

The Air Quality Strategy for England, Scotland, Wales and Northern Ireland: Addendum



SCOTTISH EXECUTIVE



Llywodraeth Cynulliad Cymru
Welsh Assembly Government



Department of the
Environment



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Department for Environment
Food and Rural Affairs

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Executive Summary

The UK Government and devolved administrations for Scotland, Wales and Northern Ireland published the Air Quality Strategy¹ in January 2000. It sets air quality standards and objectives for eight key air pollutants to be achieved between 2003 and 2008. For seven of these pollutants local authorities are charged with the task of working towards the objectives in a cost effective way. The standards and objectives are subject to regular review to take account of the latest information on the health effects of air pollution and technical and policy developments.

The Strategy's objectives for particles (PM₁₀), benzene and carbon monoxide were reviewed in 2000/01, in particular, to take account of the latest health evidence and advice on the impact of particles on people's health and of developments in Europe. Following the review, the UK Government and devolved administrations published a consultation paper² setting out proposals to introduce tighter objectives for those pollutants and to introduce, for the first time, an objective for polycyclic aromatic hydrocarbons (PAHs).

The UK Government and the devolved administrations have decided, after careful consideration and in light of the comments received during the consultation, that the objectives for the pollutants, set out below in Tables 1a, 1b and 1c, will be included as objectives in the Air Quality Strategy. This Addendum sets out the new objectives and explains the changes that have been made to the Strategy. Performance against the new objectives will be monitored where people are regularly present and might be exposed to air pollution.

Chapter 1 outlines the background to the Strategy and the new objectives. Chapter 2 sets out the principles and approaches adopted in proposing the new objectives, describes the relationships to European air quality limit values and explains the arrangements in place at local level to deliver further improvements in air quality; Chapter 3 details the new objectives and explains how these were determined and the modelling work supporting them; Chapter 4 looks forward briefly to the next review.

The UK Government's and the devolved administrations' approach to the new objectives is the same as that taken in the Air Quality Strategy 2000. For those objectives which are included in regulations for the purposes of local air quality management (LAQM), each local authority will be required to work towards the achievement of the objectives in their area. All local authorities in the UK will need to work towards achieving the new objectives prescribed in regulations for benzene and carbon monoxide. In addition, local authorities in Scotland will also work towards achieving their respective objectives for particles. For the time being, local authorities will have no statutory responsibilities for the new objective for PAHs.

¹ *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Working Together for Clean Air.* January 2000. Cm 4548, SE 20003/3 and NIA 7. The Stationery Office Ltd.

² *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland: A consultation document on proposals for air quality objectives for particles, benzene, carbon monoxide and polycyclic aromatic hydrocarbons.* September 2001. Department for Environment, Food and Rural Affairs, the Scottish Executive, National Assembly for Wales and the Department of the Environment in Northern Ireland.

Executive Summary

Table 1a: New air quality objectives included in the Air Quality Strategy for protecting human health: England and Wales

Pollutant	Objective	Concentration measured as	Date to be achieved by
Benzene	5 µg/m ³ (1.54 ppb)	annual average	31 December 2010
Carbon monoxide	10 mg/m ³ (8.6 ppm)	maximum daily running 8-hour mean	31 December 2003
Polycyclic aromatic hydrocarbons	0.25 ng/m ³ B[a]P	as annual average	31 December 2010
England (apart from London) and Wales			
Particles (PM ₁₀)	50 µg/m ³ not to be exceeded more than 7 times a year	24-hour mean	31 December 2010
	20 µg/m ³	annual mean	31 December 2010
London			
Particles (PM ₁₀)	50 µg/m ³ not to be exceeded more than 10 times a year	24-hour mean	31 December 2010
	23 µg/m ³	annual mean	31 December 2010

Table 1b: New air quality objectives included in the Air Quality Strategy for protecting human health: Scotland

Pollutant	Objective	Concentration measured as	Date to be achieved by
Benzene	3.25 µg/m ³ (1 ppb)	running annual mean	31 December 2010
Carbon monoxide	10 mg/m ³ (8.6 ppm)	running 8-hour mean	31 December 2003
Polycyclic aromatic hydrocarbons	0.25 ng/m ³ B[a]P	as annual average	31 December 2010
Particles (PM ₁₀)	50 µg/m ³ not to be exceeded more than 7 times a year	24-hour mean	31 December 2010
	18 µg/m ³	annual mean	31 December 2010

Table 1c: New air quality objectives included in the Air Quality Strategy for protecting human health: Northern Ireland

Pollutant	Objective	Concentration measured as	Date to be achieved by
Benzene	3.25 µg/m ³ (1 ppb)	running annual mean	31 December 2010
Carbon monoxide	10 mg/m ³ (8.6 ppm)	maximum daily running 8-hour mean	31 December 2003
Particles (PM ₁₀)	50 µg/m ³ not to be exceeded more than 7 times a year	24-hour mean	31 December 2010
	20 µg/m ³	annual mean	31 December 2010

A consultation exercise will be undertaken in Northern Ireland for those objectives which it is proposed to prescribe in regulations for the purposes of LAQM.

1. This Addendum incorporates tighter air quality objectives for particles, benzene and carbon monoxide into the Air Quality Strategy for England, Scotland, Wales and Northern Ireland. It further introduces an objective for polycyclic aromatic hydrocarbons (PAHs) in England, Scotland and Wales. Northern Ireland will announce its objective for PAHs early in 2003. The tighter objectives for particles and benzene supplement the objectives in the Air Quality Strategy; the new objective for carbon monoxide replaces the objective in the Strategy; the objective for PAHs is included in the Strategy for the first time.

Background

2. The Air Quality Strategy aims to:

- map out as far as possible future ambient air quality policy in the United Kingdom in the medium term;
- provide best practicable protection to human health by setting health-based objectives for air pollutants;
- contribute to the protection of the natural environment through objectives for the protection of vegetation and ecosystems;
- describe current and future levels of air pollution; and
- provide a framework to help identify what we all can do to improve air quality.

3. The Environment Act 1995 required the UK Government and the devolved administrations for Scotland and Wales to produce a national air quality strategy containing standards and objectives for improving ambient air quality. The position in Northern Ireland is different (see paragraph 5). The Act also laid the foundations for the system of local air quality management (LAQM). As a result, local authorities are required periodically to review and assess the current and future quality of air in their areas against those objectives in the Strategy which have been prescribed in regulations.

4. The UK Government and the devolved administrations are responsible for policy and legislative issues affecting the environment, including air quality. However, due to the transboundary nature of many air pollutants, it is appropriate to have an Air Quality Strategy presented in a document with common aims covering all parts of the UK. The 2000 Air Quality Strategy was produced on that basis and this Addendum to the Strategy has been similarly prepared.

5. In relation to a number of legislative provisions, the position in Northern Ireland differs from that in the rest of the UK. In particular, equivalents to Part IV of the Environment Act 1995 and the Air Quality Regulations 2000 are not yet in place. The legislation in Northern Ireland, to provide the mechanism for delivery of the Air Quality Strategy, will come into operation in early 2003. Regulations, equivalent to the Air Quality Regulations 2000 in force in the rest of the UK, will be introduced shortly thereafter.

Introduction

6. The Air Quality Strategy was published by the UK Government and the devolved administrations in January 2000. The Strategy:
- established the framework for achieving further improvements in ambient air quality in the UK to 2003 and beyond;
 - set health-based standards for eight main air pollutants and objective dates for their achievement in the short to medium term;
 - set objectives for two pollutants for the protection of vegetation and ecosystems, and;
 - identifies what needs to be done at local, national and international level to achieve the objectives.

The Strategy's air quality objectives, which are included in regulations for the purpose of LAQM, together with the new objectives included or to be included in regulations, are set out in Table 2, below.

Table 2: Air Quality Strategy 2000 objectives and objectives in the 2003 Addendum prescribed in regulations for the purposes of local air quality management			
Pollutant	Objective*	Concentration measured as	Date to be achieved by
Benzene	16.25 µg/m ³ (5 ppb)	running annual mean	31 December 2003
Benzene (apart from Scotland and Northern Ireland)	5 µg/m ³ (1.54 ppb)	annual average	31 December 2010
1,3-butadiene	2.25 µg/m ³ (1 ppb)	running annual mean	31 December 2003
Carbon monoxide (apart from Scotland)	10 mg/m ³ (8.6 ppm)	maximum daily running 8-hour mean	31 December 2003
Lead	0.5 µg/m ³	annual mean	31 December 2004
	0.25 µg/m ³	annual mean	31 December 2008
Nitrogen dioxide	200 µg/m ³ (105 ppb) not to be exceeded more than 18 times a year	1-hour mean	31 December 2005
	40 µg/m ³ (21 ppb)	annual mean	31 December 2005
Sulphur dioxide	350 µg/m ³ (132 ppb) not to be exceeded more than 24 times a year	1-hour mean	31 December 2004
	125 µg/m ³ (47 ppb) not to be exceeded more than 3 times a year	24-hour mean	31 December 2004
	266 µg/m ³ (100 ppb) not to be exceeded more than 35 times a year	15-minutes mean	31 December 2005
Particles (PM₁₀)	50 µg/m ³ not to be exceeded more than 35 times a year	24-hour mean	31 December 2004
	40 µg/m ³ (21 ppb)	annual mean	31 December 2004

Table 2: Air Quality Strategy 2000 objectives and objectives in the 2003 Addendum prescribed in regulations for the purposes of local air quality management (*continued*)

Pollutant	Objective*	Concentration measured as	Date to be achieved by
Scotland			
Particles (PM ₁₀)	50 µg/m ³ not to be exceeded more than 7 times a year	24-hour mean	31 December 2010
	18 µg/m ³	annual mean	31 December 2010
Carbon monoxide	10 mg/m ³ (8.6 ppm)	running 8-hour mean	31 December 2003
Scotland and Northern Ireland			
Benzene	3.25 µg/m ³	running annual mean	31 December 2010
* µg/m ³ : micrograms per cubic metre mg/m ³ : milligrammes per cubic metre ppb/ppm: parts per billion/million			

7. This chapter explains the principles adopted by the UK Government and the devolved administrations in setting the new objectives for air quality and the arrangements in place at local level to deliver improvements in air quality.

Standards and objectives

8. The 2000 Strategy explains that the air quality objectives are derived from air quality standards based on the best available medical and scientific understanding of the effect of individual pollutants on health. Standards, as defined by the Expert Panel on Air Quality Standards (EPAQS), are concentrations below which significant risks to public health are unlikely to occur. The UK Government and the devolved administrations have taken the standards recommended by EPAQS as the standards on which the objectives are generally based. Objectives are a statement of policy intentions for air quality for the medium term taking account of the costs and benefits, and the feasibility and practicability of moving towards the standards.

The Expert Panel on Air Quality Standards was established by the then Secretary of State for the Environment in 1991. The Panel consists of independent experts appointed for their medical and scientific expertise. The role of the Panel is:

- to advise on ambient air quality standards and other aspects of air pollution, taking account of the best available evidence of the effects of air pollution on human health
- identify gaps in knowledge needed for standard setting and suggest priority areas of research
- inform the development of policy on improvement of air quality and increase public knowledge and understanding of air quality issues.

Further information on the Panel is available on www.defra.gov.uk.

9. European Union (EU) limit values are generally derived from World Health Organisation (WHO) guideline values. In cases where an objective is derived from an EU limit value, it will be the WHO guideline value, rather than the relevant EPAQS recommendation, that forms the basis of the objective. The objectives for nitrogen dioxide in the 2000 Strategy are derived from EU limit values. This has meant that there is no longer a direct link between the one hour mean standard recommended by EPAQS for nitrogen dioxide and the objectives. This is also the case with the new objectives for carbon monoxide and for benzene set out in this Addendum. These objectives, apart from the new objective for benzene in Scotland and Northern Ireland, are derived from the EU limit value in the second Air Quality Daughter Directive³, which is itself derived from the WHO guideline value. The new benzene objective adopted in Scotland and being considered in Northern Ireland is based on the EPAQS long-term policy aim.

³ Council Directive 2000/69/EC of 16 November 2000 relating to limit values for benzene and carbon monoxide in ambient air. European Commission.

Principles and approaches

10. The 2000 Strategy's objective for benzene, a recognised genotoxic human carcinogen, was derived from a standard recommended by EPAQS as a level which the Expert Panel considered to represent an exceedingly small risk to health. The EU second Air Quality Daughter Directive's limit value for benzene took as a starting point the risk estimate recommended by WHO. For those pollutants, including human carcinogens, for which no absolutely safe level can be specified, the WHO takes a risk estimate approach, rather than recommending a guideline value.
11. The objective for particles as PM₁₀ in the 2000 Strategy was derived from the limit value in the first Air Quality Daughter Directive. EPAQS recommended a 24-hour mean standard for particles in response to evidence that acute (short-term) health effects are associated with daily changes in levels of particles.
12. The new annual mean objective for particles takes into account the possible dose response relationship estimated for the health effects from long-term exposure to particles by the Committee on the Medical Effects of Air Pollutants (COMEAP) in their May 2001 report⁴. As well as setting an annual mean, based on the long-term health effects evidence, this Addendum also incorporates a 24-hour mean objective for particles. The new 24-hour mean objective has been calculated as the approximate equivalent to the annual mean objective. Both the annual mean and 24-hour objectives are measured by a gravimetric measurement method. There is therefore no simple relationship between the standard for particles recommended by EPAQS, which was based on a continuous measurement method and the new objectives. However, the new 24-hour objective does, in practice, represent a progressive reduction towards the EPAQS standard.
13. In addition, the evidence now available suggests that there may not be a threshold for health effects of particles and that an absolutely safe level cannot therefore be specified. This is an increasing tendency for a number of pollutants as more evidence for adverse health effects accumulates from epidemiology in large populations. In earlier studies, standards or guidelines representing levels of zero or minimal effect were generally based on exposure studies on a relatively small number of individuals. It was often possible in such studies to reduce the exposures until no effect was observed in some outcome, such as lung function. However, such studies are inevitably constrained by the limited range of sensitivities of subjects which can ethically be studied, and by the range of health outcomes which can be measured.

⁴ *Committee on the Medical Effects of Air Pollutants. Report on the effects of long term exposure to particulate air pollution on life expectancy.* May 2001. COMEAP.

The Committee on the Medical Effects of Air Pollutants was established in 1992 and is one of several expert Committees to advise the Government on the effects of environmental factors on health. The Committee consists of independent scientific and medical experts and one public interest member. The role of the Committee is to:

- advise on the effects on health of both outdoor and indoor air pollutants on the basis of data currently available
- assess the need for further research
- liaise with other Government bodies to assess the effects of exposure and associated risks to human health.

Further information is available on the Committee's webpage www.doh.gov.uk/comeap/

EU limit values and UK national objectives

14. The dates by which EU Directive air quality limit values are to be met are usually expressed as 1 January in a particular year. The indicative stage 2 limit values for particles in the first Air Quality Daughter Directive⁵, for instance, are set for 1 January 2010. The UK's Air Quality Strategy objectives on the other hand have a compliance date of 31 December for the year concerned. The date proposed for achieving the new annual mean provisional objective for particles is 31 December 2010. Although there is almost a year between these dates, in practice, there is no difference. The EU limit values have to be achieved for the year in which the date is set. So compliance with the indicative stage 2 limit value for particles set in the first Air Quality Daughter Directive would be assessed for the year beginning 1 January 2010. The UK would have to demonstrate compliance after the end of 2010. Compliance with provisional national objectives set for 31 December 2010 would also be assessed after the end of 2010.

Local Air Quality Management

15. Part IV of the Environment Act 1995 requires local authorities to review and assess the current, and likely future, air quality in their areas against those objectives in the Strategy which have been prescribed in regulations for the purpose of the LAQM regime. Where a local authority considers that one or more of the air quality objectives are unlikely to be met by the due dates, the authority must declare an air quality management area (AQMA), covering the area where the problem has been identified. It must then draw up an action plan setting out the measures it intends to take in pursuit of the air quality objectives in the area. The Environment (Northern Ireland) Order will provide a similar legislative vehicle in Northern Ireland when it comes into operation in 2003.

⁵ Council Directive 1999/30/EC of 22 April 1999 relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air. European Commission.

Principles and approaches

16. However, whilst the LAQM arrangements provide a means of achieving improvements in air quality to help to secure the national objectives, they do not place an absolute obligation on local authorities to meet the objectives prescribed. The legislation only requires local authorities to act 'in pursuit of the achievement' of air quality objectives. This is because responsibility for action needed to regulate sources of emissions often lies outside their remit.

17. Practically all local authorities in England, Scotland and Wales have completed their first round of reviews and assessments against the Strategy's objectives prescribed in the 2000 Air Quality Regulations⁶. In Northern Ireland, where authorities are not yet legally obliged to undertake the work, all 26 district councils have completed the first stage of their reviews and assessments. In the UK, over 100 authorities have formally declared AQMAs; practically all of these are designated in respect of nitrogen dioxide and/or particles (around half include particles). These local authorities are now undertaking further reviews and assessments of the areas concerned and are required to submit a report within 12 months following designation of the AQMA. These authorities have been advised to prepare their action plans within 12-18 months of designation. Further details and progress are available on the web site: www.airquality.co.uk.

London Air Quality Strategy

18. The Greater London Authority Act 1999 places a duty on the Mayor for London to prepare and publish an Air Quality Strategy for London. The London Air Quality Strategy was published on 20 September 2002 and sets out how the Mayor intends to implement the national Air Quality Strategy in Greater London and achieve the air quality objectives set in the relevant regulations. London local authorities are required to take the London Strategy into account when exercising their LAQM duties under Part IV of the Environment Act 1995. The area comprising Greater London is defined by the Greater London Authority Act 1999 and contains 32 boroughs and the City of London.

Scientific and technical developments

19. In taking forward policies through the setting of air quality objectives, which are underpinned by the latest scientific, medical and technical information, full account has been taken of the Guidelines on Scientific Advice and Policy Making⁷. These set out the key principles applying to the development and presentation of scientific advice for policy making. They emphasise the importance of thinking ahead and identifying early the issues on which scientific advice is needed; of getting a wide range of advice from the best sources, particularly when there is scientific uncertainty; and publishing the scientific advice and all relevant papers. These guidelines are particularly relevant to the way that the advice on health-based air quality standards is provided by EPAQS.

⁶ *The Air Quality (England) Regulations 2000 (SI 2000/928); The Air Quality (Scotland) Regulations 2000 (SI 2000/97); The Air Quality (Wales) Regulations 2000 (SI 2000/1940)*. The Stationery Office Ltd.

⁷ *Guidelines 2000. Scientific Advice and Policy Making*. July 2000. Office of Science and Technology.

20. Our understanding of the effects of air pollution is improving all the time. Although there remain many uncertainties, we are learning continuously from research being carried out in the UK and abroad about the ways that individual air pollutants can damage health and the environment. The effects that the individual air pollutants have on health are discussed in detail in the next chapter.

Monitoring air pollution

21. Air quality objectives are set on the basis of the latest information on air pollution from the national air pollution monitoring network and using the most up to date modelling of future air quality levels.

22. There are over 1600 national air quality monitoring sites across the UK organised into two major types of network, automatic and non-automatic, that gather certain types of information depending on the reason for which the data are required. About 120 of these sites automatically record and report mainly hourly data which are made available to the public and other users. Further development of the monitoring network includes the establishment of particle "super sites" analysing not only PM_{10} and $PM_{2.5}$ particle mass concentrations but also particle numbers, size distribution and surface area. The number of sites monitoring PAHs is also being increased.

Economic analysis

23. Economic analysis involves the systematic assessment of the costs and benefits associated with alternative policy options. It is helpful not only in identifying objectives which are efficient but also in identifying the most cost effective methods of achieving the objectives. The report on the review of the 1997 UK National Air Quality Strategy was accompanied by an interim report from the Interdepartmental Group on Costs and Benefits (IGCB). This report presents the methodology adopted by the IGCB and preliminary results. Considerable further economic analysis work has now been carried out on costs and benefits to support the development of a new objective for particles. The work is explained in detail in the Group's report⁸ issued with the consultation document on the proposals for the objectives included in this Addendum. The Group's remit is to provide a comprehensive assessment of relevant costs and benefits associated with measures required to meet current or proposed air quality objectives and provide the economic analysis to support setting objectives.

⁸ *Interdepartmental Group on Costs and Benefits. An economic analysis to inform the review of the Air Quality Strategy objectives for particles.* September 2001. Department for Environment, Food and Rural Affairs.

Particles

24. The UK Government and the devolved administrations have announced new objectives for particles as PM₁₀. These supplement and strengthen substantially the objectives in the Air Quality Strategy published in 2000 of a 24-hour mean of 50 µg/m³ (micrograms per cubic metre) not to be exceeded more than 35 times per year and an annual mean of 40 µg/m³, both to be achieved by the end of 2004.

The new objectives for particles are:

- for all parts of the UK, except London and Scotland, a 24-hour mean of 50 µg/m³ not to be exceeded more than 7 times per year and an annual mean of 20 µg/m³, both to be achieved by 31 December 2010;
- for Scotland, a 24-hour mean of 50 µg/m³ not to be exceeded more than 7 times per year and an annual mean of 18 µg/m³, both to be achieved by 31 December 2010;
- for London, a 24-hour mean of 50 µg/m³ not to be exceeded more than 10 times per year and an annual mean of 23 µg/m³, both to be achieved by 31 December 2010.

25. The UK Government and the devolved administrations have set these objectives as provisional objectives (see paragraph 69), pending the review by the European Commission of the stage 2 indicative limit value for particles in the first EU Air Quality Daughter Directive, due to be completed by 2004.

26. The UK Government will encourage the Mayor for London and London authorities to work towards an aspirational annual mean target for particles of 20 µg/m³ after 2010, with the aim of achieving it by 2015 where cost effective and proportionate local action can be identified.

27. The objectives for particles have been put into regulations in Scotland⁹ for the purpose of LAQM. The UK Government and the Welsh Assembly Government intend that new particles objectives should be reviewed for their possible inclusion in regulations as soon as practicable after the review of the first Air Quality Daughter Directive and taking account of the outcome of the European Commission's review. The new particle objectives will not be put into regulations in Northern Ireland for the purpose of LAQM at present, but will be reviewed as appropriate.

⁹ *Air Quality (Scotland) Amendment Regulations 2002. (SI 2002/297)*, The Stationery Office Ltd.

Health effects of particles

28. In contrast to other pollutants, that are usually single chemical substances, particles are of complex chemical, physical and biological composition, differing from place to place and from time to time. The ambient atmosphere contains a mass of biological material in the form of bacteria, fungal spores and pollens, many of which are known to cause infection and allergic disease. In addition, ambient air also contains a large number of non-biological particles produced by human activity, including quarrying and construction activities, as well as emissions from road transport and other industrial sources.

29. Particulate air pollution can be associated with a range of effects on health including effects on the respiratory and cardiovascular systems, asthma and mortality. Although the precise mechanism by which particles damage health remains unclear, a large number of epidemiological studies have shown relationships between various indices of ill health and measurements of particle concentrations. But there remains at the moment considerable uncertainty about the precise nature of these effects. Further work is underway to reduce this uncertainty and to improve our knowledge of the ways in which particles affect human health.

Expert Panel on Air Quality Standards

30. The 2000 Strategy's particles objective was based on the EPAQS recommendation for particles, measured as PM_{10} ¹⁰. Later evidence emerged which suggested PM_{10} might not be the measurement most representative of that part of the total particle mixture that is responsible for its harmful effects on health and that toxicity may lie in a finer fraction of particles, perhaps $2.5 \mu m$ ($PM_{2.5}$) or smaller. Following a review, the Expert Panel concluded in its report¹¹ that, on the present evidence, measurement of particulate air pollution as the metric of PM_{10} , which includes essentially all respirable particles, provides the most appropriate basis for an air quality standard in the UK.

Committee on the Medical Effects of Air Pollutants

31. COMEAP reported in January 1998¹² on the short-term effects of air pollutants on health in the UK. It concluded that the evidence suggested that in 1996 the deaths of between 12,000 and 24,000 vulnerable people may have been brought forward and between 14,000 and 24,000 hospital admissions may have been associated with short-term exposure to air pollution. As a result of further studies in the USA, in its report published in May 2001¹³ on the long-term exposure to particles and mortality, the Committee concluded that, bearing in mind uncertainties over the transfer of the impact in the UK, the effects on life expectancy from long-term exposure to particles could be up to 10 times greater than the short-term effects.

¹⁰ PM_{10} means particulate matter which passes through a size-selective inlet with a 50% efficiency cut-off at $10 \mu m$ aerodynamic diameter.

¹¹ *Expert Panel on Air Quality Standards. Airborne Particles: What is the most appropriate measurement on which to base a standard?* April 2001. The Stationery Office Ltd.

¹² *Committee on the Medical Effects of Air Pollutants. Quantification of the effects of air pollution on health in the UK.* January 1998. COMEAP.

¹³ *Committee on the Medical Effects of Air Pollutants. Report on the long term effects of particles on mortality.* May 2001. COMEAP.

Sources of particles

32. Particles (PM₁₀) in the atmosphere are composed of a wide range of materials from three main source types: primary particles, arising from combustion sources (including road traffic), secondary particles, mainly sulphate and nitrate formed by chemical reactions in the atmosphere, and coarse particles, suspended soils and dusts, sea salt, biological particles and particles from construction work.

Policy developments

33. The objectives for particles in the Air Quality Strategy are derived from the EU stage 1 limit values in the first Air Quality Daughter Directive. This is a 24-hour mean objective of 50 µg/m³, with 35 permitted exceedences each year, and an annual mean of 40 µg/m³ to be met by the end of 2004.

34. Significant progress to reduce emissions of particles has been made in recent years with measures in the industrial and transport sectors. Since the Strategy was published in 2000, additional policies have been developed or have been under discussion that will contribute further to reducing emissions of particles.

Industrial

35. Particle emissions from industry in England, Scotland and Wales will be further controlled through the regulations made in 2000 implementing the EU Directive on Integrated Pollution Prevention and Control (IPPC). Legislation implementing IPPC in Northern Ireland will be operative in early 2003. The regulations extend pollution control to a wider range of industrial installations and cover an increased amount of environmental effects.

36. The EU Waste Incineration Directive, adopted in December 2000, will among other measures, impose stringent limits on emissions to air and water, controls on residues and operating conditions, and appropriate monitoring requirements. The Directive will have effect for new plant two years after adoption, and existing plant five years after adoption.

37. EU legislation under the Acidification Strategy is expected to make a significant contribution to reducing emissions of pollutants that lead to the formation of secondary particles. The Sulphur Content of Certain Liquid Fuels Directive, sets three stages of sulphur limits for heavy fuel oil and gas oil, and has now been brought into force in England, Scotland, Wales and Northern Ireland.

38. The National Emission Ceilings Directive sets limits on total emissions of pollutants, some of which lead to particle formation. Significant reductions will be needed across EU Member States to reduce emissions of sulphur dioxide, oxides of nitrogen, ammonia and volatile organic compounds by 2010.

The new air quality objectives

39. The Large Combustion Plants Directive agreed in 2001 will reduce emissions from large combustion plants, mostly power stations, refinery boilers and large boilers in industry, over the next 15-20 years. The Directive builds on the original 1988 Large Combustion Plants Directive under which the UK is committed to reducing sulphur dioxide and oxides of nitrogen from industrial plants to agreed levels by 2003.

Road transport

40. Emissions of PM₁₀ from road transport have reduced considerably in recent years primarily as a result of progressively tighter EU vehicle emission and fuel quality standards (the so-called Euro standards), despite an overall increase in traffic of 15% since 1990. The maximum permitted emissions of particles from a new diesel car bought in 2001, and meeting the Euro III standards, for example, are five times less than the maximum permitted emissions of one bought 10 years ago meeting pre-Euro I standards. Euro IV standards, which should be mandatory for new diesel vehicles in 2006, will reduce emissions of particles still further, with some diesel car manufacturers already introducing particle filters to their latest models, thereby effectively eliminating particle emissions from these vehicles.

41. The sulphur content of diesel, which influences the amount of particles emitted by vehicles, has been progressively reduced in recent years. All road diesel and most petrol now meet the 2005 limit of 50 parts per million (ppm) compared to a maximum sulphur content of 2000 ppm prior to 1996. Further reductions in the sulphur content are likely in future years as a result of a recent proposal from the European Commission to reduce levels to 10 ppm.

42. Technological developments will make a significant contribution to reducing emissions over the long-term but are unlikely to provide a complete solution, partly because of the large number of older vehicles that will remain on the roads and partly because traffic growth is expected to continue. The UK Government and the devolved administrations have therefore sought to address emissions from road transport in a number of ways beyond European regulation.

43. The UK Government's *Ten Year Plan for Transport*, published in 2000, sets out a £180 billion investment programme for transport over the next 10 years to improve public transport, cut traffic congestion, reduce pollution and boost choice. It includes increased funding for schemes to clean up emissions from older vehicles by encouraging the retrofitting of particulate traps or conversion to cleaner fuels such as road fuel gases.

44. The Scottish Executive's *Transport Delivery Report* for Scotland sets out its plan for tackling traffic congestion and reducing pollution over the next 10 – 15 years. The Report sets out the key challenges facing government, the policy tools at the Executive's disposal and a range of options for tackling the challenges. An improvement to public transport and encouraging modal shift away from cars and vans is a priority. Ongoing support will be provided to fund the conversion of vehicles to use cleaner fuels and widen access to alternative fuels in rural areas.

45. The Welsh Assembly Government issued its Transport Framework for Wales in November 2001. This seeks to create minimum standards for accessibility to transport, the quality of public transport and information services. It seeks to achieve a change in the way people choose to travel, particularly when commuting to work and to encourage people, wherever possible, to take the more sustainable option.
46. The *Regional Transportation Strategy for Northern Ireland 2002 – 2012* will contribute to air quality improvements in Northern Ireland. It aims to further develop policies and measures to reduce the adverse environmental impacts of transport, and contribute to sustainable patterns of development and movement, through support for public transport, walking and cycling, and a more responsible use of the car.

Current levels of particles

47. Total emissions of primary PM₁₀ particles from UK sources are estimated to have declined from 305 kilotonnes in 1990 to 186 kilotonnes in 1999. The major sources of emission in 1999 were residential heating (about 38 kilotonnes) (of which coal burning accounts for about 18 kilotonnes and wood burning for about 7 kilotonnes), road transport (about 31.5 kilotonnes) (of which diesel vehicles account for about 24 kilotonnes and petrol vehicles for about 7.5 kilotonnes), industrial processes (about 30 kilotonnes) and public power (about 19 kilotonnes).
48. Although road transport is not the most significant source of primary particles at the UK level, it is generally the dominant source in congested urban areas. In London, for instance, road transport is responsible for 80% of primary particle emissions. Road transport was the largest single source of national emissions of PM_{2.5} in 1999, being responsible for 28 kilotonnes of the total emissions of about 109 kilotonnes. Of these, diesel vehicles produce about 22 kilotonnes.
49. UK emissions account for about 80% of the primary fraction of annual mean PM₁₀. It is estimated that emissions in mainland Europe contribute up to about 20% to annual mean levels of primary particles in the UK. This may be much larger during short-term peak episodes. Emissions from mainland Europe make a more significant contribution to secondary particles. A report published by the Airborne Particles Expert Group (APEG)¹⁴ suggest that in a year with typical meteorology, about 15% of total annual average PM₁₀ concentrations (about 50% of secondary particles) are derived from mainland Europe. When easterly winds are more frequent, emissions from mainland Europe account for a much higher proportion particularly in South and East England.
50. Coarse particles are thought to contribute about 10 µg/m³ to annual mean concentrations of PM₁₀ across the UK. Of this, quarrying and construction work are thought to account for less than 1 µg/m³; brake and tyre wear and re-suspended dusts from road traffic for just over 1 µg/m³, mostly in city centres; wind re-suspended dusts for up to 2.5 µg/m³; and sea salt between 1.5 and 3 µg/m³. Although these particles are referred to as "coarse" for convenience, the modelling and assessment analyses recognise that a fraction would be smaller than 10 µm.

¹⁴ *The Airborne Particles Expert Group. Source apportionment of air borne particulate matter in the United Kingdom.* January 1999. Department of the Environment, Transport and the Regions, Scottish Office, Welsh Office and Department of the Environment in Northern Ireland.

Future levels of particles

51. Extensive modelling work has been carried out to support the work on setting a new objective for particles. The latest air quality monitoring data and updated modelling work has been used to establish the baseline (business as usual) position for 2010, taking account of the improvements in air quality that will be delivered by existing policy measures. This reflects national policy measures, including those set out in the UK Government's *Ten Year Plan for Transport*, the Scottish Executive's *Transport Delivery Report*, the Welsh Assembly Government's *Transport Framework for Wales* and the phased application of Best Available Techniques (BAT) through the implementation of IPPC.

52. It also takes account of EU and wider international measures, including tighter vehicle emission standards and the National Emission Ceilings Directive, which will have an impact on emissions that lead to transboundary particle pollution. The modelling also takes account of the impact of transboundary particle pollution from mainland Europe against different meteorological conditions experienced in recent years. It is not able to take account of the impact of local measures.

53. The modelling has taken the EU first Air Quality Daughter Directive's indicative stage 2 annual mean limit value for PM_{10} of $20 \mu\text{g}/\text{m}^3$ as a reference point for assessing the impact of current and possible future policy measures. Preliminary results suggest that on the basis of existing policy measures, annual mean PM_{10} concentrations in 2010 are expected to be still generally above $20 \mu\text{g}/\text{m}^3$. The highest concentrations can be expected at roadside sites in London. The results are summarised in Table 3.

54. The modelling work for individual sites across the UK suggests that the implementation of a range of potential new national measures would, in total, reduce annual mean particle concentrations by up to $2 \mu\text{g}/\text{m}^3$ across a range of fixed monitoring points in the national network. This would bring urban background levels generally down to around the level of the indicative EU stage 2 limit value in 2010 of $20 \mu\text{g}/\text{m}^3$, apart from in London where levels would still be well above this limit value.

55. Table 3 shows the projected annual mean concentrations for 2010 derived from base years 1996-1999 on the basis of existing policy measures (baseline) and an illustrative package of potential new national measures to reduce particle emissions from transport and stationary sources. These include the fitting of particulate traps to light and heavy duty diesel vehicles, early introduction of sulphur free diesel, retro fitting for older diesel vehicles, and further abatement measures for a range of industrial processes. Further details of the illustrative package of potential measures are set out in Section 1 of the Technical Annex to the consultation document published in September 2001. The modelling results below have been updated from the Table in the consultation document to take account of updates to the emission factors for traffic sources¹⁵.

¹⁵ Revised PM_{10} projections for the UK for PM_{10} objective analysis. AEA Technology, National Environmental Technology Centre. Report AEAT/ENV/R/1086.

The new air quality objectives

56. It should be noted that the range of potential new national policy measures were drawn up for the purposes of illustrating the impact that these might be expected to have on particle concentrations. There is no assumption that these are the measures that would have to be introduced in order to achieve any new objective. Any new measures proposed for the purposes of improving environmental performance would need to be justified on the basis of costs that would be incurred and the benefits that would be achieved.

Table 3: Projected annual mean PM₁₀ concentrations 2010 from base years 1996 to 1999 (µgm⁻³, gravimetric) for the baseline scenario and the illustrative package of new measures

Base year	Projected PM ₁₀ 2010 baseline				Projected PM ₁₀ 2010 Potential new measures			
	1996	1997	1998	1999	1996	1997	1998	1999
London Bloomsbury	24.8	23.1	21.6	21.7	23.0	20.9	19.9	20.0
Birmingham Centre	21.9	20.2	18.9	18.8	20.6	18.7	17.7	17.7
Cardiff Centre	22.5	24.0	21.7	21.7	21.0	21.7	20.0	20.0
Edinburgh Centre	17.9	17.4	15.8	16.2	17.0	16.3	15.1	15.5
Belfast Centre	21.2	22.5	20.4	20.6	19.5	20.0	18.6	18.7
Liverpool Centre	22.4	23.1	21.7	20.8	21.1	21.4	20.2	19.5
Rochester	21.9	19.3	17.6	17.3	21.0	18.3	17.1	16.9
Newcastle Centre	21.0	19.3	18.0	17.0	19.7	17.9	16.9	16.2
Manchester Piccadilly	22.3	21.4	20.2	20.2	20.7	19.4	18.6	18.7
Bristol Centre	22.2	21.1	20.7	20.7	20.8	20.2	19.2	19.2
Haringey Roadside		21.7	20.2	21.0		19.8	18.8	19.5
Glasgow Roadside		23.5	22.3	19.0		20.9	20.0	17.5
Marylebone Road		26.6	24.5	27.2		23.3	21.9	24.0
Camden Roadside		24.8	21.6	23.2		22.1	19.9	21.1
Sutton Roadside		20.5	19.6	19.7		19.0	18.4	18.6
Bury Roadside		24.1	23.0	22.4		21.4	20.6	20.2

57. Concentrations of particles are highest at roadside locations in urban areas. The modelling work has therefore also investigated the impact that existing policy measures and the package of potential new measures would have on roadside concentrations. The results of the roadside modelling give a slightly more pessimistic outlook of future concentrations compared to the site specific analysis at urban background locations. The work has looked at the extent to which these policy measures are expected to deliver the indicative EU stage 2 limit value of 20 µg/m³ at roadsides by 2010 or 2015. The results are summarised in Tables 4 and 5 below.

The new air quality objectives

Table 4: Number of roads exceeding the indicative EU stage 2 limit value in 2010, with and without package of new national policy measures

Area	Total road links studies	Year with "typical" meteorology (1999 Met)		Year with meteorology of High European influence on PM ₁₀ (1996 Met)	
		With new policies	Without new policies	With new policies	Without new policies
Scotland	548	3	8	4	10
Wales	282	2	5	8	42
Northern Ireland	101	9	12	12	15
Inner London	760	709	760	760	760
Outer London	789	181	694	787	787
Rest of England	4,700	55	708	1,780	3,404
Total	7,180	959	2,187	3,351	5,018

Table 5: Number of roads exceeding the indicative EU stage 2 limit value in 2015, with and without package of new national policy measures

Area	Total road links studies	Year with "typical" meteorology (1999 Met)		Year with meteorology of High European influence on PM ₁₀ (1996 Met)	
		With new policies	Without new policies	With new policies	Without new policies
Scotland	548	0	6	0	8
Wales	282	2	3	2	32
Northern Ireland	101	5	9	9	13
Inner London	760	409	752	760	760
Outer London	789	5	419	787	787
Rest of England	4,700	6	303	808	2,931
Total	7,180	427	1,483	2,366	4,531

58. Results suggest that in 2010, on the basis of existing policy measures, if meteorological conditions are typical of those experienced in most years (as in 1999), and the contribution to total particle concentrations from transboundary pollution is not unusually high, we can expect that concentrations alongside 2,187 road links across the UK will be in excess of the EU indicative limit value for particles. Of these, 2,162 road links are in England, of which 1,454 are in London. If meteorological conditions are unusual, and the contribution from transboundary pollution is exceptionally high (as in 1996), we can expect concentrations in 2010 to be in excess of the limit value alongside 5,018 road links. Of these, 4,951 are in England, of which 1,547 are in London.

59. With regard to the new objective for particles in Scotland, Table 6 shows the number of estimated roadside concentrations greater than the 18µg/m³ annual mean objective. The transboundary influence in the base year 1996 on the pollution climate in Scotland is illustrated, whereas in a year with typical meteorology the number of exceedences is reduced markedly.

The new air quality objectives

Table 6: Number of roads in Scotland with estimated PM₁₀ concentrations greater than 18 µg/m³ gravimetric in 2010 with and without the package of new national policy measures

	Year with "typical" meteorology (1999 Met)		Year with meteorology of High European influence on PM ₁₀ (1996 Met)	
	With new policies	Without new policies	With new policies	Without new policies
Scotland	7	63	47	139

Conclusion

60. The UK Government and the devolved administrations consider the new objectives for particles to be challenging but achievable. They are seen as policy drivers and have been developed to influence wider long-term policies that impact on air pollution. They are based on the most recent evidence of the effects of air pollution on health. They take account of the extensive technical analysis of the future pollution climate and the costs and benefits of the measures that might be needed to deliver them.

61. There have been substantial reductions in emissions of particles in recent years. The average number of days per year in urban areas when levels of particle air pollution have been moderate or higher has reduced from 59 in 1993 to 24 in 2001. But further action is needed in response to the latest health findings. The most recent evidence of the effects of particles on health points strongly to the need to strengthen the 2000 Strategy's objective for particles. COMEAP concluded that the effects on health of long-term exposure to particle air pollution are significant.

62. The monitoring data and modelling work shows that the situation in London is very different to that of the rest of the UK, and raises a number of important questions. An objective for 2010 that would be challenging for London would be largely achieved across the rest of the UK without further action. On the other hand, an objective for 2010 that is challenging for the UK as a whole would be impossible to meet in London.

63. The UK Government have therefore decided to set separate particles objectives for London for 2010 that will require at least as much by the way of improvements in air quality as those required to meet the objectives set for the rest of the UK. Achievement of these objectives should result in the same, if not more, improvement in health benefit for people in London than elsewhere in England.

64. Air quality in London should continue to improve beyond 2010, as a result of action taken to meet the proposed 2010 PM₁₀ objective for London and further underlying reductions in secondary particle concentrations. Although annual mean PM₁₀ concentrations should fall below 20 µg/m³ for an increasing area of London from 2010 onwards, a 20 µg/m³ annual mean objective would still almost certainly be impossible to achieve in some parts of London for a further decade without excessive measures. The UK Government therefore consider that the Mayor and London local authorities should work towards a provisional 20 µg/m³ annual mean objective after 2010, with the aim of achieving it by 2015 where cost effective and proportionate local action can be identified. No firm date will be set now for when this objective should be achieved across London.

The new air quality objectives

65. The Welsh Assembly Government has also concluded that for Wales the new provisional annual mean objective for particles should be $20 \mu\text{g}/\text{m}^3$ to be achieved by the end of 2010.
66. The Scottish Executive has set a separate annual objective for particles for Scotland of $18 \mu\text{g}/\text{m}^3$ as an annual mean to be achieved by the end of 2010. Overall, Scotland has fewer problems with air pollution than other parts of the UK, partly due to less transboundary movement of air pollution from continental Europe. The research and modelling carried out to inform the setting of the new objectives for particles suggests that achieving the $18 \mu\text{g}/\text{m}^3$ in Scotland will be equivalent to the challenge of $20 \mu\text{g}/\text{m}^3$ being met elsewhere in the UK, apart from in London. Modelling does suggest that not all locations in Scotland would meet the tougher objective, even with the introduction of the potential new policy measures, and that there may still be a handful of exceedences. However, indications are that the proportion would be less than that of roads elsewhere in the UK failing to meet the less stringent annual objective of $20 \mu\text{g}/\text{m}^3$.
67. The Department of the Environment in Northern Ireland considers that the new provisional annual mean objective for particles should be $20 \mu\text{g}/\text{m}^3$ to be achieved by the end of 2010.
68. The health effects evidence and the technical analysis focus on annual mean particle concentrations. EPAQS recommended a 24-hour mean standard for particles in response to the evidence that acute health effects occur after pollution episodes lasting at least 24-hours. There will therefore be an annual mean and a 24-hour mean objective for particles. The 24-hour mean objective will be based on a concentration of $50 \mu\text{g}/\text{m}^3$, as the Strategy's present objective, with the number of allowed exceedences set at a level to accord with the annual mean objective. The number of exceedences allowed are 7 times a year for England, Scotland, Wales and Northern Ireland and 10 times a year for London.
69. The new objectives for particles adopted into the Strategy represent the UK Government's and the devolved administrations' present judgement of targets which are generally achievable, having regard to available evidence on costs and benefits. However, there are uncertainties surrounding the future projections of concentrations of PM_{10} . Also, the provisional objective of $20 \mu\text{g}/\text{m}^3$ for the UK (apart from Scotland and London) is the same as the indicative stage 2 limit value set in the first EU Air Quality Daughter Directive. Under the Directive's requirements, the indicative limit value will be reviewed in 2003 in order to assess whether this is still appropriate or if a more stringent limit value might be introduced for Member States to achieve. In view of these uncertainties, the objectives for particles should be regarded as provisional. By this it is meant that these are more likely, because of the reasons described above, to be subject to changes by future modification of the Strategy.
70. The Scottish Executive have placed the particles objectives in regulations for the purposes of local air quality management. The Regulations came into force on 11 June 2002. Local authorities in Scotland are required to review and assess air quality in their areas against the new objectives prescribed.

71. The particles objectives will not, for the time being, be included in regulations in England and Wales for the purposes of LAQM. So far, around 50 local authorities in England and Wales have declared AQMAs in respect of the 2000 Strategy's objective for particles. The UK Government and the Welsh Assembly Government consider that it is important that local authorities are given time to take action towards the present objectives before they are asked to begin the review and assessment process in relation to the new objectives. The UK Government and the Welsh Assembly Government will look at this again in light of EU decisions following the review of the first Air Quality Daughter Directive, which is due to be completed in 2004.

72. Local authorities have a key role to play in improving air quality at the local level through the LAQM process. In London the Mayor has an important strategic role in improving air quality and published his Air Quality Strategy for London in September 2002. The Mayor is also responsible for traffic management measures in London and published his Transport Strategy for London in 2001. The UK Government recognises that achieving an annual mean objective of $20 \mu\text{g}/\text{m}^3$ for particles in London is likely to be significantly more demanding than elsewhere in England, even with a delay of a number of years beyond 2010. It is intended to review the objectives set for London with the Greater London Authority in the light of the impact on air quality of measures taken over the next few years by the Mayor and by London local authorities under the LAQM process.

Benzene

73. The UK Government and the devolved administrations have adopted new objectives for benzene into the Air Quality Strategy. These supplement and significantly strengthen the objective set in the Strategy of $16.25 \mu\text{g}/\text{m}^3$ (5ppb) measured as a running annual mean to be achieved by the end of 2003.

The new objectives for benzene are:

- for England and Wales, an annual average of $5 \mu\text{g}/\text{m}^3$ to be achieved by 31 December 2010;
- for Scotland and Northern Ireland, a running annual mean of $3.25 \mu\text{g}/\text{m}^3$ to be achieved by 31 December 2010.

Health effects of benzene

74. Benzene is a recognised genotoxic human carcinogen. Studies of industrial workers exposed in the past to high levels of benzene have demonstrated an excess risk of leukaemia which increased in relation to their working lifetime exposure. Because it is a genotoxic carcinogen, no absolutely safe level can be specified for ambient air concentrations of benzene. In their report on an air quality standard for benzene¹⁶, EPAQS recommended 5ppb ($16.25 \mu\text{g}/\text{m}^3$) as a running annual mean, a level which

¹⁶ Expert Panel on Air Quality Standards: Benzene. 1994. The Stationery Office Ltd.

The new air quality objectives

they concluded represents an exceedingly small risk to health. EPAQS took into account the advice of the Committee on Carcinogenicity, that exposure to benzene should be kept as low as practicable, and recommended a target of 1ppb ($3.25 \mu\text{g}/\text{m}^3$) as a running annual mean. The UK Government and the devolved administrations included EPAQS recommended target in the Strategy 2000 as a long-term policy aim.

Sources of benzene

75. Benzene is a volatile organic compound. In the UK the main atmospheric source is the combustion and distribution of petrol. Diesel fuel is a relatively small source of benzene. The amount of benzene in petrol was, until the beginning of 2000, regulated to an upper limit of 5% by volume by EU legislation. In recent years it comprised on average 2% by volume in the UK. Since 1 January 2000, EU legislation has required that the amount of benzene in petrol be below 1% and is presently about 0.7% by volume on average for fuel sold in the UK. The main outdoor sources of benzene remaining beyond 2005 are expected to be petrol-engined vehicle exhausts and petrol refining and distribution.

Policy developments

76. Policy measures already in place or planned for future years will contribute to a continued reduction in concentrations of benzene in ambient air. Measures agreed under the European Auto-Oil programme will reduce further the emission limits for cars, light vans and heavy-duty vehicles sold from 2001 and 2006 and reduce the sulphur content of fuels by 2005. Emissions of benzene from petrol vapour are being reduced by existing legislation which controls emissions during the storage and distribution of petrol. Benzene emission levels at petrol station forecourts can be reduced further by the use of petrol vapour recovery controls during vehicle refuelling.

77. The second EU Air Quality Daughter Directive, adopted in November 2000, sets a limit value for benzene in ambient air of $5 \mu\text{g}/\text{m}^3$ as an annual mean to be achieved by Member States by 1 January 2010.

Current and future air quality

78. Estimated annual emissions of benzene declined by 45% between 1990 and 1999. Projections show that emissions of benzene from road transport are expected to decrease by 79% between 1995 and 2010. This decrease is more than previously expected as a result of the introduction of lower maximum benzene content levels in petrol in January 2000. The annual mean concentrations for benzene recorded in urban background locations in 2000 ranged between $1.17 \mu\text{g}/\text{m}^3$ and $2.44 \mu\text{g}/\text{m}^3$. These are well below the 2000 Strategy's objective of $16.25 \mu\text{g}/\text{m}^3$ (5ppb). Forecasts from mapping work suggest policy measures now in place should achieve the Strategy's present objective of $16.25 \mu\text{g}/\text{m}^3$ (5ppb) at all urban background and roadside locations by the end of 2003.

79. On the basis of these estimates and projections, the $3.25 \mu\text{g}/\text{m}^3$ (1ppb) as a running annual average longer term target level recommended by EPAQS should be achieved at all urban background locations by the end of 2010. Although there will also be significant reductions in benzene levels at roadside locations as a result of the measures mentioned earlier, there is likely to remain a number of busy roads where levels will be higher than $3.25 \mu\text{g}/\text{m}^3$ (1ppb), particularly in urban areas in England. It is estimated that by 2010 this longer term target level will still be exceeded at about 125 roadside locations in England.

80. Mapping work carried out to forecast the concentration of benzene against the limit value of $5 \mu\text{g}/\text{m}^3$ in the EU second Air Quality Daughter Directive suggests existing policy measures should enable the UK to comply at all urban background locations and most, possibly all, roadside locations by the Directive's due date of 1 January 2010. But additional local measures may be required at some roadside locations in England to achieve the limit value.

Conclusion

81. The UK Government and the devolved administrations have introduced measures and are taking forward further policies to achieve dramatic reductions in the levels of benzene to ensure the achievement of the Strategy's objective of $16.25 \mu\text{g}/\text{m}^3$ (5ppb) by end of 2003. On the basis of present policy measures, the EU limit value of $5 \mu\text{g}/\text{m}^3$ (as an annual average) is expected to be met in urban background locations and most roadside locations by 2010. The long-term policy target recommended by EPAQS of reducing annual mean concentrations of benzene to $3.25 \mu\text{g}/\text{m}^3$ (as a running annual average) is expected to be met in most, but not all, locations by 2010 on the basis of present policy measures. However, it is recognised that further local measures will be required to tackle those areas where exceedences will still occur.

82. The UK Government and the devolved administrations have concluded that the current benzene objective of $16.25 \mu\text{g}/\text{m}^3$ to be met by the end of 2003, should be strengthened. The UK Government and the Welsh Assembly Government have decided to supplement the present benzene objective with a new objective of $5 \mu\text{g}/\text{m}^3$ as an annual average to be met by the end of 2010.

83. The Scottish Executive and the Department of the Environment in Northern Ireland have decided to supplement the present benzene objective with an objective which corresponds to the Strategy's long-term policy target of $3.25 \mu\text{g}/\text{m}^3$ as a running annual mean to be achieved by the end of 2010. The Department of the Environment in Northern Ireland intends to undertake a consultation exercise on the benzene objective in 2003.

The new air quality objectives

84. In England, Scotland and Wales the objectives for benzene have been set in regulations for the purpose of LAQM¹⁷. In setting a slightly different objective, from that which will apply in Scotland and Northern Ireland, the UK Government and the Welsh Assembly Government recognise the much wider extent of localised exceedences of the benzene long-term policy target which will still occur in 2010 in England and Wales and also the uncertainties of the extent and level of local measures which may be required to address the problems.

Carbon monoxide

85. The UK Government and the devolved administrations have adopted a new objective for carbon monoxide into the Air Quality Strategy. The new objective for carbon monoxide replaces the objective in the 2000 Strategy of 11.6 mg/m³ (10ppm – parts per million) measured as a running 8-hour mean to be achieved by the end of 2003.

The new objectives for carbon monoxide are:

- for all parts of the UK, (apart from Scotland) a maximum daily running 8-hour mean of 10 mg/m³ to be achieved by 31 December 2003;
- for Scotland, a running 8-hour mean of 10 mg/m³ to be achieved by 31 December 2003.

The objective in Scotland is effectively the same as in the rest of the UK.

Health effects of carbon monoxide

86. The main threats to human health from exposure to carbon monoxide are the formation of carboxyhaemoglobin, which substantially reduces the capacity of the blood to carry oxygen and deliver it to the tissues, and blockage of important biochemical reactions in cells. People who have an existing disease which affects the delivery of oxygen to the heart or brain (eg coronary artery disease – angina) are likely to be at particular risk if these delivery systems are further impaired by carbon monoxide.

87. The second EU Air Quality Daughter Directive sets a limit value of 10 mg/m³ which is based on the WHO air quality guideline for carbon monoxide as the concentration at which health effects arising from exposure to carbon monoxide are unlikely to be observed. In their 1994 report¹⁸, EPAQS recommended an air quality standard of 10ppm (11.6 mg/m³) as a running 8-hour mean. The EPAQS recommendation is intended to limit the exposure of the population, including susceptible individuals, and specifies levels at which harm is unlikely to occur. The 2000 Strategy's objective is based upon the EPAQS recommendation.

¹⁷ *The Air Quality (Scotland) Amendment Regulations 2002 (SI 2002/297); The Air Quality(England)(Amendment) Regulations 2002. (SI 2002/3043); The Air Quality (Amendment) (Wales) Regulations 2002 (SI 2002/3182 (w.298)).* The Stationery Office Ltd.

¹⁸ *Expert Panel on Air Quality Standards. Carbon Monoxide.* 1994. The Stationery Office Ltd.

88. In making their respective recommendations WHO and EPAQS reached slightly different conclusions from the available evidence of health effects. At present, there is no conclusive evidence of health effects occurring at concentration below the levels recommended by either WHO or EPAQS.

Sources of carbon monoxide

89. Carbon monoxide is a gas formed by the incomplete combustion of carbon containing fuels. In general, the more efficient the combustion process, the lower the carbon monoxide emission. The main outdoor source of carbon monoxide in the UK is currently road transport, which accounts for about 69% of UK emissions mainly from petrol-engined vehicles.

Policy developments

90. The range of transport measures, discussed elsewhere in the Addendum, will also contribute to reducing emissions of carbon monoxide. The introduction of tighter European vehicle emissions and fuel quality standards will make a significant contribution towards reducing emissions of carbon monoxide. So too will the policy measures in the UK Government's Ten Year Transport Plan, the Scottish Executive's Transport Delivery Report, the Welsh Assembly Government's Transport Framework for Wales and local authority traffic management schemes introduced through the LAQM arrangements. The phased introduction of BAT (Best Available Techniques) through the PPC regime of integrated permitting, being phased in until 2007, should also have an impact on reducing carbon monoxide emissions from industrial processes.

91. The second EU Air Quality Daughter Directive, adopted in November 2000, sets a limit value for carbon monoxide in ambient air of 10 mg/m³ (8.6ppm) as a maximum daily running 8-hour mean to be achieved by Member States by 1 January 2005.

Current and future air quality

92. Emissions of carbon monoxide declined by 33% between 1990 and 1999. Forecasts show that carbon monoxide emissions from transport are expected to decline by 40% between 1995 and 2005. The maximum 8-hour mean concentrations of carbon monoxide currently being recorded in urban background locations are already below 10 mg/m³. In 2000, at roadside and kerbside sites, where pollution levels are likely to be highest, measured concentrations recorded ranged from 2.9 mg/m³ to 7.5 mg/m³. Indications, from the results of work to update the emission inventory and modelling projections for all major road links, are that existing policy measures should be sufficient to reduce roadside concentrations of carbon monoxide in all areas to below 10 mg/m³ by 2003.

Conclusion

93. In view of the success of measures in reducing concentrations of carbon monoxide, and the measures in place to achieve further reductions, the UK Government and the devolved administrations have decided to replace the 2000 Strategy's objective with the more ambitious objective of achieving 10 mg/m³ as a maximum daily running 8-hour mean (in Scotland, as a running 8-hour mean) by the end of 2003. The new objectives for carbon monoxide have been set in regulations¹⁹ for the purposes of LAQM. The work already undertaken by local authorities in reviewing and assessing the 2000 Strategy's objective for carbon monoxide should allow them to check achievement of the tighter objective without the need for significant further work.

Polycyclic aromatic hydrocarbons (PAHs)

94. The UK Government and the devolved administrations for Scotland and Wales have introduced a new objective for polycyclic aromatic hydrocarbons (PAHs) into the Air Quality Strategy. PAHs are members of a large group of organic compounds widely distributed in the atmosphere. The best known PAH is benzo[a]pyrene (B[a]P). The new objective for PAHs is:

0.25 nanograms per cubic metre (ng/m³) (B[a]P) as an annual average by 31 December 2010.

95. Further modelling of PAHs in Northern Ireland is currently underway. The Department of the Environment in Northern Ireland will consider the introduction of an air quality objective for PAHs once the work is complete, presently planned for early 2003, and make an announcement.

Health effects of PAHs

96. Studies of occupational exposure to PAHs have shown an increased incidence of tumours of the lung, skin and possibly bladder and other sites. Lung cancer is most obviously linked to exposure to PAHs through inhaled air. In its report, published in 1999²⁰, EPAQS recommended an air quality standard for PAHs of 0.25 ng/m³ (0.25 nanograms per cubic metre) as an annual average, based on B[a]P as a marker for the total mixture of PAHs in the UK. This recommendation is intended to reduce any risk to the population from exposure to PAHs to one which the Panel believes would be so small as to be undetectable. The Panel also commented that it does not necessarily follow that all exposure above this standard carries a significant risk, in view of the

¹⁹ *The Air Quality (Scotland) Amendment Regulations 2002 (SI 2002/297); The Air Quality(England)(Amendment) Regulations 2002. (SI 2002/3043); The Air Quality (Amendment) (Wales) Regulations 2002 (SI 2002/3182(w.298)).* The Stationery Office Ltd.

²⁰ *Expert Panel on Air Quality Standards. Polycyclic Aromatic Hydrocarbons.* 1999. The Stationery Office Ltd.

effective application of an additional 10-fold safety factor in deriving the standard.

European proposal for a limit value for PAHs

97. An EC working group has been reviewing evidence in order to recommend a limit value for PAHs for inclusion in a future air quality daughter directive. The working group has, like EPAQS, proposed a limit value based on a maximum annual average concentration of B[a]P as a marker for PAHs. The working group recommended a limit value between 0.5-1.0 ng/m³. The European Commission will consider the working group's recommendations before coming forward with any proposals.

Sources of PAHs

98. The main sources of PAHs in the UK are domestic coal and wood burning (39%), fires (e.g. accidental fires, bonfires, forest fires, etc) (28%), anode baking and aluminium production (19%), and road transport (8%). Available data indicates a substantial decline in emissions in the UK. Emissions of B[a]P are forecast to have reduced from about 68 tonnes per annum in 1990 to about 9.5 tonnes in 2000 and are estimated to fall to about 6.4 tonnes by 2010.

Measures to reduce PAHs

99. Measures to reduce emissions of PAHs have been completed, are underway or planned at each of the principal industrial sources in the UK. The introduction of the PPC regime will require existing controls on industrial sites to be reviewed and, where appropriate, upgraded. A combination of national policies and local measures to reduce emissions of particles (PM₁₀) from vehicles and other combustion sources will also reduce future emissions of PAHs. Agricultural burning has also been significantly reduced since the early 1990s.

100. Benzo[a]pyrene is predominately present in the air attached to particles. Most carcinogenic PAHs occur almost exclusively in the long-lived particulate phase. Action being taken to reduce particle concentrations is therefore expected to have a direct impact on concentrations of B[a]P. Action being taken at national level under EU Directives setting tighter vehicle emissions and fuel standards to reduce particle emissions and local measures to cut levels of PM₁₀ from vehicles and other combustion sources, including domestic coal burning, will also contribute to the reduction of emissions of B[a]P.

Current and future air quality

101. Concentrations of PAHs in the UK are currently measured at 23 monitoring sites within the national network. A further two will be added shortly. The sites monitor

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concentrations of B[a]P as a marker for the total mixture of PAHs as well as a suite of other PAHs. The measured B[a]P concentrations can therefore be compared directly to the air quality standard of 0.25 ng/m³ recommended by EPAQS.

102. Ratified data for 2000 are available for 15 monitoring sites and show that annual average concentrations of B[a]P ranged from 0.04-1.17 ng/m³, discounting the highest level of 2.28 ng/m³ recorded in the vicinity of an industrial plant which closed during 2000. Annual average concentrations in excess of the EPAQS recommended standard were recorded at six sites, five located in industrial areas and one in a town where coal is used for domestic heating. Measurement data from 21 sites are available for 2001 and annual average concentration of B[a]P ranged from 0.05-0.96 ng/m³. Concentrations in excess of the EPAQS recommended standard were recorded at nine sites, including five in industrial areas and three in areas where local domestic solid fuel use is thought to be a significant source. Statistically significant downward trends in B[a]P concentrations have been observed between 1990 and 2000 in London, Manchester, Middlesbrough and at some rural sites. Estimates of future PAHs concentrations are that levels will continue to decline.

103. A programme of work was undertaken to inform a proposed objective for PAHs for inclusion in the Strategy. Unlike the other pollutants considered as part of the latest review of the Strategy, there has not been any previous consolidated research to assess future PAH concentrations in the UK. The work programme concentrated on improving understanding of the sources and future projections of PAHs and identifying the key areas of uncertainty.

104. Overall, the assessment indicates that current levels of B[a]P appreciably above the 0.25 ng/m³ target are limited to a small number of locations in the immediate vicinity of industrial sources and areas with significant domestic coal burning. In urban centres levels of B[a]P are presently about 0.25 ng/m³ but are expected to decline. The modelling assessment indicates that the average (measured as a population weighted average) ambient exposure to B[a]P in 1999 was 0.16 ng/m³ and that this will fall further to 0.13 ng/m³ by 2010 on the basis of present policies. In 1999 it is estimated that there were 5.8 million people exposed to levels of B[a]P above 0.25 ng/m³ but that this will fall to 2.2 million people by 2010, also on the basis of present policies.

105. The assessment shows that in 1999, total emissions of B[a]P were a third less than previous estimates. This is largely due to substantially reduced emissions from the aluminium industry and lower traffic emissions. The assessment also suggests that the key sources of B[a]P may be different to other pollutants included within the Strategy. In particular, domestic coal and wood burning appears to be the largest source nationally and leads to elevated concentrations in areas where this is widespread. Fires, including accidental and malicious fires, bonfires and forest and moorland fires are also a significant national source. Emission estimates for these sources are particularly uncertain and further work is planned in order to improve estimates of releases and future projections.

106. The assessment also indicates that contrary to previous evidence, vehicles are no longer a significant source of B[a]P. Updated vehicle emissions inventories indicate smaller releases from vehicles than previously estimated and evidence from

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measurements at the Marylebone Road kerbside monitoring site in London shows that concentrations adjacent to heavily trafficked roads are not significantly higher than at urban background locations. The results from further vehicle emissions testing and monitoring will be used to confirm these findings.

107. The objective for PAHs takes account of the improved understanding of the sources of future levels of B[a]P and the practicability of any further policy measures and the costs and benefits associated with these measures.

Conclusion

108. The limited monitoring data available at the moment for PAHs, uncertainties in the current releases of B[a]P from key sources sectors and uncertainties of information about future concentrations, suggest that any objective set now should be provisional. This will be looked at again in the light of further information on concentrations, in particular in urban areas, and work on predictions of future concentrations and any EU limit value.

109. These points, and the heavy commitment that local authorities are currently giving to the LAQM process in respect of the 2000 Strategy objectives, suggest that any target for PAHs should be set for the longer term. The UK Government and the devolved administrations in Scotland and Wales have therefore adopted an objective of achieving the EPAQS recommended standard of 0.25 ng/m^3 (B[a]P) as an annual average by the end of 2010. This will be a national standard and objective and will not at present be placed in regulations for the purposes of LAQM.

110. Air quality is getting better. The number of days of moderate or higher air pollution in urban areas in 2000 was the lowest since the present statistical series began in 1993. Provisional results of the air quality headline indicator for 2002 confirm a continued downward trend in levels of air pollution. Vehicle emissions in particular will reduce further as new vehicles and fuels become cleaner, and more polluting older vehicles fall out of the vehicle parc. But it is important to maintain and build on these improvements to air quality to reduce the impact that air pollution has on public health and meet our national objectives and the air quality limit values set under European legislation.

111. This Addendum incorporates into the Air Quality Strategy the findings from the first review of the 2000 Strategy and outcome of public consultation in 2001 on new air quality objectives. The UK Government and the devolved administrations are currently considering the scope and timing of future reviews. As indicated in Chapter 6 of the 2000 Strategy, it is likely that the next review will focus less on the air quality objectives themselves, and more on the policy measures needed to deliver them. Within this overall approach, however, the opportunity may be taken to revise individual objectives or consider new ones in the light of policy and scientific developments.

ANNEX

Useful website addresses for air quality information	
Air Quality Archive (including air quality bulletins and forecasts)	www.airquality.co.uk
Association of London Government	www.alg.gov.uk
Atmospheric Research Information Centre	www.ace.mmu.ac.uk/resources
Cabinet Office Regulatory Impact	www.cabinet-office.gov.uk/regulation
Chartered Institute of Environmental Health	www.cieh.org.uk
Clean Air for Europe	www.europa.eu.int/comm/environment/air/café/index
Department for Environment, Food and Rural Affairs	www.defra.gov.uk
Department of the Environment Northern Ireland	www.doeni.gov.uk
Department for Transport	www.dft.gov.uk
Department of Health	www.doh.gov.uk
Environment Agency	www.environment-agency.gov.uk
Environment and Heritage Service Northern Ireland	www.ehsni.gov.uk
European Environment Agency	www.eea.eu.int
Institute of Air Quality Management	www.iaqm.co.uk
Local air quality management (including maps of air quality management areas)	www.airquality.co.uk/archive/laqm
Local Government Association	www.lga.gov.uk
National Asthma Campaign	www.asthma.org.uk
National Atmospheric Emissions Inventory	www.naei.org.uk
National Society for Clean Air and Environmental Protection	www.nasca.org.uk
Northern Ireland Assembly	www.ni-assembly.gov.uk
Scottish Environment Protection Agency	www.sepa.org.uk
Scottish Executive	www.scotland.gov.uk
Scottish Local Government	www.slgju.gov.uk
United Nations Economic Commission for Europe	www.unece.org
Welsh Assembly Government	www.wales.gov.uk
Welsh Local Government Association	www.wlga.gov.uk

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