
# Select Committee upon

# Motor Vehicle Emissions

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# REPORT

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**November 1994**

**Parliament of NSW**

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# Chairman's Foreword

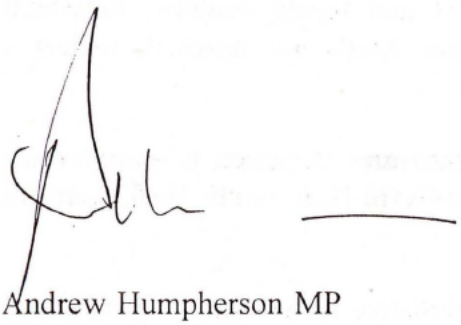
I am pleased to table the report of the Select Committee Upon Motor Vehicle Emissions.

During the course of this inquiry it rapidly became obvious to myself and other members of the Committee that emissions from motor vehicles are the most serious air pollution problem facing our urban environment both today and in the future. I believe this concern is reflected in the conclusions and recommendations of this report which were adopted unanimously by the Committee.

The Committee believed that an inspection and maintenance program for testing motor vehicle emissions from in-service vehicles should be introduced as soon as possible into New South Wales. However, it was recognised that such a system must offer convenience to motorists and at the same time be regularly and effectively audited.

There was also concern about the fact that national new vehicle emission standards are so far behind best international practice. I believe that this can be attributed to the Federal Government failing to impose higher standards on our local industry. It was believed that the standard-setting process needs to be accelerated and to have more regard to those most effected by serious motor vehicle emission pollutants such as ozone.

Finally, it was recognised by the Committee that, while Sydney needs an effective road network, it must be augmented by a comprehensive rail network combined with efficient bus interchanges and vehicle parking.



Andrew Humpherson MP
Chairman

# Committee Members

Mr Andrew Humpherson, M.P.
(Chairman)

Mr Bryce Gaudry, M.P.

Mr Brian Langton, M.P.

Dr Peter Macdonald, M.P.

Mr Bill Rixon, M.P.

## Committee Secretariat

| | | |
|---|---|---|
| Ms Catherine Watson | - | Project Officer |
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| Ms Hilary Parker | - | Assistant Committee Officer |

(vii) mechanics operating within any emission testing scheme are suitably qualified and trained.

(viii) equipment is regularly calibrated and independently checked.

11 That a proportion of the 3 x 3 fuel levy be hypothecated toward rail infrastructure.

12 That the means of reducing hydrocarbon emissions in warmer months by reducing the vapour pressure of petrol be explored.

13 That strategies be developed which create increased incentives to phase older vehicles into retirement more quickly.

14 That planning agencies, including local councils, adopt policies which ensure
(i) employment opportunities are centred around a public transport network;
(ii) car parking and access to rail/bus/ferry interchanges is optimised; and
(iii) multiple destinations, such as shopping centres, child care, schools and recreation facilities, are developed in close proximity.

15 That Sydney-wide strategies be formulated which:
(i) reduce vehicle kilometres travelled (VKTs); and
(ii) trial ride sharing/car pooling relying on 'park and ride' facilities, employer-based schemes and other incentives.

The study, which was not released, illustrated that to introduce idle emission testing within the projected six month period through the AIS system was not feasible as industry was ill prepared. It found that at least 50% of the equipment currently possessed by these AIS was not performing efficiently, training in the use of the equipment was inadequate and that the analyser industry could not currently meet the demand for supplies.

Results of the test also showed that cars were not being properly tuned, and hence manufacturers' emission standards were not being met. Analysis of the material gained during the study is continuing at the EPA and the CSIRO.

**The four-pronged approach to motor vehicle maintenance**

In November 1993 the NSW government launched the motor vehicle maintenance program. This was described as a four-pronged approach comprising:

(i) an upgrading of the skills and equipment of the motor vehicle repair industry to ensure that all vehicles that fail an emissions test can be effectively diagnosed and repaired;
(ii) a community education program;
(iii) a visual check of vehicle catalytic converters as part of annual pink slip inspections to ensure that catalysts are in place and not disconnected;
(iv) the development of an in-service emission test program.

**The Select Committee upon Motor Vehicle Emissions**

On 14 April 1994 Parliament resolved that a Select Committee Upon Motor Vehicle Emissions be established.

**The In-service Vehicles Emissions Study**

The $1.7 million In-service Vehicles Emission Study, jointly funded by the Federal Department of Transport, the EPA and industry groups such as the NRMA, was launched on 9 May 1994. It aims to randomly test 600-800 in-service vehicles under the standard certification emissions test cycle to establish an emissions inventory for the vehicle fleet, and also to subject the vehicles to a range of short emission tests to ascertain their suitability for detecting high polluting vehicles in the fleet.

Testing will be conducted by the EPA at its Lidcombe laboratory. Four types of testing systems will be trialled: full drive cycle; tow speed idle; loaded dynamometer; and IM 240. Recommendations are anticipated regarding cost-effective vehicle emission control programs.

The In-service Vehicle Emissions Study will report in about 18 months time. The timetable of the study is partly dependent on the findings of the Metropolitan Air Quality Study (MAQS) regarding the seriousness of the air pollution problem. The EPA has indicated that, should the problem be serious, the Study could look to making recommendations based on preliminary testing as early as the beginning of 1995.

# Chapter 1: Overview of motor vehicle generated pollution

## 1.1 Overview

It was generally agreed that air pollution in Sydney, while rarely reaching anywhere near the levels of highly polluted cities such as Los Angeles, was nevertheless significant and of some concern.

It is well acknowledged that the major contributor to all air quality in cities is motor vehicle emissions. Major pollutants significantly attributable to motor vehicles were identified as: hydrocarbons (HC); carbon monoxide (CO); oxides of nitrogen (NOx); lead; and particulates (PM10).

The following table outlines these various pollutants' contribution to Sydney's air quality. Obviously, the degree to which motor vehicle emissions contribute to the total pollutant emissions load for a region will be dependant upon the extent to which industrial processes also emit into the air.

**TABLE 1: PERCENTAGES OF POLLUTANTS**

| Pollutant | Proportion of Emissions from Motor Vehicles (%) |
|---|---|
| Oxides of Nitrogen | 75 |
| Hydrocarbons | 60 |
| Carbon Monoxide | 80 |
| Lead | 95 |
| Particulates | 40 |

*Source: EPA submission to the Committee*

While air quality in Sydney has improved since the introduction of the more stringent emission standards of Australian Design Rule 37 (ADR 37), it is widely acknowledged that any present gains will eventually be offset by the continuing growth in vehicle ownership.

The following chart, supplied to the Committee by the Roads and Traffic Authority, combines ABS figures of past vehicle ownership growth and RTA future predictions for vehicle ownership in Sydney:

| POLLUTANT | STANDARD | AGENCY |
|---|---|---|
| Particulate matter < 10 μm | 50 μg/m$^3$ (annual mean)<br>150 μg/m$^3$ (24-hour maximum) | US EPA<br>US EPA |
| Lead | 1.5 μg/m$^3$ (90-day average) | NHMRC |
| Carbon monoxide | 87 ppm (15-minute maximum)<br>25 ppm (1-hour maximum)<br>9 ppm (8-hour maximum) | WHO<br>WHO<br>NHMRC |
| Nitrogen dioxide | 0.16 ppm (1-hour maximum)<br>0.05 ppm (annual mean) | NHMRC<br>US EPA |
| Ozone | 0.12 ppm (1-hour maximum) | NHMRC |
| Sulphur dioxide | 0.50 ppm (10-minute maximum)<br>0.25 ppm (1-hour maximum)<br>0.02 ppm (annual mean)<br>0.175 ppm (10-minute maximum)<br>0.12 ppm (1-hour maximum) | NHMRC<br>NHMRC<br>NHMRC<br>WHO<br>WHO |

*Source: EPA submission to the Committee*

It is intended that the National Environment Protection Council will set ambient air quality goals. Any motor vehicle emission standards will be a subcomponent of this.

## 1.2 Major Pollutants From Motor Vehicles

While the notion of a 'chemical overload' on the human health system was discussed by the Total Environment Centre, ozone, particulates and NOx were generally identified as the three major pollutants which were of concern for human health.

### 1.2.1 Ozone (O3)

Professor Young, Head of Respiratory Medicine at Royal Prince Alfred Hospital, submitted to the Committee that ozone was considered to be by far the most important motor vehicle pollutant. Various studies have documented the known and suspected effects of ozone on human health. It has been found that even healthy people can suffer adverse effects from exposure to ozone at relatively low levels. Such effects include: eye irritation; coughs; chest discomfort; headaches; respiratory illness; increased asthma attacks and reduced pulmonary function.

The following graph outlines ozone levels for the Sydney region for the years 1979 - 1992.

> for ambient ozone will have a significant economic impact on industries and on motorists in NSW. (ibid p.3)

So far, only California has adopted the 0.08 goal and many consider this to be an unrealistic target. The Committee understands that the NHMRC are considering lowering the goal to somewhere in between 0.12 ppm and 0.08 ppm.

### 1.2.2 Hydrocarbons (HC)

As ozone is a secondary pollutant, one of the major concerns in addressing its formation is the complex interaction between Volatile Organic Compounds such as hydrocarbons and oxides of nitrogen (NOx). When these two types of pollutants are present, synergetic reaction takes place which results in the formation of ozone.

### 1.2.3 Nitrogen Oxides (NOx)

The main nitrogen oxides in the atmosphere which come from motor vehicles are nitric oxide (NO) and nitrogen dioxide ($NO_2$). Of the NOx, nitrogen dioxide is primarily a secondary pollutant. The major source of its precursor, nitric oxide, is fuel combustion. About three-quarters of the resulting nitrogen dioxide can be attributed to motor vehicles. The most biologically active NOx is $NO_2$. Its effects include reducing the oxygen carrying capacity of the blood and acute accumulation of fluid in the lungs. However, the main sources of $NO_2$ are indoor sources such as unflued gas appliances.

Professor Young told the Committee that NOx is mainly nitric oxide and nitrogen dioxide which are certainly known irritants but he considered their effects in outside air hard to separate from other effects of smog.

The RTA told the Committee that current 3 way catalyst technology does not result in significant reductions in NOx emissions. The more finely tuned a motor vehicle is the more NOx it produces. If a motor vehicle is running rich or running lean it actually produces more Volatile Organic Compounds but less NOx.

Evidence before the Committee was mixed regarding whether it was best to address ozone levels by addressing NOx or addressing VOCs such as hydrocarbons. In the past ozone has been addressed by attempting to control levels of hydrocarbons. Mr Chris Eiser, Manager, Mobile Sources, NSW Environment Protection Authority, told the Committee:

> It is fair to say that the NOx standard has not changed for new vehicles for quite a number of years. That was primarily due to the strategies that were used to control photochemical smog, which were primarily controlling hydrocarbons. NOx was not considered a cost effective route. (Evidence to Committee 20 July 1994)

ACVEN told the Committee that the NOx standard due to apply in the revised ADR 37/Ox from 1997 matches the US 1981-93 standard. However, the US NOx was tightened at the beginning of 1994 and '... it is likely that ADR 37/Ox will be amended in the near future to bring it into line with the new US standard'. (Letter to the Committee, 24 October 1994)

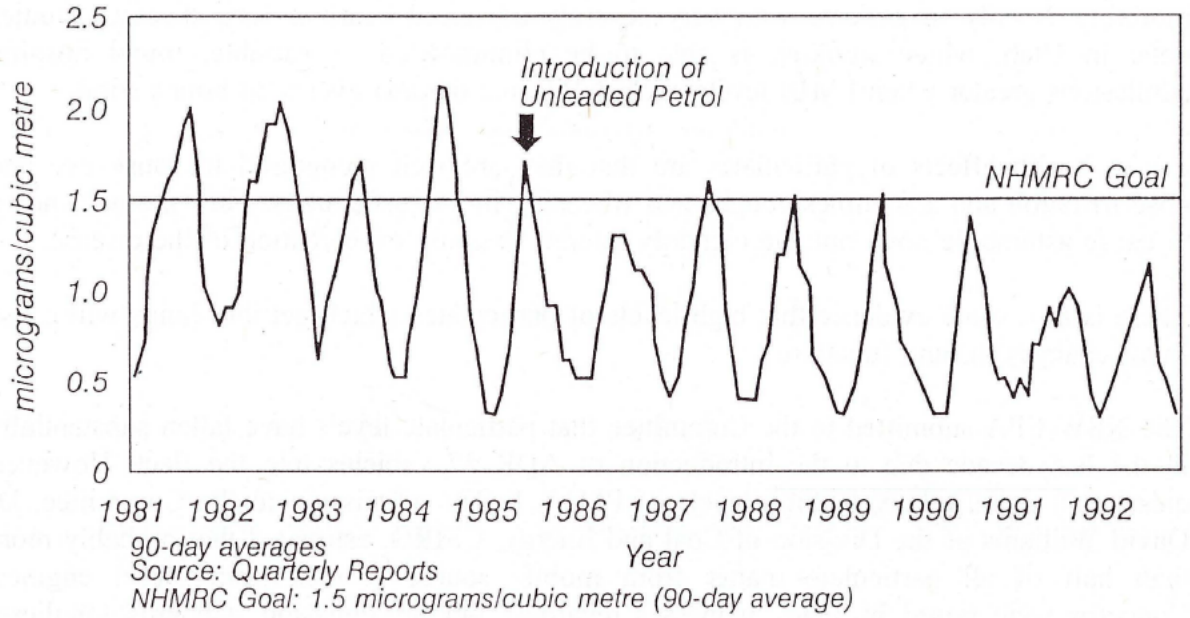
### 1.2.5 Lead

The current NSW standard for lead in leaded petrol is 0.4 g/L in urban areas and 0.84 g/L in rural areas. This was reached in 1991. NSW Refineries, on their own initiative, reduced lead to 0.03g/L in January 1994. Then, in July 1994, Shell introduced 'Half-Lead' at 0.15g/L.

The EPA submitted to the Committee that lead levels have fallen substantially in the last decade. While Newcastle and Wollongong have local smelting industries which contribute to their airborne lead, Sydney's comes almost exclusively from motor vehicles. The introduction of Australian Design Rule (ADR-37) in 1986 prohibited the registration of new vehicles that were not designed to run on unleaded fuel. Since then ambient lead levels in Sydney have almost halved.

The following chart indicates lead trends in Sydney between the years 1981 - 1992.

**TABLE 6: LEAD**




*Source: EPA submission to the Committee*

The Committee was encouraged by this downturn in ambient lead levels since the introduction of unleaded petrol. However, it does note that countries such as Canada, the USA and Austria have banned the use of lead in motor vehicle fuel altogether. Therefore, it is discouraging that in 1993, the total amount of lead added to petrol in Australia had declined by only 20-25% since the introduction of unleaded petrol in 1985. Current projections for NSW are that leaded petrol will continue to be sold until 2005-2010 (EPA, 1992).

There are also concerns regarding the health effects of some substitutes which are currently being used to replace lead (see 1.2.7 Aromatics).

The UK Government has now recommended an annual mean of 5 parts per billion (ppb) for benzene, reducing to 1 ppb as soon as possible. Similarly, the USA is currently considering limiting benzene to 1% volume and aromatics to 20% volume in their reformulated fuels.

Limited testing of benzene emissions is being done through the FORs and MAQs studies. However, the Committee understands that the EPA has recently announced major new research programs into benzene emissions.

## 1.3 Conclusions by the Committee

Based on the evidence that it received the Committee concludes that Sydney's present and predicted air pollution levels are of concern. In particular the significant contribution made by motor vehicles cannot be discounted. Firm goals based on best international standards should be set and followed for all pollutants of concern which emanate from cars.

The Committee recognises that in urban areas air quality in the long term is determined by the complex nexus between urban development, population growth, land use and transport. Therefore, numerous complementary strategies are required to address air pollution problems. It is also recognised that decisions regarding which may be the most effective mechanisms can best be determined in light of the data received from the Metropolitan Air Quality Study (MAQS).

However, given the current contribution of vehicles to air pollution in Sydney and the projected growth in motor vehicle ownership, the Committee strongly believes that it is essential that an inspection and maintenance program for motor vehicle emissions be introduced into New South Wales for at least the Sydney, Newcastle and Wollongong areas.

## 1.4 Recommendations

1 **That NSW adopt goals for all major motor vehicle-related pollutants that are in line with international best practice.**

2 **That the NSW government review the levels of lead currently allowed in petrol in New South Wales with a view to eliminating lead in petrol altogether by 1996.**

3 **That a review be undertaken of aromatics such as benzene with a view to goals being established for these in line with international best practice.**

4 **That NSW adopt an inspection and maintenance program to diagnose and repair all in-service vehicles which do not meet required levels of emission performance.**

# Chapter 2: Motor vehicle emission standards

## 2.1 Background

Prior to the enactment of the *Motor Vehicle Standards Act (Cth)* on 1 August 1989, the individual States had the power to set and enforce their own emission standards for new and in-service vehicles. However, after this Act came into force emission standards for new vehicles were set at the Federal level by the Commonwealth Department of Transport after a consultative process.

Further, in May 1992, all Commonwealth, State and local governments entered into an *Intergovernmental Agreement on the Environment*. Under this Agreement procedures are set up which aim to produce common environmental standards, guidelines or goals throughout Australia in areas such as pollution control, waste prevention and waste disposal.

## 2.2 New South Wales

### 2.2.1 New Vehicle Emission Standards

In 1972 the *Clean Air Act 1961 (NSW)* was amended to incorporate *Part 4A - Motor Vehicles*, under which it is provided in s21A(2) that motor vehicles must comply with the standards prescribed in the *Clean Air Regulations 1964 (NSW)*.

Under these regulations the emission standards for new vehicles registered on New South Wales from 1 January 1975 until 30 June 1988 were as follows:

* Vehicles manufactured from 1 January 1975 until 30 June 1976 could not emit greater than 4.5% by volume concentration of CO;

* Vehicles manufactured between 1 July 1976 and 30 June 1988 had to meet the following standards:

**TABLE 7: EMISSION STANDARDS**

| Class of Motor Vehicle | | | | | Emission (g/km) | | |
|---|---|---|---|---|---|---|---|
| Description | Engine type | Engine size (ml) | Period of Manufacture | | CO | HC | NOx |
| Any car ≤2.7t gvm | 4-stroke | <850 | 1.1.77 | 30.6.78 | 28.5 | 2.5 | 2.2 |

### 2.2.2 In-service emissions: administration of the 10-second smoke test

The *Clean Air Regulations* also empower the EPA to give notice requiring vehicles to be tested, stop vehicles for the purpose of roadside tests, and suspend registration of vehicles which are deemed not to comply with the regulations. However, the only in-service

| Year | Obser-vations | Com-plaints | 'A' letters | Inspec-tion notices | Penalty notices | Prose-cutions | Regis-tration suspen-sions | 'A' letter returns |
|---|---|---|---|---|---|---|---|---|
| 89-90 | 1336 | 695 | 255 | 358 | 456 | 22 | 26 | 145 |
| 90-91 | 940 | 109 | 104 | 62 | 587 | 7 | 8 | 26 |
| 91-92 | 4041 | 826 | 443 | 39 | 2763 | 20 | 7 | 213 |
| 92-93 | 3541 | 684 | 213 | 133 | 2617 | 10 | 14 | 99 |
| TOTAL | 15 375 | 3 116 | 6 482 | 1 753 | 8 025 | 221 | 175 | 1 193 |

*Source: EPA Submission to the Committee*

While the Act provides an option that police officers, RTA officers and local council officers may all enforce the standard, it has not been done so far. Several witnesses appearing before the Committee expressed disappointment over the level of enforcement of this test. Currently in Victoria both EPA Officers and Police enforce their 10-second smoke test and around 6,000 notices of smoke test infringement are issued to motorists per annum. It was felt that there should be more involvement at Police and local government level in NSW, particularly to identify smoky diesel vehicles. Obviously, these officers would need special training and equipment to participate in the program.

## 2.3 National vehicle emission standards

### 2.3.1 New vehicle emission standards

Since 1 August 1989, the Commonwealth Department of Transport has assumed sole power and responsibility for setting and enforcing safety, anti-theft and emission standards for new vehicles under the *Motor Vehicle Standards Act*. The National Road Transport Commission's (NRTC) legislation has now been amended to give it responsibility for all vehicle standards, both new and in-service. The Intergovernmental Agreement on the Environment also identifies a consultative role for the proposed National Environment Protection Council.

New proposals for motor vehicle emission standards are developed by the Advisory Committee on Vehicle Emissions and Noise (ACVEN). ACVEN consists of representatives of the transport and environment agencies at both the State and Federal level and also includes other Federal Departments such as Health, Industry and Energy.

ACVEN reports to the Australian and New Zealand Environment and Conservation Council (ANZECC) Standing Committee on Environment Protection and the National Road Transport Commission (NRTC).

The NRTC reports to the Ministerial Council on Road Transport (MCRT) on all road transport issues.

Australian Design Rules (ADR), gazetted under the *Motor Vehicle Standards Act 1989*, specify standards to which all new model cars sold in Australia must comply. ADRs are

**TABLE 9: AUSTRALIAN DESIGN RULE-37/00**

| Exhaust gas | Emission limit (g/km) |
|---|---|
| CO | 9.3 |
| HC | 0.93 |
| NOx | 1.93 |
| HC + NOx | - |
| Particulates (PM10) | - |

*Note:* Evaporative emissions are presently set at 2.0g, which is in line with current US and European limits.

The following chart, supplied to the Committee by the RTA, compares two models of Ford motor vehicles both with and without the catalytic system required under ADR 37/00.

**TABLE 10: EFFECT OF CATALYST REMOVAL ON EMISSIONS**

| | Hydrocarbons | Carbon Monoxide | Oxides of Nitrogen |
|---|---|---|---|
| | **Ford Falcon EFI 3.9 litre** | | |
| With catalyst | 0.5 g/km | 2.7 g/km | 6.4 g/km |
| Without catalyst | 3.4 g/km | 12.6 g/km | 10.4 g/km |
| | **Ford Laser 1.6 litre** | | |
| With catalyst | 0.17 g/km | 3 g/km | 0.16 g/km |
| Without catalyst | 3.3 g/km | 21 g/km | 9.1 g/km |

*RTA submission to the Committee*

ACVEN is currently finalising the new ADR-37/0x, under which it is proposed that emission controls in new vehicles will comply with the following standards by 1997-99. These proposed standards are the same as those which applied in the US from 1981 until 1993, before the Tier 1 limits under the US *Clean Air Act* came into effect.

*Source: Concawe (1992). TLEV = Transitional low emission vehicle; LEV = Low emission vehicle; ULEV = Ultra-low emission vehicle. California standards refer to non-methane hydrocarbons while US Federal standards are for total hydrocarbons.*

Environment groups such as the Total Environment Centre criticised the current approach of setting standards only after lengthy consultation with industry. It was pointed out to the Committee that US motor vehicle manufacturers were already meeting much more stringent standards and therefore proving this was achievable.

The EPA submitted to the Committee that the cost-effectiveness of introducing new standards must always be considered. Obviously stricter emission controls come at a progressively increased cost for each additional tonne of emissions removed. For example, the Ford Motor Company estimated the post-1996 standards will bring an on-cost of approximately $500-$600.

It was argued that the large reductions in vehicle emissions achieved to date have been met through the use of catalysts and other relatively low-cost engine and exhaust modifications. Remaining gains will require tighter control over engine performance and the addition of more complicated and expensive control systems.

The following table compares the cost-effectiveness of new vehicle emission standards in 1992 dollars:

**TABLE 13: COST-EFFECTIVENESS OF NEW VEHICLE EMISSION STANDARDS (1992 A$)**

| Standard | Cost-effectiveness (per tonne HC) | Cost-effectiveness (per tonne NOx) | Cost-effectiveness (NOx + HC) |
|---|---|---|---|
| ADR 37[1] | $1700–$3500 | n/c | — |
| US 1992[1] | $1400–$8600 | $900–$5300 | $500–$3200 |
| US 1994 (Tier I)[2] | $4000–$5200 | $2400 | not available |
| US 2004 (Tier II)[3] | $47 500–$94 800 | $11 800–$31 400 | $9400–$18 800 |
| Cal 1997 (LEV)[3] | $60 400–$124 500 | $22 600–$46 000 | $16 600–$33 600 |

*Sources: [1] EPA submission to the Committee; [2] USOTA (1989), USEPA (1991b); [3] CARB (1990b), Radian (1992); n/c = no change. Exchange rate: US$1 = A$0.70.*

In fact, the majority of new cars currently being sold in Australia are meeting much higher standards than ADR 37 due to the fact that their engines have been developed for the US market. The EPA told the Committee that:

> ...80 per cent of those vehicles (being currently tested as part of the Motor Vehicle Emission Testing Program) - these are later technology vehicles with three way catalysts - met the hydrocarbon standard for the proposed standards in 1997. Almost 60 per cent met the carbon monoxide standard and about 70 per cent met the NOx standard. So the performance of the vehicles that we are actually getting on the road is almost meeting the new 1997 standard now. (Chris Eiser, EPA, evidence to Committee 20 July 1994).

while all post 1986 cars (estimated to comprise around 50% of the current fleet) will be expected to meet ADR 37.

However, some groups, such as the Motor Trader's Association, considered it unrealistic for cars 10 years and older to meet their original design standard. Similarly, the Service Station Association felt that allowance should be made for deterioration due to ageing and factored into any requirements on the basis of each year of the vehicle's life. Obviously, consideration may also have to be given to particular makes and models as some may be found to possess systems which deteriorate more quickly than their counterparts.

The NRMA submitted to the Committee that in-service emission standards can never reflect best international practice until our new car emission standards do the same:

> There is value in updating the standards to reflect what is actually happening in the industry. When we come to a situation of in-service control there needs to be a realistic new car standard to enable the setting of realistic in-service standards. At the moment standards on both air emissions and on noise from vehicles do not reflect best international practice; therefore it is impossible to expect those standards to be maintained in-service because there is no legal backing to them. (Mr Jack Haley, NRMA, evidence before Committee 14 July 1993)

Further, it was recognised by the Committee that the introduction of standards and testing are somewhat interdependent on each other given that the stringency of any standards introduced may dictate the sophistication of testing needed.

## 2.4 Conclusions by the Committee

Overall the Committee was concerned that our current emission standards for new vehicles in Australia are so far behind the best international practice. This is typified by the fact that NOx standards in Australia are currently 8 times greater than those in the US. While it is recognised that Sydney may not have the air pollution levels of highly polluted cities such as Los Angeles, the Committee believes that we should be aiming for the best air quality realistically achievable. In addition to cars, it appears that diesel and heavy vehicle emissions need to be addressed.

The Committee also believes that the current procedures for setting standards for new vehicle emissions is extraordinarily cumbersome and is concerned at the slowness of the process.

## 2.5 Recommendations

5 **That the New South Wales Government express its concern to the Commonwealth Government that Australian Design Rules for emission controls in new vehicles are currently well behind, and are not anticipated to meet, international best practice.**

6 **That the New South Wales Government request that the Commonwealth Government review the present Australian Design Rule setting process with a view to expediting it.**

# Chapter 3: Options for inspection and maintenance programs

## 3.1 Background

As outlined in Chapter 1, the Committee believes that the introduction of a motor vehicle emissions inspection and maintenance (I/M) program is necessary for at least the Sydney, Newcastle and Wollongong areas.

The basic objectives of any inspection and maintenance program should be to reduce emissions from all in-service cars in NSW. To meet agreed air quality goals, the test must employ an effective method for detecting and repairing highly polluting vehicles. It should also incorporate education programs which promote preventive maintenance.

A number of different options exist for the implementation of such a scheme. Currently available testing regimes vary greatly in levels of technical sophistication. However, in general, types of tests can be divided into those which are possible to conduct on a decentralised basis within existing infrastructure such as local garages and service centres, generally idle testing, and those whose requirements demand large specialised infrastructure and therefore test vehicles on a centralised basis, such as loaded and transient testing. While idle testing is conducted in some parts of the US on a centralised basis, it is anticipated that if it were the preferred system for NSW it would probably be introduced within the existing Authorised Inspection Station (AIS) framework as part of the annual 'pink slip' roadworthiness test. The Committee understands that a visual check of catalytic converters on post-1986 vehicles was introduced from August 1 1991 as part of this test.

## 3.2 Decentralised idle testing

Basically decentralised emissions testing using idle tests are conducted by sampling exhaust pipe emissions on a percentage basis at idle speed (usually around 700 rpm) and then at an increased engine speed of 2500 rpm. There is no load placed on the engine during this type of test as the gearbox remains in neutral.

There are both widely recognised advantages and disadvantages of this type of testing. These are summarised below.

**Advantages** include:

* the easy incorporation into the 'pink slip' system with relatively low equipment upgrade costs for Authorised Inspection Stations;
* convenience of access for motorists Statewide;
* encouragement of small business.

**Disadvantages** include:

*The US EPA (Glover and Clemmens, 1991) found, using idle testing for I-M checks on 1976-1982 model vehicles, that detecting 26% of the small number of high polluting vehicles in the group (meaning that 74% of high polluting vehicles were not detected) caused an incorrect failure rate of 25% of the whole group. This means detecting only 26% of the small number of high polluting vehicles in the sample caused an unjustified penalty to be applied to a quarter of all the vehicles tested, a far greater number than the number of polluting vehicles found. For 1983 and later vehicles the effectiveness of the idle test was even worse - the incorrect failure rate and the high polluter rate were even less favourable.*

These data demonstrate the inadequacy and severe compromise inherent in idle type testing to achieve even a low, inefficient detection rate of high polluting vehicles; the false failure rate is unacceptably high. (NRMA Position Paper, February 1993 p.15)

Similarly, the EPA questioned the cost-effectiveness of the idle-testing:

Most analysts, including the US EPA, recognise that the basic I/M (idle-testing) program has made only modest reductions in aggregate vehicle emissions. The shortcomings of the program have led some analysts to believe that the costs of the basic I/M program exceed the demonstrable benefits (McConnell and Harrington 1992).

The following cost-effectiveness table was given in support of this conclusion:

**TABLE 14: COST EFFECTIVENESS OF THE CURRENT BASIC I/M PROGRAM IN CONTRAST TO THE ENHANCED PROGRAM**

| **COST EFFECTIVENESS OF BASIC (idle-testing) US I/M PROGRAM (1992 A$)** | | | |
|---|---|---|---|
| **Study** | **Cost-effectiveness (per tonne HC)** | | |
| USEPA (1991a) | $7600 | | |
| McConnell (1990) | $10 400 | | |
| Anderson & Lareau (1992) | $23 500 | | |
| *NB: This table assumes a centralised, annual testing program.* | | | |
| **COST EFFECTIVENESS OF ENHANCED (dynamometer based) US I/M PROGRAM (1992 A$)** | | | |
| **Study** | **Cost-effectiveness (per tonne HC)** | **Cost-effectiveness (per tonne NOx)** | **Cost-effectiveness (HC + NOx)** |
| USEPA (1992) | A$2900 | A$10 500 | A$2300 |
| Radian (1992 | A$11 500 | A$15 100 | A$6600 |
| Anderson & Lareau (1992) | A$19 800 (annual test) | n/e | A$17 800 (annual test) |

However, catalyst-equipped cars work most efficiently when the engine is under load and in open loop operation these pollutants can be more than 1,000 times greater for CO and 100 times greater for VOCs than for closed loop operation. (CSIRO submission to the Committee, May 1994 p9)

Thus, if idle testing is largely ineffective for detecting emissions from catalytic converter-equipped vehicles, should this test be introduced and only basic visual checks performed on catalytic converters, it is important to have clear data regarding the amount to which these worsen with age and wear. Evidence received by the Committee regarding the extent to which catalytic converters deteriorate and what percentage of the current fleet may have defective converters was fairly anecdotal. Representatives of the Ford Motor Company argued that, as they had no moving parts, converters should stand the test of time fairly well. However, off-the-cuff estimates regarding percentages of vehicles with non-functioning emissions equipment ranged from 1-2% of the current fleet (NRMA) to 20-30% (Exhaust Systems Professional Association).

The CSIRO submitted to the Committee that, in the absence of vehicle malfunction, the catalyst seems capable of maintaining its capabilities for at least 80,000 kms, with the oxygen sensor being its most fragile component. There are three different ways in which the durability of catalysts may be effected - (i) over-heating due to faults such as spark plug misfiring causing very high levels of unburnt fuel in the exhaust which then oxidises in the catalyst; (ii) poisoning due to excessive engine oil consumption or misfuelling; (iii) mechanical damage.

In 1989 there was a limited emission testing program of in-service vehicles carried out in NSW. The NSW EPA tested 134 in-service post-1986 model vehicles for which the vehicle emission levels when new were available, to evaluate the deterioration in emissions performance of a range of models. Also tested have been 89 new post-1986 vehicles, and 1175 pre-1986 vehicles.

An analysis of this small sample of 134 vehicles mentioned above showed that some models had severe deterioration rates in their exhaust emission control performance. Even though all the models were below the standards when new, the average emissions from some models exceeded the Australian Design Rule (ADR) level after as little as 20,000 kilometres, some vehicle models suffering more than a doubling of their new emission levels within this short period (Pengilley, NSW EPA, 1991).

The long-term trends were also of concern. For instance, the deterioration trend line for catalyst-equipped XF model Ford Falcon vehicles started from a new car carbon monoxide (CO) level on the ADR test of 5 grams per kilometre (g/km) and increased to 28 g/km at 100,000 kilometres, nearly 6 times the actual new car level, and almost 3 times the legislated new car level of 9.8 g/km. Hydrocarbon (HC) emissions rose from 0.2 to 1.9 g/km, almost a 10 times increase, over the same distance against a legislated limit of 0.98 g/km.

The Federal Office of Road Safety is currently undertaking a comprehensive study into the emission testing of Australia's passenger vehicle fleet. As of September 1994, 180 out of a total 600 cars had been tested. Due to this low sample size, preliminary results are qualified. The program is due for completion in late 1995.

**Disadvantages** include:

* the high cost of infrastructure limits the number of facilities available for use by car owners and this may force them into travelling greater distances and experiencing greater delays in order to be tested;
* motorists may face the problem of having to make repeated trips to have their vehicles tested, repaired, re-tested etc;
* it may be difficult for repairers to determine the effectiveness of their repairs as they could not afford the equipment to retest repaired vehicles;
* the separation of testing and repair functions may encourage monopoly behaviour unless strongly regulated and have financial consequences for smaller operators.

There are several possible types of test utilising dynamometers which can be conducted by such facilities :

**Long Drive-Cycle Dynamometer Test:**

This form of testing requires the test vehicle to run on a dynamometer at varying speed while the exhaust gas is collected in bags for later analysis. The RTA submitted to the Committee that this type of testing was only suitable for the purpose of approving a vehicle design and unsuitable for routine testing due to its technical complexity.

**I-M 240:**

This type of test is currently favoured by the US EPA for non-attainment areas. It is based on the long drive-cycle type test but only comprises the first two 'hills' of the drive-cycle, from zero to 340 seconds, slightly compressed into 240 seconds, which makes the accelerations marginally more severe. In the US the test is used only on vehicles with engine management systems. For other vehicles the two-speed idle test is applied.

**Acceleration Simulation Mode (ASM) Test:**

This is a less sophisticated test than the I-M 240 but is considered by some to be a more cost-effective alternative. It is a loaded dynamometer test which does not replicate the drive-cycle but accelerates the vehicle under load. It is the preferred test of the Californian State Government.

The major arguments put forward by opponents of centralised testing were cost-effectiveness and consumer inconvenience.

As previously stated, the US EPA has estimated that the enhanced I/M program would reduce HC emissions by 28% and NOx by 9% compared with having no I/M program. Despite the higher testing and repair costs associated with the enhanced I/M program, the US EPA estimated that the cost-effectiveness of the enhanced I/M test (US$2000 per ton of HC removed) would be greater than that of the basic idle test. When CO and NOx reductions were included, the cost-effectiveness improved to US$1600 per ton of pollutant removed. (US EPA 1992)

The Committee heard from Envirotest Technologies which is the largest contractor currently testing in the United States. In 1992, the company tested 11.5 million vehicles

However, it was generally considered that the device was in its evolutionary stages. The CSIRO felt RSD results could be currently used with the following proviso:

> The conclusion is that, provided situations leading to open loop operation or idle on deceleration are avoided, remote sensing data (RSD) provides a better picture of on-road emissions than idle tests. (CSIRO submission to the Committee, May 1994)

### 3.5 On-board diagnostics

The increasingly computerised nature of motor vehicle engine systems means that potential exists in the future for in-built systems in motor vehicles which would monitor and record a large number of emission control parameters for the purpose of detecting malfunctions and deteriorations in vehicle performance which may impact on emission control standards.

An initiative in the US which will increase the efficiency of, and enormously simplify, I-M testing is the introduction from 1996 of On-Board Diagnostics-Phase 2 (OBD-II) requirements for all new cars. OBD-II requires a system on every car which monitors and records a large range of emission control system parameters :

> ...for the purpose of detecting malfunction or deterioration in performance that would be expected to cause a vehicle to fail emissions standards. When such problems are detected, a malfunction indicator lamp located in the dashboard of the vehicle will be illuminated, instructing the vehicle driver to `Service Engine Soon'. Codes indicating the likely problem will also be stored in the vehicle's computer for ready access by the supervising technician to aid in the proper diagnosis and repair of the vehicle. (United States Environmental Protection Agency, 1992)

As with RSD, all parties which submitted to the Committee were excited about the prospect of such technology but considered it to be insufficiently technically advanced at present.

### 3.6 Conclusions by the Committee

It was recognised by the Committee, that due to various factors including unique air pollution concerns and different constitutional power distributions, the US experience was not directly transferable to local requirements. Any specific requirement pertaining to local conditions should be recognised in the MAQS and In-Service Vehicle Emissions Study.

It is also obvious that the US is the undisputed fore-runner in motor vehicle emission controls and is still coming to terms with its complexity after many years. However, the Committee generally favoured decentralised testing due to the convenience it offers motorists, providing this system is regularly audited, the repair industry is adequately trained and equipment is regularly calibrated and independently checked and it can provide a mechanism to ensure catalytic converters are in working condition.

# Chapter 4: Complementary strategies

## 4.1 Travel demand management

All parties generally agreed that the primary way to address motor vehicle emission problems was via reducing vehicle kilometres travelled (VKTs), ie a planning solution rather than a technical one.

The Department of Transport (DOT) told the Committee that it believed that any long-term attainment of air quality gains will have to involve travel demand management and that public transport must be a focal point for investment over the next development period. The DOT further submitted that the argument was not really about rail versus road but a balance between the two. A number of transport corridors have been identified which should serve as the focus of financial investment. The Department of Transport considered that this issue has been adequately addressed within the 'Integrated Transport Strategy' and 'Sydney's Future'.

However, these documents were criticised by a number of witnesses, including the Total Environment Centre (TEC), for creating a framework of options in a 'very neutral way'. The TEC and others were concerned about the current focus on motorway building, seemingly at the expense of public transport. In response, the Department of Transport told the Committee that, while it obviously had no legislative base to direct the RTA, it can impact upon its decisions through the Integrated Transport Strategy and Transport Action Forum mechanisms.

Various groups argued that there is a direct correlation between the increase in road capacity and the increase in vehicle usage. However, the DOT submitted that results of modelling to date do not necessarily demonstrate this. The Department considered that a whole series of factors impact upon road usage:

> To simply speak of roads as generating congestion is nonsense. The totality of land use and transport has to be examined if Sydney is to be viable and equitable. (RTA document to Committee 20 July 1994)

Parties such as Action for Public Transport argued that the most viable public transport solution was heavy rail which could carry large capacities of commuters over long distances. However, the DOT considered that cross regional buses were more important than fixed transport links in certain locations.

The NRMA argued that Sydney required a basic road network of arterial roads, in particular, for commercial and freight traffic. This needs to be supplemented by a rail, bus and ferry system.

It was generally agreed by all witnesses, including the RTA, that externality costs such as air and noise pollution were not currently being properly quantified in cost-benefit analysis for new roads. This has the effect of making the initial infrastructure investment needed for forms of public transport such as railways look disproportionately large by comparison.

2 *Road maintenance costs for trucks (22.5 tonnes) and buses (16 tons) are average values for different weights and axle/tyre configurations.*

3 *The environmental impact costs for private cars assume no catalytic converter. If such a converter is in use, these costs fall to 0.2 cents (rural) and 1 cent (urban) per km.*

4 *The total includes a uniform 0.22 cents per km cost for traffic surveillance.*

The Committee generally agreed with the following comments made by Professor Laird in his submission:

> Sydney's rail system was essentially designed for an extended city with a population of two million.... The population is now 3.5 million, with Newcastle and Wollongong, now over 4 million. Despite the growth of Parramatta as a regional centre, and long standing proposals to improve rail access to Parramatta, there is no direct Hornsby-Parramatta link.... Whilst not implying that rail capital work spending should match road capital works, it is fair to say that post World War II funding policies of both the Federal and State Government have favoured road over rail.... Similarly, whilst total Federal and State Funding for roads has appreciably risen over the last, say seven years, from about $1000 million in 1986-87 to $1600 million in 1992-93, it has not grown in real terms for rail, and a recent five year $2600 million rail capital works program was extended to seven years.
>
> Submission to the Committee, 27 July 1994

Many parties, including the Department of Transport, floated the idea that a proportion of the 3 x 3 fuel levy, for example, 1 cent per litre, could be diverted into financing selected rail track infrastructure. The Committee was enthusiastic about this concept.

The Committee felt that there is the need for a balance of road and rail infrastructure. A basic road network is required to enable movement of people and freight for which public transport is not a feasible option. In tandem with this, a comprehensive rail/bus/ferry network is required in urban areas.

Evidence was given to the Committee of the need for several rail links to enhance the Sydney rail network. These included the Sydney Airport link, Hornsby-Parramatta line and Harris Park 'Y' link, which have all been announced by the Government. Other areas inadequately serviced by rail which remain a priority include the Warringah peninsula.

## 4.2 Reformulated fuels

The EPA identified the use of reformulated fuel as essential to obtain the full benefits of new-generation emission control equipment. Ford Australia similarly believed that levels of emission controls in the US are becoming so tight that unless fuel is extremely well controlled and less volatile few savings can be made in the future. They argued strongly for the need for greater reformulation of fuels in Australia, submitting also that engines can only be designed around the fuels made available by oil companies.

Once again, the US is the world leader in this area. However, there is currently considerable debate about the cost-effectiveness of their Phase I reformulated petroleum, which has increased oxygen content. Current estimates given to the Committee indicated that introducing this type of fuel will result in a reduction in HC emissions from 15% to 5%. However, estimates in refinery production costs are around US$0.04 - US$0.16 per gallon. (AQIRP, 1993)

saw a need to focus on access rather than mobility, ensuring that employment opportunities are directly centred around a public transport network.

Another option to limit vehicle use has been the raising of charges for access to parking spaces. Parking charges can induce changes in commuter behaviour, particularly into the CBD, as there is a strong link between parking availability and choice of transport mode. Options discussed before the Committee included more parking provided at railway stations and parking levies in commercial centres which can be used to substitute public transport. Therefore the Committee supports the current strategy of the Government to use funding from CBD parking spaces to develop parking at regional railway stations. This reduces dependence on motor vehicles and subsequently vehicle kilometres travelled.

## 4.5 Car-pooling

The Committee was interested in programs being trialled in Southern California to encourage ride-sharing. The Committee believed that American cities were far more advanced than Australia in this regard and it was considered that financial incentives such as the waiving of tolls for cars with three or more people and construction of more `park and ride' facilities for car poolers should be considered.

## 4.6 Public education

The need for public education programs was strongly supported. The EPA told the Committee that it was currently undertaking an advertising campaign to encourage motorists to keep their cars adequately tuned.

## 4.7 Planning considerations

A recent Sydney University report identified a problem typical for many Sydney residents which is multi-destination trips in motor vehicles. In addition to commuting, the vehicle is often used on the same occasion to travel to child-care centres, schools, shops and/or recreation. Accordingly, the centralisation of these activities, at a location well served by public transport, can reduce reliance on the motor vehicle.

When planning and reviewing urban areas, the following initiatives could be taken, where possible:

(i) schools, shops and recreation areas should be accessible by safe bike paths.

(ii) new railway stations should be located to serve a regional area with a well designed bus interchange servicing local suburbs. Convenient and accessible car parking also needs to be provided in close proximity.

## 4.8 Conclusions by the Committee

Overall, the Committee believed that significant gains in air quality could not be made by an I/M program alone. The major issues of alternative transport modes and retirement of older vehicles must be addressed.

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# Appendix 1: Minutes of Proceedings

# PROCEEDINGS OF THE COMMITTEE

No. 1

**Thursday, 21 April 1994**
**at 11.30am, Parliament House, Sydney**

MEMBERS PRESENT

Mr Gaudry
Mr Humpherson
Mr Rixon
Mr Langton
Dr Macdonald

In attendance: Ms C. Watson, Project Officer

The Clerk-Assistant (Committees) opened the meeting and referred to the entry in the Votes and Proceedings of the Legislative Assembly, 14 April 1994 which established the Committee.

The Clerk-Assistant called for nominations for the election of Chairmna.

Resolved, on motion of Mr Rixon, seconded by Dr Macdonald, That Mr Humpherson be elected Chairman of the Committee.

Mr Humpherson took the Chair and addressed the Committee.

Certain procedural motions were circulated.
Resolved, on motion of Mr Langton, seconded by Mr Gaudry, That the procedural motions, as circulated, be agreed to.

The Committee discussed staffing needs and resolved, on the motion of Mr Rixon, seconded by Dr Macdonald, That Ms Catherine Watson be the Project Officer to the Committee.

The Clerk advised that if expert or specialist assistance was required in the course of the inquiry, the Committee could seek the Speaker's approval for the appointment of a consultant.

The Committee discussed the terms of reference and particular areas of interest and possible contact people who could brief the Committee.

Resolved, on the motion of Mr Gaudry, seconded by Dr Macdonald, That the Chairman, Mr Langton and the Project Officer examine available background material and prepare short summaries of the major issues as preliminary briefing material.

Committee was circulated.

Discussion ensued regarding the preparation of an Issues Paper.

The Committee agreed to invite the EPA to provide a briefing to the Committee, possibly in the second week in June.

Mr Langton distributed documents.

The meeting adjourned at 12.40pm.

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No. 3

**7 June, 1994,**
**at 11am, Parliament House, Sydney**

MEMBERS PRESENT

Mr A Humpherson (Chairman)

| | |
|---|---|
| Mr Gaudry | Mr Langton |
| Dr Macdonald | Mr Rixon |

In attendance: Ms Lisa Corbyn, Deputy Director General, Environment Protection Authority, Dr Steven McPhail, Manager Air Quality, Environment Protection Authority, Mr Chris Eiser, Manager, Mobile Sources Environmental Protection Authority.

Mr Frank Howarth, General Manager (Vehicle Registrations), Mr Ross Jones (Environment and Community Impact Division), Dr Maxine Cooper, General Manager ( Environment and Community Impact Division), Mr Bruce Dowdell, Manager (Vehicle Standards), Roads and Traffic Authority.

Ms Catherine Watson, Project Officer, Mr Patrick Manning, Research Officer, Ms Kendy McLean, Assistant Committee Officer.

The Chairman opened the meeting .

The Committee resolved, on the motion of Mr Gaudry, seconded by Mr Rixon, that (pursuant to section 4(2) of the Parliamentary Papers (Supplementary Provisions) Act), the Committee authorises the publication of submissions presented to it, unless the Committee otherwise orders or directs.

Ms Corbyn, Dr McPhail and Mr Eiser then briefed the Committee on aspects of air quality in New South Wales, including sources of air pollution, the systems used to measure air pollution, and the Metroopolitan Air Quality Study (MAQS).

At 11.05am the hearing resumed.

Mr Bill Joris, Executive Director, Service Station Association, sworn and examined. Evidence concluded, the witness withdrew and the committee adjourned.

At 2.00pm the hearing resumed.

Mr John Smith, Executive Director, Transport and Planning, Department of Transport, affirmed and examined. Evidence concluded, the witness withdrew.

Mr Herbert Beauchamp, Chairperson, Toxic Chemicals Committee, Total Environment Centre, Ms Elizabeth O'Brien, Air Quality Project Officer, Total Environment Centre, and Mr Jeff Angel, Co-director of the Total Environment Centre, affirmed and examined.

Committee adjourned at 4.13pm until 9.30am on Thursday 14 July, 1994.

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No. 5

**Thursday 14 July, 1994 at 9.30am**
**Jubilee Room, Parliament House, Sydney**

MEMBERS PRESENT

Mr Humpherson (Chairman)

Mr Gaudry
Dr Macdonald
Mr Langton
Mr Rixon

In attendance: Ms C Watson, Project Officer

The press and public were admitted.

Mr Tony Selmes, Executive Director, Motor Traders' Association of NSW, Mr Francis Bernard Davis, Divisional Manager, MTA and Mr James Robert Gibbons, Director of Operations, MTA affirmed and examined. Evidence concluded, the witnesses withdrew.

Mr David John Williams, Division of Coal and Energy Technology, CSIRO, sworn and examined. Evidence concluded, the witness withdrew.

Mr James Stephen Windeyer Donovan, Secretary, Action for Public Transport, affirmed

EPA all affirmed and Mr Michael Crowley, Principal Policy Officer, EPA took the oath and were examined.

At 9.25am, a quorum being present, the Committee resolved on the motion of Mr Langton, seconded by Mr Rixon that the evidence already given be tabled and received as part of the formal proceedings. Evidence concluded, the witnesses withdrew.

Mr Max Moore-Wilton, Chief Executive, Roads and Traffic Authority and Mr Ross Jones, Manager, Community Issues and Air, RTA took the oath and Mr Bruce Dowdell, Manager, Vehicle Standards, Roads and Traffic Authority, Mr David Stewart, General Manager, Transport and Network Development, RTA, Mr Robert Morris, Director, Sydney Region, RTA and Mr Frank Howarth affirmed and were examined. Evidence concluded, the witnesses withdrew.

Mr William Pickett, Mr Rod Vaughan and Ms Yvonne Howie, Consultants to Envirotest Systems Corporation, all took the oath and were examined. Evidence concluded, the witnesses withdrew.

At 1.05pm, the Committee went in camera

Mr Kevin Ford, General Manager, Legal Services, Roads and Traffic Authority, on oath, and Mr Robert Morris, on former affirmation, were examined. Evidence concluded, the witnesses withdrew.

The committee adjourned at 1.30pm.

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No. 7

**Thursday 24 November, 1994**
**at 2.00pm, Parliament House, Sydney**

MEMBERS PRESENT

Mr Humpherson

Mr Gaudry
Dr Macdonald

Mr Langton

In attendance: Ms C. Watson, Project Officer

The confirmed the minutes of the meetings held 21 June, 14 July and 20 July.

# Appendix 2: List of Submissions

# List of Submissions

| Submission No | Name |
|---|---|
| 1 | The Vaucluse Progress Association |
| 2 | Alex J Marr |
| 3 | Robert Holland |
| 4 | Institute of Automotive Mechanical Engineers (Inc) |
| 5 | Society of Automotive Engineers Australasia (NSW Division) |
| 6 | William Norman |
| 7 | Service Station Association (Ltd) |
| 8 | Associate Professor Philip Laird, Department of Mathematics, University of Wollongong |
| 9 | FP Gill |
| 10 | Coalition of Transport Action Groups Inc |
| 11 | Kevin Eadie |
| 12 | Action for Public Transport |
| 13 | AGL Gas Companies |
| 14 | NSW Department of Transport |
| 15 | Total Environment Centre |
| 16 | Division of Coal and Energy Technology, CSIRO |
| 17 | R Stevenson |
| 18 | Roads and Traffic Authority of NSW |
| 19 | Envirotest Technologies |
| 20 | Environment Protection Authority |
| 21 | Electro Technics Australia Pty Ltd |
| 22 | Motor Traders' Association of NSW |
| 23 | NRMA Limited |

# Witnesses in order of appearance

## Witnesses

Ms Lisa Corbyn
Dr Steven McPhail
Mr Chris Eiser
Mr Frank Howarth
Mr Ross Jones
Dr Maxine Cooper
Mr Bruce Dowdell
Mr Frank Burgess
Mr Basil Lombe
Mr Jim Henman
Mr Bill Joris
Mr John Smith
Mr Herbert Beauchamp
Ms Elizabeth O'Brien
Mr Jeff Angel
Mr Tony Selmes
Mr Francis Davis
Mr James Gibbons
Mr David John Williams
Mr James Donovan
Professor Philip Laird
Mr Jack Haley
Mr David Kenneth Anderson
Dr John Goldberg
Mr David Fewchuk
Mr Simon Coulson
Mr William King
Dr Neil Shepherd
Mr Christopher Eiser
Dr Stephen McPhail
Mr Michael Crowley
Mr Max Moore-Wilton
Mr Ross Jones
Mr Bruce Dowdell
Mr David Stewart
Mr Robert Morris
Mr Frank Howarth
Mr William Pickett
Mr Rod Vaughan
Ms Yvonne Howie
Mr Kevin Ford
Mr Robert Morris