Auto-Oil II Cost-effectiveness Study

Part I: Introduction and Overview

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by

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## Contents

FOREWORD .................................................................................................................. 1

1. INTRODUCTION ................................................................................................. 3

2. HISTORY OF THE EUROPEAN AUTO-OIL PROGRAMME .......... 3
   2.1 The First European Auto-Oil Programme .............................................. 3
   2.2 The Second European Auto-Oil Programme ........................................... 5

3. OVERVIEW OF THE AUTO-OIL II PROGRAMME ...................... 9
   3.1 The organisational structure .............................................................. 9
   3.2 The methodology .......................................................................... 10
   3.3 The Scope ..................................................................................... 16

4. THE AOPII COST-EFFECTIVENESS ANALYSIS ................. 20
   4.1 Composition of the Working Group .............................................. 21
   4.2 Objectives of the Working Group .................................................. 21
   4.3 The work programme ..................................................................... 22

ANNEX A: THE WG7 TERMS OF REFERENCE .......................... 26

ANNEX B: EXPERIENCE FROM THE AUTO-OIL I PROGRAMME... 29

ANNEX C: EXPERIENCE FROM THIRD COUNTRIES ................. 31
Tables and Charts

Figure 1: Organisational structure of AOP II .......................................................... 9
Figure 2: Overview of the AOP II methodology ................................................... 12
Table 1: Air emissions and concentrations covered in Auto-Oil II .................... 17
Table 1: Auto-Oil II Cities and Countries .......................................................... 18
Table 3: AOPII source categories ...................................................................... 19
Table 4: AOPII Vehicle Categories ................................................................... 19
Table 5: Source Categories covered in the AOP II City Inventories ............... 20
Figure 3: Overview of the Cost-Effectiveness work programme ..................... 23
Foreword

Whilst the need for integrated analysis is often quoted by many stakeholders involved in environmental policy making, putting the ideas in practice is much harder. The Auto-Oil Programme is correctly considered to be one of the pioneering programmes in applying integrated analysis. However, when embarking on the second stage of the Auto-Oil Programme, numerous and often heated debates were held before coming to an acceptable consensus in terms of methodology, analytical tools and data requirements. Indeed, integration means considering many views from a wide range of experts. It also means consolidating different jargon, different priorities, and data which vary in quality. In addition, a commitment to the principles of shared responsibility, sound science and transparency, deadlines often need to be downgraded in importance to ensure the necessary buy-in of stakeholders.

Having established the methodology, the analytical tools and the transport base case (or reference scenario), the next step is to analyse the cost-effectiveness of policy scenarios for tackling future air quality problems, and to update this report accordingly. At the same time, we remain committed to enhance the methodology and data whenever appropriate and feasible.

This report, released in August 1999, is to form the basis for the final report from the cost-effectiveness analysis group (WG7) to be presented towards the end of AOPII. It includes a comprehensive account of the work undertaken in WG7 to date. The report also incorporates most reports and notes discussed in WG7 so far. The report includes the final transport base case run finalised in June 1999 by the WG7 consultants after having modified previous versions to account for the final comments of the working group members in the spring of 1999. The report aims to take account of the many views expressed around the WG7 table, including some views expressed outside the scope of the cost-effectiveness working group, for example those expressed by the European Parliament prior to the adoption of the AOP I Directives (containing the mandate of AOP II).

Given the amount of work undertaken so far and the time available for detailed reporting, it is acknowledged that there is still ample scope to improve the quality and consistency of this report. Therefore, editorial comments and suggestions from WG7 members are welcomed by the chair in view of increasing the accessibility of the report to outsiders whilst preparing the final report due end 1999. An executive summary will be added then which will also account for any remaining differences of opinion to support the longer-term work.

Finally, the results presented to date are the result of months of intense work and collaboration among the many members of the AOP II working groups. This could not be achieved without the competence and commitment of a large number of people. We are particularly indebted to the experts of Standard & Poor’s-DRI (DRI) and the University of Leuven (KUL) for carrying-out a difficult task in the most transparent way possible. Our appreciation goes to Alain Henry (DRI), Stef Proost (KUL), Elisabeth Waelbroeck Rocha (DRI), Marjolein Jansen (KUL), Sylvie Demeulenaere, and Silvia Pariente-David (DRI). We are equally grateful to all the members of the cost-effectiveness
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1. Introduction

This part of the cost-effectiveness study report provides general background for the cost-effectiveness analysis carried out in the context of the Second European Auto-Oil Programme (AOP II).

Chapter 2 includes a brief history of the European Auto-Oil Programme and the mandate for AOP II. Chapter 3 provides a summary of the organisational structure of AOP II and an overview of the methodology and scope. Chapter 4 describes composition and objectives of the AOP II cost-effectiveness working group and summarises the state of play of the work programme established at the outset of the programme.

Part II of the study report describes the policy simulation tool (TREMOVE) that has been designed and developed to support the AOP II cost-effectiveness analysis. This tool has also been used to help constructing the reference scenario. Important comments on the current status of the model are included in the executive summary and annex to Part II.

The reference scenario, i.e. the AOP II transport base case, is described in Part III of the study report. This base case will be used for analysing alternative transport policies aimed at further reducing emissions from transport whenever air quality concentrations do not meet Community standards.

Parts IV through VI are still being developed and currently represent preliminary draft reports.

Part IV of the AOP II Cost-effectiveness study report currently contains a description of a limited number of scenarios that have been constructed to test the TREMOVE model. A discussion on these scenarios has not yet taken place and is scheduled for the second half of 1999. Part IV will be further developed when future policy scenarios have been provided by the other AOP II working groups and when the input data have been transferred to the cost-effectiveness working group. This part will also include a description of other than road-transport policy options, which will have to be considered simultaneously.

Part V of the report contains a draft description of the optimisation tool (LEUVEN II) that has been developed to assist the search for future cost-effective strategies for achieving Community air quality standards.

The conclusion of the cost-effectiveness analysis will be summarised in Part VI of the report. An overall executive summary will be developed in parallel.

2. History of the European Auto-Oil programme

2.1 The First European Auto-Oil Programme

Directive 70/220/EEC was the first directive to lay down emission limits for passenger cars\(^1\). Since then, subsequent amendments to Directive 70/220/EEC and the adoption of legislation for light commercial\(^2\) and heavy duty\(^3\) vehicles

have strengthened and extended Community policy in this area. When Directive 70/220/EEC was again amended by the adoption of Directive 94/12/EC in 1994 it was estimated that emissions of regulated pollutants would be reduced by over 90% by 1996/97 compared their levels in the early 1970’s.

However, whilst preparing for that directive, it was concluded that the overall increase of traffic volumes was overtaking the considerable technical achievements and that further action would be needed to achieve future air quality objectives. It then being apparent that the emission reduction potential offered by further improvements in vehicle technology was possibly limited and very costly in comparison with other potential solutions, the pursuit of future air quality objectives necessitated a reassessment of the existing policy approach. Hence, the European Commission organised a conference in October 1992 with the interested parties to discuss the issue of vehicle emission standards for the year 2000 and beyond. The major conclusion of this conference was that future emission standards should be based on a comprehensive and integrated approach. Subsequently, a technical work programme was initiated at the end of 1992 to provide a solid foundation upon which to base its future legislative proposals.

In accordance with the principle of ‘shared responsibility’ (cf. The 5th Environmental Action Programme), the Commission invited the European automobile and oil industries to collaborate in the realisation of this programme, which became known as the Auto-Oil Programme (AOP). The AOP embodied the new approach as outlined in the legislative proposals submitted to the Council and Parliament in 1993, and reflected in Article 4 of Directive 94/12/EC adopted by Council in 1994. When proposing emission standards to apply from 2000 onwards, the Commission now had to adopts an approach such that proposed measures:

- were designed to produce effects to meet the requirements of the Community’s air quality criteria and related objectives;
- were subjected to a cost-effectiveness assessment, undertaken for each measure, whilst in the global assessment taking account of, inter alia, the potential contributions from:
  - traffic management,
  - enhanced urban public transport,
  - new propulsion techniques, and
  - alternative fuels;
- were proportional and reasonable in the light of the intended objectives.

In other words, the AOP was to provide policy-makers with an objective assessment of the most cost-effective measures for reducing emissions from the road transport sector, to a level consistent with the attainment of the EU air quality standards. The measures examined included vehicle technology, fuel quality, mechanisms for improved durability and the complementary, predominantly non-technical measures mentioned above.

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The cost-effectiveness analysis carried-out during the first AOP was reported in November 1995.\(^4\) The outcome of a major research programme on vehicle-fuel quality interactions, resulting from intensive co-operation between the European Motor and Fuel industry was published in the so-called EPEFE report, i.e. “European Programme on Emissions, Fuels and Engine Technologies”. The overall AOP report was published by the European Commission in 1996.\(^5\)

Simultaneously and as a result of the AOP, the Commission adopted a Communication in June 1996 on a future strategy for the control of emissions from road transport (COM 96/248), together with several proposals for directives. Among these were proposals related to:

- the quality standards for diesel and petrol fuels (96/0163), and
- passenger car emissions (96/0164).

Other initiatives have followed on from the AOP, including proposals for:

- tighter emission standards for light commercial vehicles\(^6\),
- tighter emission standards for heavy-duty vehicles\(^7\), and
- improved procedures for inspection and maintenance\(^8\).

The term “Auto Oil proposals“ is applied indiscriminately to some or all of the legislative actions referred to above. However, the term is most frequently applied to the proposals that were adopted together in June 1996.

### 2.2 The Second European Auto Oil Programme

As part of the above mentioned proposals on passenger cars (96/0164) and petrol and diesel fuels (96/0163) submitted in June 1996, the Commission set out the basis upon which its future proposals on passenger car emission standards and fuel quality standards will be developed. This was to form the mandate for a follow-up Programme, referred to as the Auto-Oil II Programme.

The second European Auto Oil Programme (AOPII) was established in the spring of 1997. It was designed to provide the technical input for the Commission’s work on future vehicle emission limit values, fuel quality standards and related measures. It was specifically intended to satisfy the requirements of Articles 3 and 9 of the proposed Directives, which established the mandate for AOPII. These articles referred to the need to come forward

\(^4\) A cost-effectiveness study of the various measures that are likely to reduce pollutant emissions from road vehicles for the year 2010, Commission of the European Communities, Directorate General III – Industry division III E5, Automobiles and other road users and Touche Ross Management Consultants, Final Report, November 1995.

\(^5\) The European Auto Oil Programme, Directorate Generals for Industry; Energy; and Environment, Civil Protection and Nuclear Safety, European Commission, 1996 (XI/361/96)

\(^6\) Subsequently merged with the proposal 96/0164 and adopted by the Commission in February 1997.

\(^7\) COM (99) 89, adopted by the Commission on December 3, 1997

with an updated strategy to meet the requirements of the Community air quality standards and related objectives by 2010 at least cost. In particular, the Commission was required to submit proposals for a further tightening of the standards, confirming or amending the indicative values for the year 2005.

The AOPII mandate, however, was amended several times as the proposals were discussed in the European Council and Parliament. The first amendment was defined mid 1998 after the Council had agreed a common position, taking account of the amendments proposed by the European Parliament.

At the time, the amended mandate\(^9\) specified that the Commission [was] to propose a further tightening of the emission standards for motor vehicles and quality standards for diesel and petrol fuels no later than 30 June 1999. The Commission’s proposals [had] to be based on a revised and enhanced version of the AOP I methodology. The strategy put forward in those proposals [was] to be designed in such a way as to meet the requirements of the Community air quality standards and related objectives\(^10\) at the least possible cost. The strategy [was] also to be consistent with the objectives laid down in the Community strategy to reduce CO\(_2\) emissions from passenger cars\(^11\) and improve fuel quality, and [was] to take account, as far as possible, of:

- trends in air quality towards the year 2010 and beyond;
- noxious pollutant emissions in Europe from transport and non-transport sources, and an estimate of the contribution that existing and pending and potential emission reduction measures from all sources could make to improve air quality;
- technical developments with regard to vehicle technologies as well as new propulsion technologies (e.g. electric propulsion, fuel cells) and their market potential;
- refinery technologies;
- the potential for reducing vehicle emissions by the use of alternative fuels such as natural gas (CNG), liquefied petroleum gas (LPG), dimethyl ether (DME) and biofuels, including the distribution systems needed for their application;
- possible improvements in the test procedures, in particular measurement methods for particulates and consideration of extending durability provisions\(^12\); and
- the potential and feasibility of technical, non-technical and local measures to reduce vehicle emissions; in this context the contribution of transport and other policy measures such as traffic management, urban public transport,

\(^9\) As amended; relevant amendments are indicated in italics.

\(^10\) In particular the deadlines laid down for the attainment of these objectives, for example on acidification and eutrophication.

\(^11\) As laid down in the Council conclusions of 25 June 1996.

\(^12\) The addition of a new test procedure at low temperatures, originally included in the AOP II mandate, has now been incorporated in the AOP I proposals, as amended.
enhanced inspection and maintenance and vehicle scrapping schemes should be evaluated;

- the particular situation of captive fleets and the potential for emission reductions related to the use by such fleets of fuels with very stringent environmental specifications;

- the potential emission reductions to be gained from fixing the environmental specifications of fuels to be used in agricultural tractors as covered by Directive 74/150/EEC and in internal combustion engines to be installed in non-road mobile machinery as covered by a future Directive;

- the contribution that selective and differentiated fiscal measures could make to reducing vehicle emissions, without any negative impact on the functioning of the internal market, taking into account the effects of revenue losses on neighbouring countries;

- the effects of any such measures on CO₂ emissions;

- the strategies followed by relevant third countries to improve air quality and the emission limit values and environmental fuel specifications envisaged in those strategies;

- the supply situation and qualities of crude oil available to the Community.

The Commission’s proposal [was] to contain, inter alia, mandatory emission limit values to be applied from 1 January 2005, confirming or amending the indicative limit values in the proposed directives 96/0163 and 096/0164. In addition, the proposal [was] to establish whether the framework under which Member States can make provision for tax incentives should be revised.¹³

Based on the amended articles, and to focus the work in the context of the AOPII cost-effectiveness analysis, the objectives of the Programme were defined by the members of the cost-effectiveness analysis group as follows:

The objective of AOP II is to develop a revised and enhanced methodology for the integrated assessment of measures to reduce noxious pollutant emissions in the Community from road transport and other sources. This is to provide a technical input for the development of further proposals on vehicle emission standards, fuel quality standards and other measures in the context of a strategy designed to produce effects to meet the requirements of the Community air quality standards and related objectives at least possible cost. Based on the insights that are gained regarding the relative cost-effectiveness of other measures, the Commission will also consider the need for proposals additional to those concerning vehicle emissions and fuel quality.

In the event, however, the directives adopted in October 1998 by the Council and European Parliament, containing the package of measures on fuels¹⁴ and passenger car and light commercial vehicles¹⁵ as well as the final AOPII

¹³ Established in Directive 70/220/EEC, as amended by the proposed Directive 96/0164.


mandate, went further than anticipated and settled many, though not all, of the 2005 standards. The package included:

- A two-step tightening of vehicle emission limit values for passenger cars and light commercial vehicles, with the first step in the year 2000 and the second step in 2005;
- New environmental specifications for petrol and diesel fuels to take effect from the year 2000; very low sulphur fuels to be mandatory from 2005;
- Provision made for earlier phase-in of very low sulphur fuels (2005 specifications);
- Leaded fuels to be phased out by 2000 (though with the possibility of derogation up to 2005);
- The need for proposals to be brought forward by the Commission for further complementing measures to take effect from 2005.

As a result, revised terms of reference for AOPII were issued in autumn 1998. These contained two principal aims:

- To complete the work which is being done under Auto-Oil II to assess future air quality and establish a consistent framework within which different policy options to reduce emissions can be assessed using the principles of cost effectiveness, sound science and transparency; and
- To provide a foundation (in terms of data and modelling tools) for the transition towards longer-term air quality studies covering all emission sources.

Within this new, relatively wide remit, there was a specific need to provide the analytical foundation for a limited set of Community measures which would take effect from around 2005 and would complement those specifications which were already fixed in the Auto-Oil I conciliation process. These new measures could include:

- environmental specifications for two and three wheeled vehicles;
- environmental specifications for heavy duty vehicles;
- Community provisions for improved roadworthiness testing;
- environmental specifications for petrol and diesel fuels complementing the mandatory specifications for sulphur and aromatics;
- specifications for fuels used by captive fleets; and
- environmental specifications for liquid petroleum gas, natural gas and bio-fuels.

Whereas the short-term needs to evaluate additional vehicle technologies were limited for the time being, the revised terms of reference did not, however, alter the need to evaluate the potential of other predominantly non-technical measures. Thus, from a methodological perspective, the overall objectives of AOPII described above remains more or less unchanged, although the scope of the Programme, in particular the balance of efforts between the respective measures that need to be analysed, has been modified.
3. Overview of the Auto-Oil II Programme

In order to achieve the AOP II objectives, the Commission developed an organisational structure and a draft work programme that was presented for discussion to the stakeholders in January 1997. This chapter provides an overview of the organisational set-up of AOPII, the overall methodology and the scope.

3.1 The organisational structure

In order to design and implement AOPII, a number of Commission services started to draft a preliminary work programme and organisational structure in the second half of 1996.

In January 1997, the Commission again invited the AOP stakeholders and proposed an organisational structure for discussion. The intention also was to extend the stakeholder dialogue. Therefore, not only the vehicle manufacturing and refining industries but also the Member States, NGOs and other experts were invited. The organisational structure, subsequently agreed in the spring of 1997, is shown in Figure 1.

![Organisational Structure of AOPII](image)

Seven working groups have been established, each of which are operating on the basis of its individual terms of reference. Each working group is formed of a number of experts nominated by the stakeholders and chaired by a Commission official. These working groups are:

- environmental objectives (WG1 / DGXI),
- vehicle technologies (WG2 / DGIII),
- fuel quality and alternative fuels (WG3 / DGXVII),
- inspection and maintenance (WG4 / DGVII),
- non-technical measures (WG5 / DGVII),

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16 Whereas in the first AOP (AOP I) the European automobile and oil industries formed the main players along with the Commission, the numbers of stakeholders in AOP II has been extended to include several Member States, related industries and NGOs.

17 For an accurate and detailed account of the respective responsibilities, see the discussion papers prepared by the respective working groups.
• fiscal measures (WG6 /DGXXI), and
• cost-effectiveness analysis(WG7 / DGXI).

The work of the seven working groups is co-ordinated by the Commission’s Management Group\textsuperscript{18} and reported to a contact group\textsuperscript{19}. In a number of cases sub-groups were also created to tackle particular issues and provide technical advice. These included sub-groups on: urban air quality modelling and measures related to other than road transport sources (WG1), and fuels/vehicles interactions and EPEFE equations (WG2/3).

Direct information exchanges with the AOPII cities are organised through a city contact group hosted by the Commission’s Joint Research Centre in Ispra. The Commission’s JRC based in Petten and the European Environment Agency have also been involved in the work of the working groups.

Following the final amendment of the AOPII mandate and the drafting of the revised terms of reference mentioned above, it was agreed not to change the organisational structure of the Programme so as to avoid on overly administrative burden. Instead, it was decided to reduce the number of meetings and to rely more on exchange of information via surface and electronic mail. Some groups, merged their activities taking place under AOPII with other regular meetings (e.g. WG5 co-ordinated the activities on non-technical measures with the CANTIQUÉ project, a concerted action in the research programme related to the same subject but with a longer time horizon).

3.2 The methodology

It had become clear from the AOP-I experience that, in order to carry out a proper integrated assessment of future air quality concentrations and potential emission reduction scenarios across various sources and domains, a good understanding is required of:

• Current air quality concentrations and emission levels;
• The relationship between air quality and emissions taking account of geographical and meteorological conditions specific to the domains;
• Available forecasting methodologies and tools for emissions and air quality taking account of available historical data; and

\textsuperscript{18} The management group includes the chairmen and rapporteurs of each of the working groups and meets as a function of needs. It is to oversee the day to day management of the various working groups, to facilitate the interface between the different working groups and to co-ordinate the administrative details relating to the organisation of meetings and contracts. It consists of members from a wide range of Commission Services, including: Industry (Directorate General III), Transport (Directorate General VII), Environment (Directorate General XI), Energy (Directorate General XVII), and Indirect Taxation (Directorate General XXI. A number of other services were also supporting the activities, including: Economics and Finance (Directorate General DG II), and Research (Directorate General XII).

\textsuperscript{19} The contact group is chaired by the Commission and serves as a forum where all the interest groups have the opportunity to discuss issues of general interest and to receive and comment upon interim reports and progress reports from the working groups.
Current and future technology and socio-economic activity levels.

The methodology developed in the context of the first Auto-Oil Programme came a long way towards integrating the above mentioned elements. Indeed, compared to previous exercises, the complexity of the methodology had already increased significantly—a price to pay if one wanted to stick to the principles of sound science, shared responsibility and transparency. Although this methodology was very comprehensive, it was felt, however, that it was to some extent biased towards the analysis of technical command-and-control measures and not sufficiently suited to analyse these measures at an equal footing with market-based instruments.

Hence, when designing the AOPII methodology, the aim was to build on the approach of the first programme but improving it where possible. The approach taken in AOPII was discussed intensely and developed within the context of the cost-effectiveness analysis and environmental objectives working groups, in close co-operation with other working groups and co-ordinated by the Commission’s Management Group. The methodology has also been developed over time to reflect the amendments made to the AOPII mandate (see above), the progress being made within the respective AOPII working groups, and the resources available. To some extent it may still be subject to changes as some stages still need to be implemented. The current methodology is presented in Figure 2.²⁰

²⁰ The main symbols used in Figure 2 are explained as follows: drums refer to databases, circles are connectors, crossed circles refer either to “and” or “or”; rectangles with vertical bars refer to models, a parallelogram refers to data in the broad sense, a rectangle with a curved baseline refers to a report.
**Auto-Oil II Cost-Effectiveness Study**

**Part I: Introduction and Overview**

**Figure 2: Overview of the AOP II Methodology**
The scheme presented in Figure 2 above is best be described as a series of steps. Also, in practice, there are many more interfaces than what can be shown here.\textsuperscript{21}

\textbf{Step 1: Identify environmental objectives.}

This step belongs to the domain of the environmental objectives working group (WG1) and relates to the definition of air quality standards (step 1A), whilst also considering regional ozone and acidification objectives (step 1B). The link to ozone is needed because of its emission precursors (e.g. NOx emission affect NO2 concentrations but also cause ozone formation).

Rather than fully integrating the forecasting of ozone and acidification formation into AOPPII, maximum use is made of the analysis carried out in the context of the work on the proposed directive for national emission ceilings, recently finalised by the Commission. For example, as shown in Figure 2, the national emission ceilings established in the context of the Community ozone and acidification strategy are being compared to the AOPPII emission inventories to derive regional emission reduction targets for NOx and VOCs to be considered alongside with local emission reduction targets. The targets established in WG1 are subsequently used in the cost-effectiveness analysis working group (WG7) to evaluate the effectiveness of proposed policy options (see step 6). An alternative to using emission reduction targets, would be to incorporate the so-called blame matrices describing the (complex) relation between ozone precursors and concentration directly in the AOPPII optimization tool.\textsuperscript{22}

\textbf{Step 2: Forecast base case trends in emissions of all pollutants.}

This step belongs mainly to the domain of WG1 but requires the involvement of all working groups in order to achieve a consistent level of analysis when considering future reduction options. Indeed, forecasting emission levels also requires account to be taken of changes in technology and activity levels and of the impact of current and expected legislation; It is important to note that the AOPPII base case has been developed at three levels which are subsequently linked to maintain the necessary coherence. The three levels are often referred to as the transport base case (step 2A, mainly managed by the cost-effectiveness working group (WG7) in close co-operation with all other groups), the overall base case (step 2B, which covers all sectors, including the transport and the other than transport sources, and is managed by WG1 in support of the air quality modelling), and the city emission inventories (step 2C, including detailed a spatial emission base case directly supporting the air quality modelling). More explanation is provided in Part III of the AOPPII Cost-effectiveness study report.

\textbf{Step 3: Forecast future air quality.}

\textsuperscript{21} In an ideal world these steps might be carried out sequentially though with the small risk that by the time the programme had reached the reporting stage the early steps might need to be repeated. In practice most of the above steps were carried out simultaneously.

\textsuperscript{22} The latter option may be tested on an experimental basis towards the end of the AOPPII programme, in view of developing future analytical tools.
This step also belongs to the domain of WG1 supported by JRC-Ispra and the EEA, and relates to the air quality modelling at urban and regional scale, using several meteorological and air quality models, observed historical air quality data historical and projected emission inventories. (Historical emission inventories are projected using indices calculated in step 2.)

**Step 4: Establish emission reduction targets**

Having established detailed emission inventories (step 2) and forecasted air quality concentrations (step 3), these predicted concentrations (for 2010 and beyond) now need to be compared against the selected air quality standards (step 1). Where exceedances are predicted, compatible emission reduction targets need to be established. This is not a trivial exercise as concentrations are affected by many parameters, including geographical and meteorological conditions, timing, location and heights of emissions, etc. In addition, some pollutant concentrations have several precursors and trade-offs between respective precursor reductions need to be accounted for in order not to generate reverse effects.

At this time, the current knowledge about the relation between emissions and air quality, is used to establish urban and/or regional emission reduction targets for all pollutants (connector A in step 4A and C in step 4B), whilst differentiating between transport sources (emitted at ground level and within the urban area) and other sources (often emitted at higher levels and outside the urban boundaries). These targets are subsequently used to design appropriate policy options (step 5), and to assess their cost-effectiveness (step 6).

Ideally, as mentioned above, the proper (often non-linear) relations between emissions and concentrations would be fully described based on the air quality analysis through so-called air quality functions. These would then be incorporated in the optimisation model used in step 6 to directly assess whether air quality (rather than emission reduction) targets are achieved. This step (see connector B from step 4A to 6) may be introduced on an experimental basis pending a better understanding of the nature of these relations.

**Step 5: Identify policy options**

Having indicated the remaining future air quality problems and having quantified compatible emission reduction targets, appropriate policy options can now be identified related to the transport sector (connector A in step 5A) or other sectors (connector A step 5B). Step 5A is the domain of the AOPII working groups dealing with vehicle technology (WG2), fuel quality (WG3), inspection and maintenance (WG4), transport demand management and other non-technical measures (WG5), and fiscal measures (WG6). Step 5B, related to policy options for the non-transport sector is the domain of a WG1 subgroup.

All groups are responsible for identifying a range of policy option and for collecting data on costs, changes in activity levels as a result of proposed measures and anticipated emission reduction effects. These data are then forwarded to the cost-effectiveness working group which has developed the analytical framework and modelling tools for assessing the wide range of measures on an equal footing. However, while AOPII extended the analysis from transport policy options to options in other sectors, the policy simulation tools have been developed mainly for the transport sector. Policy options for
other sectors are currently collected from existing sources (mainly from the ozone and acidification studies) and are likely to be focussed on technical solutions only at this time.

**Step 6: Carry out cost-effectiveness analysis of potential measures**

This step is the domain of the cost-effectiveness analysis working group (WG7). At this stage, all information collected in the previous steps is to be used in an integrated assessment. Two analytical tools have been developed for this purpose, i.e. a transport policy simulation tool (TREMOVE) and an optimisation tool (LEUVEN). The bulk of the analysis is centred on the TREMOVE model which allows to analyse technical and market based solutions on an equal footing. For each country considered, policy options can be defined at the level of a sample city, the other urban areas as a whole, the non-urban areas or the country as a whole. A European assessment is done by considering all countries (or areas) simultaneously. The common cost denominator used in TREMOVE is the total cost to society (i.e., the transport users, service providers and government). TREMOVE also allows for calculation of direct and induced emission reduction effects. The latter may occur when policy options significantly upset the price structure of currently used transport modes (including non-motorised, road, rail and waterway transport for passengers and/or freight). Part II of the cost-effectiveness study report contains further detail about the TREMOVE model. TREMOVE has also been used to help constructing the transport base case as explained in step 23.

LEUVEN II is an optimisation tool that is used to help select cost-effective solutions, taking account of the environmental targets (connector A in step 4A, C in step 4B) which can differ by geographical domain (e.g. different cities or different countries). It is thus a tool that also helps to assess to what extent Community policies are warranted and when “subsidiarity” may provide more cost-effective solutions. In this context it should be noted that the tools are developed for a strategic analysis rather then for studying detailed local solutions. They provide benchmarking capacity for either more detailed or more aggregated exercises. The methodology is further detailed in the following chapter related to the cost-effectiveness analysis and in other working group reports.

**Step 7: Report cost-effective measures to achieve air quality standards**

Finally, the activities carried-out in the working groups are disseminated, discussed and reported and the conclusions are summarised in an overall report describing future air quality concentrations, standards, and cost-effective solutions to achieve air quality standards where remaining exceedances are still expected to exist. Individual working groups may also report separately and in more detail on their activities and conclusions. Given the revised terms of reference discussed above, and the preliminary results in terms of future air quality exceedances, the bulk of the reporting will concentrate on the transport base case following the adoption of the so called AOP-I directives, the related air quality predictions and the methodology, analytical tools and databases.

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23 A discussion on the transport base case is provided in Part III of the AOP II Cost-effectiveness study report
developed in the context of AOPII. The latter is required to ensure a proper transition of the AOP activities into the longer term air quality analysis.

3.3 The Scope

This section summarises the scope of AOPII. The focus is mostly on those aspects of the scope that are relevant for the environmental and cost-effectiveness analysis, without trying to provide an exhaustive description. More detail can be found in the following chapters, in Part II of the AOPII Cost-effectiveness study report describing the TREMOVE model, and in Part III describing the transport base case. Reference is also made to the reports of the other working groups for more specific detail.

The specification of the scope has been developed in parallel with the design of the methodology and starts from the guidance found in the AOPII mandate. The outcome of the discussions taking place in WG7, those in other working groups, and the debates in the context of the adoption of the AOP-I directives have also been accounted for. The decisions taken in WG1 relating to the environmental objectives and the air quality modelling have a direct impact on the scope of the work undertaken in other working groups, and in particular WG7.

Time Horizon

The overall time horizon for AOPII extends from 1990 through 2020 with annual or five-annual intervals. As a general rule, policy measures under consideration in AOPII would have to be implemented by the year 2005. Environmental standards have to be attained throughout Europe by the year 2010 and have to be maintained beyond that date. It has therefore been decided that the period under consideration extends until 2020.

Environmental objectives

WG1 has selected a number of pollutants that will need to be assessed in AOPII. These are listed in Table 1 below.

The core emission analysis of AOPII focuses on carbon monoxide, nitrogen oxides, particulate matter, total and non-methane volatile organic compounds, and benzene. These are related to air quality concentration for carbon monoxide, nitrogen oxide, particulate matter, benzene and ozone concentrations which are analysed in the air quality analysis carried out by WG1.

Whenever feasible, other emissions have been included to facilitate the link with related exercises and to improve consistency of analysis across European environmental programmes. They are, however, not specifically targeted. Depending on the availability of information for the respective activity areas, these emissions include sulphur dioxide (acidification), carbon dioxide, and methane (climate change), and particulate matter other than from diesel engines. Also, where data is available, the possible effects of AOPII scenarios on emissions for 1,3 butadiene and PAHs and particulates smaller than PM$_{10}$ will be accounted for. As the base case for the second category of emissions is not being used in the air quality modelling, and not central to the objective of AOPII, it is discussed separately.
**Geographical scope**

Environmental standards apply uniformly throughout Europe. Nevertheless, for pollutants other than regional ozone, the AOPII focuses on a detailed analysis of a number of cities because urban areas are more likely to suffer from air pollution. The *geographical domains* covered by AOP II are presented in Table 2 below.

The air quality analysis covers 10 European cities that were selected by WG1, *inter alia*, on the basis of their representativity for urban air pollution and data availability. The city of Reggio Emilia has been included within the Milan domain to enable the investigation of the impact of proposed measures downwind of a major city. The overall analysis for all sectors covers 15 European countries, and 3 non-EU countries. The non-EU countries (i.e., Estonia, Poland and Switzerland) needed to be included because the air quality modelling covers parts of these countries. The transport sector analysis covers a detailed analysis for nine EU countries (including 10 cities and 9 other and non-urban areas) and cost-effectiveness information can be extrapolated to the other 6 EU countries (only at the national level).
### Table 2: Auto-Oil II Cities and Countries

<table>
<thead>
<tr>
<th>Domains</th>
<th>WG7 Transport sector analysis</th>
<th>WG1 Other sector analysis</th>
<th>WG1 air quality analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Finland</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>1 Helsinki</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>Other Urban</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Urban</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 France</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>2 Lyons</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Urban</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Urban</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Germany</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>3 Berlin</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Cologne</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Other Urban</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Urban</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Greece</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>5 Athens</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Other Urban</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Urban</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>5 Ireland</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>6 Dublin</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Urban</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Urban</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Italy</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>7 Milan</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Regio-Emilia</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Urban</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Urban</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 Netherlands, The</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>8 Utrecht</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Other Urban</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Urban</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Spain</td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td>9 Madrid</td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td>Other Urban</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Urban</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 United Kingdom</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>10 London</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>Other Urban</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Urban</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 Austria</td>
<td>x</td>
<td>x</td>
<td></td>
</tr>
<tr>
<td>11 Belgium</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12 Denmark</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 Luxembourg</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14 Portugal</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 Sweden</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estonia</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poland</td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Switzerland</td>
<td>x</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Sectors and source categories**

Several source categories are considered in AOPPII. The list of source categories considered at the overall level is provided in Table 3. These categories are organised according to the ten main CORINAIR\(^{24}\) anthropogenic source categories. The equivalent SNAP1 code is presented in a separate

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\(^{24}\) CORINAIR is the European Environment Agency’s air emission inventory
column. The categories covered by the transport base case are included in category 7. The latter are further specified below.

### Table 3: AOPII Source Categories

<table>
<thead>
<tr>
<th>CORINAIR anthropogenic source categories used in AOPII</th>
<th>SNAP1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combustion in energy and transformation industries: including public electricity, combined heat and power stations, district heating, transformation to solids and to gases, petroleum refineries</td>
<td>1</td>
</tr>
<tr>
<td>Non-industrial combustion plants: heat generation in other sectors than industry and energy</td>
<td>2</td>
</tr>
<tr>
<td>Combustion in manufacturing industry: heat generation and production processes whose heat demand is met directly through combustion</td>
<td>3</td>
</tr>
<tr>
<td>Production process industries: non-combustion sources</td>
<td>4</td>
</tr>
<tr>
<td>Use of solvents and processing of other products</td>
<td>5</td>
</tr>
<tr>
<td>Extraction and distribution of fossil fuels: energy related non-combustion sources e.g. off-shore gas and oil installations</td>
<td>6</td>
</tr>
<tr>
<td>Road transport</td>
<td>7</td>
</tr>
<tr>
<td>Other mobile sources and machinery: including operation of aircraft, ships, tractors, construction machinery, lawn mowers, military and other equipment</td>
<td>8</td>
</tr>
<tr>
<td>Waste treatment and disposal: waste incineration, landfill</td>
<td>9</td>
</tr>
<tr>
<td>Agriculture</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 4 shows, by way of example, the main vehicle categories covered in the transport base case for the purpose of calculating emissions from road transport.

### Table 4: AOPII Vehicle Categories

| Motorcycles | 2 stroke <50cc  
|             | 2 stroke >50cc  
|             | 4stroke 50-250cc  
|             | 4stroke 250-750 cc  
|             | 4stroke >750cc  |
| Passenger Cars | Gasoline-small (<1.4 l)  
|                | Gasoline-medium (1.4 l – 2.0 l)  
|                | Gasoline-large (>2.0 l)  
|                | Diesel –medium (<2.0 l)  
|                | Gasoline-small (>2.0 l)  |
| Light Duty Vehicles | Gasoline  
|                    | Diesel  |
| Heavy Duty Vehicles | Gasoline  
|                    | Diesel 3.5 – 7.5 T  
|                    | Diesel 7.5 – 16 T  
|                    | Diesel 16 – 32 T  
|                    | Diesel >32 T  |
| Buses and Coaches | Diesel |

As explained in Part II of the AOPII Cost-effectiveness Study Report, other than road transport modes are also considered for the purpose of analysing changes in transport demand. These include, non-motorized modes, rail and inland waterways. Emission estimates for the latter are currently not available.

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25 These vehicle categories are further linked to technology vintages as explained in Part II of the AOPII Cost-effectiveness study report.
Finally, Table 12 shows the source categories covered in the city-emission inventories. The emissions from road transport vehicles are again distributed according to a specific indexing system compatible with the air quality models being used by WG1. As can be seen, consideration is also given to the height at which emissions are released. This is important for determining the proper relation between emissions and air quality concentrations.

### Table 5: Source Categories Covered in the AOP II City Inventories

<table>
<thead>
<tr>
<th>AQ-IDX</th>
<th>AQ-CODE</th>
<th>CORINAIR HEIGHT</th>
<th>NAME OF ACTIVITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>PCg</td>
<td>7</td>
<td>Passenger Cars Gasoline+LPG including evaporative emissions</td>
</tr>
<tr>
<td>2</td>
<td>PCd</td>
<td>7</td>
<td>Passenger Cars Diesel</td>
</tr>
<tr>
<td>3</td>
<td>LDV</td>
<td>7</td>
<td>Light Duty Vehicles</td>
</tr>
<tr>
<td>4</td>
<td>HDV</td>
<td>7</td>
<td>Heavy Duty Vehicles</td>
</tr>
<tr>
<td>5</td>
<td>Buses</td>
<td>7</td>
<td>Buses</td>
</tr>
<tr>
<td>6</td>
<td>2WV</td>
<td>7</td>
<td>Two Wheeled Vehicles</td>
</tr>
<tr>
<td>7</td>
<td>NCP</td>
<td>2</td>
<td>Non-Industrial Combustion Plants</td>
</tr>
<tr>
<td>8</td>
<td>CMN</td>
<td>3</td>
<td>Combustion in Manufacturing Industry</td>
</tr>
<tr>
<td>9</td>
<td>SLV</td>
<td>6</td>
<td>Solvent and Other Product use</td>
</tr>
<tr>
<td>10</td>
<td>EDF</td>
<td>5</td>
<td>Extraction and distribution of fossil &amp; other Fuels</td>
</tr>
<tr>
<td>11</td>
<td>SPS</td>
<td>1</td>
<td>Combustion in Energy &amp; Transformation Industries &lt;50MW, gas turbines, stationary engines</td>
</tr>
<tr>
<td>12</td>
<td>MPS</td>
<td>1</td>
<td>Combustion in Energy &amp; Transformation Industries 50-300MW</td>
</tr>
<tr>
<td>13</td>
<td>LPS</td>
<td>1</td>
<td>Combustion in Energy &amp; Transformation Industries &gt;300MW</td>
</tr>
<tr>
<td>14</td>
<td>PRO</td>
<td>4</td>
<td>Production Process Industries</td>
</tr>
<tr>
<td>15</td>
<td>WAS</td>
<td>9</td>
<td>Waste Treatment &amp; Disposal</td>
</tr>
<tr>
<td>16</td>
<td>OSM</td>
<td>8</td>
<td>Other mobile sources and machinery</td>
</tr>
<tr>
<td>17</td>
<td>ARG</td>
<td>10</td>
<td>Agriculture</td>
</tr>
<tr>
<td>18</td>
<td>NAT</td>
<td>11</td>
<td>Natural Emissions</td>
</tr>
<tr>
<td>19</td>
<td>TOT</td>
<td>0</td>
<td>Total Sources</td>
</tr>
<tr>
<td>20</td>
<td>TRA,(1+2+3+4+5+6)</td>
<td>0</td>
<td>Total Traffic Sources</td>
</tr>
<tr>
<td>21</td>
<td>AREA,(7+8+9+10+11)</td>
<td>50</td>
<td>Total Area Sources</td>
</tr>
<tr>
<td>22</td>
<td>AREA,(12+13+14+15)</td>
<td>120-250</td>
<td>Total Large Area Sources</td>
</tr>
<tr>
<td>23</td>
<td>OSRC,(16+17+18)</td>
<td>0</td>
<td>Other Area Sources</td>
</tr>
</tbody>
</table>

### Policy options

The AOPII mandate required an assessment of selected pollutant abatement measures for road transport to achieve European environmental standards in 2010 at least cost, taking into account the potential of the other sectors. In the short-run, particular attention has to be paid to complement a number of fuel quality parameters for 2005. With respect to vehicle technologies, the main focus in the short-run will be on measures for motor cycles and alternative propulsion systems for captive and city fleets. A number of outstanding more technical issues need to be settled related to vehicle standards such as durability testing and cold start limit values. The latter are likely to fall outside scope of the strategic assessment. In any case is the Commission required to assess the potential of so called non-technical measures, including transport demand and fiscal measures which may be implemented at the local or regional scale. A more detailed discussion on the AOPII measures that can be assessed is found in Part II of the Cost-effectiveness study report and in Part IV.

### 4. The AOPII cost-effectiveness analysis

As mentioned in Chapter 2, the cost-effectiveness analysis will be carried-out in working group 7 (WG7) of the Auto-Oil II Programme, assisted by a consortium of experts contracted by the Commission. Section 1 below describes the composition of WG7. Section 2 summarizes the WG7 objectives.
as defined at the outset of the programme. Section 3 summarises the state of play of the work programme.

4.1 Composition of the Working Group

The work done in WG7 is chaired by the Environment Directorate, DGXI.B2 (Economic Analysis and Employment Unit). The members of the working group consist of experts from Austria, France, Germany, Italy, the Netherlands, Sweden, Spain, the United Kingdom, ACEA, EUROPIA, CLEPA, EFOA, and T&E.

In August 1997, the Commission contracted an external consultant to assist in the technical development of the cost-effectiveness analysis and the objective study of the output and formulation of the final results. The study contract has been awarded to a consortium led by DRI, including experts from the Katholieke Universiteit Leuven (KULeuven).

DRI is acting as co-ordinator of the consortium and of other contributors, including consultants from other working groups. In that capacity it is providing day-to-day assistance and support to the chair of WG7. DRI is taking guidance from, and is directly reporting to, the chair of WG7. Finally, DRI is also assisting in facilitating the communication of the outcome of the study to the interested parties.

KULeuven is acting as scientific co-ordinator, assuming responsibility for the development of the integrated optimisation model and working jointly with DRI on the Transport Model. KULeuven will also participate in the evaluation and interpretation of the modelling results.

4.2 Objectives of the Working Group

The main objective of WG7 is to provide technical assistance for undertaking an economic analysis of local, regional, or European policy options laid down in the context of the European Auto-Oil Programme. This includes the design and implementation of the necessary tools to support the analysis. Indeed, the aim is to evaluate in an objective and consistent way those pollutant abatement measures capable of reducing emissions from road-transport and other sources in pursuit of European air quality standards.

The cost-effectiveness analysis carried out by WG7 heavily relies on the air quality modelling (WG1), and on the input provided by the other working groups. Indeed, these working groups will have to deliver the bulk of the data needed, define, calculate and evaluate the effects and costs of pollutant abatement policy options. To ensure an effective co-ordination between the working groups, the chair relies on, and closely co-operates with the Commission’s inter-service Management Group and its secretariat, in accordance with the organisational set-up of the Programme described before.

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26 See Part II of the Cost-effectiveness study report.

27 However, WG7 has no mandate to change the terms of reference of the respective working groups. Therefore, major changes to the latter, should this be required, have to be taken up with the Management Group set-up to co-ordinate the overall work programme of the AOP II.
4.3 The work programme

This section provides an overview of the main tasks that have been identified at the outset of the study in order to accomplish to accomplish the overall objectives of WG7 in accordance with the methodology described in Chapter 3. A graphical overview is presented in Figure 3 and each task is briefly explained below.

Task 1: Review of the AOPII mandate

This task consisted of the analysis of the AOPII mandate as contained in the AOPI proposals as amended (see Chapter 2). It build on the preparatory work done by the Commission prior to the kick-off of AOPII in January 1997 when it proposed the terms of reference of the respective working groups. This task also included discussing the experience gained from AOPI and from similar exercises held in third countries and developing the WG7 interface with other working groups. The objective of this task was to agree on the WG7 terms of reference, and to provide clarity with respect to the analytical framework to be adopted and the concepts and definitions to be used in AOPII. The monitoring of the AOPII mandate continued until the final adoption of the AOPI proposals sometime in the course of 1998.

The outcome of these discussions has provided the basis for further developing the terms of reference of the group, outlining a conceptual approach and a detailed work programme, and also for contracting consultants to assist in the work of WG7 (see above). The terms of reference of WG7 agreed at the outset of the Programme are included in Annex A. The key concepts and definitions applicable in the AOPII cost-effectiveness analysis were described in the First Interim report from WG7 and incorporated in Part I and II of this report. A summary of the experience gained from AOPI, related to the cost-effectiveness analysis, is provided in Annex B. Experience from third countries is summarised in Annex C.

Task 2: Define scope of the WG7 cost-effectiveness analysis

This task included the detailed specification of the scope of the cost-effectiveness analysis, consistent with the mandate and the discussions held in the context of Task 1. The definition of the scope for the WG7 cost-effectiveness analysis also depends on the work being done in other working groups, in particular the work in WG1 related to the environmental objectives and the air quality modelling. The scope of the WG7 cost-effectiveness analysis is described in Chapter 3 and further detailed in Part II and III of this report.
Task 3: Develop methodology

This task involved outlining a methodology for the cost-effectiveness analysis that is capable of fulfilling the AOPII mandate, covering the scope identified in Task 2, whilst at the same time being consistent with the concepts and definitions identified in Task 1. This task also had to take into account the experience gained from the AOPI methodology and the need for enhancements where appropriate and possible. In this task, particular attention was to be paid to ensuring compatibility with the air quality methodology developed in parallel by WG1, to ensure the most integrated analysis possible. This task also included a discussion of the validation procedures and that were needed for assuring the robustness of the cost-effectiveness methodology.
The AOPII cost-effectiveness methodology developed in WG7 was described in Chapter 5 of the First Interim report and is incorporated in Parts II, III, and V of this study.

**Task 4: Enhance/developt models**

In this task, mainly of a technical nature, the consultants developed enhanced policy simulation and assessment tools required to support the cost-effectiveness methodology outlined in Task 3. This task consisted of reformulating existing models, or components thereof, to take account of the scope of the study and the methodology agreed by Working Group 7. Most attention so far went to the development of the TREMOVE model which is used to simulate transport policy options and also to construct the base case (see step 5). Pending the availability of input data from other working groups, a limited number of tests were carried out based on preliminary or dummy data. The development of the policy assessment model (i.e. LEUVEN II) has been finalized but, pending the availability of input data from other working groups, testing has been very limited to date. As part of the further testing procedures, indications will be given of what are the critical parameters that need to be carefully monitored.

Detailed specifications of the models are provided in Parts II and V of this report. Models have been made available to WG7 experts allowing to gain insights into the detailed functioning of models. Once fully tested, models will also be made available to stakeholders upon request.

**Task 5: Define format for submission of data/information by WG2-6**

Having identified the scope (Task 2) and methodology (Task 3) of the cost-effectiveness analysis, as well as the models needed in support the methodology (task 4), this task focused on the specification of the input data requirements for WG7 and the format in which these data have to be delivered. This task involved considerable interaction between WG7 and other working groups (and their consultants) responsible for identifying possible measures and related data. It also involved the identification of a number of milestones for a timely delivery of data to WG7 as well as an agreement on the procedures for the validation of input and output data. To date, however, limited input has been received due to the delays incurred in the overall AOPII time table.

The guidelines for data collection were provided in Chapter 7 of the First Interim Report released in February 1998 and incorporated in Part IV of this report. Guidelines are continuously subject to clarification as working groups make progress in the identification of future pollutant abatement measures. Whereas most guidelines refer to data associated with policy options, working groups also assisted in the collection and validation of the transport base case data (see next).

**Task 6: Define a base case to 2020**

This task consisted of specifying the overall base case, against which AOPII policy options were to be evaluated in terms of cost and effects.

Whilst WG1 was co-ordinating the overall process for constructing the base case, the task of WG7 is to contribute to the detailed construction of the base case related to the road transport sector. Specifications for constructing the
AOPPII base case were discussed in WG1/WG7 ad hoc meetings which were also attended by experts from other working groups. The task also included the specification of validation and calibration procedures in WG7 (and in WG1), involving other working groups, in particular WG2 and WG3.

The transport base case is discussed in Part III of this report.

**Task 7: Select cost-effective policy scenarios**

This task is not yet completed to date due to delays in the overall AOPPII timetable. It is dedicated to the identification of an optimal set of policy measures to reach the environmental objectives of AOPPII at least cost. As this “what’s best” scenario will depend, among other, on the assumptions made in the models and the robustness of the input data, a sensitivity analysis will be carried-out. This “what-if” analysis will be based on changed assumptions for critical parameters identified in prior tasks (i.e. Task 4). The incremental costs and effects of pollutant abatement policy options compared to the base case will be calculated or assembled in WG7 and be used as an input into the optimisation model LEUVEN2. Those costs and effects related to the transport sector will be estimated through the integrated transport emission forecasting model (TREMOVE). Costs and effects of policy options in other sectors will be assembled by WG1 and checked for consistency with the transport data in WG7, before inclusion in the optimisation model.

The preliminary results will be presented to WG7 in accessible formats (including tables and graphs), to facilitate the analysis and discussions. For example, the contribution of the key measures of the optimal policy mix in achieving the desired emission reduction will be commented upon. This will allow more transparency in the tractability of inputs to better understand the results. Preliminary examples of policy scenarios are currently provided in Part IV of this report.

**Task 8: Evaluates side effects of policy scenarios**

The analysis described in Task 7 will be complemented in this task to take account of the fact that the conclusions from the AOPPII need to be consistent with other EU strategies and policies. Cost-effective scenarios will be tested for the possible “side effects” identified by WG7 (see Part II of this study). These “side effects” also cover aspects that are not immediately revealed in a cost-effectiveness analysis. For example, the distribution of costs across sectors or differences in time paths for selected emission reduction scenarios that lead to early achievement of some targets.

**Task 9: Prepare conclusion and final report**

In this task, the findings emerging from the cost-effectiveness analysis will be analysed and summarised for inclusion in the final report from WG7. Care will be given to common sense interpretation of the modelling output, by providing as much transparency as possible on assumptions made and the limitations of the approach. Draft final reports will be prepared so that the different AOPPII stakeholders can provide comments. Conclusions will be formulated in terms of the attractiveness of different policy solutions. The report will then be finalised on the basis of comments received. The final report will include an executive summary which is to present the results in an accessible format to facilitate their interpretation and dissemination outside WG7.
Annex A: The WG7 Terms of reference

1. Objectives

The objective of the working group is to

- devise a multi-faceted strategy,
- covering road-transport and other than road-transport emission sources
- at local and European level,
- to enable the Commission to propose a cost-effective set of measures
- for achieving the objectives resulting from the Community air quality standards.

The results from working group 7 will be established in close co-operation with the other working groups.

These results will, inter alia, provide the basis for the discussion and the decision on the emission limit values to be applied from January 2005, confirming or modifying the indicative limit values stipulated in the current proposals.

2. Scope

Pending any modifications, Article 5 of the proposed directive 96/0164 (COD), and Article 9 of the proposed directive 96/0163 (COD), determine the initial scope of the cost-effectiveness analysis which must be undertaken by the Commission services. The scope could be amended by the Institutions during the decision process on the Auto-Oil I proposals. Therefore, the programme should be flexible to incorporate any modifications to the Commission’s proposal.

3. Methodology —Research and Tasks to be Undertaken

Where possible, the methodology will be based on a revised and enhanced version of the methodology used for the Auto-Oil I programme.

At the outset, the working group will undertake review and research activities to evaluate the possibility to enhance the models used in the Auto-Oil I Programme (e.g., the underlying assumptions, the nature and number of parameters, etc.), and to develop the appropriate methodology to be used in the Auto-Oil II Programme. Their applicability within the enlarged scope of the exercise needs to be assessed. The main modifications will be the inclusion of the non-transport emission reduction measures and non-technical measures. Several models can be used as a basis, including TRANSOPT, EUCARS, RAINS, or the LEUVEN model, all with different merits and shortcomings. Confirmation and/or revision of the basic assumptions underlying the Auto-Oil

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28 As agreed at the outset of AOPII in the spring of 1997, the terms of reference were not amended following the final adoption of the AOPPII mandate. However, the work plan and time table contained in section 4 has become obsolete and has been removed. Reference is made to Chapter 4 of this report for a more up to date description.
I programme will to some extent be subject to the decisions taken in the context of working group 1 (number of pollutants, time intervals, etc.). The simulation model will have to be compatible with the air quality and emission models used to calculate the emission reduction objectives (Working group 1), in particular the level of aggregation of data.

Concurrently, an integrated concept needs to be developed to accommodate the enlarged scope of the Auto-Oil II Programme. In particular, allowance for analyzing the potential from sources other than road-transport needs to be included in the model(s). Provided major obstacles do not occur during the initial phase of the programme, the following approach is envisaged:

1. When revising emission reduction targets related to road-transport sources, the emission reduction potential of other (principally stationary) sources will be considered simultaneously. In order to determine an initial order of magnitude for sector-related emission reduction targets, current data on the cost-effectiveness of various measures will be considered, including inter alia: the results of the AOP1; the analysis undertaken to support the development of the Community strategies on acidification and ozone; the studies undertaken in connection with the Communities’ legislative proposals on Large Combustion Plants, the Incineration of Dangerous Waste, Emission Standards for Non-Road Mobile Machinery, Air Quality Standards for NO₂, Particulates, CO₂, Benzene and information available to Member States Industry and NGOs.

2. When developing cost-effective measures, or a set of measures, the emission reduction targets will initially be those set for road-transport sources.

3. Time permitting, the exercise will be extended to a more detailed analysis of the measures related to other sources eventually including non-technical and fiscal measures. Upon availability of these data, the order of magnitude for sector related emission reduction targets could be revised.

This approach will be worked out further at the working group level in order to put forward a pragmatic and transparent methodology, capable of delivering on time.

The preliminary list of outstanding issues include decision to be made on:

- discrete/continuous scenarios;
- consecutive/simultaneous optimization;
- model constraints (number of pollutants, number of measures, type of measures);
- use of welfare/real (financial) costs — concept definition and data update;
- developing integrated concept for including non-technical and fiscal measures;
- reference year and time horizon;
- NPV assumptions;
- possible emission discounting;
• inclusion of effects on CO₂ emissions;
• possible overlaps and economic side effects

4. Interaction Between Working Group 7 And Other Working Groups

It is acknowledged that the activities of working group 7 depend strongly on the work of the other working groups and *vice versa*. Working group 7 will closely co-operate with all working groups in order to assure data compatibility and validity in all stages of the process. A high level of co-operation and flexibility between all working groups will be essential for the success of the programme.

The input for the cost-effectiveness will be provided by working groups 1 (environmental objectives) and 2 through 6 (measures). The output of the various vertical working groups will have to be presented in a format suitable for the cost/effectiveness optimization, and will have to be compatible with the model capabilities and characteristics. Thus, an important role of working group 7 will be to provide guidance to the other working groups with regard to the required nature, format, and level of detail of the data to be delivered. The input will be screened before acceptance.

In case this task is subcontracted, the contractor(s) must be able to liaise with the other working groups in order to take into account the format of their results, which will be inputs to the model, and give them information about the possibilities/limitation of the optimization model in order to instruct them on the format of the data able to be introduce into the modeling process.

4. Working plan (Preliminary)

[obsolete following the subsequent revisions of the AOPII mandate, the terms of reference and the related timetable. See Chapter 2 and 4 of this report for details.]
Annex B: Experience from the Auto-Oil I Programme

The AOPII mandate requires that the AOPII proposals from the Commission should be based upon a revised and an enhanced methodology relative to that applied in AOPI.

Throughout the Auto-Oil I exercise, and during the initial discussions on the Auto-Oil II Programme, the need for a more integrated approach to policy assessment became apparent. Such an approach is needed if there is to be a simultaneous analysis of the impact of regulations and norms that directly affect technology – the technical measures – and of measures that specifically aim to alter the behaviour of transport users – the non-technical measures. At the outset of the work in WG7, a number of comments or criticisms have been made concerning the methodology employed for the Auto-Oil I Programme, which are summarised below:

- the Programme focused on technological solutions implemented through the command-and-control approach; not enough attention was given to the use of fiscal instruments and measures for transport demand management;
- the models used were not capable of dealing adequately with fiscal instruments or with transport demand management measures;
- the allocation of emission reduction targets across sectors did not occur in an integrated way, thereby insufficiently taking into account the potential of other-than-road-transport emission sources;
- the methodology, in particular the modelling tools, should have been developed in a more transparent way.

The Commission has responded positively to the comments resulting from the Auto-Oil I experience. It has committed itself to maintaining a high level of transparency in Auto-Oil II, and to address the above-mentioned concerns as fully as possible.

The mandate of Auto-Oil II (see Chapter 2) requires in itself a broader approach to the analysis of cost-effective policies than that adopted for Auto-Oil I. It is recognised that technical standards and fiscal measures that affect factors such as travel demand or modal choice are complementary rather than exclusive. The cost-effectiveness methodology must allow a simultaneous analysis of these different instruments.

It has also become clear that forecasts of travel demand and a thorough and detailed understanding of the composition of the vehicle stock are important. Indeed, emissions are a function not only of the number of vehicles, but also their technical characteristics, average usage, and the characteristics of the fuel used. In order to incorporate all these elements, Auto-Oil II requires integrated modelling tools that allow different policy measures to be handled within a consistent analytical framework.

However, given the increased complexity of the modelling task compared to Auto-Oil I it is important that the methodology employed is well understood, and that any assumptions used in the modelling are clearly stated and open to scrutiny. It is therefore essential that the work of all working groups is closely integrated. In addition, it will be important to make judicious use of sensitivity
analysis to test the robustness of modelling results, and to allow as much time as possible for the analysis of the modelling output.
Annex C: Experience from third countries

Useful experiences can be drawn from looking at how the cost-effectiveness of measures is assessed in other parts of the world. At the outset of the work to be done in WG7, DRI reviewed what is currently being done in the US and, in particular, in California.

Some care has to be taken in drawing lessons from the US experience for Europe, because of differences in problems and approaches between the two regions. However, there are a number of interesting conclusions to be drawn from these efforts that are applicable irrespective of the original situations and the desired effects of the programmes.

• There is no single best approach to cost-effectiveness analysis. The choice of methods and models to use depends on both the analytical needs and the resource availability. There is a long list of interesting models or techniques that can be used, and types of improvements that can be made to existing models. Some of these improvements are necessary for good analyses but others may generate only small marginal benefits. Analysts therefore need to select a methodology with the real-world context in mind and not based (exclusively) on abstract theory. Cost-effectiveness analyses should be policy-relevant. The analysis is a means to achieve such a goal, but not an end in itself.

• In the case of the US, the analyses show that reasonable technical measures and fuel programmes are more cost-effective than traffic management measures. Advanced vehicle technology and fuel programs, however, are very expensive.

With respect to the cost-effectiveness of emission control measures in the transport sector, it can be concluded that it is important to consider the interactions among the individual emission control options - a feature embedded into the proposed methodology for AOP II. These conclusions were based on the Californian experience, which is used as a model by the other States within the US, and is followed with interest in other parts of the world.