonne vehicle mass and**
  - **particle emissions are improving marginally as new vehicle emission standards are introduced**

3.2 Growth of diesel vehicle use and emissions in Australia

Analysis of the Australian diesel fleet commissioned under NEPC Project 1 shows that diesel vehicles are increasing as a proportion of the total fleet. In 1995 diesel vehicles comprised 8.3% of the fleet. This will increase to 15% by 2015. Over this time diesel vehicle travel in metropolitan areas is anticipated to increase by 146%. This trend is likely to continue because diesel vehicles are more fuel efficient than petrol vehicles. The estimated population of the diesel fleet in Australia in 1995 and that forecast for 2015 is given in Table 3-2.

Table 3-2 Diesel vehicle populations 1995 and 2015

Vehicle Type	Total Number of All Vehicles 1995	Total Number of All Vehicles 2015	Number of Diesel Vehicles 1995	Number of Diesel Vehicles 2015
Car	8,608,906	11,021,000	223,387 (3)	556,870 (5)
Light Commercial	1,566,868	3,236,000	332,932 (21)	1,280,170 (40)
Rigid/ Other Trucks	351,154	327,690	253,968 (72)	264,360 (81)
Articulated Trucks	57,939	89,460	56.906 (98)	87,890(98)
Buses	45,511	52,170	37,338 (82)	38,180 (73)
Total	10,922,746	14,726,320	904,529 (8)	2,226,480 (15)

Source: NEPC Project 1 () signifies % of diesel vehicles as compared to total number of vehicles in each category

Further analysis of the estimated distance travelled by diesel vehicles in metropolitan areas is given in Table 3-3 and indicates that by 2015 light commercial vehicles will become the dominant diesel vehicle category, accounting for 43% of the total annual distance travelled in metropolitan areas. The percentage of distance travelled by rigid trucks is estimated to decline from 34% of all diesel travel in 1996 to 18% in 2015 as freight forwarders continue to switch to the use of articulated vehicles. Despite this decline in distance travelled, rigid trucks will remain significant emitters of particles (33% of the total diesel emissions) in 2015. The proportion of particles emitted by light commercial vehicles will increase from 16% in 1996 to 30% in 2015 (Table 3-5).

Table 3-3 Distance travelled by vehicle age

		Distance Travelled by Age (Millions vehicle – km)						Total metro (3)
VEHICLE	Year	0-3	4-6	7-10	11-15	16-20	>20	
Passenger Vehicle	1996 (1)	598.7	452.4	471.6	378.0	142.6	---	2043.2 (23)
	2015	1605.3	1213.0	1264.5	1013.6	382.4	---	5478.8 (25)
Light Commercial	1996	668.1	477.2	487.8	371.2	112.4	4.2	2121.0 (24)
	2015	2945.9	2104.2	2151.0	1636.6	495.7	18.7	9352.0 (43)
Rigid Trucks	1996	612.1	642.7	748.0	658.0	336.7	63.0	3060.5 (34)
	2015	789.4	828.9	964.6	848.6	434.2	81.3	3946.9 (18)
Articulated Trucks	1996	354.5	248.8	244.6	165.8	22.8	---	1036.5 (12)
	2015	825.9	579.6	569.9	386.4	53.1	---	2415.0 (11)
Buses	1996	183.6	138.7	144.6	115.9	43.7	---	626.6 (7)
	2015	187.2	141.4	147.4	118.2	44.6	---	638.8 (3)
Totals	1996	2417.0	1959.8	2096.6	1688.9	658.2	67.3	8887.8
	2015	6353.7	4867.1	5097.5	4003.4	1410.0	100.0	21831.6

Source: NEPC Project 1

Note:
1. 1996 is used for metropolitan travel as 1995 data are not available for all vehicle categories.
2. --- signifies negligible.
3. ( ) signifies percent of total distance travelled by all vehicles

Although 25% of the diesel vehicle fleet is greater than 16 years old these vehicles provide only 8% of diesel travel by diesel vehicles. (Table 3-4). However, vehicles 7-15 years old account for 43% of distance travelled in metropolitan areas. Older vehicles built to less stringent emission standards therefore continue to play a significant role in fleet emissions (Table 3-5).

Table 3-4 Distance travelled by vehicle age group

Vehicle Age (years)	% of total diesel fleet population	Metro distance travelled millions km 1996(1)	Metro distance travelled millions km 2015	Total distance travelled millions km 1995	Total distance travelled millions km 2015
0-3	26	2,417 (27)	6,354 (29)	6,296 (27)	16,374 (30)
4-6	14	1,959 (22)	4,867 (22)	4,545 (20)	12,224 (22)
7-10	18	2,096 (24)	5,097 (23)	5,699 (25)	12,646 (23
11-15	18	1,688 (19)	4,003 (18)	5,025 (22)	9,719 (17)
16-20	6	658 (7)	1,410 (6)	1,359 (6)	3,123 (6)
>20	19	67 (1)	100 (1)	293 (1)	188 (0.3)
Totals	100	8,888	21832	23,217	54,275

Source: NEPC Project 1

Notes: 1. 1996 is used for metropolitan travel as 1995 data in this format is not available for all vehicle categories.
2. ( ) signifies % of total diesel for column.

Using emissions data from Projects 2.2 and 7, an estimate of the relative contribution of each vehicle category to total emissions from the diesel fleet has been made (Table 3-5). The data indicate that when the combined effect of emissions performance, vehicle numbers, and distance travelled are considered, rigid and articulated trucks are the principal sources of urban NO_x emissions from diesel vehicles, while rigid trucks are the dominant source of particles, with significant contributions from LCVs and articulated vehicles. The modelling suggests that by 2015, the NO_x picture is similar, but cars, light commercials and rigid trucks will be the major sources of particles.

Table 3-5 Contribution to emissions by vehicle type, Metropolitan NSW, 1996 and 2015 (% of total)

Vehicle Type	*CO*		*NO_x*		*HC*		*PM_{10}*	
	1996	***2015***	***1996***	***2015***	***1996***	***2015***	***1996***	***2015***
Passenger Vehicles	***4.6***	***10.9***	***1.8***	***3.4***	***2.0***	***3.2***	***8.8***	***18.6***
LCVs	***15.3***	***25.1***	***4.2***	***5.6***	***3.0***	***12.8***	***15.8***	***29.7***
Rigid Trucks	***45.2***	***29.3***	***46.7***	***40.7***	***69.6***	***49.6***	***51.9***	***33.1***
Artic. Trucks	***22.2***	***23.1***	***28.1***	***29.3***	***14.9***	***17.9***	***14.4***	***11.0***
Buses	***12.7***	***11.7***	***19.2***	***20.9***	***10.5***	***16.5***	***9.2***	***7.6***
Totals	***100.0***	***100.0***	***100.0***	***100.0***	***100.0***	***100.0***	***100.0***	***100.0***

Source: Cox, J.B. 2000. Diesel Fleet Characteristics : Emission Projections Update ; Preliminary Report to the National Road Transport Commission.

Key Points

- **The number of diesel vehicles and the distance they travel is increasing significantly**
- **Light commercial vehicles are growing in number and distance travelled, particularly in urban areas which are most sensitive to diesel emissions**
- **Rigid trucks, while declining in number and distance travelled, will continue to be significant emitters of particles**

3.2.1 *Deterioration of emission performance*

The Preparatory Projects have shown that NO_x emissions do not deteriorate significantly over the life of a vehicle. This suggests that emission performance of oxides of nitrogen is more a function of engine design.

In relation to particle and smoke emissions, the results of NEPC Project 7 have demonstrated that there are significant numbers of in-service vehicles with emissions performance significantly worse than could be reasonably expected given the age and usage of the vehicle.

Table 3-5 demonstrates that older vehicles show a greater frequency of faults, which adversely affect emissions performance, than newer vehicles. Nevertheless, a significant number of vehicles less than five years old also have faults that are related to deterioration in emission performance.

Table 3-5 Frequency of significant emission related faults in the Australian diesel fleet

Vehicle Mass	Vehicles < 5 years old ADR 70			Vehicle 6-20 years old Pre ADR 70		
	% with significant emission faults			% with significant emission faults		
	NO_x	Particles	Opacity	NO_x	Particles	Opacity
< 3.5 tonnes	4	13	4	5	32	10
3.5 to 12 tonnes	2	13	5	5	12	14
12 to 25 tonnes	0	11	0	3	20	3
> 25 tonnes	0	8	0	0	1	1

Note: Values based on the percentage of vehicles identified in NEPC Project 7 that have emission levels above the proposed in-service emission Standards.

These results suggest that a significant number of vehicles are operating well below their optimum emissions performance (even accounting for reasonable deterioration) and significant emission reductions could be achieved from moderate improvements in maintenance.

3.2.2 *Causes of high emissions*

Faults related to emission performance

Section 3.1.1 provided information on the number of high emitting vehicles with significant emission related faults found within the diesel fleet. In vehicles under five years old engine faults related to poor emission performance are generally of a minor nature which can be corrected by regular servicing. Faults generally relate to blocked air filters, fuel filters plugged with tainted fuel and minor injector problems. In older vehicles faults are mainly related to deterioration of fuel injectors.

The smaller (<3.5t and 3.5-12t) vehicles older than 5 years (pre ADR70) have a very high number of air filter, fuel filter and injector faults. This suggests that these vehicles are not serviced regularly and are deteriorating more rapidly than other sectors of the diesel fleet. Programs designed to reduce vehicle emissions should focus their attention on reduction of the occurrence of these faults.

Types and frequency of significant emission faults in vehicles identified as high emitters and the estimated frequency of these faults in the overall fleet are described in Table 3-6. As mentioned above, some types of faults appear with high frequency in vehicles identified as high emitters. Overall, the frequency of faults that would cause vehicles to be excessive emitters is low on a fleet-wide basis.

Table 3-6 Frequency of emission related faults

Vehicle Class	Compliance Date	Types of emission related faults % Occurrence rates in high emitters and in ( ) fleet							
		Injectors	Fuel Pump	Air Filter	Fuel Filter	Poor Fuel	Exhaust System	Tappets	Other Faults
<3.5t	1980-1995	37 (12)	17 (5)	20 (6)	20 (6)	11 (4)	3 (1)	6 (2)	6 (2)
	1996-2000	0 (0)	0 (0)	15 (2)	15 (2)	15 (2)	0 (0)	0 (0)	0 (0)
3.5-12t	1980-1995	31 (4)	15 (2)	8 (1)	15 (2)	15 (2)	0 (0)	31 (4)	0 (0)
	1996-2000	29 (2)	14 (1)	43 (3)	43 (3)	29 (2)	0 (0)	0 (0)	0 (0)
12-25t	1980-1995	27 (5)	18 (4)	18 (4)	23 (5)	9 (2)	0 (0)	18 (4)	0 (0)
	1996-2000	17 (2)	17 (2)	33 (4)	33 (4)	33 (4)	0 (0)	0 (0)	17 (2)
>25t	1980-1995	100 (1)	0 (0)	100 (1)	100 (1)	100 (1)	0 (0)	0 (0)	0 (0)
	1996-2000	0 (0)	0 (0)	100 (3)	100 (3)	100 (3)	0 (0)	0 (0)	0 (0)

Note: Values are derived from NEPC Project 7 data and the application of proposed in-service particle Standard. Top value is frequency of fault occurrence in vehicles with particle emissions above the proposed in-service particle Standard. Value in brackets is estimated frequency of faults occurring in the fleet category that would cause a vehicle to exceed the Standard.

All manufacturers have recommended maintenance schedules for all faults identified above. The results of NEPC Project 7 suggest that many vehicle owners vehicles are avoiding recommended maintenance, especially in regard to fuel injector systems.

Tampering

The vehicle faults found in NEPC Project 7 also included many vehicles that had been tampered with either deliberately or through negligent actions. Table 3-7 illustrates that tampering in diesel vehicles identified as high emitters occurs across the fleet, but principally in older vehicles up to 25t GVM.

Table 3-7 Frequency of emission related engine component tampering

Frequency of tampering in high emitting vehicles (%)				
	<3.5t	**3.5-12t**	**12-25t**	**>25t**
1980-1995	69	67	50	40
1996-2000	0	50	14	0

Source: NEPC Project 7

Note: Values are the frequency of occurrence in vehicles identified as having emissions above the proposed in-service Standard for particles.

There is strong anecdotal evidence that a significant proportion of tampering is the result of vehicle owners attempting to maximise the power performance of their vehicles. This can often be easily accomplished by altering the manufacturer's adjustments for fuel delivery.

Smaller vehicles in the fleet tend to be those with the lowest power to mass ratios. This could explain why tampering is found more in smaller vehicles where power deficits will be more apparent. Newer, larger vehicles tend to have more sophisticated fuel delivery systems that are often more difficult to alter, and appear to have larger power to mass ratios so that power deficits are less apparent. This could explain a lower frequency of tampering.

It is anticipated that the rate of tampering found in identified high emitting vehicles would be higher than in the overall fleet.

All jurisdictions have implemented the National Road Transport Reform (Vehicle Standards) Regulations 1999. These regulations require that vehicle emission control equipment be maintained to ensure its operation remains essentially in accordance with the original design of the vehicle.

Typically, identification of tampering or mal-maintenance has relied on detailed visual inspection looking for non-standard components fitted or for obvious signs of tampering without direct knowledge of a vehicle's emission performance. The proposed in-service emission standards, combined with NEPM programs involving some form of testing and repair, will now provide a means to assess the in-service emissions performance of a vehicle. From the results of these tests, further investigations (such as a detailed inspection of a vehicle and all relevant equipment) into any tampering and mal-maintenance may be indicated.

Key Points

- **Older vehicles show a greater frequency of faults which adversely affect emissions performance, than newer vehicles**
- **Faults generally relate to blocked air filters, fuel filters plugged with tainted fuel and minor injector problems**
- **Results of Project 7 suggest that many vehicle owners vehicles are avoiding recommended maintenance**
- **many vehicles had their air/fuel systems tampered with, either deliberately or through negligent actions**

4 REDUCING EMISSIONS FROM IN-SERVICE VEHICLES – OBJECTIVES AND OPTIONS

4.1 Objectives

Given the adverse health and environmental impacts associated with diesel emissions and the increasing use of diesel vehicles in Australia, there is a need to implement strategies to reduce emissions from diesel vehicles, including those currently in service.

The need for improved management of in-service diesel emissions can be met either by jurisdictions individually, or addressed on a national basis. A national approach is appropriate as vehicles are mobile across all jurisdictions, and emission performance standards for new vehicles are regulated on a national basis. Some States and Territories have implemented or are implementing some in-service emission reduction measures, including smoky vehicle programs (New South Wales, Victoria, South Australia, Queensland, Western Australia). It would therefore be consistent, cost effective and efficient to also establish a national framework under which in-service emissions from diesel vehicles can be managed.

In taking action to deal with emissions from in-service diesel vehicles, the objectives are to:

- identify and develop strategies and mechanisms for:
  - reducing emissions from the diesel vehicle fleet; and
  - ensuring that diesel vehicles achieve and maintain optimum emissions performance;
- provide a legal underpinning for managing in-service emissions from diesel vehicles; and
- allow flexibility of action by jurisdictions to address specific problems related to emissions from diesel vehicles; and
- facilitate consistency of application to vehicle operators across the country.

4.2 Options

This section outlines the potential options for reducing emissions from the diesel vehicle fleet in Australia. The options considered are:

1. Do nothing;
2. Control of vehicle use and traffic management; and
3. In-service vehicle emission reduction measures.

4.2.1 Option 1 – Do Nothing

The principal programs currently in place which are aimed (wholly or in part) at reducing diesel vehicle emissions are:

- new vehicle emission standards;
- fuel quality standards;
- use of alternative fuels; and
- smoky vehicle programs.

Governments could decide to do nothing further.

New Vehicle Emission Standards

Setting minimum emissions standards for new diesel vehicles will ensure that the impact of the Australian diesel fleet on air quality is minimised over the long term as older, higher emitting vehicles are gradually replaced by newer better performing vehicles. In Australia, these emission standards are set by the Australian Design Rules (ADRs) which are regulations under the Commonwealth *Motor Vehicle Standards Act 1989.*

ADR70/00) currently set limits on emissions of carbon monoxide, hydrocarbons, oxides of nitrogen, and particles from diesel vehicles and ADR30/00 currently set limits on emissions of smoke.

New, more stringent ADRs were gazetted in December 1999. These new standards will greatly reduce allowable emissions from the diesel fleet beginning in 2002. Table 4-1 summarises the changes in NO_x and PM emission performance that will occur as a result of the introduction of new Australian Design Rules.

Table 4-1 Percentage reductions in emissions from diesel vehicles under the new ADRs

ADR & Euro Standards	**NO_x**		**PM**	
	Limits	% Reduction over ADR70/00	Limits	% Reduction over ADR70/00
Heavy Duty Diesels	g/kWhr		g/kWhr	
ADR 70/00(Euro 1)	8	-	0.36	-
ADR80/00 (Euro 3)	5	38%	0.1	72%
ADR80/01 (Euro 4)	3.5	56%	0.02	94%
Diesel Cars	g/km		G/km	
ADR 70/00(Euro 1)	0.44	-	0.14	-
ADR79/00 (Euro 2)	0.25	43%	0.08	43%
ADR79/01 (Euro 4)	0.08	82%	0.025	82%
Diesel Light Commercials	**$HC+NO_x$** g/km		**PM** g/km	
ADR79/00 (Euro 2)	1.2	-	0.17	-
ADR79/01 (Euro 4)**	0.46	62%	0.06	65%

* Limits for LCVs under ADR70/00 are in different unit of measure and are not comparable to the Euro 2 and Euro 4 limits.

** Percentage reductions are from Euro 2 to Euro 4.

Fuel Quality Standards (cleaner diesel fuels)

The major benefit of improved diesel fuel quality is in supporting and enabling the introduction of improved vehicle technologies necessary to achieve the stringent vehicle emissions standards outlined above. In particular, lower fuel sulfur levels are a prerequisite for the use of advanced catalyst technologies. Nevertheless, lower sulfur levels will also reduce particle emissions from existing vehicles.

The *Fuel Quality Act 2000* enables the Commonwealth to establish national fuel quality standards for a range of fuel types, including diesel. Regulations specifying limits for fuel parameters which affect both vehicle operability and the pollutant emissions from motor vehicles will be made in 2001 and come into effect from 2002. Modelling performed as part of NEPC Project 1 predicts the particle emissions reductions flowing from the reduction in the sulfur content of diesel fuel as specified by *Measures for a Better Environment* will result in approximately a 10% -15% reduction in particle emissions from diesel vehicles in metropolitan areas by 2015.

Combined Effect of New Emission Standards and New Fuel Standards

Modelling results outlined in NEPC Project 1 suggest that the new fuel and vehicle emissions standards will produce a reduction in pollutant emissions from the diesel fleet of 36 - 80% by 2015 (Table 4-2).

Table 4-2 Projected changes in annual metropolitan diesel fleet emissions - 1995 to 2015

	EMISSION FORECASTS (TONNES)			
	CO	**NO_x**	**HC**	**PM_{10}**
ADELAIDE 1996	2156	3616	386	564
ADELAIDE 2015	831	1236	219	96
NET REDUCTION (%)	**61**	**66**	**43**	**83**
BRISBANE 1996	4534	8256	763	1196
BRISBANE 2015	2634	4855	634	276
NET REDUCTION (%)	**42**	**41**	**17**	**77**
CANBERRA 1996	481	935	80	123
CANBERRA 2015	232	426	59	25
NET REDUCTION (%)	**52**	**54**	**26**	**80**
DARWIN 1996	325	505	52	92
DARWIN 2015	181	268	45	20
NET REDUCTION (%)	**45**	**47**	**13**	**78**
HOBART 1996	556	1066	102	131
HOBART 2015	262	560	73	25
NET REDUCTION (%)	**53**	**47**	**28**	**81**
MELBOURNE 1996	8651	15727	1729	2007
MELBOURNE 2015	4357	9779	1182	402
NET REDUCTION (%)	**50**	**38**	**32**	**80**
PERTH 1996	3139	5751	585	783
PERTH 2015	1756	3116	437	188
NET REDUCTION (%)	**44**	**46**	**25**	**76**
SYDNEY 1996	7579	16475	1701	1602
SYDNEY 2015	3426	7697	1045	358
NET REDUCTION (%)	**55**	**53**	**39**	**78**

Source: NEPC Project 1

These projections represent a maximum outcome as they assume that all vehicles will be maintained throughout their working life, and that there will be no adulteration of fuel or tampering with vehicles.

The work undertaken in NEPC Project 7 indicates that a significant number of vehicles with high emissions have been operated on poor or adulterated fuel, and had major emission related faults. It is therefore unlikely that the outcomes predicted in Table 4-2 will be achieved in full. The vehicle faults found in NEPC Project 7 also included many vehicles that had been tampered with either deliberately or through negligent actions resulting in a deterioration of emission performance.

Use of Alternative Fuels

There are a number of existing and emerging alternative fuels with the potential to substitute for diesel which have a reduced impact on the environment compared to current diesel fuel. Fuels such as hydrogen and Compressed Natural Gas (CNG) are being trialled in a number of in-service applications around the world, particularly in bus fleets. The Australian Greenhouse Office has implemented the Alternative Fuels Conversion Program with the aim of converting 800 buses and 4,000 heavy-duty vehicles a year to CNG and LPG.

However, until widespread infrastructure is available it is unlikely that there will be a significant move toward CNG. While fuels such as hydrogen are promising from an environmental perspective, their use is in a relatively early stage of development. In addition the large existing investment in the diesel fleet means that there will not be a large scale replacement of diesel use with alternative fuels in the near future.

Smoky Vehicle Programs

A number of jurisdictions (New South Wales, Victoria, South Australia, Queensland, Western Australia) currently operate smoky vehicle programs based on the NRTC guideline "10 second smoke test". These programs identify vehicles with unacceptable emissions of visible smoke (as described in the guideline). Jurisdictions require or request owners of those vehicles to repair faults causing the excessive emissions.

Assessment of Option 1

The new vehicle emission and fuel standards being implemented nationally from 2002 to 2006 are projected to achieve substantial emission reductions. Alternative fuels are not expected to be available at significant levels in the near future.

Smoky vehicle programs can be effective in reducing visible smoke pollution, but there is no evidence to suggest that such programs will have a significant impact on other emissions of concern (eg particles) from diesel vehicles. It has been assumed in the past that visible smoke is a good indicator of other emissions such as particles. NEPC Project 2.2 demonstrated that emissions of visible smoke do not correlate well with laboratory measured particle emissions. These programs address visible smoke only, and do not explicitly tackle other emissions of greater health concern.

While existing and scheduled new vehicle and fuel quality standards are predicted to achieve significant emissions reductions, the ability to realise these improvements is limited by the existing high rates of vehicle tampering, poor vehicle maintenance and fuel adulteration. Smoky vehicle programs address the issue of visible smoke but can not reliably address emissions of greater health concern. Smoky vehicle programs may form part of a larger suite of in-service programs.

In meeting the objective of reducing emissions from the in-service fleet as outlined in Section 4.1, Option 1 is inadequate as it does not have a significant impact on emissions from the existing vehicle fleet.

4.2.2 Option 2 – Control of Vehicle Use and Traffic Management

As emission reductions from technological improvements to conventional vehicles and fuels becomes progressively smaller, there is a need to deal with the underlying growth in vehicle travel. As indicated in Section 3.2, urban travel by diesel vehicles is expected to increase by over 140% by 2015. NEPC Project 2.2 shows that the emissions performance of diesel vehicles is greatly affected by the manner in which the vehicle is driven and traffic conditions, with generally lower emissions in less congested driving conditions.

Management of vehicle use is a complex issue involving:
- transport planning;
- urban design;
- road pricing; and
- development of alternatives to vehicle use

amongst other factors.

Assessment of Option 2

While improved traffic flow conditions will reduce emissions from diesel vehicles this cannot be achieved uniformly across urban areas. Without ensuring vehicles are well maintained improvements to traffic flow will not address the fact that many vehicles continue to be operating at excessive emission levels.

Measures to limit diesel vehicle use in urban areas and improve the operating conditions for those vehicles will become increasingly important in reducing total emissions, such programs are by their nature infrastructure specific and do not lend themselves to a national approach.

4.2.3 Option 3 - In-service vehicle emission reduction measures

In-service emission reduction measures are those which improve or maintain the emissions performance of a vehicle during its useful life. Work conducted as part of the diesel NEPM preparatory projects has shown that diesel vehicle emissions performance deteriorates during the vehicle life and that it can be improved through vehicle maintenance or repair.

The available methods for reducing in-service emissions rely on either:
- optimising vehicle performance according to the manufacturer's specifications by tuning and repairing vehicles; or
- improving the original emissions performance of the vehicle by retrofitting exhaust treatment devices or rebuilding the engine.

There are a number of well established strategies for managing emissions from in-service diesel vehicles that could be developed for managing emissions from the Australian diesel fleet. In addition to smoky vehicle programs discussed above, these include:
- test and repair programs;

- audited maintenance programs;
- retrofitting of vehicles with improved technologies;
- rebuilding of engines to higher emission standards; and
- in-service emissions performance standards

While some jurisdictions operate smoky vehicle programs, there are no significant measures being implemented to maintain the in-service emission performance of the Australian diesel fleet.

Test and repair programs

The objective of a test and repair program is to ensure compliance with in-service emission performance standards by use of in-service emissions testing, combined with a requirement for vehicles that do not meet the specified standards to be repaired.

An emissions test is the most definitive means of establishing if a vehicle is emitting excessive levels of pollutants. Testing at regular intervals using a standardised test will provide reasonable assurance that, providing a vehicle has not been tampered with, it will be in compliance with emissions standards. To maximise the effectiveness of the program and minimise cost, it is necessary to establish the vehicle types that are most likely to be out of compliance and the time it may take them to become non-compliant again after a test, in order that they may be targeted.

Test and repair programs allow vehicle operators to check that their vehicles are in compliance, and/or to demonstrate that out of compliance vehicles have been repaired effectively.

Audited maintenance programs

Audited maintenance programs are essentially standard quality systems similar to Quality Assurance programs. The objective of audit programs is to ensure the maintenance of emission performance of the diesel fleet while minimising oversight by government. These types of programs generally require vehicle owners to provide evidence that their vehicles are maintained on a regular basis with such evidence subject to external audit.

Retrofitting of vehicles with improved technologies

There is a capacity to reduce harmful emissions from vehicles built to pre-2002 standards by retrofitting exhaust system components such as oxidation catalysts and particle traps. The objective of diesel retrofit programs is to improve the emissions performance of in-service vehicles by fitting exhaust after treatment devices.

There are a large number of vehicles in the diesel fleet which have no emissions control technology, except to limit smoke. Catalysts and other advanced exhaust control technology will not be fitted to most new diesel vehicles until the introduction of ADR79/00 and ADR80/00 in 2002. There are number of retrofit programs in place throughout the world that rely on a mixture of regulatory and market measures.

Rebuilding of engines to higher emission standards

The objective of diesel engine rebuild programs is to improve the emissions performance of existing vehicles by the fitment of low emission engine upgrade kits at the time of rebuild.

Where kits are available, they give a vehicle operator the ability to extend the life of a vehicle, while improving its emissions performance to a level better than the original specification.

The operation of a rebuild program has many similarities to a retrofit program, with the key difference being that many retrofit technologies have generic application, whereas rebuild programs are developed for specific engines or engine families.

In-service emission standards

Management of in-service emissions requires a performance benchmark for establishing a definition of adequate emission performance. This is achieved through the development of a set of in-service emission standards for identified emissions and a test protocol for measuring a vehicle's emission performance against the standards.

Capacity for Reducing Emissions from In-service Fleet

NEPC Project 7 demonstrates that significant reductions in particle and smoke emissions can be achieved in a large proportion of vehicles ranging from those with very high emissions rates to those with rates typical of the average of the tested groups. Table 4-3 illustrates that emissions of particles can be reduced by up to 44% in newer vehicles and over 50% in older faulty vehicles.

Table 4-3 Effect of repair of high emitting diesel vehicles

Vehicle Mass	Vehicles < 5 years old ADR 70			Vehicle 6-20 years old Pre ADR 70		
	Average change in emissions per vehicle following repair %			Average change in emissions per vehicle following repair %		
	NO_X	Particles	Smoke Opacity	NO_X	Particles	Smoke Opacity
< 3.5 tonnes	+15	-16	+7	+12	-48	-6
3.5 to 12 tonnes	0	-44	-26	+11	-53	-27
12 to 25 tonnes	0	-38	+25	+7	-45	-28
> 25 tonnes	+8	-13	+10	+19	-9	-6

Source: NEPC Project 7

As indicated in Table 3-5 vehicles greater than 25 tonnes have low fault frequencies. The limited effect of repair suggests that those faults that do occur are of minor significance in regard to emission performance.

The slight increase in emissions of oxides of nitrogen following repair demonstrates a known trade-off that occurs in improving particle emission performance. Repairs that improve combustion can result in higher combustion temperatures and the formation of oxides of nitrogen. This increase as a result of repair suggests that NO_x emissions may have been restored to levels similar to those when the vehicles were new.

The estimated effect of repairing high emitters on overall fleet performance is shown in Table 4-4. The results demonstrate that maintenance and repair can significantly reduce fleet particle emissions in light commercial and medium-heavy trucks - by 6-27% in the older vehicles and 4-12% in newer vehicles. As noted above vehicles greater than 25 tonnes have a lower frequency of faults and low response to repair and this sector of the fleet therefore shows the smallest change in overall emissions performance.

Table 4-4 Impact of repair on overall fleet performance

Vehicle Mass	Vehicles < 5 years old ADR 70			Vehicle 6-20 years old Pre ADR 70		
	Average change in emissions following repair %			Average change in emissions following repair %		
	NO_X	Particles	Smoke Opacity	NO_X	Particles	Smoke Opacity
< 3.5 tonnes	+2	-4	+2	+4	-27	-3
3.5 to 12 tonnes	0	-12	-6	+1	-6	-5
12 to 25 tonnes	0	-8	+5	+1	-15	-9
> 25 tonnes	+1	-3	+2	0	0	0

Source: NEPC Project 7

These results suggest that a significant number of vehicles are operating well below their optimum emissions performance (even accounting for reasonable deterioration) and significant emission reductions could be achieved from moderate improvements in maintenance.

Assessment of Option 3

Option 3 offers considerable scope to meet the emission reduction objectives outlined in Section 4.1. Measures aimed at improving the maintenance and repair of emission related components in diesel vehicles have been demonstrated to deliver significant reductions in emissions of particles and smoke from in-service vehicles. Implementation of in-service programs provides an improved means of enforcing vehicle tampering legislation. The retrofit of emission control devices to existing vehicles also offers the capacity to reduce emissions of hydrocarbons and particles. Low emission rebuild kits also offer some scope to reduce NO_x and particle emissions. A more detailed description of specific strategies encompassed by Option 3 is given in Chapter 6.

Option 3 is the preferred option and a range of options for its implementation are discussed in Chapter 5.

5 REGULATORY OPTIONS FOR IN-SERVICE EMISSION REDUCTION PROGRAMS

As discussed in Option 3 of Section 4.2.3 above, there is significant potential for reducing emissions from in-service vehicles by implementing programs that increase the level of vehicle maintenance within the fleet or directly limit exhaust emissions through retrofit of emission control devices or use of low emission engine rebuild kits.

In addition to the design of particular strategies for reducing emissions in-service, it is also necessary to consider the most appropriate means of delivering such programs.

The delivery options evaluated in this section are :

- Voluntary Industry Agreements
- State/Territory Regulation
- Commonwealth Regulation
- National Environment Protection Measure

In considering the options below, each option is evaluated on the basis of whether it fails to meet any of the following criteria:

- does the option provide a nationally consistent approach to the management of in-service emissions;
- does the option provide the flexibility necessary for application to varying jurisdictional air quality requirements;
- are there adverse impacts on competition;
- are there any regional and rural impacts including regional environmental differences; and
- is it effective in delivering the anticipated reductions in in-service emissions from diesel vehicles, particularly emissions of particles.

5.1 Voluntary Industry Agreements

Programs to improve maintenance and/or adopt retrofit or rebuild strategies could be implemented by incorporation into voluntary agreements between governments and transport operators. For example, the Australian Trucking Association (ATA) proposes to develop an environmental management system for the trucking industry that will include measures to reduce diesel in-service emissions. This proposal includes the development of a 'green fleet' program under which accredited vehicle operators undertake regular vehicle maintenance audited by an independent body. The ATA is seeking to work with government to implement this proposal. The bus industry has also issued its own Bus Industry Environment Guide that offers best practice information on reducing emissions and encourages members to participate in a range of initiatives.

Evaluation

The effectiveness of voluntary agreements rely on the goodwill of industry participants, the incentives required and the industry coverage of the organisations who are signatories to the agreement. In the case of the ATA proposal, the ATA is the major peak body for the trucking industry, but it does not represent 100% of operators. The ATA proposal also allows for voluntary adoption of the program by individual operators. The bus industry publication is a guideline that is in not binding on members.

It is predicted that light commercial vehicles will be a substantial and growing source of emissions. Emissions from private passenger vehicles (including 4WDs) are also predicted to increase in the next 15 years. The majority of vehicles in these categories will not be covered by major industry organisations. It may therefore be difficult to achieve national consistency of approach under this option.

The potential lack of consistency in this approach could have adverse impacts on competition with 'free-riders' obtaining a short term financial benefit (through lack of maintenance). Without the implementation of a program that involves incentives to comply or disincentives to those who do not comply, those operators who act to limit emissions may be placed at a competitive disadvantage.

NEPC Project 7 has shown that substantial emissions reductions can be achieved through improved maintenance and repair of vehicles. An industry agreement which successfully encourages improved vehicle maintenance amongst its members could provide a flexible and effective means for reducing in-service emissions, and could play a role in a package of measures to reduce emissions. However, industry agreements are necessarily limited in scope and could not be relied upon alone to deliver emission benefits across the fleet.

5.2 State/Territory Regulation

Under this option each jurisdiction would implement strategies and/or standards as it deemed appropriate. A number of jurisdictions have indicated in their air quality management plans that they intend to address in-service emissions using a variety of strategies including encouragement of improved vehicle maintenance, vehicle scrappage programs and vehicle testing and repair programs in order to meet the standards in the Ambient Air Quality NEPM.

Evaluation

This option allows for complete jurisdictional flexibility in implementing in-service programs and tailoring them to their needs.

This option does not provide any impetus for jurisdictions to take action to reduce in-service emissions. State based regulation of in-service diesel emissions may focus on urban areas where pollutant levels are higher, and as such State regulation is unlikely to adversely impact on regional and rural areas. Smoky vehicle strategies are the only ones likely to be applied outside major urban centres, as they relate more to impact on individuals rather than broader air quality concerns.

This option provides no mechanism for ensuring a nationally consistent approach. While jurisdictions could take the information from the preparatory projects and develop their own programs, there is a considerable risk that different emission standards will result. Inconsistency of mandatory standards between jurisdictions has the potential to have adverse impacts on competition. It is also incompatible with the NEPC goal of ensuring equivalent protection from air pollution.

5.3 Commonwealth Regulation

Management of in-service motor vehicles is a State and Territory legislative responsibility. There is no readily available legislative mechanism to enable the Commonwealth Government to regulate in-service emissions. A review of the *Motor Vehicle Standards Act 1989* in 1999 advised against the use of this Act as a means of setting in-service standards because provision for the establishment of in-service standards already existed in under the *Road Transport Reform (Vehicle Standards) Regulations 1999*, developed by the National Road Transport Commission. While it is proposed that standards be set under these latter Regulations, they may not be used to provide guidelines for strategies for implementation by jurisdictions.

Evaluation

While it may be possible for the Commonwealth to use its constitutional powers to regulate in this area, the Commonwealth has made a policy decision to not regulate for in-service vehicles.

In any case, the use of the NRTC's vehicle standards regulations provides a nationally consistent approach, and are an effective option for setting in-service emission for standards for diesel vehicles, as has been done for other vehicle matters. This option is most likely to limit any competition issues, as all jurisdictions would utilise the same emission limits. While such a national regulation would apply to all vehicles, there is the capacity for jurisdictions to limit enforcement to urban areas, thus minimising impacts on rural or regional areas which do not experience air quality problems.

Commonwealth regulation is not an appropriate mechanism for strategies delivering which must have sufficient flexibility to be tailored to the particular needs of each jurisdiction.

5.4 National Environment Protection Measure

The NEPC is empowered to make NEPMs that become law within each State and Territory in accordance with the legal framework of each jurisdiction. As they are incorporated into law in each jurisdiction, NEPMs enable the implementation of a consistent national approach.

NEPMs may include any combination of a goal, standards, protocols and guidelines, allowing for flexibility in the design of a NEPM. Moreover, guidelines in a NEPM may be adopted by jurisdictions according to their environmental needs.

Section 14 of the NEPC Act states that ambient air quality and motor vehicle emissions may be addressed by a NEPM (Appendix 3).

Under the NEPC Act, standards pertaining to the technical aspects of vehicles are to be developed by the NRTC. This involves development of national in-service emissions standards under the Australian Vehicle Standards Rules administered by NRTC.

Evaluation

A NEPM allows for the implementation of a consistent national approach, while simultaneously providing jurisdictions flexibility in implementation. If all jurisdictions implement a vehicle testing program using the standardised emissions test, both governments and industry can be certain that a vehicle which passes the test has emissions performance which is acceptable across the country.

The use of the NRTC's legislative mechanisms in concert with a NEPM enables common national in-service emissions standards to be set, while allowing flexibility in the means of achieving those standards via the NEPM. The combination of NRTC standards and NEPM guidelines limits the potential for competition issues to arise as all jurisdictions have the same objective to achieve. Flexibility in implementation mitigates the impact in rural and regional areas. The NEPM offers the capacity to adopt all of the strategies that are likely to be effective in reducing in-service emissions of diesel vehicles.

5.5 Preferred Regulatory Mechanism

A National Environment Protection Measure in conjunction with the NRTC regulations is the only mechanism which satisfies all of the specified assessment criteria. Together they:

- provide nationally consistent in-service standards to underpin the management of in-service emissions;
- allow for flexibility of application to varying jurisdictional air quality requirements;
- limit the potential for competition issues to arise;
- not adversely impact on regional and rural Australia; and
- provide the capacity for jurisdictions to implement programs which reduce in-service emissions (particularly emissions of particles) from all diesel road vehicles.

In 1999 the NEPC adopted a set of criteria for national action to be used in determining whether an environmental issue warrants the development of a NEPM. These criteria are:

- there is a clear and agreed role for government;
- the problem crosses a number of State/Territory borders and/or impacts on major population areas;
- a single national response is likely to be the most efficient and effective response;
- the national response needs to be statutory in nature and other statutory options are not appropriate; and
- it is identified in the NEPC Act as an environmental area that may be addressed by a NEPM.

As outlined in the discussion below, the proposed NEPM meets these criteria.

State and Territory Governments currently manage emissions from in-service vehicles through smoky vehicle programs and through the Australian Vehicle Standards Rules (AVSRs) issued by the NRTC. The AVSRs include standards for all aspects of in service vehicle performance including emissions performance. The emission standards in the AVSRs are currently limited to noise standards and a smoke standard.

The air quality problems arising from diesel exhaust emissions occur principally in major population centres throughout Australia. The need for improved management of in-service diesel emissions can be met either individually by each jurisdiction, individually, or addressed on a national basis. A national approach is appropriate as vehicles are mobile across all jurisdictions and emissions control standards for new vehicles are regulated on a national basis. It would therefore be consistent to also apply standards for in-service emissions on a national basis as with all other aspects of in service performance that relate to vehicle safety, noise and smoke emissions.

Comments received in response to the NEPM Discussion Paper support a national approach to the management of in-service diesel emissions. However, there are sufficient differences amongst jurisdictional airsheds to require flexibility to adopt emission management strategies that are appropriate to the severity of the problem.

A NEPM offers both a national approach and flexibility of implementation. The option of including protocols and guidelines allows for a nationally consistent approach that jurisdictions can tailor to their specific air quality needs. By comparison, the alternative approaches to a NEPM outlined above do not offer these advantages.

As reducing in-service diesel emissions will incur some cost to the vehicle owner, while the major benefit flows to the community at large, a statutory mechanism is necessary. As discussed above, a NEPM, in conjunction with the appropriate NRTC regulation, is the most appropriate and flexible statutory option available.

6 SUMMARY OF THE PREFERRED APPROACH

It is proposed that In-service Emission Standards and a National Environment Protection Measure for Diesel Vehicle Emissions be developed as a joint package for ensuring adequate means to manage emissions from in-service diesel road vehicles.

6.1 Emissions standards developed by the NRTC

The NRTC Act requires that the NRTC develop nationally consistent road transport legislation. One of the principles underpinning the development of this legislation is the "minimisation of the adverse environmental impacts of road transport". Section 10B of the NRTC Act requires that the NRTC develops emission standards for in-service vehicles in conjunction with the NEPC.

It is proposed that this NEPM be developed in conjunction with Standards developed by the National Road Transport Commission, for the management of emissions of particles, NO_x and smoke opacity for in-service diesel vehicles.

6.1.1 How standards can be used

Having an emission performance standard for in-service vehicles provides a uniform and consistent mechanism for:

- benchmarking the performance of the in-service fleet;
- identifying vehicles with excessive emissions; and
- developing, monitoring and evaluating emission reduction programs.

6.1.2 Development of in-service emission standards for diesel vehicles

To ensure that the in-service emission Standards are an effective tool for managing emissions from in-service vehicles:

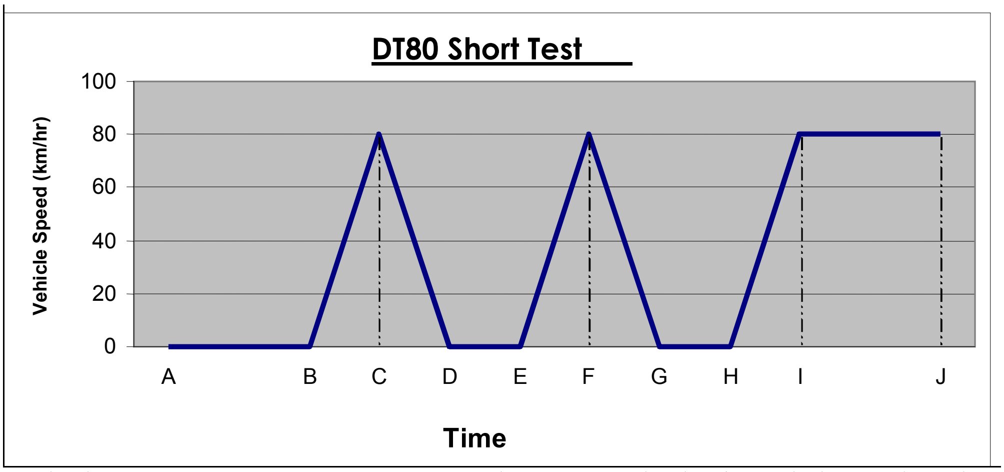
- the Standards should represent a level of in-service emission performance that takes into account the original emission performance to which a vehicle was built and certified (under Australian Design Rules for new vehicles) and takes into consideration normal engine component wear under a reasonable maintenance regime;
- there is an accurate and repeatable test method for measuring a vehicle's emission performance against the Standards;
- application of the Standards in emission management programs is practical; and
- measurement of in-service fleet performance by application of the Standards will allow analysis of actual on-road diesel fleet emissions.

As part of the NEPC diesel emissions preparatory projects, work was undertaken to evaluate a range of potential in-service emission test methods for their ability to accurately and effectively measure emissions of in-service diesel vehicles.

Potential emission tests were also evaluated for accuracy in predicting emission performance under real world driving conditions, by comparing emissions results on the in-service tests with emissions results obtained on urban emission drive cycles. This allows jurisdictions to use in-service test results to estimate actual on-road emissions from the in-service diesel fleet.

A short in-service test (the DT80 test cycle) was selected as meeting these criteria. A description of the test is provided in the draft NEPM.

Figure 6-1 DT80 in-service emission test cycle



Note: Under the DT80 test regime emissions are measured over a test cycle whereby a vehicle is accelerated at full throttle to 80 km/hr three times followed by a 60 second period of steady speed. Three idle periods are also included in the test cycle.

The Standards have been developed for vehicle categories which reflect differences in vehicle size and the original emission certification to which the vehicle was manufactured.

The Standards have been developed using the following process:

1. test a representative sample of the Australian in-service diesel fleet and identify vehicles with excessive emissions levels of oxides of nitrogen, particles and smoke;
2. identify potential standards by determining the emission levels:
   - above which emission related faults are readily identifiable
   - above which repair of faulty vehicles reliably results in a significant improvement in emission performance
   - below which the emission levels of repaired vehicles occur.
3. compare the potential Standards identified in step 2 with appropriate vehicle certification standards to ensure that they are not more stringent than the certification standards.

6.1.3 Proposed in-service emissions standards (the Standards)

The proposed emission performance Standards are provided in Table 6-1.

The process by which the Standards were developed ensures that emissions for any vehicle that is reasonably maintained will not exceed the Standards. Accordingly, any well maintained vehicle should meet the requirements of emissions reduction strategies implemented to achieve the standards. Vehicles that achieve emissions levels below the Standard can be considered to be adequately maintained.

The proposed Standards are based on the DT80 in-service emissions test, and are expressed in grams/kilometre/tonne vehicle mass in order to account for the wide range of vehicle sizes within the vehicle categories.

Table 6-1 Proposed in-service emission performance Standards

	Vehicles built 1995 and earlier	Vehicles built 1996 and later
Vehicle Mass	**NO_x Emissions (grams/kilometre/tonne vehicle mass)**	
<3.5 tonnes	1.5	1.5
3.5 to 12 tonnes	1.5	2.0
12 to 25 tonnes	2.0	1.5
> 25 tonnes	1.5	1.2
	Particle Emissions (grams/kilometre/tonne vehicle mass)	
<3.5 tonnes	0.23	0.23
3.5 to 12 tonnes	0.23	0.15
12 to 25 tonnes	0.08	0.05
> 25 tonnes	0.07	0.03
	Smoke Opacity (%)	
<3.5 tonnes	25	25
3.5 to 12 tonnes	25	25
12 to 25 tonnes	25	25
> 25 tonnes	25	25

6.2 A NEPM developed by the NEPC

It is proposed that the NEPC develop a NEPM which sets out guidelines for use by jurisdictions in reducing emissions from in-service diesel vehicles in order to meet the Standards listed above.

Under the proposed NEPM, jurisdictions would be required to assess their needs in addressing diesel vehicle emissions. Jurisdictions would have flexibility in determining which guideline, combination of guidelines or other feasible strategies will best suit their emissions management needs, and in determining the scale and scope of action required. The guidelines will provide national consistency of approaches to implementing the proposed emissions management methods, to facilitate equitable treatment of industry.

The test protocol developed in the NEPC preparatory projects can be used in a wide range of applications for managing the performance of diesel vehicles. These applications range from a core evaluation component in an in-service test and repair program to a tool for the development, monitoring and evaluation of emission reduction management strategies such as smoky vehicle, audited maintenance and engine retro-fitting programs.

6.2.1 NEPM Goal and Environmental Outcomes

NEPM Goal

The proposed national environment protection Goal of this NEPM is to reduce exhaust emissions from diesel road vehicles, by facilitating compliance with in-service diesel vehicle emissions standards.

Desired Environmental Outcome

The proposed desired environmental outcome of this NEPM is to reduce pollution from in-service diesel vehicles.

6.3 Content of the NEPM

The draft NEPM contains a package of guidelines to facilitate in-service compliance with emissions standards.

The strategies available to jurisdictions to help achieve the standard have been the subject of preliminary research and/or evaluation by the NEPC.

The NEPM guidelines include the following proposed strategies:

- smoky vehicle management;
- emission testing and repair programs;
- retrofit programs;
- audited vehicle maintenance programs; and
- engine rebuild programs for improving the original performance of in-service diesel vehicles.

It should be noted that the implementation of each strategy is not mutually exclusive. Jurisdictions could develop an integrated approach comprising multiple strategies. The inclusion of these strategies in the NEPM do not restrict jurisdictions from pursuing best practice and developing additional strategies not included in the NEPM.

6.3.1 Smoky vehicle management programs

Excessive visible emissions of smoke are unsightly and demonstrate that a vehicle is no longer meeting the certification standard required for smoke and is unlikely to meet the proposed in-service standards.

A smoky vehicle program is intended to identify vehicles that have deteriorated to a point where excess emissions can be detected visually and to require or encourage vehicle owners to repair them. It will not detect all vehicles that may have excess emissions of oxides of nitrogen, hydrocarbons, carbon monoxide or fine particles. As mentioned previously, results of the preparatory projects show that emissions of visible smoke correlate poorly with laboratory measured emissions of particles and other gaseous pollutants.

ADR 30/00 specifies a range of acceptable smoke opacity tests for new vehicles. Given the expectation that there will be some level of deterioration, a simple visual test commonly known as the '10 second smoke rule' is specified in the schedule to the Road Transport Reform (Vehicle Standards) Regulations 1996 and has been legislated in several jurisdictions. The NEPM will facilitate a uniform approach to smoky vehicle programs implementing the 10 second smoke rule.

The NEPM addresses the elements of a smoky vehicle program, which are to:

- clearly identify the level of emissions which is unacceptable;
- set up a system for government officers to report smoky vehicle offences;
- train and authorise government officers;
- set up a system for the public to report smoky vehicles;
- educate the public about the system;

- develop a strategy for reporting by government officers (random, roadside, targeted, periodic inspections, etc); and
- ensure the vehicle repair industry is trained to detect and rectify faults associated with excessive smoke emissions.

6.3.2 Vehicle testing and repair programs

Vehicle testing and repair programs involve subjecting a vehicle to a standard emissions test, comparing the results to an emissions standard and requiring those vehicles that do not meet the standard to be repaired.

Vehicle test and repair programs for light petrol engined vehicles have been implemented in a number of countries including the United Kingdom, the United States and Canada. The form of the program varies from idle tests to dynamometer testing and from centralised test facilities to a network of "authorised" testers.
Diesel vehicle testing programs have also been implemented in those countries. These programs test vehicles against a smoke standard only and can involve idle or dynamometer based tests at roadside or fixed station locations.

The test and repair program proposed for diesel vehicles under this NEPM involves testing of vehicles against particulate, smoke and NO_x emissions standards. The test to be applied is a dynamometer based transient test and may be conducted using fixed location or mobile facilities. As well as assessing emissions, testing would also offer the opportunity to detect the use of poor quality or adulterated fuel.

The scale of the test and repair programs can be tailored to meet objectives for maintenance of in-service performance. For example a large scale program may aim to test the entire fleet over a specified time period such as 5 years. Alternatively a smaller program could select a sub-population for testing, targeting known poor performance categories or randomly selecting a population for testing. While smaller programs would not test every vehicle, the possibility of being tested could encourage owners to improve the emissions performance of their vehicles.

The NEPM provides guidance on how to:

- identify appropriate target vehicle groups;
- develop a means of obliging or encouraging target vehicles to be tested and polluting vehicles to be repaired;
- establish a testing regime with appropriate infrastructure that is effective in identifying high polluting vehicles with repairable faults;
- develop a communications program to ensure that the public and repair industry are convinced of the benefits of the program so that avoidance behaviour is minimised;
- develop an appropriately educated and cooperative repair industry;
- establish quality and fraud control mechanisms; and
- establish a means of monitoring the effectiveness of the program and developing modifications if necessary.

6.3.3 *Diesel Vehicle Retrofit Programs*

The objective of diesel retrofit programs is to improve the emissions performance of in-service vehicles by fitting exhaust after treatment devices.

There is capacity to reduce harmful emissions fromvehicles built to pre-2000 by retrofitting exhaust system components such as oxidation catalysts and particle traps. There are a number of retrofit programs in place in the US and Europe, which rely on a mixture of regulatory and market measures. Some technologies such as oxidation catalysts are well proven in the field, while others are in various stages of development and application.

The NEPM provides guidance on how to:

- identify appropriate target vehicle groups;
- identify suitable retrofit technologies for the target group;
- establish a system for evaluating and approving retrofit technologies;
- develop a regulatory or market strategy to ensure retro-fitting occurs; and
- monitor the emissions performance of the vehicles to enable estimates of the emissions benefit from the technology.

In a retrofit program, retrofit devices need to be objectively evaluated for their:

- capacity to deliver emission reductions;
- applicability to particular vehicles/engines (specific or broad application); and
- durability and reliability.

The NEPM refers to the two most readily available exhaust after treatment technologies – diesel oxidation catalysts and particle traps.

Particle traps are effective at reducing particle emissions and may have some specific applications but they need to be very carefully tailored to particular engines <u>and</u> their in-service use patterns to be effective, and fuel sulfur levels must be ≤500ppm.

Diesel oxidation catalysts (DOC) are well proven technology, commercially available and are currently used in retrofit programs in he US and Europe. DOCs are effective in reducing hydrocarbon, carbon monoxide and particulate emissions, but have no effect on NO_x emissions. DOCs are also effective in reducing odours from diesel exhaust.

DOCs are the cheapest after-treatment technology. The unit costs for DOCs is in the range of $1,500 - $4,500, with the variability being related to production volumes and specifications. These figures are based largely from the urban bus experience in the US and Europe, and it may be that smaller catalysts for light vehicles would be cheaper.

DOCs are also the cheapest after-treatment technology to fit. They are often installed in the same way as a standard muffler replacement and can be fitted in about an hour in many cases.

DOCs require no maintenance and are very durable (one estimate of catalyst life is 600,000km).

6.3.4 Audited Maintenance Programs

The objective of audited maintenance programs is to ensure the maintenance of emission performance of the diesel fleet while minimising the need to conduct emission tests.

A vehicle that has not been modified from manufacturer's specifications and which has been maintained to the specifications of the manufacturer should not become a polluting vehicle.

Evidence of good maintenance could therefore be presented by operators as proof that their vehicles continue to comply with emission standards. Other operators and the public would require external audit of the maintenance regime to ensure the credibility of the program.

The form of audit employed could range through presentation of evidence of annual maintenance and repair, more comprehensive recording of vehicle checks and maintenance to random testing of vehicles.

The NEPM will provide guidance on how to:

- identify the areas where an audited maintenance program could cost effectively contribute to improving air quality;
- target the vehicle categories in those areas that would benefit in terms of emissions reductions from program participation;
- assess vehicle or fleet operators for suitability for inclusion in a program;
- establish appropriate maintenance systems to ensure the maintenance of emission performance;
- incorporate means of auditing and objectively measuring the effectiveness of the maintenance regime; and
- develop a regulatory or market strategy to ensure adequate adoption of the program.

It is envisaged that industry groups will independently develop their own audited maintenance systems and seek accreditation from government. For example, the Australian Trucking Association is developing an environment module to its TruckSafe program that could from the basis of an audited maintenance program. The NRTC is exploring the possibility of developing an environment module for the National Heavy Vehicle Accreditation Scheme (NHVAS), which currently serves as an alternative compliance mechanism to mandatory maintenance regimes that check for compliance with safety standards. While all operators have the opportunity to join industry programs or the NHVAS, the schemes may be unsuitable for light vehicles or very small businesses. In these cases jurisdictions may choose to implement much simpler systems that, for example, simply require owners to present evidence of maintenance before registration can be renewed.

6.3.5 Diesel Engine Rebuild Programs

The objective of diesel engine rebuild programs is to improve the emissions performance of existing vehicles by fitting low emission engine upgrade kits at the time of rebuild.

There is a capacity to reduce harmful emissions from current and earlier model vehicles by fitting low emission engine rebuild kits when an engine is undergoing a major overhaul. Such rebuild kits aimed at reducing particle emissions are currently available for a limited number of US engines. New low NO_x kits will be developed in the US following a 1998 agreement between the US EPA and seven engine manufacturers.

Where kits are available, they give a vehicle operator the ability to extend the life of a vehicle, while improving its emissions performance to a level better than the original specification.

The NEPM provides guidance on how to:
- identify appropriate target vehicle groups and engines;
- seek support from the industry to develop low emission rebuild kits;
- establish a system for evaluating and approving rebuild kits;
- develop a regulatory or market strategy to ensure kits are used at time of rebuild; and
- monitor the emissions performance of the vehicles to enable estimates of the emissions benefit from the rebuild kits.

6.4 Implementation of the NEPM by jurisdictions

It is envisaged that the combination of national in-service emission standards and the proposed NEPM would provide a flexible means for jurisdictions to reduce diesel vehicle emissions.

The NEPM recognises the different degrees of impact of diesel exhaust emissions between, and within, participating jurisdictions. Jurisdictions will be required to make an assessment of the need to manage emissions from in-service diesel vehicles. This assessment may take account of, but not be limited to, the following:
- data on emissions from diesel vehicles;
- growth trends in the number of diesel vehicles and annual total distance travelled of the diesel fleet;
- an estimation of the proportion of diesel vehicles out of compliance with in-service emissions standards and an assessment of the impact of this level of non-compliance;
- the cost effectiveness of management options;
- localised air quality issues related to the impact of emissions from diesel vehicles; and
- relevant Ambient Air NEPM Standards.

As mentioned above, jurisdictions would have flexibility in determining which guideline, combination of guidelines or other feasible strategies will best suit their emissions management needs. Flexibility also exists for jurisdictions in determining the scale and scope of action required.

Jurisdictions will be required to report to the NEPC on an annual basis on implementation of the NEPM. These reports will include:
- an assessment of the need to take action;
- a description of actions taken; and
- an assessment of the effectiveness of these actions in reducing in-service diesel vehicle emissions.

Implicit in implementation of the NEPM will be the acknowledgment by jurisdictions that vehicles crossing jurisdictional borders will be subject to the provisions of compliance programs implemented within the jurisdiction to which the vehicle has travelled.

Key Points
- **Setting in-service emission standards allows for an objective measurement of a vehicles in-service emission performance**

- **A NEPM is the optimal way of managing in-service performance as it provides both a national approach and flexibility**
- **The preferred approach to improve in-service emissions from the diesel fleet is to use NRTC regulation to set in-service standards and a NEPM to provide strategies that will help achieve the standards**
- **It is proposed that the NEPM will comprise five strategies and the jurisdictions can determine which strategy or combination of strategies best suits their particular needs**

7 IMPACTS OF THE PREFERRED APPROACH

This Chapter considers the potential impacts of both the NEPM and in-service standards. Section 7.1 relates to the costs and benefits of setting in-service standards. Section 7.2 considers the costs and benefits of the emissions reduction strategies given in the NEPM Guidelines. This analysis is intended to assist policy makers in designing and costing potential emissions reduction programs.

The analysis identifies affected stakeholders and, where possible, monetary estimates of costs and benefits. Not all costs and benefits are able to be quantified in monetary terms. Stakeholders who are able to value any of these costs or benefits are invited to make submissions advising of their estimates and their source.

To assist clarity of presentation, the analysis separates the impacts of the in-service standards from the impacts of the NEPM Guidelines. It is recognised that in practice, the two cannot be separated, as compliance strategies are essential to achieving in-service standards. The structure is intended to assist jurisdictions in making decisions about implementation choices by identifying the full potential costs and benefits of in-service standards and then identifying the relative cost effectiveness of each NEPM Guideline. This will enable jurisdictions to evaluate the optimal combination of programs to suit their particular needs.

7.1 Costs and Benefits of setting in-service standards

7.1.1 Costs of meeting in-service standards

The direct costs associated with meeting the proposed in-service standards for diesel vehicles comprise only the cost of the vehicle repairs necessary to bring all diesel vehicles into compliance with the standards, and does not include indirect costs to vehicle owners, such as loss of vehicle use time associated with testing, which may in some instances be significant. The analysis does not include the costs of implementing any combination of the NEPM Guidelines to achieve full compliance, which are considered in Section 7.2.

Repair Costs

The results of NEPC Project 7 show that the repair costs to meet in-service standards vary considerably between vehicles depending on factors such as vehicle size, age and the identified engine problem. The cost of repairs may vary from $60 to over $2000, with the average cost of repair being $921 (NEPC Project 7).

Non-compliance with the standards within the current diesel fleet also varies, ranging from a failure rate of 1-10% for articulated trucks to about 32% failure for diesel cars and light commercial vehicles.

These figures can be used to extrapolate the total cost of achieving 100 per cent compliance with the proposed in-service standards for the Australian diesel vehicle fleet. The total cost is estimated to be around $66 million.

It is important to note that this estimated cost would only apply in the first year in which in-service standards were being applied, as it assumes all vehicles requiring repair are repaired in that year. The cost of meeting in-service standards would be expected to fall considerably in ensuing years as vehicle operators undertake regular maintenance.

Owners of well maintained vehicles will not incur any of the first year repair costs.

7.1.2 *Benefits of meeting in-service standards*

Achievement of the proposed in-service diesel vehicle emission standards would reduce particle and smoke opacity emissions from diesel vehicles. The ensuing benefits, broken into public and private benefits, are discussed in detail below.

Public Benefits

The public benefits of introducing in-service diesel vehicle emissions standards include the actual and perceived increases in welfare and quality of life received by society as a result of:

- reduced risk of morbidity and chronic mortality;
- increased or enhanced roadside amenity;
- increased or enhanced residential and recreational visual amenity; and
- avoided costs of clean up and remediation of buildings and other infrastructure.

Avoided health costs

As discussed in Section 2.1.2, increases in PM_{10} emissions are associated with an increase in morbidity and mortality. In addition there is emerging evidence of the relatively greater health risks associated with particles less than 1 μm (PM_1). 92% of diesel particle emissions are less than 1μm.

It is possible to place a monetary value on the avoided health costs which would result from the introduction of in-service emission standards for diesel vehicles by drawing upon international research in this area and extrapolating for Australian conditions.

In choosing appropriate international studies to draw upon it was necessary to use studies in which the calculation of results in the study were transparent; the methodology, models and assumptions used were consistent; and the analysis was comprehensive.

Based on these criteria, figures on avoided health costs were extrapolated from a recently completed extensive study undertaken by the European Commission, *European Commission ExternE Transport Project: Technical Final Report DG12 Brussels '98 (the ExternE study).*

The ExternE study estimated the particle emission damage costs from diesel vehicles for a range of European cities. They used the 'impact pathway' approach, which sought to trace the passage of a pollutant from the place of emission to the final impact and place a value on the economic costs associated with those impacts.

Using this approach, the ExternE study estimated that the avoided health costs associated with reducing one tonne of particulate matter in a medium size city (eg with similar population characteristics to Perth) to be A$224 600. This comprised an estimated benefit of avoided morbidity costs from exposure to PM_{10} of A$95,200 per tonne and avoided chronic mortality costs of A$129,300 per tonne.

It is important to note that the avoided health costs associated with reducing one tonne of particulate matter are likely to vary considerably depending on the population characteristics and transport infrastructure of a city. For instance, cities such as Melbourne and Sydney, which have higher populations and are more densely populated, and which have major transport routes in high density areas, may have a much higher monetary value associated with the avoided health costs associated with a reduction of one tonne of particulate matter. Conversely, smaller and less densely populated cities, such as Canberra, may have a lower monetary value attached to a one tonne reduction.

Thus a recent Swedish study (Leksell, 2000), in which an economic valuation of increased mortality due to exhaust emissions of fine particles ($PM_{2.5}$) was carried out for different regions of Sweden, showed that valuations varied with geographic factors, city size, and from one part of a city to another. Given that about 90% of particulates from diesel emissions are less than 2.5μm diameter the valuations from this study is relevant in the present context. Thus for the inner city area of Stockholm, the valuation ranged from $A1.25 million per tonne of particulates to $A308,000 per tonne in the "outer parts of Greater Stockholm". For comparison on city size, the valuation for Stockholm inner city (population 400,000) was $A1.25 million per tonne, Gothenburg (481,000; $A942,000), Malmo (235,000; $A788,000) and Uppsala (120,000; $A558,000).

On balance, given the characteristics of Australia's major urban centres, it would be expected that the total health benefits associated with reduced emissions of particulate matter, based on the ExternE figure used for Perth, are likely to be an underestimate. All figures for the Swedish study quoted above are well above the ExrternE estimate, even for a small city having one tenth the population of Perth.

It is also important to note that the estimate for chronic mortality relies heavily on the assumption of the statistical value of a human life. The ExternE study used a figure of A$5 million per life in its analysis. The statistical value of a human life has been the focus of a large number of studies and estimates ranges from as low as A$500 000 to around A$15 million. (The Swedish study used $A2.5 million.)

Research commissioned by NRTC shows that compliance with the proposed standards would provide an estimated reduction in PM_{10} of 148 tonnes nationally in the first year (Appendix 1, Table A) following compliance. There is an on-going benefit, which decreases with time as the maintained vehicles retire from the fleet and those that remain have a declining annual use as the vehicle age increases. Using data from the ExternE study, the initial reduction in the first year would equate to total health benefits for Australia of $33 million of meeting in-service diesel vehicle standards. Due to the on-going benefit in emissions reduction following compliance (because the emission benefits of repair would last longer than one year), the total health benefits would be considerably greater than $33 million.

<u>Amenity Benefits</u>

Amenity benefits relate to improved livability, particularly in urban areas, through reduced smoke emissions, reduced odour at the local level, and general improvements in visibility. While these benefits are not readily quantifiable in monetary terms they are likely to be considerable and are discussed in greater detail below.

- <u>Roadside Amenity</u> - There are potentially very significant benefits from improved roadside amenity. People in urban areas, including pedestrians, cyclists and other road users are adversely affected through high levels of smoke emissions in localised areas. NEPC Project 7 shows that compliance with standards will provide a significant reduction in smoke emissions from a large proportion of vehicles. For example, 14% of Pre-ADR 70 vehicles (3.5 to 12 tonnes) diagnosed with a fault showed a 27% smoke opacity improvement after repair. Vehicle repair is also likely to significantly reduce odour.

Most vehicles emit smoke and higher emissions when accelerating or under a heavy load. This can result in vehicles with emission related faults continually emitting annoying smoke while being driven. This may occur every time a vehicle accelerates from a traffic light or climbs a hill. Based on the percentage of faulty vehicles in the fleet identified in NEPC Project 7, it can be conservatively estimated that there are well over 1 million instances of excessive smoke emissions caused by diesel vehicles with identifiable faults in Australian capital cities every day.

- Recreational and Tourist Visual Amenity – While roadside amenity is affected by highly localised and frequent incidences of excessive smoke emissions, recreational and tourist visual amenity is adversely affected by the general decline in total visibility which results from high levels of particle emissions. Recreational visual amenity can be regarded as a very important issue in Australia as relatively clean air and environment are two of the attributes highly regarded by international visitors. These visitors tend to spend much of their time in cities, where the impacts of vehicle emissions are most noticeable (DSARD 1999).

  While it is not possible to put a monetary figure on the improvements to recreational and tourist amenity which would result through introducing in-service standards, it has been conservatively estimated that 5% of international visitors might be deterred from visiting cities with significant pollution problems (AATSE 1997).

Other public benefits

There are a range of other public benefits which cannot be easily quantified and included in a cost-benefit analysis. For instance, one potential benefit of meeting in-service standards would be the associated increase in public confidence that the road and transport system is working safely and efficiently. By reassuring the public that diesel vehicles are well maintained, safe and not excessively polluting, the public could be expected to be more receptive to maintaining the privileges drivers currently enjoy, such as access to certain road networks with very limited curfews and comparatively high mass limits. All of these privileges clearly have productivity and economic benefits. Public acceptance of diesel vehicles has economic and productivity benefits that are not easily quantifiable.

Private benefits

It is anticipated that, in addition to the wide range of public benefits discussed above, there are also likely to be many private benefits to diesel vehicle owners from the introduction of the in-service standards. These include:

- a potential improvement in either fuel economy or power output of the vehicle (vehicles that have been tampered with may not necessarily improve power output);
- improved reliability of the vehicle;
- reduced productivity losses from unscheduled repairs and maintenance; and
- improved vehicle resale value.

While these private benefits are likely to be substantial they have not been quantified in monetary terms at this stage.

A summary of all the potential public and private benefits associated with introducing in-service diesel vehicle emissions standards are outlined in Table 7-1. It is important to note that apart from the benefit associated with avoided health costs, it is not been possible to place a monetary value on any of the potential benefits. This becomes a particularly important issue in the comparison of the costs and benefits of introducing an in-service diesel vehicle emissions standard and is discussed in detail in the cost-benefit section below.

Table 7-1 Summary of benefits of meeting in-service diesel standards

Benefit	Quantification	Monetary benefit
Avoided health costs	148 tonne reduction in PM10 in year 1 valued at $224 600 per tonne.	$33 million
Improved roadside amenity	Significant reductions in vehicle smoke opacity likely to reduce level of visible roadside incidences significantly.	Expected to be very high.
Improved recreational and tourist visual amenity.	Australian studies suggest visiting polluted cities might deter 5 per cent of tourists.	Likely to be relatively high.
Private benefits to diesel vehicle owners	▪ Improved fuel economy and performance. ▪ Reduction in unscheduled breakdowns ▪ Improved resale value.	Likely to be significant.
Reduced soiling of buildings and property	Reduction in cleaning costs.	Likely to be relatively low.
Total Quantifiable Benefits		**$33 million**
Costs		
Direct cost of meeting in-service standards		$66 million
Total Quantifiable Costs		**$66 million**
Quantifiable Cost-Benefit Ratio		**2:1**

7.1.3 Comment on costs and benefits

Where information is available, cost-benefit analysis is the most appropriate economic assessment method to determine whether specific standards or regulatory initiatives are economically justified.

In the case of evaluating diesel vehicle in-service standards there are significant categories of benefits which can not be monetised (or in many cases even quantified), resulting in a significant limitation to this analysis. Given that a large number of the potential benefits of in-service standards were not able to be included in this analysis, it would not be prudent to use these figures for economic justification. An alternative approach would be to view the calculated difference between costs and monetised benefits ($33 million) as a 'bench-mark' value to judge the worth of the unquantified and non-monetised benefits. This allows stakeholders and decision makers to determine to what extent the unquantified benefits are likely to exceed $33m.

7.2 Impact analysis of NEPM guidelines

7.2.1 Introduction

The benefits and costs of each of the Guidelines are dependent the scope and scale of implementation. An advantage of the proposed NEPM is that it allows jurisdictions to implement the Guidelines according to their air quality needs. This flexibility makes cost-effectiveness analysis difficult.

The costs of strategies to reduce emissions from in-service diesel vehicles include:

- public costs involved in implementing and administering the programs; and
- private costs such as those incurred by participating vehicle operators.

This section considers the benefits and costs of implementing each Guideline as well as their relative strengths and weaknesses. The actual costs in any one year will depend on the choice of program(s) and the timing of their implementation. In addition, a program could target known poor performance vehicle categories or randomly select a vehicle sub-population for testing, thus simultaneously reducing costs and enhancing program effectiveness.

The figures outlined in this section include many assumptions about how the program would be run and it should be noted that any changes to the parameters of the program would affect both costs and benefits within the range. To address this issue, a guide to the potential per unit costs of key cost components for each NEPM Guideline is also provided. This is intended to assist policy makers in designing, and determining the total costs of any potential emission reduction program.

It should be noted that the costs and benefits are identified on the assumption that they are entirely new initiatives unrelated to any existing initiatives. In reality it is recognised that most jurisdictions have existing initiatives such as maintenance programs for heavy vehicles. This provides a significant potential for cost saving to both jurisdictions and vehicle operators through synergies such as:

- test and repair programs that use centralised emission testing facilities could easily be combined with safety inspection programs that use centralised inspection facilities, thereby significantly reducing the cost to jurisdictions and to vehicle owners;
- test and repair programs that use mobile test facilities could combine with mobile brake testing facilities for an inexpensive random test program; and
- an 'environment module' of an audited maintenance program could easily and inexpensively be combined with the maintenance module of existing safety related programs.

7.2.2 Potential benefits and costs of specific NEPM guidelines

Emissions testing and repair programs

<u>Benefits</u>

An emissions test is the most objective means of establishing whether a vehicle is emitting excessive levels of key pollutants. By testing at regular intervals, together with requirements for repairs, there is reasonable assurance that a vehicle will be in compliance with emissions standards and the full potential for emissions reductions will be realised. However, there are a number of factors that need to be addressed to maximise the potential benefits. For example jurisdictions need to consider their targeting strategy and issues of perceived equity. These are discussed below.

- To maximise the effectiveness of the program and reduce its cost it is necessary to establish the vehicle types that are most likely to be out of compliance and the time it may take them to become non-compliant again after a test and subsequent repair. For example, NEPC Project 7 data suggests that greater benefits would be gained by targeting cars and light commercial vehicles rather than articulated trucks.
- Ideally under a test and repair program, all vehicles failing the test would be repaired to the point where they pass it. However, considerations of equity and practicality suggest that it may be necessary to place a ceiling on the scope of effort and amount of money to be spent on repairs.

The benefits (and costs) of a testing and repair program will vary with the comprehensiveness of the program. Which vehicles are targeted, the number of tests per year and the level of repairs required will affect both costs and benefits of a program.

The level of particle emissions is not uniform across the Australian diesel fleet. For some vehicles, particle emissions are up to 600% higher than the fleet average. NEPC Project 7 data shows that there is the potential to achieve a 53% particulate emission reduction from vehicles with identifiable faults within certain classes. The total potential emissions reduction from achievement of the proposed in-service standards, when expressed as a percentage of the total fleet is 5%.

The potential particle reduction and associated benefits diminish in subsequent years due to the retirement of older technology vehicles and their replacement with vehicles built to more stringent emissions standards, with presumed and having improved levels of durability.

<u>Costs</u>

The administration and program running costs of emission testing and repair are likely to be high. This cost will not necessarily be borne by jurisdictions administering the testing and repair program. Jurisdictions may seek to recover costs by charging vehicle owners a fee for testing. Alternatively the whole program could be contracted out on a cost recovery basis. Factors that influence the cost of emission testing include:

- number of vehicles that must be tested annually;
- number of emission testing stations required for reasonable access;
- number of testing lanes required based on emission testing throughput rates;
- emission testing personnel requirements; and
- administrative and enforcement costs

Appendix 1 (Tables C and D) gives an indication of the implementation and annual operating costs associated solely with vehicle testing. They are given for both light and heavy-duty vehicles using a single lane mobile testing unit or a two lane fixed testing station. These costs assume the use of workshop-grade emissions measurement devices.

A test and repair program is also likely to impose a number of costs on vehicle owners. These costs will vary significantly depending on whether the vehicle needs to be repaired and the amount of time and lost productivity that is incurred through the test and repair procedure.

Vehicle owners may also be liable for any testing fees that may apply, and owners of vehicles that require repair will also incur the costs of repair. These repairs will often constitute normal prudent maintenance practice or represent the outcome of avoided repair costs in the past. The repair undertaken will also provide a benefit in terms of improved reliability, improved power or improved fuel economy, lower capital depreciation costs and longer vehicle life.

The vehicle operating costs associated with the delivery and collection of the vehicle from the inspection centre and the associated loss in productivity are also expected to be significant. The actual cost will depend on the type of inspection facility chosen and the productivity associated with the vehicle being tested.

NEPC Project 7 shows that repair costs for each vehicle category and the actual repair cost can vary widely. These results also show that a $60 repair may provide as much emission benefit as a $1000 repair in similar vehicles.

Table 7-2 Summary of Strengths and Weaknesses of Test and Repair Programs

Strengths	Weaknesses
High, and easily quantifiable, emissions benefits	High cost
Based on short, objective and scientifically reliable test	Shifts responsibility for vehicle condition onto government.
Equitable – all vehicle owners treated fairly.	High capital costs limit scope to modify program.
Flexible – can target specific vehicle classes.	Owners of vehicles that 'pass' first time incur the cost of the test.
Administrative costs can be cost-recovered.	
Less open to abuse by vehicle operators than some other programs.	
Data collected from the program enhances future policy decision making.	
High credibility	

Table 7-3 Summary of cost components of Test and Repair Program

Type of Cost	Unit Cost	Total Cost
Administrator		
Administrative and Operational	▪ $50/inspected vehicle **a** ▪ Can be partially cost recovered through $40 inspection fee	Number of vehicles being inspected times unit cost less the total level of cost-recovery from inspection fee.
Vehicle Operator		
Repair Costs	$921**b**	▪ Unit cost times vehicles undertaking repair ▪ Depends on proportion of inspected vehicles requiring repairs
Inspection Costs	$40 **c**	Unit cost times number of vehicles inspected (vehicles requiring repairs will be inspected twice)
Indirect cost of inspection (loss of vehicle use time)	$40 **d**	Unit cost times number of vehicles inspected

Type of Cost	Unit Cost	Total Cost
Indirect cost of repair (loss of vehicle use time)	$40 **d**	Unit cost times number of vehicles requiring repairs
Compliance Fee	Not Applicable	$0

a. Based on estimate of $40 per vehicle inspection fee for operational costs plus $10 per vehicle for administrative costs. b. Based on Project 7 data for vehicle repair costs. c. Based on average per vehicle inspection cost of testing all pre 1995 vehicles in Sydney (inspection facility costs are provided in Appendix 1) d. Based on estimate from '*Cost Effectiveness of Periodic Motor Vehicle Inspection – A Report for the Federal Office of Road Safety*'.

Audited Maintenance Programs

Benefits

A vehicle that has not been modified from the manufacturer's specifications and which has been maintained to the specifications of the manufacturer is unlikely to become a high polluting vehicle. This has obvious environmental benefits. Audited maintenance programs can be structured in a number of ways, with consequences for both the costs and benefits. If all vehicles were well maintained the estimated full benefits of in-service standards could be realised. Anything less than full compliance, however, will erode the potential benefits.

At the simplest level, an audited maintenance program may operate by encouraging fleet operators to keep records of regular maintenance. These records could be endorsed periodically allowing claims to being a "environmentally friendly" operation. Such a program involves minimal costs, but the benefits are difficult to quantify.

At the other end of the spectrum, a program could require operators to undergo prescriptive maintenance designed to reduce emissions. Operators could be required to run regular checks on vehicles so that any small faults would be quickly identified. Regular or random testing of vehicles could be used to verify operators' maintenance claims. Such a program would be likely to offer greater emissions reductions than the simpler model.

As the emphasis is on prevention rather than repair, the emission benefit of an audited maintenance program may potentially be greater than the benefit of a test and repair program. With an audited maintenance program all vehicles in the program will achieve reduced emissions, while only those vehicles exceeding the in-service standards will have reduced emissions under a test and repair program. As noted above, however, the achievement of these benefits in an audited maintenance program depends heavily on a high level of compliance.

Costs

The costs of an audited maintenance scheme are largely borne by the vehicle operator. Vehicle operators who join audited safety programs of this type (such as TruckSafe) incur costs relating to:

- membership of the scheme (this can cover the administrative costs of the administrator of the scheme);
- putting in place management systems to achieve compliance;
- reporting on compliance;
- independent auditing of compliance;
- repair costs in year 1; and
- ongoing maintenance costs for the proportion of the vehicle fleet that is not already undergoing regular maintenance.

It is likely that audit would include occasional random vehicle tests. Vehicle testing could be undertaken at a convenient time and place and involve fewer vehicles than in a test and repair program. It would therefore be less expensive for the vehicle operator than under a test and repair program. This is consistent with the 'alternative compliance' approach used for audited maintenance programs relating to safety.

Operators who are members of audited maintenance programs will also incur vehicle repair and maintenance costs. The repair costs, consistent with those identified in NEPC Project 7 may only be incurred in the first year of the program. In future years the ongoing maintenance program would reduce the need for major repairs, but it is very difficult to quantify the likely reduction in cost.

Similar programs currently exist for heavy vehicle safety related issues. The cost of complying with the National Heavy Vehicle Accreditation Scheme's maintenance module is $60 joining fee plus $20 per vehicle per annum. Vehicle owners are also liable for implementing internal systems to meet the requirements of the module and for third party auditing. There has been no attempt to quantify these costs, and organisations with similar programs in place are invited to provide advice during the public consultation period.

Jurisdictions may incur costs that ensure sufficient incentives are in place to encourage participation in audited maintenance programs. Without such incentives an operator may be commercially disadvantaged through joining a scheme.

Jurisdictions may also wish to market the scheme. This may entail the provision of brochures and publications, the provision of an Internet site, a telephone inquiry line and presentations to industry through others. Funding of the marketing function may be paid for by the jurisdiction or from payments from vehicle owners.

Jurisdictions will need to ensure that any scheme is perceived as fair and rigorous. This could simply involve ensuring compliance is independently assessed, or could warrant involvement by the regulator.

Table 7-4 Summary of Strengths and Weaknesses of an Audited Maintenance Program

Strengths	Weaknesses
Low cost to government.	Requires incentives for operators to join the scheme.
Offers highest emission reduction benefits through preventative maintenance and continuous compliance.	Greater assurance of compliance requires greater costs.
Can be linked to incentive programs.	High set up costs for operators who are not already in a similar safety related scheme.
Builds on existing alternative compliance strategies relating to safety – only marginal cost increases.	Requires repair industry training to ensure suitably qualified auditors.
High level of industry involvement and support – onus of responsibility is on vehicle owner.	Potential for abuse by operators if audit is not rigorous resulting in loss of credibility.
Encourages public and user awareness.	

Table 7-5 Summary of cost components of an Audited Maintenance Program

Type of Cost	Unit Cost	Total Cost
Administrator		
Administrative and Operational	▪ $80 per vehicle in scheme **a** ($20 in subsequent years) ▪ Fully cost-recovered	$0 – full cost recovery (see compliance fee below)
Provision of incentive to join	May be financial or non-financial	Dependent on nature of incentive
Vehicle Operator		
Repair Costs	$921**b**	▪ Unit cost times vehicles requiring repairs in first year of program. ▪ Depends on proportion of inspected vehicles requiring repairs.
Maintenance Costs	$250-$500 **c**	Unit cost times number of vehicles in program that were not already undertaking regular maintenance.
Inspection Costs	$40 **d**	Unit cost times number of vehicles randomly tested.
Indirect cost of inspection (loss of vehicle use time)	$40 **e**	Unit cost times number of vehicles randomly tested.
Indirect cost of repair (loss of vehicle use time)	$40 **e**	Unit cost times number of vehicles requiring repairs in first year of program.
Compliance Fee	$80 per vehicle in program **a** ($20 in subsequent years)	Unit cost times number of vehicles in program

a. Based on administrative cost of National Heavy Vehicle Accreditation Scheme for year 1. b. Based on Project 7 data for vehicle repair costs. c. Based on data from Project 7. d. Based on data from Project 7. e. Based on estimate from '*Cost Effectiveness of Periodic Motor Vehicle Inspection – A Report for the Federal Office of Road Safety*'.

Diesel Vehicle Retrofit Programs

Benefits

The key environmental benefit of a retrofit program is likely to be on improving 'hotspots' such as bus terminals, underground carparks, truck depots and in congested urban transport corridors where pedestrians and other road/roadside users are exposed to vehicle exhaust. Widespread application of retrofit programs will also impact on ambient air quality. Overseas programs and local research provide information on the potential environmental benefits of retrofit programs.

Diesel oxidation catalysts (DOCs) appear to have widespread application to broad vehicle groups. DOCs are effective in reducing hydrocarbon, carbon monoxide, and particulate emissions, but have no effect on NO_x emissions. Overseas data (based largely on heavy-duty diesel vehicles) report the following emissions reductions, along with improvements in odour:

- particles: 20-50%
- hydrocarbons: 50-90%
- carbon monoxide: 45-90%

The magnitude of the reductions depends on several factors, including engine technology and fuel quality. Use of DOCs with fuel sulfur levels above 500ppm can result in increased particle emissions due to interference with catalyst operation, though some devices can be constructed to cope with high sulfur fuel.

It is difficult to quantify how these reductions translate to improved air quality at sensitive locations such as bus terminals or other depots. The improvement would depend on the particular local circumstances such as vehicular movements, weather conditions and dispersion.

Particle traps are also well proven technology and are currently the most effective after treatment technology for reducing PM emissions. They can reduce PM levels by up to 90-95%. Some particle traps are also effective at reducing HC and CO levels by up to 50-90%. Particle traps tend to be designed to work with specific engine families. While the environmental benefits are very impressive, they can be easily destroyed if they become clogged.

Costs

The major costs of a retrofit program are those associated with the purchase, installation and maintenance of the exhaust after-treatment devices. These costs will be borne by the vehicle operator. In the case of any programs requiring retrofit of privately operated vehicles, a government incentive of some type, with its associated costs, may be necessary to implement the program due to the high cost involved. The costs of DOCs and particle traps are discussed below.

- The unit cost for DOCs is in the range of $1,500 - $4,500, with the variability being related to production volumes and specifications. These figures are based largely from the urban bus experience in the US and Europe, and it is likely that smaller catalysts for light vehicles would be cheaper. DOCs are the least expensive after-treatment technology to install, can be fitted in about an hour, require no maintenance, and are very durable (one estimate of catalyst life is 600,000km).

  Particle traps are much more complex than DOCs and cost considerably more to purchase and operate. Current costs for particle traps are in the order of $8,000 - $15,000, though this may fall to around $5000 with technological improvements. Particle traps also have much higher maintenance requirements than DOCs.

Table 7-6 Summary of Strengths and Weaknesses of a Retrofit Program

Strengths	Weaknesses
Quantifiable benefits in terms of emission reductions from each vehicle.	Expensive for individual operators (may need government subsidy or higher charges to consumers)
	No incentive for uptake without prescriptive regulation or government subsidy.
Low administrative costs for government.	Application of retrofit technologies is limited to relatively well maintained vehicles.
Relatively easy to implement the program.	
Benefits last for the life of the vehicle.	
Better able to address odour problems than other programs.	

Table 7-7 Summary of cost components of a Retrofit program

Type of Cost	Unit Cost	Total Cost
Administrator		
Administrative and Operational	Depends on the level of any subsidy provided to offset high costs to vehicle operator	Unit cost times number of vehicles undertaking engine retrofit
Vehicle Operator		
Engine retrofit costs	$1500 to $4500 **a**	Unit cost times number of vehicles undertaking engine retrofit
Repair Costs	Not applicable	$0
Maintenance Costs	Not applicable	$0
Inspection Costs	Not applicable	$0
Indirect cost of inspection (loss of vehicle use time)	Not applicable	$0
Indirect cost of repair (loss of vehicle use time)	Not applicable	$0
Compliance Fee	Not applicable	$0

a. Based on unit costs of for retrofit of Diesel Oxidation Catalysts.

Diesel Engine Rebuild Programs

<u>Benefits</u>

Many vehicles in the existing diesel fleet have minimal or no emissions control technology. Consequently, there is potential to significantly reduce NO_x and particle emissions, by fitting low emission rebuild kits at time of major engine overhaul, where such kits are available.

The benefit of such a program would be realised by ensuring that, when an engine rebuild was required, the engine be rebuilt to a later design standard than it was originally manufactured to. For example pre-ADR70/00 vehicle could be upgraded to meet the equivalent of the ADR70/00 standards, thereby significantly improving NO_x and particulate emissions. Data from NEPC Project 7 show that, for particulates, ADR 70 vehicles performed 70% better than earlier model vehicles.

At present the potential environmental gains from engine rebuild kits are limited by the lack of kits available for the Australian diesel fleet.

<u>Costs</u>

The opportunity for rebuilding an engine to an advanced emission standard usually only occurs when the engine has fulfilled its useful life. In cases where it is feasible to upgrade an engine the cost of improving emission performance would be marginal, as the rebuild may only require a few new components over and above the standards parts list. Stakeholders are invited (during the public consultation period) to provide information on typical costs of low emission engine rebuilds, relative to "standard" rebuilds only require a few new components over and above the standards parts list.

Table 7-8 Summary of Strengths and Weaknesses of an Engine Rebuild Program

Strengths	Weaknesses
Quantifiable benefits for vehicles converted.	Very few kits are currently available.
Improves performance beyond original standards.	Unlikely to be cost effective for lighter vehicles.
Lower cost than replacing vehicle.	May need incentives or regulation to encourage uptake.
Durable long term benefits.	

Table 7-9 Summary of cost components of an Engine Rebuild Program

Type of Cost	Unit Cost	Total Cost
Public		
Administrative and Operational	Not available	Not available
Vehicle Operator		
Engine rebuild costs	Not available	Not available
Repair Costs	Not applicable	$0
Maintenance Costs	Not applicable	$0
Inspection Costs	Not applicable	$0
Indirect cost of inspection	Not applicable	$0
Indirect cost of repair	Not applicable	$0
Compliance Fee	Not applicable	$0

Smoky vehicle management programs

Benefits

Evidence suggests that smoky vehicle programs are an effective means for addressing the public amenity problem of excessive smoke emissions from vehicles. The public clearly places a high priority on the amenity value of smoke emissions as around 12,000 reports are made annually in Victoria alone (nearly double all other pollution complaints). While this data does not allow the amenity benefit to be quantified, it shows that the smoky vehicle issue is more immediately important to the public than other pollution issues.

Most jurisdictions have had programs in place for some time and they all receive considerable public support. While the environmental benefits are difficult to quantify, the results of NEPC Project 7 suggest that vehicle repair and servicing of faulty vehicles can yield a 28% reduction in smoke opacity in certain vehicle classes.

Smoky vehicle programs vary in effectiveness depending on what action is taken when smoky vehicle reports are received. The program proposed in the draft NEPM proposes that reports received from authorised officers result in a requirement that the vehicle be repaired, and reports from the public result in a letter of warning being sent to the owner. A less rigorous approach would lead to less impact on owners of smoky vehicles, but would also provide reduced benefits.

Costs

Jurisdictions would incur the administrative costs associated with implementing a smoky vehicle program. These would include the costs of training and employment of authorised enforcement officers and processing of infringement notices. It would be possible for a jurisdiction to utilise existing enforcement officers such as police and road transport officers, and existing processing systems such as vehicle registration systems to reduce these costs. In addition, some, or all of these costs could be recovered through fines for infringements. Several states run smoky vehicles programs. Annual costs of these programs vary from $15,000 (WA) to $250,000 (NSW).

The WA program runs as a public hotline. Members of the public call in to identify smoky vehicles (approximately 4800 complaints annually). On average, 50 faulty vehicles per month (600 per annum) are reported by their owners to have been repaired based on the program. No action is taken to confirm these reports and no penalties are issued. Costs for the year include staff costs ($12,000), postage ($2,000), and registration searches ($600).

NSW runs a more stringent smoky vehicles program. Officers of the EPA, the Roads and Traffic Authority, and Councils can identify smoky vehicles. Four thousand six hundred vehicles per year are identified. NSW estimates that about 625 vehicles are repaired through this program every year. Costs of running the program for the year include staff costs ($182,000), vehicle running costs ($30,000), supplies and equipment ($30,000). Legal costs by the EPA are $60 - 80,000 per year with some of these costs being recovered where the Court awards legal costs to EPA.

Based on data from NEPC Project 7, the NSW program is only capturing a fraction of the smoky vehicles and therefore realising only a fraction of the benefits. Achieving the full potential benefits would involve considerably more cost.

Owners of identified smoky vehicles would incur the costs of repairs to their vehicle and any associated costs of the vehicle being out of commission while it was being repaired. They would also incur the costs of any infringement fines that applied. From the programs already operating in Australia there is little information on the cost of the program to vehicle owners, including the cost of repairs and vehicle down time. Under the NSW program, the community has been charged fines of $280,078 (average fine of between $500 and $1500) and court costs of $51,230.

Table 7-10 Summary of Strengths and Weaknesses of Smoky Vehicle Programs

Strengths	Weaknesses
Directly addresses widespread public concern regarding smoke emissions.	Not an accurate means of targeting vehicles with high particle emissions (some may have good smoke levels, but poor total particle emissions)
High public participation rates.	Does not directly address the key health issue of ambient particle levels.
Reduces smoke and particle emissions.	Regarded as subjective and not scientifically rigorous.
Relatively inexpensive to administer and enforce.	Reports made by the general public may be unreliable.
Costs to Government capable of being recovered	Effect of repair is not quantified – benefits not easily costed.
Strong public education component.	
Encourages fleet managers to put in place management systems to address smoke.	
Encourages behavioural change through peer pressure.	
Flexible implementation options.	

Table 7-11 Summary of cost components of Smoky Vehicle Program

Type of Cost	Unit Cost	Total Cost
Administrator		
Administrative and Operational	▪ $400/repaired vehicle **a** ▪ Can be partially cost recovered with compliance fees	(% of fleet undertaking repair times unit cost) less the total level of cost-recovery from compliance fees
Vehicle Operator		
Repair Costs	$300 - $800 **b**	▪ Unit cost times vehicles undertaking repair ▪ Depends on level of compliance
Inspection Costs	Not applicable	$0
Indirect cost of inspection	Not applicable	$0
Indirect cost of repair	$40 **c**	Unit cost times number of vehicles requiring repairs
Compliance (fines)	$500-$1500 **d**	Compliance fee times number of vehicles failing to comply

a. Based on total administrative and operational costs of NSW EPA smoky vehicle program divided by NSW EPA estimate of number of vehicles undertaking repairs. b. Based on NEPC Project 7 data for vehicle repair costs. c. Based on estimate from '*Cost Effectiveness of Periodic Motor Vehicle Inspection – A Report for the Federal Office of Road Safety*'. d. Based on average level of fines used in NSW EPA smoky vehicle program.

Summary

The cost of repairing or servicing diesel vehicles to ensure the fleet was in compliance with the proposed standards is approximately $66m. This cost would decrease after the first year.

It is recognised that vehicle owners are unlikely to comply voluntarily, so there will also be a cost associated with introducing compliance programs. These programs may comprise elements of the NEPM Guidelines. To the extent possible, the costs associated with each Guideline have been quantified. The actual cost of any compliance program will depend on how a jurisdiction utilises the NEPM Guidelines in combination with existing programs to address particular problems.

The benefits of having the fleet comply with the proposed in-service Standard include improved vehicle performance or fuel consumption, improved reliability and resale value, improved roadside amenity, better public confidence and an avoided health costs of around $33m. These benefits would decrease after the first year.

The particular benefits of each NEPM Guideline have been evaluated and compared in terms of strengths and weaknesses. The benefits will be maximised by combining programs in the NEPM with existing emission or safety programs.

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APPENDIX 1: DIESEL VEHICLE EMISSION REDUCTION AND COST DATA

This Appendix provides some data relevant to the discussion in the text of the Impact Statement.

Potential particle emission reduction from repair of high emitting vehicles

Table A provides the results of modelling that compares the annual effect on aggregate particle emissions by repairing all high emitting (defined as exceeding the proposed in-service emission Standard) vehicles older than five years to a base case (do nothing) scenario. The modelling assumes that all high emitting vehicles would be identified and repaired in 2002. Table B gives the annual reductions in terms of percentage reduction in comparison to the base case.

The potential annual reductions of particles decrease annually in comparison with the base case as that older vehicles with outdated technologies are retired from the fleet and are replace with newer vehicles with more stringent emission controls and improved durability.

Table A Reduction in Particles Emissions due to Repair (tonnes)

Year	NSW	VIC	QLD	WA	SA	TAS	NT	ACT
2003	36.9	46.9	26.8	18.8	11.1	2.3	2.2	2.7
2004	33.0	41.7	24.1	16.9	9.9	2.0	2.0	2.4
2005	29.1	36.6	21.3	15.0	8.7	1.8	1.8	2.1
2006	25.3	31.6	18.6	13.1	7.5	1.5	1.5	1.9
2007	21.6	26.8	16.0	11.2	6.4	1.3	1.3	1.6
2008	18.0	22.2	13.4	9.4	5.3	1.1	1.1	1.3
2009	14.6	17.9	10.9	7.7	4.2	0.9	0.9	1.1
2010	11.4	13.9	8.5	6.0	3.3	0.7	0.7	0.8
2011	8.6	10.3	6.4	4.5	2.4	0.5	0.5	0.6
2012	6.1	7.2	4.5	3.2	1.7	0.3	0.4	0.4
2013	4.0	4.6	2.9	2.0	1.1	0.2	0.2	0.3
2014	2.4	2.6	1.6	1.1	0.6	0.1	0.1	0.2
2015	1.2	1.3	0.9	0.6	0.3	0.1	0.1	0.1

Source: Cox, J.B. 2000. Diesel Fleet Characteristics: Emission Projections Update; Preliminary Report to the National Road Transport Commission.

Table B Reduction in Particles Emissions due to Repair (% of actual emissions)

Year	NSW	VIC	QLD	WA	SA	TAS	NT	ACT
2003	4.6	5.1	5.3	5.4	5.3	4.6	5.2	5.2
2004	4.4	4.8	5.0	5.0	5.0	4.3	4.9	4.9
2005	4.1	4.4	4.7	4.7	4.6	4.0	4.6	4.6
2006	4.2	4.4	4.7	4.7	4.8	4.1	4.8	4.8
2007	3.8	4.0	4.3	4.3	4.3	3.8	4.3	4.3
2008	3.4	3.6	3.8	3.9	3.9	3.4	3.9	3.9
2009	3.1	3.2	3.4	3.4	3.5	3.0	3.4	3.5
2010	2.6	2.8	2.9	3.0	3.0	2.5	2.8	3.0
2011	2.2	2.3	2.3	2.4	2.5	2.1	2.3	2.4
2012	1.7	1.8	1.8	1.9	1.9	1.6	1.7	1.9
2013	1.2	1.2	1.3	1.3	1.3	1.1	1.2	1.3
2014	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.8
2015	0.5	0.4	0.4	0.4	0.5	0.4	0.4	0.5

Source: Cox, J.B. 2000. Diesel Fleet Characteristics: Emission Projections Update; Preliminary Report to the National Road Transport Commission.

Indicative capital and recurrent costs for vehicle emissions testing facilities

Tables C and D provide indicative costs of constructing and operating mobile and fixed site testing facilities. These costs are derived from operation of testing facilities during NEPC Projects 2.2 and 7.

Table C Mobile System – Indicative Costs

EQUIPMENT DESCRIPTION	LIGHT DUTY		HEAVY DUTY	
Dynamometer, computer, ramps, etc (heavy duty dynomometer includes dual axle capability).	$190,000		$350,000	
Emissions measuring equipment (I/M grade)	$90,000		$95,000	
Vehicles (1 x 4~6tonne + 1 x light commercial) for conveying system to operating location.	$85,000		$105,000	
Vehicle fit-out, including calibration gases, computers, data loggers, wireless communication systems, racking, air-conditioning, etc	$100,000		$100,000	
Generator, ancillary equipment, trailers	$50,000		$80,000	
Software licences and database/communications	$120,000		$120,000	
Operations staff: 3 x Lane operators 1 Administration	@45K @35K	$170,000 pa	@45K @35K	$170,000 pa
Calibration equipment		$20,000		$20,000
Reference gases and consumables		$10,000pa		$10,000pa
TOTAL (Capital)	**$655,000**		**$870,000**	
TOTAL (Recurrent)	**$180,000pa**		**$180,000pa**	

Source: NEPC Project 7

Table D Fixed system (two lane operation) – Indicative Costs

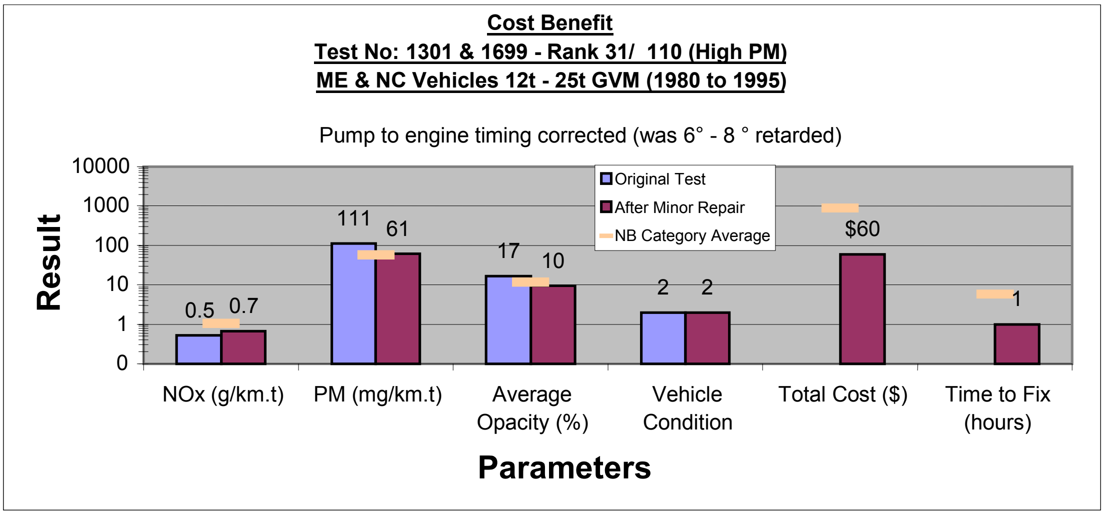
EQUIPMENT DESCRIPTION	LIGHT DUTY		HEAVY DUTY	
Dynamometer, computer, etc (heavy duty dynomometer includes dual axle capability)	2@ $190,000	$380,000	2@ $350,000	$700,000
Emissions measuring equipment (I/M grade)	2 @ $90,000	$180,000	2@ $95,000	$190,000
Software licences and database/communications	1@ $120,000	$120,000	1@ $120,000	$120,000
Building Areas: • Test cell 20m x 6m x 6m (HD), 12m x 5m x 3m (LD) • Office 6m x 6m • Amenities 2m x 4m • Gas store 2m x 4m • Equipment/tool store 4m x 6m • Customer waiting area & transaction counter 6m x 4m Soundproof enclosure/lane	$220m^2$ at $1,000/$m^2$ 2@ $100,000	$220,000 $200,000	$340m^2$ at $1,000/$m^2$ 2@ $200,000	$340,000 $400,000
Operations staff: 1 x Vehicle reception 4 x Lane operators 2 x Administration 1 x Manager	@40K @45K @35K @50K	$340,000pa	@40K @45K @35K @50K	$340,000pa
Calibration equipment		$20,000		$20,000
Reference gases and consumables		$20,000pa		$20,000pa
TOTAL (Capital)	**$1,120,000**		**$1,770,000**	
TOTAL (Recurrent)	**$360,000pa**		**$360,000pa**	

Source: NEPC Project 7

The relationship between costs and effect of repair

The following figures demonstrate that in some cases significant emissions reductions can be obtained be obtained for minor repair costs. Figure 1 shows that for a cost of $60 the particle emissions of one vehicle were reduced 45% (111 mg/kilometre/tonne to 61 mg/kilometre/tonne). In comparison the particle emissions of the vehicle in Figure 2 were also reduced by 45% (35 mg/kilometre/tonne to 19 mg/kilometre/tonne), but at a cost of $1,330.

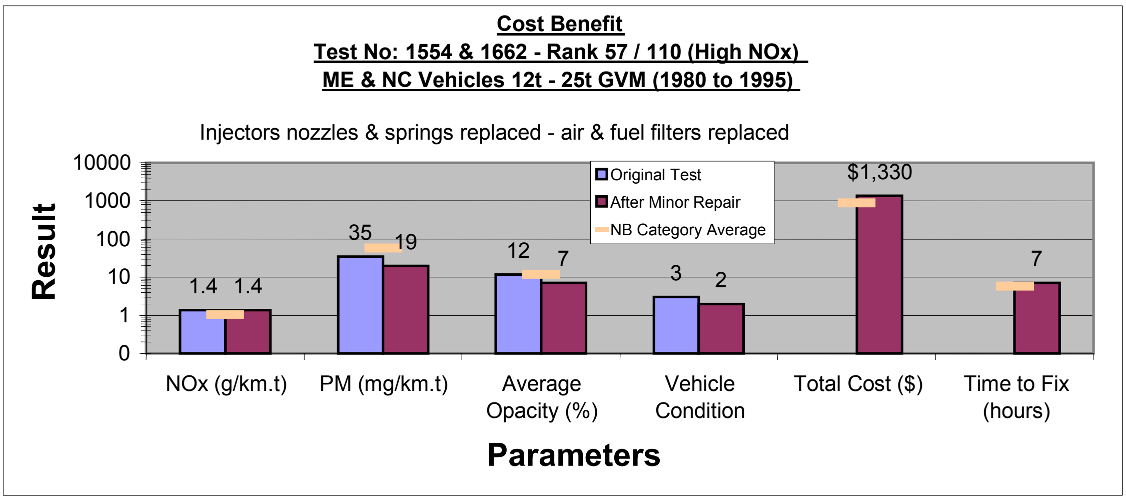
Figure 1: Repair Example – Vehicle 1



Source: NEPC Project 7

Note: Y axis is non-dimensional log scale to allow different magnitudes and types of values. Cross bars indicate mean value for the class of vehicles examined.

Figure 2: Repair Example – Vehicle 2



Source: NEPC Project 7

Note: Y axis is non-dimensional log scale to allow different magnitudes and types of values. Cross bars indicate mean value for the class of vehicles examined.

APPENDIX 2: SUMMARY OF NEPC PREPARATORY PROJECTS

The NEPC commissioned a series of preparatory projects in order to develop an information base on which decisions on whether a NEPM on diesel vehicle emissions was warranted, and if so, the scope and detail of such a NEPM.

A brief description of the projects is given below. A detailed report on each project is available at www.nepc.gov.au.

NEPC Project 1 - Diesel Fleet Characteristics

This project defines the demographics of the Australian diesel fleet to assist in assessing the benefits to be gained in emissions reductions by implementation of the NEPM and other diesel fuel/vehicle policies. It provides a detailed description of the Australian diesel fleet that includes modelling from a base year of 1995 to 2015 for metropolitan and country areas in each state of:

- vehicle numbers, age and size distributions;
- travel demand; and
- emissions of carbon monoxide, oxides of nitrogen, hydrocarbons, and particulate matter for the diesel fleet.

The modelling compares the effects of existing emissions standards for diesel vehicles and the introduction of future emission standards and reduced fuel sulfur levels as described in the Commonwealth's *Measures for a Better Environment*.

The modelling suggests that there will be significant reductions in emissions from diesel vehicles over the next fifteen years as new vehicle emissions and fuel quality standards are implemented.

NEPC Project 2.1 – Drive Cycles

This project established typical urban driving patterns of diesel powered road vehicles, and derived composite urban emission drive cycles, by Australian Design Rules vehicle category, for major Australian urban areas. Development of drive cycles reflecting Australian conditions allows a 'benchmark' emissions profile to be established when vehicles are tested on that drive cycle.

Composite urban emission drive cycles of thirty minutes duration, representing typical driving patterns for six diesel vehicle categories operated under congested, minor, arterial and freeway road flow conditions were developed by attaching data loggers to privately owned diesel vehicles.

Project 2.2 – Vehicle Testing

This project had three objectives:

- measurement of 'real world' emissions from the Australian diesel vehicle fleet;
- comparison of the emissions performance of six short emission tests against the 'benchmark' emissions performance of the composite urban emission drive cycle to

determine their suitability to be used in the management of emissions from the in-service diesel fleet; and
- evaluation of a methodology for measuring particle emissions in an in-service program.

Using the composite urban emissions drive cycles developed in NEPC Project 2.1, 80 diesel vehicles were tested under laboratory conditions for emissions of carbon monoxide, oxides of nitrogen, hydrocarbons and particulate matter. Vehicles from 6 size categories and ranging in age from 0 to 20 years were tested. The results provide the first estimates of "real world" emissions from the Australian diesel fleet. The data will be used to refine the modelling predictions from NEPC Project 1 and assess emission performance by age and size sectors of the fleet.

A short emission test demonstrating significant potential for use in in-service testing was identified and was selected for further evaluation in a pilot program (NEPC Project 7). An instrument capable of measuring particle emissions by means of laser light scattering photometry was identified as suitable for use in an in-service environment. Emission results indicate that light-duty diesel vehicles appear to exhibit disproportionably high levels of emissions.

NEPC Project 3 [subsumed by the Fuel Quality Review carried out by Environment Australia]

NEPC Project 4 – Drive Cycle Correlations

This project examined the correlation between the emission performance of vehicles on the two most promising in-service tests and one of the emission certification tests specified under current Australian Design Rules for diesel vehicle emissions. The results of this project assisted in the establishment of pass/fail cut points for classifying vehicles as high emitters during the pilot project (NEPC Project 7).

NEPC Project 5 – Dynamometer Correlations

The purpose of this project was to examine the international literature and on-going efforts to establish a correlation between emissions measured on a chassis dynamometer and on an engine dynamometer for heavy-duty diesel vehicles, and to provide advice on establishing such correlations in Australia. Information from this project was used to complete the design of NEPC Project 4.

Information about this correlation is necessary in order to determine the extent to which heavy-duty vehicle emissions measured in an in-service test (on a chassis dynamometer) can be compared with those measured in certification tests (measured on an engine dynamometer).

The results of this study demonstrate that progress has been made in achieving satisfactory correlations for steady state emissions tests (tests conducted at a constant speed intervals) and that results have been mixed for correlating transient emissions tests (tests involving periods of acceleration and deceleration).

NEPC Project 6 – In-service Emissions and Engine Deterioration

This project had three main objectives:
- examine in-service emissions deterioration rates for both light-duty and heavy-duty diesel vehicles;

- examine worldwide emission control programs that are designed to maintain original engine emission performance over its useful life; and
- examine programs that are related to improving the emission performance of in-service vehicles (through retro-fit of control technology or upgrade at the time of engine rebuild) and assess the applicability of both types of programs to Australia.

The results of this project indicate the following:

- the emissions deterioration of heavy-duty diesel vehicles has not been studied extensively due to the lack of adequate test facilities, and the expense involved;
- there has been a growing realisation that in-service diesel vehicles do not maintain certification level emissions (new vehicle emissions) over their useful life;
- in-service emissions deterioration occurs for several reasons including lack of adherence to the manufacturer's maintenance regime, mal-maintenance, tampering, design defects in emissions control systems and underestimation of the deterioration rate of vehicles in the design of the vehicle; and
- EU countries, Japan and seven States in the USA have initiated in-service testing of diesel vehicles. All programs are based on evaluation of smoke emissions. No significant estimates of cost effectiveness have been undertaken.

Information regarding international initiatives to set standards for the reconditioning and retro-fitting of advanced emission reduction technologies to in-service diesel engines were used to scope potential components of a diesel emissions NEPM.

NEPC Project 7 – Pilot Study

For this project, 615 diesel vehicles were tested for emission performance. 120 of the vehicles were examined for engine faults that related to poor emission performance. A subgroup of these vehicles were repaired and retested to determine the extent to which improvements in emission performance can be obtained.

The objective of this project was to finalise evaluation of a selected short test to determine the practicality of identifying high emitting diesel vehicles through in-service testing.

The project provided information about the frequency of emission mal-performance within the Australian diesel fleet and identified significant contributors of high emissions. Importantly it provided information required for the assessment of potential emission reductions by identifying and repairing high emitting vehicles. It also provided information about costs associated with in-service vehicle testing.

The results of this project indicate:

- deterioration emissions of fine particles is significant in some vehicle size classes for vehicles more than five years of age;
- repair of high polluting vehicles can result in significant improvement of their emission performance.

Applying the results of this project to vehicle census data from NEPC Project 1 for each capital city shows that:

- repair of high emitting vehicles more than five years of age will reduce present fleet emissions of the diesel fleet by approximately 5% in the first year; and
- the repair effect on fleet emissions is expected to diminish for each following year as older technology vehicles are retired from service and are replaced by vehicles built to more stringent emission standards (assuming that the later technology vehicles have improved durability in emission related components).

APPENDIX 3: ASSESSMENT OF DRAFT NEPM AGAINST COAG COMPETITION POLICY PRINCIPLES AND RELEVANT SECTIONS OF THE NEPC ACT

Under the COAG Competition Policy Principles, an assessment of competitive implications is required as part of the process for making subordinate legislation. If approved by NEPC, the proposed NEPM will be adopted as subordinate legislation within jurisdictions (under the processes for adoption of NEPMs set out in jurisdictional legislation).

The proposed NEPM and the anticipated implications of its adoption are explained in detail in the Impact Statement.

The draft NEPM for Diesel Vehicle Emissions has been framed within the objects of the NEPC (as set out in Section 3 of the NEPC Act) to ensure that:

- people enjoy the benefit of equivalent environmental protection from air, water or soil pollution and from noise wherever they live in Australia; and
- decisions of the business community are not distorted, and markets are not fragmented, by variations between participating jurisdictions in relation to the adoption or implementation of major environment protection measures.

These objectives generally complement the aims of the Competition Policy Principles. Accordingly, every effort has been made to ensure that the proposed NEPM reflects these objectives and that due regard was given to Competition Policy Principles.

As the draft NEPM comprises a Goal and Guidelines it is considered unlikely to introduce inequalities which would run counter to the Competition Policies Agreement. The draft NEPM has been designed to provide for improved consistency of approach to management of emissions from in-service diesel vehicles while providing the flexibility for jurisdictions to efficiently and effectively target and address air quality issues.

An assessment of the COAG Competition Policy Principles against the draft NEPM indicates that by ensuring that maintenance of diesel vehicles is assessed against national in-service emission performance standards, it will not affect competition within any market.

The draft NEPM includes a consistent set of national guidelines and its implementation is expected to contribute towards achieving the aims of the National Competition Policy Principles, which are:

- reducing administrative duplication between various governments; and
- ensuring that, as far as possible, the same rules of market conduct apply to all market participants.

NEPC Act – Section 14

Section 14(1)(g) of the National Environment Protection Council Act provides for making of NEPMs relating to motor vehicle emissions, except (as provided in section 14(2)), emission standards relating to the design, construction and technical characteristics of new and in-service motor vehicles, which may only:

(a) be developed and agreed in conjunction with the National Road Transport Commission; and

(b) be determined in accordance with the *National Road Transport Commission Act 1991* and, where appropriate, the *Motor Vehicle Standards Act 1989.*

Accordingly, it is proposed that in-service diesel vehicle emission standards be developed under the *National Road Transport Commission Act*, and that the draft NEPM comprise guidelines for achieving those standards.

NEPC Act - Section 15

Section 15 of the National Environment Protection Council Act sets out the issues the National Environment Protection Council is required to have regard to in making a NEPM:

- **whether the measure is consistent with section 3 of the Intergovernmental Agreement on the Environment section 15(a)).** The NEPC has been mindful to ensure that the principles of the Agreement have been considered and taken into account where appropriate during the development of the draft NEPM;
- **the environmental, economic and social impacts of the measure section 15(b)).** Every effort was made to ensure that the available scientific, social, environmental and economic data were considered when developing the draft NEPM and Impact Statement. Comments made during the key stakeholder consultation phase were also considered. The Impact Statement also invites stakeholders to contribute any further information on impacts during the public review process;
- **the simplicity, efficiency and effectiveness of the administration of the measure section 15(c)).** The NEPC Committee has guided the development of the draft NEPM so that its administration will be simple, effective and efficient eg. the draft guidelines in the NEPM recognise and build upon existing accepted programs, procedures and methodologies where available;
- **whether the most effective means of achieving the desired environmental outcomes of the measure is by means of a national environment protection standard, goal or guideline or any particular combination thereof section 15(d))**. NEPC Committee considered various options for achieving the desired environmental outcome of the draft NEPM. The Impact Statement canvasses those options and suggests that the proposed NEPM is the most effective way to achieve the proposed environmental outcomes espoused in the draft NEPM. The NEPC will consider all relevant submissions on this matter;
- **the relationship of the measure to existing inter-governmental mechanisms section 15(e))**. The draft NEPM and Impact Statement takes account of inter-governmental mechanisms, eg *National Road Transport Commission Act 1991*, the *Commonwealth Motor Vehicle Standards Act 1989*, the Inter Governmental Agreement on the Environment and Council of Australian Governments requirements contained in the Principles and Guidelines for National Standard Setting and Regulatory Action by Ministerial Councils and Standard Setting Bodies. The Impact Statement has been developed keeping these relationships in mind;

- **relevant international agreements to which Australia is a party section 15(f))**. There are no relevant formal international agreements to which Australia is a party in the context of this draft NEPM;
- **any regional environmental differences section 15(g))** have been considered and where appropriate the draft NEPM endeavours to take account the wide variation in air quality within and between jurisdictions.

NEPC Act – Sections 16, 17 and 18

The requirements to give notice of intention to prepare a draft NEPM and Impact Statement (section 16) and the preparation of the draft NEPM and Impact Statement (section 17) have been met. The requirements for public consultation under section 18 are being met.

APPENDIX 4: PROJECT TEAM AND TECHNICAL SUPPORT

Project Team

Project Chair	Ms Anthea Tinney (Environment Australia)
Project Manager	Mr Marc Thompson (NEPC Service Corporation)
Project Team	Mr Bruce Dowdell (NSW RTA) Mr Tim Eaton (National Road Transport Commission) Ms Helen Fitzgerald (NSW EPA) Mr Matthew Minchin / Mr Doug Munro (EPA Victoria) Ms Vicki Ratliff (Environment Australia) Mr Jon Real (Department of Transport and Regional Services)
Project Officer	Mr Haemish Middleton/Ms Lisa Davies NEPC Service Corporation
Project Assistance	Ms Monina Gilbey, NEPC Service Corporation

Consultants

John Cox and Apelbaum Consulting Group	NEPC Project 1
Nelson English, Loxton and Andrews	NEPC Projects 5 and 6
NSW Environment Protection Agency	NEPC Project 2.1
Parsons Australia Ltd	NEPC Projects 2.2 and 7
VIPAC Engineers and Scientists	NEPC Project 4