EMISSIONS FROM HEAVY DUTY DIESEL ENGINED VEHICLES
EMISSIONS FROM
HEAVY DUTY DIESEL
ENGINED VEHICLES

The Government's response to the Fifteenth Report of the Royal Commission on
Environmental Pollution

LONDON: HMSO
1992 has been a busy year for all in Government concerned with the control of emissions from motor vehicles. We have seen the introduction of strict new emission standards for new passenger cars and heavy duty diesel engined vehicles and the addition of emission tests to the annual roadworthiness checks for these types of vehicle already in-service on our roads. In addition, a new EC Directive on ozone control is expected to come into force shortly.

We are now looking forward to continued progress by working together with colleagues both on the domestic front and internationally. The Government will be developing tighter emission standards for both on and off-road motor vehicles that will require vehicle and engine manufacturers to develop and implement technology advances. Vehicle operators and the public will also have a role to play by ensuring that their vehicles are well maintained to ensure that emissions from these vehicles are minimised.

The combination of these measures will lead to dramatic reductions in emissions from the UK vehicle fleet with consequent benefits to all in terms of air quality, health and amenity.

The Royal Commission on Environmental Pollution’s Fifteenth Report provided a detailed reminder that despite substantial progress in the control of motor vehicle emissions, more still needs to be done. This response sets out how we intend to tackle these issues and shows the Government’s continued commitment to environmental protection.

I am most grateful to the Royal Commission for the work that went into the production of its Fifteenth Report, and wish it well for its next wider ranging study on transport and the environment.

JOHN MacGREGOR
Secretary of State for Transport

October 1992
## CONTENTS

<table>
<thead>
<tr>
<th>FOREWORD</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INTRODUCTION</th>
<th>Paragraph</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>i-v</td>
<td></td>
<td>iii</td>
</tr>
</tbody>
</table>

### PART I

**Principle of Motor Vehicle Pollution Control and Air Quality Management**

<table>
<thead>
<tr>
<th>Paragraph</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-20</td>
<td>1-5</td>
</tr>
</tbody>
</table>

- Current and future emission standards for new motor vehicles
- Control of emissions from motor vehicles in-service
- Monitoring and forecasting of UK air quality
- Research
- Fuel quality

### PART II

**The Government’s Response to the Royal Commission’s Recommendations**

<table>
<thead>
<tr>
<th>Paragraph</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-70</td>
<td>6-23</td>
</tr>
</tbody>
</table>

- Emissions and their impact
- The control of emissions from new vehicles and engines
- Engine test cycles
- Economic instruments
- The urban environment and buses
- Standards and tests for vehicles in service
- Fuels and Lubricants

### REFERENCES

<table>
<thead>
<tr>
<th>Paragraph</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td></td>
</tr>
</tbody>
</table>
INTRODUCTION

i. The Government welcomes the Royal Commission’s report. It is a detailed and wide ranging study of an important aspect of environmental control.

ii. The Government accepts the Royal Commission’s view that there is an increasing need for proper measures to reduce and, as far as possible, eliminate emissions from heavy vehicles so as to safeguard our local and global environment and the health of our citizens. Many such measures are already being taken and the report recognises this. In conjunction with other Member States of the European Community, we are introducing much stricter standards for emissions from buses and lorries. And the development of new, even tighter standards will continue. Indeed, the latest European Community Directive commits Member States to adopt even stricter standards than those already agreed for 1996 so that they take effect by 1999.

iii. The report makes a number of other recommendations which the Government also accepts. But it has reservations about others. For example, though the Government believes that it is desirable to use market-based instruments in achieving its environmental objectives, where it is cost effective to do so, it is not convinced that the Royal Commission’s specific recommendations in this area offer significant environmental benefits by comparison with the potential cost to the Exchequer.

iv. In the first Chapter of its report, the Royal Commission mentions its commitment, given in 1984, to keep vehicle emissions under review. This work is part of that process and is therefore timely. Heavy diesels form a significant and very visible part of the vehicle fleet and their emissions give rise to public concern. They affect both local air quality and global atmospheric conditions as well as causing soiling of our buildings.

v. At the same time, heavy vehicles, both lorries and buses, form an integral part of the way in which the economy works and of many people’s ability to travel freely from place to place. The right balance needs to be struck between the need for this type of transport in the modern world and the need to conserve the local and global environment and safeguard the health and well being of our citizens.
PART I

PRINCIPLE OF MOTOR VEHICLE POLLUTION CONTROL AND AIR QUALITY MANAGEMENT

1. The Environment White Paper, *This Common Inheritance*[^11], commits the Government to improving the quality of the environment in many ways. Much has already been done and the Government will continue to seek progress both on the domestic front and in conjunction with its European Community partners. In particular, the United Kingdom has taken a leading role in the Community in promoting tighter emission standards not only for passenger cars but also for lorries and buses, which form the main subject of the Royal Commission's report. As we move towards the turn of the century, the Government will continue to press the European Commission to propose to the Council of Ministers the tightest feasible emission requirements for all types of road vehicle, whether fuelled by petrol or diesel.

2. Domestic and industrial sources of air pollution are generally in decline. On the other hand, as the demand for transport, particularly road transport, grows with increasing prosperity, so do emissions from transport sources. The Departments of the Environment and Transport work closely together to reduce the impact on air quality.

3. The Government's approach to reducing air pollution from the UK transport fleet draws on the following principles:
   - setting emission standards for new motor vehicles that are challenging to the industry but technically feasible within pre-determined timescales. This is done in agreement with the other Member States of the European Community;
   - monitoring the construction of new vehicles, and controlling alterations in vehicle construction through the type approval scheme;
   - monitoring and control of existing motor vehicle emissions through the system of roadworthiness testing;
   - air quality monitoring and forecasting for public information, to assess the effectiveness of existing control policies, to inform future policy development, and to measure compliance with international air quality obligations;
   - using research to determine the emission factors (representative emissions) from the UK vehicle fleet and assess new developments in motor vehicle technology;
   - setting standards for fuel quality.

CURRENT AND FUTURE EMISSION STANDARDS FOR NEW MOTOR VEHICLES

4. Emission standards that new vehicles and new engines have to meet in this
country are laid down in The Road Vehicles (Construction and Use) Regulations \(^{(2)}\), made under powers provided by the Road Traffic Act \(^{(3)}\).

5. These standards have a long history, and the UK has a good record of leading the field even before joining the European Community. The problem of smoke from diesel engined road vehicles was first examined in 1963, and this led eventually to the creation in 1971 of British Standard BS Au141a \(^{(4)}\). The British Standard was subsequently used as a basis for a European Community Directive, 72/306/EEC \(^{(5)}\). Regulation 61 of the Construction and Use Regulations refers not only to the British Standard, but also to the European Community Directive and ECE Regulation No.24 \(^{(6)}\) for smoke emissions from diesel engined vehicles. In 1989, the Construction and Use Regulations were amended to apply the provisions of European Community Directive 88/77/EEC \(^{(7)}\), to control for the first time emissions of carbon monoxide, hydrocarbons and oxides of nitrogen from heavy duty diesel engined vehicles. EC Directive 88/77/EEC was a first step. Although it set as a requirement the most stringent standards based on existing technology, the Council of Ministers recognised, in agreeing the Directive, that more needed to be done.

6. That is why the UK played a prominent part in the development of the new EC Directive, 91/542/EEC \(^{(8)}\). This Directive sets standards for gaseous and particulate emissions from diesel engined vehicles over 3.5 tonnes gross vehicle weight, which challenge the industry to do better than hitherto. It already gives effect to a number of the measures recommended by the Royal Commission’s report. The new standards are introduced in two stages. The first affects vehicles newly registered for use on the road from the start of October 1993 and the second from the start of October 1996.

7. The first stage sets a realistic engineering target while achieving useful reductions in the short term. The second stage brings in stricter limits for all pollutants in line with the 1994 model year standards to be enforced in the United States, which are the strictest standards being applied anywhere in the world. Although the UK Government sought to include a revision of the emissions test cycle for the second stage so as to introduce the more stringent and realistic US transient test, the European Commission and other Member States did not agree. A proposal to introduce the transient test is now on the agenda for discussions on a further set of standards to be applied in 1999. In line with the Royal Commission’s recommendation, the UK will press for yet tighter standards and a test cycle which mirrors the pattern of driving which actually occurs on the road.

CONTROL OF EMISSIONS FROM MOTOR VEHICLES IN-SERVICE

8. The Secretary of State for Transport has statutory responsibilities for ensuring the roadworthiness of the 24 million vehicles in use on the road in the UK. The Vehicle Inspectorate Executive Agency (VIEA) exercises these responsibilities on his behalf.

9. Under the Plating and Testing Regulations \(^{(9)}\), all vehicles over 3.5 tonnes gross vehicle weight have to undergo an annual roadworthiness test one year from the date of first registration. The test is principally a safety check but it includes a smoke emission check under free acceleration conditions. The engine is revved in neutral gear with no load applied. This visual smoke check has been in operation since 1968. It has been successful in ensuring that vehicles meet a minimum environmental standard in service. The annual test is backed-up by roadside enforcement and spot-checks on
operators premises. In extreme circumstances a vehicle can be prohibited from further use on the road until it has passed the full roadworthiness test.

10. Early in 1991 the Government decided that the visual smoke check was outdated and that an instrumented check should be developed. It agrees with the Royal Commission that a more stringent approach is needed as increasingly efficient engines are developed for road vehicles. Since the beginning of September 1992 all annual roadworthiness and roadside smoke checks have been conducted with a portable smoke meter. From January 1993 the use of the instrumented smoke check will be extended to tests on diesel engined passenger cars and light goods vehicles.

11. The Government has set up a telephone hotline to enable members of the public to report smoky vehicles. It is run by VIEA and results so far have been encouraging.

MONITORING AND FORECASTING OF UK AIR QUALITY

12. There are three statutory air quality standards in the UK, which are also the subject of European Community Directives. They cover smoke and sulphur dioxide\(^1\), lead in air\(^2\) and nitrogen dioxide\(^3\). In May 1992, a new Directive was adopted on ground-level ozone. This provides for common monitoring and data exchange arrangements and sets ozone concentration levels above which information and health alerts must be issued to the public. However, unlike the previous Directives, it does not set limit values. The Government has established an expert panel to advise on air quality standards in the UK.

13. Through protocols to the Convention on Long Range Transboundary Air Pollution agreed within the United Nations Economic Commission for Europe (UNECE), the UK is committed to taking action on NOx and volatile organic compounds (VOCs). The UK signed the NOx Protocol\(^4\) in 1988, which commits the UK to freezing overall national NOx emissions, from all sources stationary and mobile, at 1987 levels by 1994. The UK also signed the VOC Protocol\(^4\) in 1991. This places on signatories an obligation to achieve a 30% reduction in VOC emissions by the end of 1999 compared with the level in 1988 (Parties can however select a different base year in the period 1984 - 1990 if they wish).

14. The Government operates a range of air quality monitoring networks and is committed to further expansion. They include networks to monitor levels for the three European Community standards mentioned in paragraph 12. Ground level ozone, hydrocarbons, acid rain and acid in water are also monitored at a number of sites.

15. Some of these monitoring sites are telemetric, allowing daily air quality bulletins to be produced. These, together with forecasts provided by the Meteorological office, are made available to the media, on CEEFAX and on a free telephone line, which also provides health guidance\(^4\).

RESEARCH

16. In the Department of Transport, the Vehicle Standards and Engineering Division (VSE) has a research programme covering many aspects of motor vehicle emissions. The current programme includes:
• a programme that will determine a database of emissions from lorries and buses while driven on the road to help in the appraisal of environmental impacts and identify crucial aspects of on-road driving that are inadequately controlled by present type approval test cycles;

• an investigation into the possibility of an automated remote smoke checking system for motor vehicles. Such a system could ensure year-round monitoring of on-road smoke emissions from vehicles, not just at the time of annual test or spot check;

• a review of the control technology to be applied to diesel engined vehicles to meet future standards and to determine whether retro-fitting of old engines with emission efficient technology is viable;

• an investigation into the emissions from vehicles under cold start conditions and identification of measures necessary to reduce fuel consumption and emissions under cold starts, and;

• the development of a modelling package for forecasting UK vehicle fleet operation with respect to traffic growth and emissions by vehicle type and use over a wide range of vehicle operation and traffic conditions.

17. In the next financial year VSE will be commissioning research into alternative type approval test cycles for heavy duty diesel engined vehicles, on-board diagnostic systems, correlation of on-road smoke and smoke measured during free acceleration testing and reviewing evaporative emission requirements. With a 1992/93 programme spend exceeding £700,000 and with a total current project spend of over £2.5 million, the expansion of the VSE research programme reflects the importance of the contribution of vehicle emissions to the national inventory. Similarly, the air quality research programme of the Department of the Environment continues to expand rapidly in many fields, including ground level ozone and hydrocarbons, motor vehicle emissions and their abatement, air toxics, urban monitoring and pollution deposition to the North Sea.

FUEL QUALITY

18. The Control of Pollution Act 1974 gives the Secretary of State for Transport the power to control the composition and content of any fuel used in motor vehicles. The Environmental Protection Act gives more general powers to control substances suspected of causing pollution.

19. With active participation in the British Standard Institution's fuels committee, the Government is able to set standards for fuel quality which will contribute to reducing motor vehicle emissions while at the same time giving the motor and oil industries realistic engineering targets.

20. The introduction of tighter emission standards for heavy duty diesel engined vehicles from 1996 will lead directly to the introduction of improved quality diesel fuel. The reduction of the sulphur content of diesel fuel to 0.05% m/m, as required in a draft European Community Directive, will enable engine manufacturers to meet the stringent limits on emissions of particulate matter. Although the quality of diesel fuel is not
directly controlled by regulation, the Government will be taking steps to change this anomaly as soon as practically possible, in line with the recommendation of the Royal Commission.
PART II

THE GOVERNMENT'S RESPONSE TO THE ROYAL COMMISSION'S RECOMMENDATIONS

EMISSIONS AND THEIR IMPACT

21. As indicated in paragraph 2.30 of the Royal Commission's Report, studies to date have indicated only a weak linkage between diesel emissions and cancer and it may not be possible to quantify the relationship much further, either through epidemiological or animal inhalation studies. In so far as the effects appear to be related to the particulate (smoke) phase, the practical implication is that risks would be minimized by reducing particulate emissions as a whole. This is the policy being pursued by Government. Pointers towards the carcinogenic agents that might be involved have been obtained through mutagenicity studies, and this work is continuing.

22. The methodology to assess NOx, hydrocarbons and particulates was developed to achieve a balance between the cost of instrumentation and effectiveness in the control of the known primary pollutants. To extend this capability on a routine type approval test basis to assess, for example, individual hydrocarbon species by the use of gas chromatographic techniques, at least for the present stage of emission control, would place a substantial additional cost burden on the manufacturing industry. Measurement of known carcinogenic compounds and other health risk species is carried out on selected engines by Warren Spring Laboratory (WSL) and others on a routine basis. This research indicates that overall reductions in the regulated pollutants are associated with similar, but not necessarily linear, reductions in individual compounds. Under Government contract, the Transport Research Laboratory (TRL) are conducting a study of unregulated compounds that will monitor selected organic compounds in vehicle exhaust. This work should give a clearer indication of the relative responsibility of road vehicles for the emissions of these compounds and the extent to which the current, more broad emission standards achieve reductions. The Government will continue this research on new technology products as they emerge and, in line with the recommendation of the Royal Commission, will develop proposals in the European Community and work towards extending this work into the type approval regime when the cost and

Further work should be done to identify the specific sources of carcinogenicity in diesel exhaust and the toxicological effects of defined fractions or combinations of components. (7.1)

The UK Government should propose that the European Community develops more discriminating techniques for analyzing emissions from heavy duty diesel vehicles. This should be done in liaison with other authorities, with a view to introducing internationally agreed protocols on the measurement of such emissions. (7.2)
complexity of such systems reduce sufficiently to make this approach a practical possibility.

THE CONTROL OF EMISSIONS FROM NEW VEHICLES AND ENGINES

23. Particulate emissions standards are now part of the latest Directive controlling emissions from heavy duty diesel engined vehicles (European Community (EC) Directive 91/542/EEC). Visible particulate emissions (smoke) are subject to a separate EC Directive, 72/306/EEC, which controls smoke primarily at full load only. The UK has been pressing unsuccessfully for some years to tighten the limits for smoke emissions. It may now prove unnecessary to continue to press for a lowering of the 72/306/EEC smoke limits since, with the introduction of particulate emission control in 91/542/EEC, visible smoke emissions should also improve from the relatively clean engines that will form an increasingly large proportion of the vehicle population in the future. However, the Government will continue to monitor the situation to see if the benefits are realised in service. The Government will also continue research into the effects of transient engine operation on smoke, particulate and gaseous emissions and, dependent on this work, propose to the European Commission further improvements to, and consolidation of, the 91/542/EEC and 72/306/EEC Directives.

24. As explained in paragraph 11.8 of the White Paper, This Common Inheritance, the Government intends action on air quality to be based increasingly on the definition of acceptable standards for the protection of health and the wider environment. It has now constituted an Expert Panel on Air Quality Standards which in turn will receive guidance on medical matters from the Committee on the Medical Effects of Air Pollutants (COMEAP). The Panel’s recommendations on standards or guidelines for individual pollutants will eventually provide an important context for the development of future policy on the control of emissions, including pollution from motor vehicles. Meanwhile, the Department of the Environment urban air quality monitoring network is being extended in terms of both geographical coverage and range of pollutants measured in order to improve our knowledge of pollution levels in cities, and the chemistry of exhaust gas emissions is being further studied under the Department’s air quality research programme.

25. Since air quality guide values for the main pollutants found in vehicle exhausts will take some time

Consideration should be given to the possibility of consolidating the limit on smoke emissions into the Directive on other emissions from heavy duty diesel vehicles, 88/77/EEC. (7.3)

A more fundamental approach should be taken to setting emission limits for vehicles. Guide values for air quality should be set in the light of the best available data on the health effects and other impacts of the pollutants and should be reviewed periodically. Measures designed to move towards achievement of those values should then be devised. These would include the setting of limit values for heavy duty and other vehicle emissions but would also need to address other factors. The Government should commence the necessary programme of work. (7.4)

Until the work described above has been done, we support the continuation of the present approach of
to establish, the Government agrees that, for the moment, the aim should continue to be to reduce all emissions as far as reasonably practicable and economically feasible.

26. The Government accepts the need to seek further reductions in both particulate and NOx (NO/NO₂) emissions and will continue to press the European Commission for these pollutants to be reduced as far as is economically and practically feasible by regulation. The implementation of emission standards for light duty vehicles that imply the fitting of catalysts on all petrol cars will achieve a large reduction in road transport NOx, but not particulates, which are predominantly from diesels. The technology for reducing NOx from diesels generally makes engine efficiency worse, with increases in fuel consumption, CO, HC, particulates and smoke and can also lead to the formation of secondary unregulated pollutants. Reduction of urban nitrogen dioxide (NO₂) levels will be achieved by applying the latest technology advances to the reduction of particulate emissions from heavy duty diesel engined vehicles (with benefits to be gained in emissions of NOx), further reductions in NOx limits to account for traffic growth and the reduction in NOx emissions from light duty petrol engined vehicles. A reduction in particulate emissions will also provide large and cost effective reductions in other pollutants.

The role of NOx in the creation of photochemical pollution and in damage to ecosystems and buildings through acidic depositions from the atmosphere (‘acid rain’) continues to be studied closely under the Department of the Environment research programme. Attention is also being given to possible direct effects on health of exposure to NO₂ in streets and other outdoor environments, and this is among the range of pollutants under consideration by a sub-group of the Department of Health COMEAP group. There are existing World Health Organisation air quality guidelines and European Community limit values for NO₂, designed to protect public health, and control of NOx emissions from motor vehicles (both diesel and petrol) is an important factor in ensuring compliance with such values.

27. Analytical techniques already exist, or are under development, for measuring specific components. However, the cost and complexity of these procedures make it difficult at the present time to incorporate these into the type approval procedure. The Government will

The findings of the expert committees with respect to the carcinogenicity of diesel particulates justify a precautionary approach which seeks to reduce such emissions from diesel engines as far as is practicable. There is also a strong case for continuing to seek reductions in emissions of NOx. On the basis of present knowledge, we consider that future emission limits, including those to be implemented in the European Community at the end of the decade, should require tighter control of both NOx and particulate matter; they should not concentrate on one to the exclusion of the other. This policy will need to be reviewed in the light of further work on the impacts of emissions which we recommend above. It may also be influenced by technical developments. (7.6)

Consideration should be given to the setting of separate limit values for some of the various components of emissions from heavy duty diesel vehicles. (7.7)
nevertheless continue to fund research into the relationship between individual and composite emissions and seek to establish limit values for those components which still show cause for concern and which the present, more general, measures fail to control.

28. The development of emission control from agricultural, industrial and construction machinery is now a firm agenda item in both the European Commission’s Motor Vehicle Emissions Group (MVEG), and the United Nations Economic Commission for Europe’s working group, the group of experts on pollution and energy (GEPE). The Government will continue to press for the development of an EC Directive and an equivalent ECE Regulation for these categories of vehicle, for implementation as soon as possible.

ENGINE TEST CYCLES

29. The Government welcomes the Royal Commission’s views on test cycles and has convinced the European Commission of the need to review the test procedure for heavy duty diesel engined vehicles with the aim of introducing transient elements into the cycle. This work will be completed in time for the next phase of emission control towards the end of the decade. In support of this work, TRL is undertaking research into typical driving patterns of a wide variety of diesel powered vehicles, the first phase of which is due to be completed towards the end of 1993. This first phase aims to establish typical driving modes of vehicles based in the UK from which typical test cycles can be synthesized. A second phase will then be necessary to measure emissions from new technology diesel engines and to establish a ranking order for each engine and each cycle so that a composite type approval test cycle can be developed which is representative of typical European driving, whilst at the same time providing the degree of emission control that is fully effective under all normal road conditions. It may well be impossible for one single test cycle to prove representative of European vehicle use and that the current US transient test cycle may be the best compromise, even for Europe, leading to the use of test equipment in Europe that is currently in use in the USA. However, this will be decided once the final outcome of the present research is known.

30. The Government has already been directly involved in the respective harmonisation of ECE
Regulations 83 and 49 with the new EC Directives 91/441/EEC and 91/542/EEC and will offer similar cooperation in the development of further harmonization issues within the ECE, especially in the development of new test cycles. The Government considers that the ECE forum is the best place in which to seek agreement on harmonization issues since all major trading nations, and in particular the major vehicle and engine producers, are represented. Nevertheless, the Government agrees that the OECD and UNEP may also have a role to play.

31. A degree of family certification is already written into the latest EC Directive for heavy duty diesel engines and vehicles (91/542/EEC) and ‘worst case’ selection is operated for engines of similar type. Unlike the American system, which has a very broad family concept built into its regulatory system, coupled with very heavy penalties and total recall procedures for any vehicle found not to comply, the main control mechanism in the European system is through type approval.

The type approval system relies on the concept that any production vehicle should, on average, exhibit similar emissions to the type approved vehicle. To extend the family concept to, for example, different fuel injection systems or different methods of aspiration which could have totally different emission characteristics, would make it difficult, if not impossible, to convince our European partners that general compliance with the standards would be maintained.

The Government agrees with the Royal Commission, and believes that there is scope for both greater flexibility in the type approval selection and greater assurance of general compliance by establishing an effective quality control monitoring procedure. The Government has recently been successful in having its proposal for a more effective statistical sampling system for vehicle emissions adopted for use in the European Community. The Government will continue to push this system within the ECE, ultimately proposing a much wider family concept, together with the same quality control monitoring system for off-road vehicles and equipment. Should this combined system prove to be effective in the control of emissions from production versions of this latter category of diesel engine products, then the Government believe that the conditions may be right to permit an expansion of the family concept for road vehicles.
32. The new mandatory emissions Directive, 91/542/EEC, has removed the need to offer incentives to manufacturers to make vehicles with low emission technology, as this will happen as a matter of course. It is unlikely that the graduation of VED would induce a significant increase in the use of less polluting vehicles. The present level of VED is low in relation to the additional purchase cost of vehicles with low emission technology and compared with running costs. For example, a new medium-capacity bus with low emission technology might cost about £3,000 more than the corresponding conventional bus. In comparison, the appropriate annual rate of VED is currently only £300. A very large increase in the general level of VED would be required to establish an effective increase in the uptake of low emission vehicles in the short term before the EC Directive takes effect. In addition, the application of incentives after the date of implementation of the relevant stage of EC Directive 91/542/EEC to encourage manufacturers to make vehicles with low emission technology is prohibited under the requirements of the Articles of the Directive.

33. The Government considers that there would be no significant impact on air pollution by applying incentives to new engines which meet the requirements of EC Directive 88/77/EEC, especially since this Directive applies no particulate standard and since the levels set for carbon monoxide, oxides of nitrogen and hydrocarbons are no better than those achieved by typical new vehicles prior to the introduction of the Directive. An extension of the economic incentives incorporated in 91/542/EEC beyond the date by which all new engines would have to comply would similarly have no practical value or impact on the replacement engine market, since the Directive applies only to new vehicles and new engines.

34. Particulate traps are still unproven in service and consequently TRL are conducting research into such systems as part of a more general study of the practicability of retrofit systems to improve the emissions performance of heavy duty vehicles. The results of this study are expected late in 1996. The new emissions Directive, 91/542/EEC, sets a particulate limit in its first stage of limits, to be applied from the 1st January 1993 to new trucks and buses. It is likely that particulate traps will not be necessary and probably not the...
technology that engine manufacturers will adopt to meet these new standards. As the new Directive applies in 1993, such a system of grant aid for fitting of particulate traps would be short lived.

35. Companies already receive corporation tax capital allowances in recognition of depreciation of plant and machinery. The regime treats new buses in the same way as other plant. The present 25% allowance provides an effective 7-8 year write-off period. This is already generous to bus operators, as most buses remain in operation beyond 8 years. The present regime gives relief for nearly 60% of asset cost in the first three years. More generous treatment for buses would amount to a special subsidy which would be hard to justify or ring-fence. This would run counter to the Government's policy of maintaining tax neutrality and low overall rates of tax, which help businesses by allowing higher levels of profitability and investment.

We see no substantial environmental benefit from allowing special grants for bus engines meeting the EC standards in advance of their becoming mandatory. The mandatory emissions limits provide sufficient incentive in themselves for bus manufacturers to expand production and fitting of cost-effective pollution control equipment, up to and beyond implementation of the new standards.

36. With reference to paragraphs 32 and 35, TRL is continuing to look at the feasibility of retro-fitting existing engines to meet more recent emissions legislation than the engine was originally designed to meet. A graduated system of VED would be difficult to administer and enforce; the current rate of VED is so low compared to the cost of retro-fitting that a reduction in VED would not constitute an incentive.

37. The Government awaits the results of the study being conducted by TRL, expected late in 1996, and referred to in paragraph 34. When the results are known the Government will take steps to investigate appropriate means to encourage retro-fitting of traps to buses. However, as mentioned in paragraph 35, such encouragement is unlikely to be in the form of grant aid.

38. As mentioned in paragraphs 32 and 36, TRL is conducting research into the feasibility of retro-fitting or rebuilding engines to meet more recent emissions legislation. However, as a very large increase in VED would be required to achieve an effective incentive, it is unlikely that this would result in a significant uptake.
by operators, certainly before the need for a scheduled re-build.

39. Referring to paragraph 35, the current regime on tax allowances is already generous to bus operators and extra grants or incentives would be in opposition to Government policy of tax neutrality.

40. As mentioned in the preceding paragraphs, the Royal Commission's suggestions of graduated VED and grants to encourage the rebuilding and retro-fitting of engines to meet more recent emissions limits runs counter to the Government's policy on tax neutrality. The Government believes that new emission standards are sufficient to encourage engine and bus manufacturers to fit the appropriate emission reducing technology and that the development of more stringent in-service checking of emissions, as mentioned in paragraphs 51-53, will provide the means to ensure that older engines are replaced more frequently than would otherwise be the case.

41. The Government has explored the case for a fuel duty differential to encourage the earliest possible take-up of low sulphur diesel fuel. However, in practice a duty differential in this case could not accelerate the installation programme for the refinery plant and equipment and would not be cost-effective. There is currently no desulphurisation plant within the UK, or indeed the EC, oil refining industry capable of producing diesel with a maximum sulphur content of 0.05% m/m. The existing desulphurisation plant is not capable of operating at a sufficiently high severity to reduce the sulphur content to such low levels. To install the necessary plant requires a lead time of four years, which is why the European Commission's latest proposal for a Council Directive relating to the sulphur content of gas oil requires 0.05% m/m sulphur diesel to be mandatory from the 1st October 1996, the earliest practicable date.

Additionally, there is no infra-structure which would permit the simultaneous distribution and sale of two grades of automotive diesel in the UK. In view of the lead-time to install the necessary refinery plant, a second diesel distribution system would have a very short life - one year at most. It would not therefore be cost effective for UK retailers to supply both grades in

An additional incentive for engine rebuilding should be offered for buses in the form of a grant for the fitting of a rebuilt engine which meets the emission values specified in EC Directive 88/77/EEC, or in future the values in one of the stages of amendment, provided that the old engine is either scrapped or surrendered to be rebuilt to meet those values. (7.19)

A grant should be offered for replacing the old engine in a bus with a new one which meets tighter emission values. This would be on condition that the old engine were either scrapped or surrendered to be rebuilt to meet the emission values specified in EC Directive 88/77/EEC, or in future the values in one of the stages of amendment, for use in another vehicle. The size of the grant should reflect the certificated emissions performance of the replacement engine: one amount if the engine met whatever were the limits then in force and a larger one if it met limits which had been adopted but not yet implemented. (7.20)

The Government should introduce a fuel duty differential in favour of low sulphur fuel which is more than sufficient to offset the additional cost of its production, thus compensating the producer and enabling the retail price to be lower. It should do so from the earliest possible date and should maintain the differential until the use of such fuel becomes mandatory. (7.21)
parallel.

42. As mentioned in paragraph 41, there is no infrastructure in the UK which would permit the simultaneous distribution and sale of two grades of automotive diesel before the date on which the proposed Council Directive requires low sulphur diesel fuel to be available.

43. The Government is sponsoring research into the technical and economic potential for the use of alternative fuels, but the evidence so far suggests that substitution of alternative fuels for diesel and petrol is at present a less cost-effective means of abating pollutant emissions than the development of existing diesel and petrol technologies.

The Energy Technology Support Unit (ETSU) published report ETSU-R-33 \[^{18}\] in April 1987, which ranked synthetic fuel options for road transport applications in the UK.

For the purpose of the report, the price of crude oil was assumed to be $28 per barrel. On that basis, petrol, free of taxes and duties, cost $5.50/GJ to produce. The two closest fuels to that were, (a) upgrading of heavy fuel oil or very heavy crude at $6.00/GJ and (b) petrol from LPG at $7.50/GJ. Alternative fuels that came out worse than these costs were methanol from coal at $14.40/GJ, methanol from wood at $14.70/GJ, and ethanol from sugar beet at $15.40/GJ.

ETSU published a further report in October 1987, ETSU-R-44 \[^{19}\], which assessed ethanol as a transport fuel in the UK. The report did not consider ethanol as a substitute for diesel but did conclude that its manufacture would not become economically viable until crude oil prices reached $55-65 per barrel. Crude oil prices are currently about $20 per barrel so alcohols as alternative fuels are certainly less economically viable than they were in 1987 when ETSU published its two reports.

TRL is currently reviewing the potential emission reduction benefits, practicality and economics of alternative fuels and will report the findings by the end of 1992. Notwithstanding the proviso stated in paragraph 35, the Government will then re-evaluate the potential for encouraging the use of such fuels in selected sectors of the transport industry and, in particular, the passenger transport sector. Indeed, the Government has announced its intention to provide

---

\[^{18}\] ETSU-R-33

\[^{19}\] ETSU-R-44

---

The Government should consider restricting the fuel duty rebate for buses to diesel fuel with a sulphur content not exceeding 0.05% at the earliest practicable date. (7.22)

Subject to its judgment of the study recommended at 7.50, the Government should seek to encourage the use of alternative fuels by buses and should consider the most appropriate means of doing so. One might be to offer a grant towards the cost of fuel storage and delivery equipment. Provided that the vehicle met the emission values specified in one of the stages of EC legislation pertaining to diesel vehicles, the appropriate rate of VED recommended at 7.12 should be charged. It should also attract the appropriate level of grant for a new bus or a replacement engine recommended at 7.15 and 7.20 respectively. (7.23)
some resources towards demonstration projects involving clean fuel.

THE URBAN ENVIRONMENT AND BUSES

44. The Government agrees with the Royal Commission that urban emissions, especially NOx and particulates need to be reduced as far as practical and economic considerations permit. To this end the Government will continue to monitor, through the Department of the Environment's air quality programme, both ambient concentrations of these pollutants and the identification of the chief sources of these pollutants by individual vehicle class and continue its extensive research programmes at TRL looking at emission control technology and other measures applied to vehicles. By monitoring the development of particulate traps, flow-through NOx catalysts and other abatement technologies, the Government will certainly consider the need for establishing much lower emission limits for specific classes of vehicle, including buses. The Government does not see the standards set in EC Directive 91/542/EEC as the last step and will be pushing for further improvements that will lead to improved urban air quality.

45. The Government agrees that it may be necessary to establish lower emission limits for certain categories of vehicle that operate in urban areas. The Government, in addition to the programme of work at TRL, will be reviewing advances, especially in the field of catalytic trap technology, for possible application to urban polluters.

46. As noted in paragraph 44, the Government's programme of research work at TRL will consider the extent of vehicle pollution, by vehicle type and use. Should urban air quality show deterioration in the future, and it is clear that vehicle emission Directives are not achieving adequate benefits in air quality, then the Government will determine the need for lower emission standards for vehicles operating in the urban area.

STANDARDS AND TESTS FOR VEHICLES IN SERVICE

47. The Government agrees that a method of assurance that emission control systems will remain
effective for the life of the vehicle is highly desirable. However, it is considered that the US durability test does little to add to this objective, other than to increase test time, complexity and cost, since the basic emission control system is already designed to be durable for other factors, such as performance and market-driven engine life targets. Additionally, a durability test carried out under controlled test conditions is no guarantee that the vehicle will exhibit similar characteristics under the varied in-use requirements to which it is subject.

Market forces, coupled with a strong policy of in-service enforcement, is the most effective assurance of durability control, since this 'control' is applied to each individual source of pollution.

The increasing use of on-board electronic engine management systems, which will become more common as emission standards are tightened, presents an ideal base for the development of on-board diagnostic systems. These systems could be used as the prime means of both vehicle durability control and in-service checking and enforcement by the Department of Transport’s Vehicle Inspectorate Executive Agency (VIEA). These systems are under development in the USA. Whilst the Government would not oppose a durability test being incorporated into the various emission control Directives if a more effective means cannot be agreed, the primary objective is to promote the incorporation of engine diagnostic requirements into future European Directives, together with a strong European-wide in-service enforcement policy.

48. Early last year, The Department of Transport published a Guide to Maintaining Roadworthiness, describing essential and basic types of inspection necessary to ensure a vehicle’s roadworthiness. TRL have an on-going research programme looking at the frequency of different maintenance problems and their influence on emission rates. This will identify the most common and important faults so that a simple and effective maintenance check can be designed. It is important that vehicle operators understand that low emissions and efficient engine operation are a year-round requirement and not just a tedious compliance factor to be dealt with at the time of the annual roadworthiness test. As such, the guide will be extended to add appropriate engine management checks into the cycle of inspections, for which records are required to be kept by vehicle operators as part of their compliance with their operator licence
requirements. A smoke check is listed in the guide for both heavy goods vehicles and passenger service vehicles, as part of an example of a safety inspection record, but presently there are no other specific engine maintenance checks listed which could affect vehicle emissions performance. The Government recognises the value of vehicle maintenance as an essential part of an operators practice, and this should include environmental as well as safety items. The Government will take steps to ensure that engine maintenance takes a more prominent role in these standard maintenance checks and, as mentioned above, this will be included in the next edition of the guide.

An effective engine diagnostic system, as outlined in paragraph 47, would obviate the need to regulate for appropriate maintenance. It is accepted, though, that should agreement on a diagnostic system requirement fail to be reached, a system for ensuring appropriate maintenance procedures are carried out will need to be developed. This will hinge on the results of the TRL work mentioned above and the inclusion of engine maintenance as part of the operator licensing requirements.

49. The new instrumented emission check will be able to detect, at the time of the annual test or at a roadside spot check, whether the engine is in good condition as far as smoke emissions are concerned. It would be difficult, if not impossible, to check other items such as engine timing due to lack of access, unless on-board diagnostics are specified for new vehicles. It is recognised that an effective engine diagnostic system will take time to develop and may not be widely available before the end of the decade. In the intermediate term, the Government agrees that the EC Roadworthiness Directive [21] should be developed to require maintenance of critical emission control components and we will be working towards this aim with our European partners.

50. The Government considers that the expertise and the onus for ensuring that vehicles are correctly maintained lies firmly with the vehicle manufacturers. The manufacturers already recognise this responsibility and realise it through in-house training schemes for their dealers and service outlets, backed up with comprehensive service manuals. Larger organisations, such as the major bus operators who operate their own service and maintenance procedures, are generally afforded the same training facilities by the vehicle and/or engine manufacturers. Little environmental

It will shortly be possible to require that an engine should be kept in good condition as defined by an appropriate set of parameters. The Government should develop this approach as part of its own legislative control of emissions from heavy duty diesel vehicles in service and should propose its introduction throughout the European Community. (7.29)

The Government, in liaison with the relevant trade associations, should ensure that the standards of training and qualification for those maintaining heavy duty vehicles are reviewed and should initiate any action needed to ensure that the necessary standards are achieved by all operators. (7.30)
benefit would be gained by introducing additional training and qualification schemes as such schemes are already operated on a professional and commercial basis.

The Government's policy is to utilise the VIEA in the most cost effective way by deploying their existing expertise, manpower and resources to catching those gross polluters which have clearly failed to utilise the maintenance facilities which are already available to them, or even failed to implement such procedures. Roadside checks and annual inspections of emissions from such vehicles will be progressively expanded to ensure these objectives are achieved.

51. VIEA tests on smoke measuring instruments were completed earlier this year and an instrumented smoke test at roadside spot checks and at annual inspections of all heavy duty diesel vehicles was introduced on the 1st September 1992. Further tests are also being undertaken with the aim of expanding the use of the instruments to smaller commercial diesel vehicles and diesel powered cars on the 1st January 1993.

52. The Government recognises the limitations of the free acceleration smoke test as not necessarily being a true assessment of the smoke that may be emitted under actual operation on the road. However, the greatly increased cost of installing equipment that would permit measurement under load has prevented a more suitable system being developed. The Government considers that the draft roadworthiness Directive should, ultimately, be the means of applying an effective pan-European in-service smoke test procedure and it is working with the European Commission to develop this Directive. The Government will also provide the Commission with the results of the work conducted in the UK in the early 1980's using free rollers and using the vehicle's brakes as means of applying load.

53. To develop and apply diagnostic testing to existing vehicles as a means of supplementing an in-service smoke test and aimed at improving other emissions would have limited value since the bulk of current vehicles have been developed to meet only a smoke standard. The Government believes that smoke emissions from current designs of vehicles should be controlled either by actual measurement or by a check of engine condition. Since the Government is committed to smoke control by actual measurement...
against specific standards, it would not be cost effective to develop a supplementary system that would not add any further incentive to improve on these standards. However, in order for the vehicle operator to be sure of meeting in-service smoke standards, whilst at the same time ensuring his vehicles are operated at peak efficiency, such diagnostic systems could be a useful aid to vehicle maintenance. This would be a commercial opportunity for diagnostic equipment manufacturers in conjunction with vehicle and engine manufacturers, but which should be driven by market forces without any further need for intervention.

54. As stated in paragraph 47, the Government is supportive of advanced diagnostic techniques for the maintenance and control of emissions from future designs of low emission engines. The Government is also committed to promoting such systems in new EC Directives for type approval and in-service use. Research by manufacturers is already well advanced and it is unlikely that additional Government funded research will be needed into the basic systems and sensors. It may be necessary to consider research aimed at adapting these systems into an effective enforcement programme and this will be considered in conjunction with negotiations with other EC Member States.

55. The Government is fully supportive of the new EC roadworthiness Directive for the control of in-service emissions and will continue to work with the European Commission to ensure that an effective means of control is established, initially for smoke and, eventually, for all other regulated emissions. Due consideration to diagnostics and ‘roller’ testing will be given. (see also paragraphs 47 and 54).

56. The VIEA will be carrying out a greater frequency of smoke checks and will also endeavour to make roadside spot checks more effective by targeting the most likely offenders. This will result in an extra 3,400 targeted checks on heavy diesel engined goods vehicles and a total of 4,100 checks on passenger service vehicles, conducted mainly in urban areas. These checks have already begun.

Effectiveness will also be enhanced by removing the judgemental nature of the check by use of a smokemeter, when this technology comes into use later this year (refer also to paragraph 51).

57. The Government agrees that vehicle operators

Research should be carried out into the application of advanced engine diagnostic techniques to emissions control. The Government should sponsor such research if necessary. It should also consider the feasibility of requiring the incorporation of the necessary sensors and other equipment into new heavy duty engines. (7.34)

The UK Government should press for the introduction, throughout the European Community, of diagnostic engine testing and possibly for the introduction of a ‘roller’ test for smoke. (7.35)

The Vehicle Inspectorate should carry out more spot checks of emissions from heavy duty vehicles; we welcome the Government’s commitment in the 1990 Environment White Paper to do so. The checks should incorporate the new instrumented measure of smoke and diagnostic techniques to indicate performance in controlling other emissions. (7.36)

We welcome the statement that the Government will place considerable

19
should take account of engine emission performance, essentially smoke, when accounting for vehicle maintenance as part of their operator licensing requirements. As mentioned in paragraph 48, the Government is conducting research at TRL with a view to identifying the most common operational faults with respect to emissions performance, for ultimate inclusion of a simple and effective check in the operator licensing requirements.

58. TRL are currently involved in studies pertaining to remote sensing of exhaust emissions from road vehicles. TRL are members of an industrial consortium that is seeking to develop for production a device that can sense a wide range of gas phase emissions simply by using the available background light as the illuminating source. The device is not being developed especially for transport emissions, but its application in this field should not be problematical. In addition, TRL have recently purchased a set of remote emissions testing equipment from the USA and will complete an evaluation of this equipment and report by April 1994.

59. The VIEA has set up smoky vehicle spotter programmes. Results over the year April 1991 - March 1992 are quite encouraging. During this period the number of calls received at VIEA district offices totalled 1483, passenger service vehicles having attracted most attention with 46% of all calls. Large goods vehicles were close behind with 39%. Letters of report from VIEA to operators whose vehicles were cause for complaint totalled 79% of those notified. Arrangements have been made to follow-up unsatisfactory responses from vehicle operators, and operators who do not respond or reply in an acceptable manner will receive a visit from a vehicle examiner.

It is noted that only a few local authorities have so far allowed their environmental health officers to participate in this work due to the costs incurred. The police do not have the necessary technical expertise or equipment to take on the primary enforcement role with regard to this recommendation. However, members of Traffic Departments are regularly involved with the Local Authority Trading Standards Departments and with the Department of Transport on multi-agency checks of heavy goods vehicles and an emissions check is being considered for incorporation into the current programme.

60. The Government agrees that further public awareness is necessary and arrangements have been
made to highlight the reporting of smoky vehicles. A Department of the Environment information leaflet entitled *Wake up to what you can do for the environment* \(^{22}\) was published in June 1991 and made available in supermarkets and other public places. In addition to highlighting vehicle emission issues and giving advice on fuel economy, economical driving techniques, choice of vehicle etc, the leaflet offers advice as to how members of the public can report smoky lorries, buses and coaches. In addition the Government will be taking appropriate steps to ensure that the public is made more aware of the existence of telephone hotlines.

61. TRL have in hand a project that is looking at the feasibility of various retro-fit devices for achieving emission reductions from vehicle engines currently in service (see paragraph 34).

**FUELS AND LUBRICANTS**

62. *BS 2869: Part 1: 1988* \(^{23}\) already advises limits for cetane number and other properties of automotive diesel fuel. Although this British Standard, unlike those for petrol, is not legally enforceable, this is an anomaly which the Government undertakes to correct. The Government does not consider there to be an additional need for an EC Directive unless members of the Comité Européen de Normalisation Technical Committee 19 (CEN/TC19) fail to adopt the currently proposed European automotive diesel standard voluntarily. This will be kept under review.

63. At present, there is no agreed laboratory test for aromatic compounds or radicals in diesel fuel. CEN is taking the first essential step in evaluating the environmental effects of aromatics in diesel by developing test methods for aromatics in its working group CEN/TC19/WG18. The results of this work are due early in 1993 and the Government is giving CEN every encouragement for early completion of this work. TRL are at present conducting a research programme looking at non-regulated emissions.

64. As mentioned in paragraph 63 above, the results of the CEN working group are due early in 1993. Consequently, the Government will be reviewing the situation at that time.

65. *The Control of Pollution Act* \(^{19}\) gives the Secretary of State for Transport the power to control...
the composition and content of any fuel used in motor vehicles. The Environmental Protection Act \textsuperscript{20} gives more general powers to control substances suspected of causing pollution. In the past, and this practice will continue, fuel and additive manufacturers have consulted with Government before introducing a new fuel additive. Government advice was then given as to whether the additive was suitable or not, without resort to legal powers under the Control of Pollution Act. The introduction of a European diesel standard will not inhibit the Secretary of State’s ability to ban undesirable diesel additives unless, by so doing, a restraint of trade or distortion of competition were created in the EC. The possibility of the latter eventuality seems extremely remote.

66. As mentioned in paragraphs 22 and 68, the Government sees no justification at present to test for more individual emission species in the type approval test. The Government and the European Commission have no plans at present to introduce a type approval test for emissions as a result of fuel additives, but should the results of the TRL research mentioned in paragraph 61 indicate that fuel additives intended to regenerate particulate traps are causing a potential emissions problem, the Government will review the need for this type of testing.

67. CEN/TC19/WG24, which develops diesel standards for Europe (and EFTA), has a mandate to study future diesel fuel quality in the light of the more stringent heavy duty diesel exhaust emission standards being applied from October 1995. A future fuel standard will be appropriate to future emissions standards and so CEN will have a completion deadline of the middle of this decade. The Government, through its participation in British Standards Institution technical committees, is supporting this CEN activity.

68. The Government has been actively involved in CEN/TC19/WG24 and the MVEG who have both conducted a significant amount of work into studying the relationships between motor vehicle diesel fuel quality and engine emission characteristics. The Government knows that there are correlations between the physical characteristics of the fuel and exhaust emissions, for example cetane number, cetane index, density, sulphur content, volatility and viscosity.

The MVEG agreed that performance measurement of reference fuels used for vehicle emissions testing shall be an agenda item for discussion in the near future, and the Government welcomes this initiative. CEFIC has adopt the following approach:

The use of potentially hazardous metals as fuel additives should be banned until the combustion products of such additives, emitted from the exhaust, have been subjected to appropriate toxicological testing.

No new substance should be permitted to be used as a fuel additive until similar testing has been carried out on it.

A programme of such testing on existing substances used as fuel additives should be established as a basis for reviewing their continued use (7.45).

If a metal additive is used for regeneration of a particulate trap and most of the metal is retained within the filter element, this should be taken into account in evaluating the environmental impact of the emissions. If the metal is potentially hazardous, care should be taken in the eventual disposal of the filter. (5.23)

The merits of introducing a further improved diesel fuel should be kept under review, taking account of the energy cost of its production. (5.24) If one is introduced, its use should be required from an appropriate date. In the interim, financial incentives should be created for the use of the new fuel similar to those we recommend for 0.05% sulphur fuel at 7.21 and 7.22 (5.25)

When more discriminating techniques for measuring emissions have been developed, and more selective limit values adopted, the Government should consider whether the development of a diesel fuel standard related to emissions performance is then feasible and desirable. (5.27)
agreed to start a preliminary study on this topic and the Government awaits the results with interest. However, as mentioned in paragraph 22, while the Government sees no justification at present to test for individual hydrocarbon species in the type approval test, it will review the need for this type of testing in conjunction with fuel quality standards.

69. The Government sees the application of an emissions related standard for engine lubricants as impracticable. Engine oils are designed to provide adequate lubrication and in some cases cooling for the moving parts of an engine; engines are designed to minimise the contribution of lubricants to exhaust emissions. Certainly, with the introduction of tighter emissions standards in 1995, lubricants that have a low propensity for contribution to emissions, especially particulates, will be demanded by engine manufacturers as a matter of course.

70. TRL is currently reviewing the potential emission reduction benefits of using alternative fuels and alternative power sources in the transport sector. The final report is due by the end of 1992. Additionally they shall also be studying the implications of production and supply factors on the choice of fuel for road vehicles, concentrating on energy and emission aspects. The Department of the Environment have also placed contracts to examine future engine technologies and new fuels.
REFERENCES


6. ECE Regulation, *Uniform provisions concerning the approval of compression ignition (c.i.) engines with regard to the emission of visible pollutants*, 1986, Regulation No.24, Addendum 23 (03 series of amendments).


14. United Nations Economic Commission for Europe: *Protocol to the 1979 convention on long range transboundary air pollution concerning the control of*
emissions of volatile organic compounds or their transboundary fluxes, 1991.

15. Air quality bulletins and forecasts, available on 0800 556677 (free telephone service) and CEEFAX page 196.


17. Environmental Protection Act, 1990, Chapter 43, London: HMSO.


22. Department of the Environment, Wake up to what you can do for the environment, 90 ENV 42.
