Children's Environment and Health Action Plan for Europe

Development of a UK Children's Environment and Health Strategy

Regional Priority Goal III: Respiratory Health – Indoor and Outdoor Air Pollution

Report prepared by the Health Protection Agency for the Interdepartmental Steering Group (ISG) on Environment and Health

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This report reflects understanding and evaluation of the current scientific evidence as presented and referenced in this document.

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This is an HPA document and, as such, does not necessarily represent the views of the Department of Health or the individual Departments, Agencies or Devolved Administrations that comprise the ISG.

EXECUTIVE SUMMARY

Children's Environment and Health Action Plan for Europe: Regional Priority Goal III

We aim to prevent and reduce respiratory disease due to outdoor and indoor air pollution, thereby contributing to a reduction in the frequency of asthmatic attacks, in order to ensure that children can live in an environment with clean air.

We aim to achieve a substantial reduction in the morbidity and mortality from acute and chronic respiratory disorders in children and adolescents by:

(a) developing indoor air quality strategies that take into account the specific need of children;

(b) implementing the Framework Convention on Tobacco Control, by legislative measures, through the drafting and enforcement of the necessary regulations and by setting up health promotion programmes that will reduce smoking prevalence and the exposure of pregnant women and children to environmental tobacco smoke;

(c) improving access of households to healthier and safer heating and cooking systems as well as cleaner fuel;

(d) applying and enforcing regulations to improve indoor air quality, especially in housing, child care centres and schools, with particular reference to construction and furnishing materials;

(e) reducing emissions of outdoor air pollutants from transport-related, industrial and other sources through appropriate legislation and regulatory measures which ensure that air quality standards such as those developed under EU legislation take into account the values set by the WHO air quality guidelines for Europe. In particular we call upon car manufacturers to equip new diesel motor vehicles with particle filters or other appropriate technologies in order to drastically reduce emissions of particles, and to that effect we will continue to develop legislative and regulatory measures as well as economic incentives.

WHO, 2004a

A review has been undertaken to assess the current status relating to air quality issues that may affect children in the UK; consideration has been given as to whether the areas highlighted in the Children's Environment and Health Action Plan for Europe's (CEHAPE) Regional Priority Goal III (RPG III; see box above) have been addressed and, where relevant, gaps and areas for further improvement have been highlighted. This paper considers indoor and outdoor air quality and has highlighted the following:

- Outdoor Air Quality in the UK is of a generally high standard. Despite the significant improvements in the quality of the air in the UK, there are still concerns regarding levels of pollution and health effects of exposure on children *[bullet point (e) in box above]*.
- Current UK legislation sets standards and objectives for a variety of outdoor air pollutants known to have health effects. This legislation is regularly reviewed and revised as needed and local authorities have a statutory responsibility to regularly

review and assess air quality in their own area and take action to improve air quality where this is shown to be necessary *[bullet point (e) in box above]*.

- Further rural monitoring of $PM_{2.5}$ is needed to assist in the characterisation of regional $PM_{2.5}$ background levels, the quantification of urban increments and the characterisation of $PM_{2.5}$ episodes *[bullet point (e) in box above]*.
- There appears to be a lack of research activities regarding air pollution and children's health and it is possible that this is an area that needs further work.
- Indoor Air Quality is less well legislated for in the UK, particularly where children are concerned although building regulations in the UK set standards for ventilation in buildings including schools *[bullet points (a)and (d) in box above]*.
- There appears to be a lack of public awareness of the dangers from indoor air quality resulting from poor maintenance of gas appliances suggesting that further work may need to be done in this area *[bullet point (c) in box above]*.
- Many children are exposed to environmental tobacco smoke in the home. There is a concern as to whether exposure in the home may become a larger problem as a result of legislation introduced in the UK banning smoking in enclosed public spaces. NHS Scotland is currently funding a study to examine the effects of the introduction of a smoking ban in Scotland on children's exposure and a similar study has been commissioned in Wales by the Welsh Assembly Government *[bullet point (b) in box above]*.
- Studies show that social inequalities do exist where more deprived populations live in areas of higher pollution such as close to industries or main roads *[bullet points (a) and (e) in box above]*.

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1 INTRODUCTION

At the Fourth Ministerial Conference on Environment and Health in 2004, the countries in the WHO European Region, including the UK, committed themselves to building a healthy future for their children by adopting the Children's Environment and Health Action Plan for Europe. This was drafted to ensure reduction and, where possible, elimination of children's exposure to environmental risk factors. Individual countries were required to develop national children's environmental and health action plans (CEHAP) the purpose of which being to identify:

- specific environmental risks to children;
- initiatives currently in place to reduce these risks and
- gaps or areas where work may be directed to continue to reduce or eliminate such risks.

The CEHAPE has identified four Regional Priority Goals under which specific areas of risk are to be considered. The four RPGs are: to (i) ensure safe water and adequate sanitation; (ii) ensure protection from accidents, injuries, obesity and physical activity; (iii) ensure clean indoor and outdoor air quality; and (iv) aim to reduce exposure to chemical, physical and biological hazards.

1.1 Background

Clean air is essential to a good quality of life. A wide variety of air pollutants are known or suspected to have harmful effects on the health of the population, including children. A report by the Committee on the Medical Effects of Air Pollution (COMEAP) reported that air pollution results in between 12,000 and 24,000 premature deaths and between 14,000 and 24,000 hospital admissions and readmissions in the UK population (COMEAP, 1998).

Children are more likely to be susceptible to the effects of poor air quality both indoors and outdoors for a number of reasons. Children take in more air per unit body weight at a given level of exertion than adults, and so toxins in the air are absorbed more rapidly than in adults. Children may be more susceptible as they spend more time outdoors than adults and are potentially outdoors when pollution levels are at their highest. Children's lungs are growing and developing therefore, exposure to air pollution may result in cellular changes that may cause long term damage, preventing the lung from achieving full growth and function as the child matures to adulthood.

The UK Government and Devolved Administrations are committed to improving air quality. Although air quality in the UK is generally of a good standard, there are still some hotspots of poorer air quality, particularly in city and town centres related to emissions from transport and, most commonly in the South of England, there can be individual high pollution episodes which can harm the environment and health.

1.2 Structure and aims of this report

This is one of a series of four papers addressing the individual RPGs. this paper addresses RPG 3: reducing the rates of respiratory illness in children by improving indoor and outdoor air quality. What follows is a comprehensive review of the current situation in the UK with regard to indoor and outdoor air quality (including environmental tobacco smoke). The paper highlights key legislation in place to support measures aimed at reducing risk and protecting the public (including children) and identifies a number of national, regional and local initiatives which support the achievement of this goal. In so far as data are available, the paper highlights the current situation relating to children and attempts to identify areas where levels of risk are not sufficiently known or addressed. Areas of concern and gaps in knowledge or activity are identified and recommendations on how these gaps may be filled are provided.

This report aims to assess the current status relating to air quality issues that may affect children in the UK. Both indoor and outdoor air quality are considered and where there are gaps in activity or areas where further improvements need to be made, these are highlighted. Appendix A summarises UK initiatives that address the specific goals of CEHAPE.

Unless specified information presented in this report is applicable to the whole of the UK and, where relevant, issues specific to Devolved Administrations or to local and regional areas, are also highlighted. Legislation references throughout the document may be predominantly sourced from English law; however it should be noted that equivalent separate legislation and policy documentation may exist in Wales, Scotland and Northern Ireland when referring to particular areas.

Whilst every effort has been made to ensure this document is comprehensive, it should be recognised that there are many other activities undertaken throughout the UK at a local, regional and national level as well as internationally (at WHO Europe Member State level), all of which also contribute to meeting the commitments of CEHAPE. Further information on relevant on-going activities and new CEHAPE initiatives aimed at fulfilling the UK's commitments to CEHAPE will be placed on the HPA's web page in due course.

Box 1.1 Examples of common outdoor and indoor pollutants and the health effects of exposure

Sulphur Dioxide (SO_2) is an acidic gas that combines with water vapour in the atmosphere producing acid rain. The principal source of SO_2 gas is the burning of sulphur containing fossil fuels in power stations. The health effects of moderate concentrations of SO_2 include a decline in lung function in asthmatics. At high levels, tightness in the chest and coughing can occur to the extent that increased use of bronchodilator therapy is required.

Particulate matter is a complex mixture of organic and inorganic materials produced from a variety of sources such as industrial processes and natural sources. A principal source of airborne particulate matter in Europe is road traffic emissions, particularly from diesel vehicles. Heath effects of inhalation of fine particulate matter can cause inflammation and a worsening of respiratory and cardiovascular diseases. In addition, they may carry surface adsorbed carcinogenic compounds into the lungs.

Carbon Monoxide (CO) is a colourless, odourless and tasteless gas produced as a result of the incomplete combustion of fossil fuels. Carbon monoxide is produced almost entirely from road traffic emissions (90%) in European urban areas. Heath effects of inhalation of high concentrations of CO leads to reduced oxygen availability (increase in carboxyhaemoglobin), thus preventing normal oxygen transport throughout the blood. Other health effects include; exhaustion, fatigue, flu-like symptoms in young healthy adults and ECG changes in patients with ischemic heart disease.

Nitrogen Oxides (NO_2) are formed during high temperature combustion processes from the oxidation of nitrogen in the air of fuel. Approximately 50% of the emissions in Europe result from road traffic, resulting in greatest concentrations in urban areas where road traffic is heaviest. Health effects include; lung irritation and lower resistance to respiratory infections, prolonged exposure to high levels may result in an increase in acute respiratory illness in children.

Ozone is a highly reactive oxidising agent that is present naturally in the atmosphere as a result of the action of sunlight on NO_2. Levels are highest during hot, still and sunny weather. Health effects of exposure include; airway irritation, increasing symptoms in those suffering from asthma and lung diseases. Ozone is also a highly reactive oxidising agent that can cause inflammatory reactions in the respiratory tract.

Volatile Organic Compounds (VOCs) comprise a broad range of organic compounds that are released in vehicle exhaust gases either as unburned fuels or as combustion products and are also emitted by the evaporation of solvents and motor fuels. VOC compound emissions react to form ground level ozone, one of the components of summer smog, with health effects similar to ozone and nitrogen oxides.

Environmental Tobacco Smoke (ETS), also known as second-hand smoke, consists of side-stream and main stream smoke exhaled by the smoker or from the tip of a cigarette. ETS consists of more than 4000 chemical compounds of which at least 40 are known carcinogens. Health effects following exposure to ETS in adults and children and has been causally linked with lower-respiratory tract infections such as bronchitis and pneumonia, increased risk of sudden infant death syndrome, asthma, respiratory symptoms and acute and chronic middle-ear disease in children (Taylor *et al.*, 2005).

2 OUTDOOR AIR QUALITY

2.1 Legislation

The Clean Air Act represents one of the early pieces of legislation implemented to improve air quality in the UK (Appendix B). European Union (EU) Directives specify air quality limit values designed to protect human health. The principal EU directive to date is the Air Framework Directive (96/62/EC), which defines the policy framework for 12 air pollutants known to have harmful effects on human health and the environment. A series of daughter directives specify limit values and monitoring methods for the key pollutants. In particular the first daughter directive sets mandatory limits for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead (CEU, 1999). The second daughter directive outlines mandatory limits for carbon monoxide and benzene (CEU, 2000); the third daughter directive sets aspirational targets for low level ozone in ambient air (CEU, 2002). These have been transposed into UK law through the Air Quality Limit Values Regulations 2003, the Air Quality Limit Values (Scotland) Regulations 2003 and the Air Quality Limit Values (Amendment) Regulations (Northern Ireland) 2002.

A fourth directive was published in 2004 setting aspirational targets for Polycyclic Aromatic Hydrocarbons (PAHs), nickel, arsenic, mercury and cadmium (CEC, 2005). The UK Government and Devolved Administrations have transposed the Directive into national law, and consolidated transposition of 1 to 3, through the Air Quality Standards Regulations 2007 in England, and equivalent legislation in Northern Ireland, Scotland and Wales.

The Environment Act 1995 (and analogous legislation in Northern Ireland) set new standards for environmental management which required the UK government to develop a National Air Quality Strategy (NAQS) that set targets for air pollutants of concern. The first NAQS was produced in 1997 and included objectives for eight key air pollutants based on the best available scientific understanding of their effects on health.

The strategy was revised in 2000 and sets out the short to medium term policy framework for air quality in the UK. The objectives are: benzene, 1, 3-butadiene, carbon monoxide (CO), lead, nitrogen dioxide (NO_2), ozone, PM_{10} and sulphur dioxide (SO_2). All have target dates between 2003 and 2010 and, with the exception of ozone, are included in the Air Quality (Scotland) Regulations 2000, the Air Quality (Wales) Regulations 2000, Air Quality Regulations (Northern Ireland) 2003 and the Air Quality Regulations 2000 for the purposes of Local Air Quality Management (LAQM). Under LAQM, all local authorities in the UK are required to regularly review and assess air quality in their areas against the air quality objectives. If this work indicates that an objective is unlikely to be achieved by the due date, the authority concerned must declare and Air Quality Management Area (AQMA) and produce an action plan outlining how it intends to tackle the issues identified. Air Quality Management Areas may vary in size from a single building to an entire local authority area. Action plans may include a range of measures for improving air quality such as green travel plans, tighter vehicle emission standards or traffic management and, in England, are required to be

incorporated into local transport plans (from 2008 local transport plans will be known as regional transport plans in Wales). By January 2007, around 200 local authorities across the UK have established one or more AQMAs, the vast majority resulting from transport emissions of NO_2 and/or fine particles in urban areas.

The Strategy was revised again in 2003 and several new objectives were introduced. These included tighter long term objectives for benzene in Scotland and Northern Ireland, a similar objective for particles in Scotland only, a tightening of the existing objective for carbon monoxide across the UK and a new UK objective for PAHs, although this was not included in regulations for LAQM purposes. New long term particle objectives for the rest of the UK were also introduced but, as with PAHs, were not included in regulations. New regulations were introduced to reflect these developments. An addendum to the Strategy was published in 2003. A further review of the Strategy commenced in 2006 and was concluded in mid 2007. This review focused more on the effectiveness to date of the policies contained in the Strategy in achieving their aims, rather than further changes to the objectives.

The UK Air Quality Strategy aims to:

- Map out as far as possible future ambient air quality policy in the UK 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 individuals can do to improve air quality.

The current air quality objectives and dates by which these need to be achieved are shown in Table 2.1.

Table 2.1 National air quality objectives for the protection of human health

Pollutant	Objective	Measured as	To be achieved by
Benzene			
All Authorities	16.25 μg/m^3	Running annual mean	2003
England and Wales	5 μg/m^3	Annual mean	2010
Scotland and Northern Ireland	3.25 μg/m^3	Running annual mean	2010
1,3-Butadiene	2.25 μg/m^3	Running annual mean	2003
Carbon monoxide			
England, Wales and Northern Ireland	10.0 mg/m^3	Maximum daily running 8 hour mean	2003
Scotland	10.0 mg/m^3	Running 8 hour mean[a]	2003
Lead	0.5 μg/m^3	Annual mean	2004
Set for children	0.25 μg/m^3	Annual mean	2008
Nitrogen dioxide[b]	200 μg/m^3, not to be exceeded more than 18 times per year	1 hour mean	2005
	40 μg/m^3	Annual mean	2005
Ozone[*]	100 μg/m^3	Running 8 hour mean, not to be exceeded more than 10 times per year	2005
Particles (PM_{10})[c]			
All authorities	50 μg/m^3, not to be exceeded more than 35 times per year	24 hour mean	2004
	40 μg/m^3	Annual mean	2004
Scotland[d]	50 μg/m^3, not to be exceeded more than 7 times per year	24 hour mean	2010
	18 μg/m^3	Annual mean	2010
Particles ($PM_{2.5}$) UK (except Scotland)	25 μg/m^3		2010
Scotland	12 μg/m^3	Annual Mean	2015
UK Urban Areas	15% reduction in concentrations at urban background		Between 2010 and 2020
Polycyclic aromatic hydrocarbons	0.25 ng/m^3 B[a]P	Annual average	2012
Sulphur dioxide	266 μg/m^3, not to be exceeded more than 35 times per year	15 Minute Mean	2005
	350 μg/m^3, not to be exceeded more than 24 times per year	1 Hour Mean	2004
	125 μg/m^3, not to be exceeded more than 3 times per year	24 Hour Mean	2004

Notes:

[a] The Quality Objective in Scotland has been defined in Regulations as the running 8-hour mean, in practice this is equivalent to the maximum daily running 8-hour mean

[b] The objectives for nitrogen dioxide are provisional.

[c] Measured using the European gravimetric transfer sampler or equivalent.

[d] These 2010 Air Quality Objectives for PM_{10} apply in Scotland only, as set out in the Air Quality (Scotland) Amendment Regulations 2002.

*Ozone is not included in the Regulations

From Defa (2007) *The Air Quality Strategy for England, Scotland, Wales and Northern Irelan. Volume 1,* available [Aug 07] at: **http://www.defra.gov.uk**

There are a number of other pieces of legislation, aimed at controlling emissions to air, which are of relevance. Appendix C lists some of the main EU and equivalent national legislation; these are not specific to children but consider the health of the entire population of the UK.

The use of lead in petrol required the addition of 1,2-dichloroethane scavengers which contributed to emissions of dioxins in vehicular exhaust fumes. The general sale of leaded petrol was banned (with some exceptions) in the UK from December 1999, following the implementation of the European Directive 98/70/EC.[1]

Directive 2003/17/EC requires that unleaded petrol with a maximum sulphur content of 10mg/kg and lead content of 0.005g/l should not be marketed after 1 January 2009. EU member states should ensure that unleaded petrol may only be marketed and sold if it complies with the environmental specifications in Directive 2003/17/EC.

Volatile organic compounds (VOCs) are precursors to the formation of ground level ozone and, as such, a reduction in emissions will lead to improvements in air quality and consequently public health. The UK has committed to reducing the total annual emissions of VOCs to 1200 kilotonnes by 2010[2] and maximum VOC levels have been set for paints, varnishes and vehicle refinishing products[3]. It is estimated that the Regulations will reduce VOC annual emissions in the UK by 30.1 kilotonnes.

Emissions from industrial installations are controlled by the Integrated Pollution Prevention and Control (IPPC) system, which aims to ensure a high level of protection for the environment as a whole (which includes health) in an integrated manner (HPA 2004). As such, emissions to air, water, land and other environmental effects are considered together. Under the system, an operator must apply for a permit from the Regulator (the environment agencies[4] or Local Authority) and the applicant must consider all environmental and health impacts associated with the emissions from the installation for the granting of the permit and for the lifetime of the operation of the process. In order for a permit to be granted IPPC requires industry to employ Best Available Techniques to prevent or minimise harmful emissions and environmental impacts resulting from its activities.

Environmental and health protection are the key drivers of IPPC and in the UK regulations require the consideration of potential health impacts to be wide-ranging. As part of the process of determining an application for a permit, the Regulator must consult with a number of statutory consultees and is legally bound to consider their views before granting a permit. In England, Primary Care Trusts, and in Wales, Local Health Boards, are amongst the statutory consultees and have a responsibility to offer a public health opinion of the installation, including the likely impacts of emissions on the local population. In Northern Ireland the local Health and Social Services Boards are statutory consultees and in Scotland, the consultees include NHS Boards. In formulating

[1] Petrol and diesel fuel must now conform to the requirements of the Motor Fuel (Composition and Content) Regulations (Amendment) 2003 (SI 2003, No. 3078). Petrol, diesel and gas oil must conform to British Standard EN ISO 3830:1996, as defined in Directive 2003/17/EC.

[2] Under the Gothenburg protocol and the National Emissions Ceilings Directive 2001/81/EC.

[3] Under the Volatile Organic Compounds in Paints, Varnishes and Vehicle Finishing Products Regulations 2005 which came into effect on 01 January 2007 and implements the requirements of Directive 2004/42/CE

[4] The Environment Agency in England and Wales, the Scottish Environment Protection Agency in Scotland and the Environment and Heritage Service in Northern Ireland)

this opinion, consideration is given to sensitive population groups or key receptors, which include children or schools likely to be affected by the installation (HPA 2004).

The IPPC system is implemented in England and Wales by the Pollution Prevention and Control (PPC) (England and Wales) Regulations 2000 (SI 2000, No. 1973), and analogous legislation in Northern Ireland and Scotland. The process came into effect on 1 August 2000 and installations covered have to be brought into compliance by 30 October 2007.

2.2 Current Status

In the past 10 years the UK's national air monitoring networks have increased considerably as a result of both the growing concern about health impacts, and the requirements of the Air Quality Strategy and associated legislation. Local authorities have also increased their local networks considerably and many contribute data to UK wide monitoring programmes funded and supported by the UK Government and Devolved Administrations. Of the 1600 air quality monitoring sites included in the UK network, 120 of them operate automatically, providing hourly information on a range of pollutants. The remaining, non-automatic sites measure average concentrations over a specified sampling period, typically a week or month.

The National Atmospheric Emissions Inventory (NAEI, 2007) funded by the Department for the Environment, Food and Rural Affairs (Defra), the Welsh Assembly Government, the Scottish Executive and the Department of Environment, Northern Ireland, compiles estimates of emissions to the atmosphere from UK sources such as motor vehicles, power stations and industrial plants.

The UK Air Quality Archive[1] website provides a national resource on air pollution, providing information on current air pollution levels throughout the UK, together with analyses of trends, patterns of pollution, detailed statistics, downloads and 24 hour pollution forecasts. Comprehensive websites, providing local data not included in the UK Archive, have been produced for the Welsh Assembly Government[2] and Northern Ireland.[3] A similar web-based air quality information resource for the Scottish Executive was established in April 2007.

The Department for Environment, Food and Rural Affairs also provides a resource for air pollution data and statistics, providing information on trends in emissions and ambient concentrations of atmospheric pollutants and on acid deposition in the UK.[4]

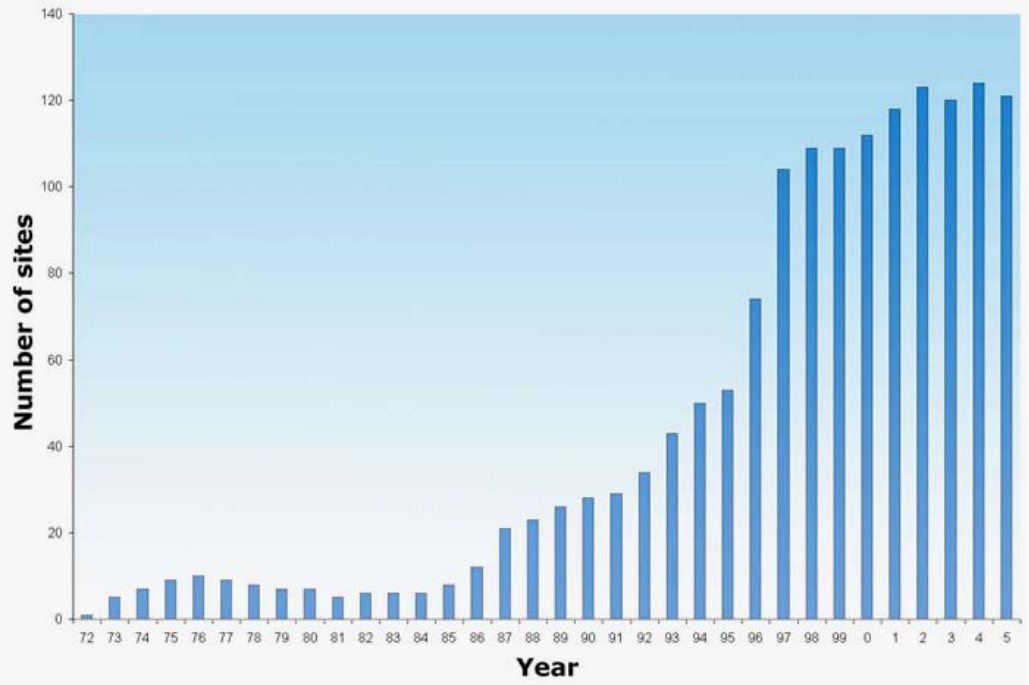
[1] UK Air Quality Archive (2007) *Welcome to the UK Air Quality Archive,* available [May 2007] at: http://www.airquality.co.uk/

[2] The Welsh Air Quality Forum (2007) *Air Quality in Wales*, available [May 2007] at: http://www.welshairquality.co.uk/

[3] *Northern Ireland Air,* available [May 2007] at: http://www.airqualityni.co.uk

[4] Defra (2007) *E-Digest Statistics about: Air Quality*, available [May 2007] at: http://www.defra.gov.uk/

Figure 2.1 Numbers of automatic air monitoring stations, 1973–2005



Source: Defra

Trends in air pollution show that the levels of various outdoor pollutants have steadily decreased in recent years. Please refer to Appendix A which demonstrates how the levels of different pollutants have decreased by source over the last number of years with graphs outlining the levels of pollutants in relation to the Air Quality Standards in the UK.

Particulates

Between 1990 and 2005 PM_{10} emissions fell by 51%. About two-fifths of this decrease was attributable to a reduction in emissions from power stations of 84% over the same period. Road transport now contributes 22% of all PM_{10} emissions with the main source of road transport emissions being exhaust from diesel engine vehicles.

The original air quality objective for particles stated that by the end of 2004, the 24 hour mean should not exceed 50 µg m^3 more than 35 times and that the annual mean should not exceed 40 µg m^3. In 2004 24-hour means exceeded the 50 µg m^3 more than 35 times at three sites in the UK while the London Marylebone Road monitoring site was the only site to exceed the 40 µg m^3 annual mean.

Nitrogen Oxides

Total nitrogen oxides emissions fell by 45% between 1990 and 2005 to 1627 thousand tonnes. The combustion of diesel, petrol and coal are the major sources of NO_x emissions, with road transport accounting for 37% and energy industries contributing another 27% of the total emissions.

The UK Air Quality Strategy health objective states that the 1 hour mean should not exceed 200 µg/m^3 more than 18 times a year by 2005. The health objective that the

annual mean should not exceed 40 μg/m^3 to be met by 2005 was achieved by 75% of the sites in 2005.

Carbon Monoxide
Carbon Monoxide emissions fell by 71% between 1990 and 2005. The major source of CO in the UK is road transport and emissions from this source fell by 79% between 1990 and 2004 as a result of the introduction of catalytic converters on petrol vehicles. Carbon Monoxide emissions from residential fossil fuel use fell by 57% in the same period due to the decline in use of solid fuels in favour of gas and electricity.

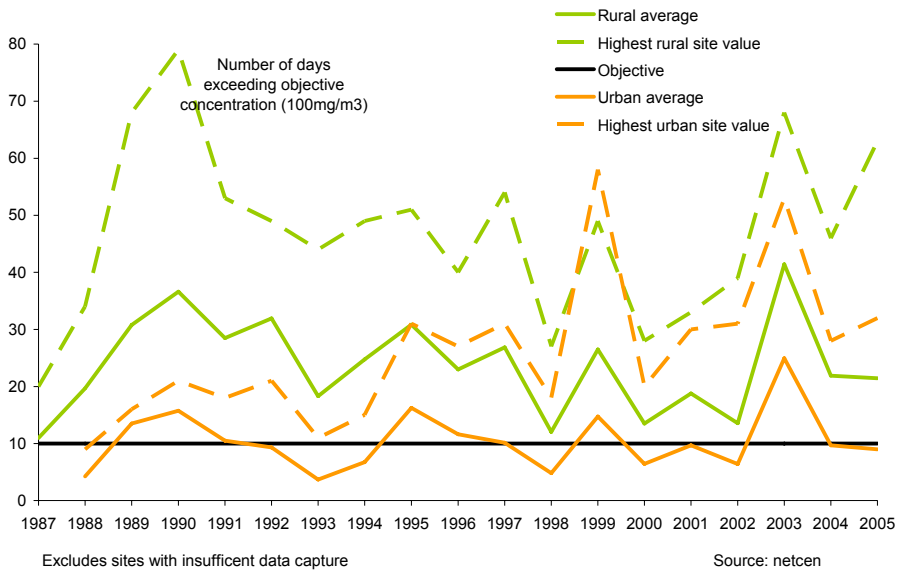
Sulphur Dioxide
Sulphur dioxide emissions fell by 85% between 1990 and 2005, with power station emissions falling by 84%, primarily due to the reduction in the use of coal. Following a reduction in the sulphur content of fuels, road transport emissions decreased by 85% since 1998 and emissions from residential fuel fell by 71% between 1990 and 2004.

Volatile Organic Compounds
Total VOC emissions fell by 58% between 1990 and 2005 with road transport emissions falling by 86% over the same period, primarily as a result of the introduction of catalytic converters for petrol cars.

Benzene emissions also fell by 75% between 1990 and 2005 and by 42% between 1999 and 2000 alone, largely due to a reduction in the benzene content of petrol as well as the ongoing effect of catalytic converters. Emissions of 1,3-butadiene fell by 73% between 1990 and 2004.

Ozone
There is evidence that near ground level ozone concentrations of typically 20 to 30 μg m^3 per annum have doubled over the past 100 years to the current levels of approximately 70 μg m^3 per annum over the UK. Ozone concentrations recorded at rural sites are generally higher than those at urban sites (Figure 2.2) due to the presence of other pollutants in urban areas such as nitric oxide which reacts with ozone to form NO_2. These rises i may potentially lead to increased exposure to ozone in children which in turn may lead to increased adverse health effects as highlighted in Box 1.1.

Figure 2.2 Ground level ozone exceedances: 1987–2005



Source: Defra (2006); Defra (2006) *E-digest Statistics about: Air Quality. Ozone,* available [May 2007] at: http://www.defra.gov.uk/

There has been considerable debate about the merits of switching from PM_{10} to $PM_{2.5}$ as the metric for particulate air pollution. The current objectives are based on the 1995 Expert Panel on Air Quality Standards (EPAQS) standard for PM_{10}. In 2001 the EPAQS re-examined the adequacy of using PM_{10} as the basis for an air quality standard but concluded that there was not enough evidence on which to base a standard on an additional or alternative metric such as $PM_{2.5}$. Following this, in 2003 a WHO working group published a review of the available scientific evidence which concluded that there was a strong association between $PM_{2.5}$ and serious health effects. As a result the WHO has since recommended the following new guideline values for PM_{10} and $PM_{2.5}$.

- $PM_{2.5}$, 10 µg m^3 annual mean; 25µg m^3 24 hour mean
- PM_{10}, 20 µg m^3 annual mean; 50µg m^3 24 hour mean

In December 2004, the CAFE working group on Particulate Matter published a position paper which recommended the use of $PM_{2.5}$ as the principal metric for assessing exposure to particles. It advised replacing the current PM_{10} stage 1 limit values with a limit value based on $PM_{2.5}$. The EPAQS did not reject the WHO advice on the health impacts of $PM_{2.5}$ but did question whether there would be any additional benefit to changing the metric to $PM_{2.5}$ on the grounds that the two fractions are highly correlated, suggesting that PM_{10} is an adequate surrogate for $PM_{2.5}$ (CAFE 2004).

The Air Quality Expert Group (AQEG) published their second report on particulate matter in the UK in 2005 (AQEG, 2005). The report provides an update of the science of particulate matter and an assessment of the attainability of the Air Quality Strategy objectives and EU limit values for particulate matter. The report concluded that further work is needed to assist future policy analyses on suspended particulate matter. $PM_{2.5}$ is currently measured in a small number of locations, mainly around the London region and as such there is a lack of co-located PM_{10} and $PM_{2.5}$ monitoring in urban

background and rural sites for the purposes of policy assessment. The report concluded that further rural monitoring of $PM_{2.5}$ is needed to assist in the characterisation of regional $PM_{2.5}$ background levels, the quantification of urban increments and the characterisation of $PM_{2.5}$ episodes.

The UK Government and Devolved Administrations published the latest Air Quality Strategy for England, Scotland, Wales and Northern Ireland in July 2007.

The Strategy:

- sets out a way forward for work and planning on air quality issues
- sets out the air quality standards and objectives to be achieved
- introduces a new policy framework for tackling fine particles
- identifies potential new national policy measures which modelling indicates could give further health benefits and move closer towards meeting the Strategy's objectives.

The updated Air Quality Strategy retains many of the objectives set out in the original Air Quality Strategy however a key change is the adoption of an 'exposure reduction' approach for $PM_{2.5}$ which reflects the views of the WHO and wider scientific community (DEFRA, 2007).

Strict legislation controlling emissions from industry and legislation controlling residential fuel use along with an increase in the number of vehicles means that road transport is currently one of the largest sources of air pollution in the UK. Monitoring data show that concentrations of SO_2 have decreased in the last number of years, particularly as a result of the move away from coal use as a domestic fuel with no exceedances of the 1 hour mean objective level at urban sites since 1998 and only one exceedance of the 24 hour mean objective between 2000 and 2005 suggesting adequate control of SO_2. The introduction of catalytic converters to petrol cars has contributed to the reduction of VOCs and nitrogen oxides. Despite this exceedances of both nitrogen oxides and VOCs of the objective levels still occur at monitoring sites. The use of diesel fuel in place of petrol has resulted in a decrease in carbon dioxide emissions; however they produce more fine particles.

Despite the significant improvements in the quality of the air in the UK there are still concerns about the levels of pollution observed and the possible health effects of exposure on children. In the UK the burden of childhood asthma exacerbations attributable to non-biologic air pollution (i.e. vehicle exhausts and emissions from stationary sources) is considerable, with 36 in 1000 children possibly having asthma that can be attributed to non-biological air pollution in England and Wales (HPA, 2005). The burden of disease attributable to air pollution on the long term lung function of children may be considerable with up to 57 children per 1000 population being affected in England and Wales (HPA, 2005). Gauderman *et al* investigated the association between residential exposure to traffic and 8-year lung function development. They also investigated the joint effects of local traffic exposure and regional air quality on children's lung development. The study found that living in close proximity to a freeway was associated with deficits in lung function development in children. Eight year

increases in FEV_1 and MMEF at 18 years were smaller for children who lived at least 1500m from a freeway. Deficits in 8-year growth resulted in lower FEV_1 and MMEF at 18 years of age for participants who lived within 500m of a freeway. As lung development is virtually complete at 18, it is possible that a deficit at this age will persist into later life. Although carried out in California, it is likely that similar effects might be seen in children living close to man traffic routes in the UK ad is therefore perhaps an area in which further research should be directed, given that traffic is currently one of the primary sources of air pollution in the UK.

The CMO Committee on Carcinogenicity of Chemicals in Food, Consumer Products and the Environment (COC) has reviewed the epidemiological literature relating to childhood leukaemia and exposure to traffic exhaust and petrol fumes. There is evidence to suggest that the incidence of acute lymphoblastic leukaemia in children is increasing. Benzene is a known human leukemogen and so benzene in vehicle exhaust and fuel vapours could represent a potential risk factor in the development of childhood leukaemia. Vehicle exhaust is a complex mixture of chemicals which makes it difficult to quantify exposure to individual compounds. The COC reviewed 17 studies that have investigated the possible association between proximity of residences to road traffic exhaust fumes and/or petrol stations and garages and either childhood leukaemia or childhood cancer, only three studies were UK based. Overall the COC concluded that the available evidence was insufficient to allow conclusions that there is an association between risk of childhood leukaemia and proximity to petrol stations, garages and road traffic. Positive associations between exposure to vehicle exhaust and childhood leukaemia were observed in ten of the studies reviewed however it was felt that factors such as small sample size and recall bias may have had an impact on the results and so the COC have concluded that further research is needed in this area (COC 2005).

2.3 Current and Planned Initiatives

2.3.1 Clean Air for Europe

The Clean Air for Europe (CAFE) programme aims to establish a long-term, integrated strategy to tackle air pollution and to protect against its effects on human health and the environment. CAFE was launched in March 2001 and aimed to develop, collect and validate scientific information on the effect of air pollution; to support the correct implementation and review the effectiveness of existing legislation and to develop new proposals as and when is necessary; to ensure that the requisite measures are taken at the relevant level and to develop structural links with the relevant policy areas; to develop an integrated strategy to include appropriate objectives and cost-effective measures. The objectives of the first program phase are: particulate matter, tropospheric ozone, acidification, eutrophication and damage to cultural heritage; to disseminate the information gathered during the programme among the general public. A new phase of CAFÉ, the implementation of the Thematic Strategy on Air Pollution, started in September 2005 and is likely to be concluded during 2007 (EUROPA 2007).

2.3.2 Air Pollution Research Database

The Institute for Environment and Health (IEH), with support from the Department of Health (DH) and Defra has produced a searchable database where users can access up to date information on UK researchers in the field of air pollution. The Air Pollution

Research Database (APRED) highlights the expertise of researchers as well as their areas of interest. It covers many aspects of air pollution, including:

- emissions from sources in the outdoor environment, e.g. vehicles and stationary combustion sources;
- emissions from materials used in the indoor environment and the environmental design aspects of buildings;
- exposure to ambient and indoor pollutants or environmental and physical phenomena and methods of measurement; and
- the health effects of pollutants (chemical and biological), environmental and physical phenomena and psychological factors, their potential interactions and mechanisms of action, and the factors influencing the susceptibility of particular sub-populations.

APRED provides a useful tool for identifying ongoing research projects in the field of air pollution, both indoor and outdoor. Equally APRED can help to identify gaps in current research activity and emerging areas of concern.[1]

There are few studies listed in the APRED database that relate specifically to the effects of air pollution on children's health. One study conducted a systematic review of the research evidence, published between 1966 and 2001 examining the relationship between air pollution and perinatal health outcomes; however none of the studies reviewed were UK based.

The lack of research projects on APRED may reflect a gap in research activities regarding air pollution and children's health and it is possible that this is an area that needs further work.

2.3.3 The UK Air Pollution Forecast

Air pollution forecasts in the UK currently cover five pollutants, ozone, NO_2, SO_2, CO and PM_{10}. For each of the UK regions (Figure 2.3) air pollution levels are predicted for rural, urban and roadside areas. The forecast is described in terms of an air pollution index which is based on the health effects of each of the different pollutants. The air pollution index and banding system is approved by COMEAP and uses a 1–10 index divided into four bands based on the health effects of the pollutants. These bands are 1–3 (Low), 4–6 (Moderate), 7–9 (High), and 10 (Very High). The overall air pollution index for a site is calculated using the highest concentration of the five pollutants listed above. Latest studies report that when air pollution is low effects are unlikely to be noticed even by those who are sensitive to air pollution. When air pollution is moderate sensitive people may notice mild effects, but these are unlikely to need action. When air pollution is high sensitive people may notice significant effects and may need to take action and when air pollution is very high effects on sensitive people, described for high pollution, may worsen.

The forecasts are currently published at least twice a day and are valid for 24 hours from the time of issue. Forecasts can be obtained from Teletext, a freephone number,

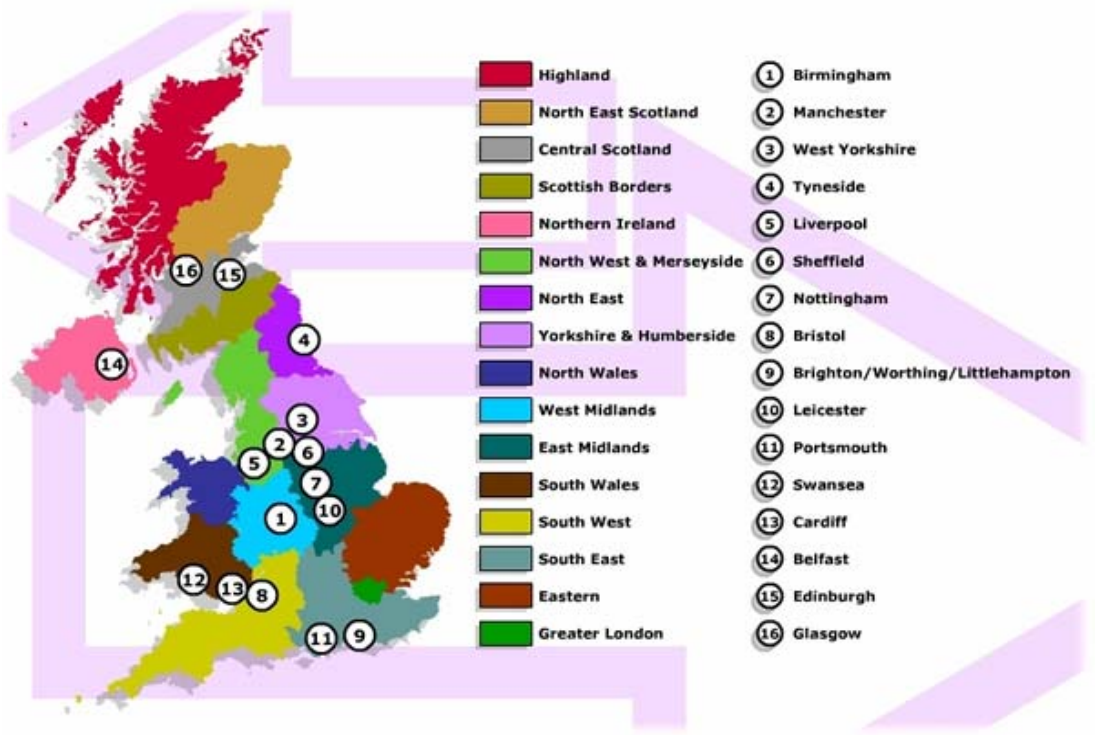
[1] IEH (2007) *APRED*, available [May 2007] at: http://www.silsoe.cranfield.ac.uk/ieh/

newspapers, and TV and radio weather forecasts. In Wales, forecasts are available on the Welsh Air Quality Forum website. Local initiatives are also in place (Box 2.2)

Box 2.1 airTEXT – keeping people informed about local air pollution[1]

airTEXT is a service provided throughout London that sends air pollution alerts and health advice to those who are most likely to be affected by air pollution when pollution levels reach MODERATE or higher in more than one tenth of the selected London borough. It is a free service for people with asthma, emphysema, bronchitis, heart disease or angina or for people living or working in London. There is an online registration form and alerts can be received by text, recorded voice message or e-mail. Alerts are sent either evening before or the morning of an expected air pollution episode, allowing individuals to prepare or make changes to plans. Each alert contains brief information about symptoms and health advice.

Figure 2.3 United Kingdom air pollution forecast regions



Source:*UK Air Quality Archive,* available [May 2007] at : http://www.airquality.co.uk/

2.3.4 Sustainable Transport Initiatives

There are numerous sustainable transport initiatives taking place in the UK. Whilst these are not primarily aimed at reducing air pollution levels, they may nonetheless have a beneficial impact on air pollution levels by virtue that they seek to reduce the number of car journeys made. A number of these initiatives of relevance to children are highlighted in Box 2.3.

[1] CERC (2007) *your air. Air pollution forecasts and alerts for airTEXT*, available [May 2007] at: http://www.airtext.info/

2.3.5 School Travel Plans

School Travel Plans aim to reduce traffic around schools and, as such, may have a beneficial impact on air pollution levels. Further detail on school travel plans is provided in (Wyke et al 2007).

Box 2.2 Sustainable Transport and the Journey to School

The Walking Bus

The Walking Bus picks up children at set points along a route to school and the children walk in pairs with an adult 'driver' at the front and adult 'conductor' at the rear. The walking bus route is selected to avoid busy roads where possible and, along with reducing traffic around the school, can reduce children's exposure to air pollution.[1]

Wheatfields School, St. Albans was the first school to take part in the walking bus scheme. Children are encouraged to take a 'green' route to school and are rewarded for cycling, using public transport or the walking bus. Of the 375 pupils in the school, 130 use a walking bus every day. The school has been widely used as an example of how to run a walking bus scheme and has won a BBC peoples award.

Park and Stride

Park and Stride schemes encourage parents who normally drive their children to school to park further away from the school and walk their children the final part of the journey to reduce traffic around the school gates. This may, in turn, reduce the amount of traffic generated air pollution to which children are exposed.

For example, Cornwall County Council was concerned about the level of congestion around St Ives school. A Park and Stride scheme was implemented encouraging parents to use a nearby Tesco's car park to drop off and pick up children, thus reducing the level of congestion around the school gates. Similarly, in York, parents with children at Archbishop of York CE Junior School or Bishopthorpe Infant School are able to use car parks at the nearby pub, church, village halls and social club, before walking their children to school. Permits for cars have been designed by the school children and letters were sent to parents to publicise the scheme.

Sustainable transport in Scotland

In Scotland, School Travel Coordinators work with schools in their areas to develop and implement travel plans. SUSTRANS, the sustainable transport charity, also to provide grants to schools for capital and resource projects, including funding for cycle storage facilities, lockers, improved paths and walkways and support materials for walking buses and other similar initiatives.

For example, in order to improve safety and encourage children to walk and cycle to school, the parents and teachers of Torbain Primary School in Kirkcaldy, Fife, introduced a park and walk scheme, promoted existing footways as safer routes, constructed five new footway links to the school, installed four new Zebra crossings and have implemented *No Waiting* and enforceable *School Keep Clear* road markings.

'Smarter Choices:Wales'

The Welsh Assembly Government launched 'Smarter Choices:Wales' in February 2007, which outlines alternative modes of transport and aims to encourage efficient and sustainable travel[2].

Travelwise and The School Run

In Northern Ireland, Travelwise NI is a roads service initiative designed to encourage the use of sustainable transport options. The website provides information for parents on getting their children to school by cycling, walking buses or car sharing.

The School Run is a new web-based journey sharing initiative developed to give parents the opportunity to find a travel partner for their children for the school journey. Roads Service are carrying out a trial with nine schools from across Northern Ireland and parents from these schools will have access to the programme during the 2006/2007 school year.

[1] *The Walking Bus Guide*, available [May 2007] at: http://www.thewalkingbus.co.uk/

[2] *Smarter Choices Wales,* available [September 2007] at: http//new wales.gov.uk/topics/transport/integrated transport/smarterchoices

2.4 Gaps and Areas for Concern

2.4.1 Social Inequalities

Studies to date support the view that the most deprived areas have the worst environmental quality as a result of factors such as:

- living near areas with high levels of industrial pollution, or waste sites;
- living in inner city areas close to congested major roads with high traffic densities; and
- having limited access to areas of high environmental quality.

A study conducted by Netcen found that in all parts of the UK except Wales, the most deprived communities experience the highest average levels of air pollution (measured by both NO_2 and PM_{10}). The reason given for the differences observed in Wales is that the more deprived populations tend to be in less urbanised areas such as the South Wales Valleys rather than the inner city areas. In England, more than 70% of the population living in the most PM_{10} polluted areas is categorised as being in the most deprived deciles (1–4). The equivalent figure in Scotland is 60% and in Northern Ireland the most deprived communities (decile 1) account for almost 50% of the population in high pollution areas (Netcen 2006).

A greater proportion of children live in areas of higher deprivation and thus in areas of higher pollution and as a population group they experience higher levels of inequality than other population age groups. The UK Sustainable Development Strategy produced by DEFRA has identified the issue of environmental inequalities as a key area requiring attention and states that the government will fund further research on the causes of environmental inequality and the effectiveness of measures to tackle the inequalities (Broughton et al 2005).

2.4.2 Pollution Hotspots

So called hotspots, where children may be exposed to high levels of air pollution, for example around the school gates or near industrial areas, may be an area for concern. There are a number of initiatives currently in place to help schools reduce the amount of traffic dropping children off and picking them up which will in turn reduce the levels of traffic generated pollution around schools, however parents are often unwilling to allow their children to walk or cycle to school unaccompanied because of fears for their safety. This is an area which needs further work and possible ways of mitigating parents concerns need to be investigated. Some schemes, such as the walking bus, can only work if parents are willing to volunteer their time. It is important therefore to keep encouraging parents and reminding them of the value of such schemes. Where possible schools should apply for funding to help set up and maintain these schemes.

2.4.3 Exposure

Outdoor air legislation focuses on reducing pollution in air quality overall without estimating the actual exposure (and therefore risk) to individuals. However it is important for exposure to be considered when developing strategies to improve air quality in different locations. For example, reducing air concentrations near urban schools or hospitals may have a more significant impact than reducing levels on a busy road where people spend little time, even if levels there are significantly higher. To address this,

guidance on air quality reviews and assessments needs be extended to include exposure and specifically air pollution exposure to children.

3 INDOOR AIR QUALITY

3.1 Legislation

Indoor air quality (IAQ) refers to the physical, chemical and biological properties of air in an indoor environment such as the home or school. The quality of indoor air is affected by a wide variety of factors including heating, air conditioning and ventilation systems as well as by outdoor pollutants. Ventilation is at the heart of IAQ, poor ventilation in buildings can result in damp mouldy conditions, high levels of VOCs and CO_2 and other pollutants. Legislation relating specifically to IAQ does not currently exist in the UK however legislation governing such factors as smoking in public places or building regulations contribute to addressing and improving IAQ.

3.1.1 Building Regulations - Ventilation

The Building Act 1984 and the Building (Scotland) Act 2003 form the basis of the building control system in the United Kingdom and are concerned in the main with setting of building standards, compliance with and enforcement of those standards and powers in relation to dangerous buildings. The standards themselves are prescribed in regulations, supported by technical standards for compliance with these regulations. There is a requirement to obtain a building warrant to erect, demolish and alter buildings including schools and residences. Through this regulatory process it is possible to control aspects of buildings such as heating, ventilation, design and construction which may be relevant in insuring water and dampness are excluded. Thus, in different ways the building control system acts to secure improved standards of air quality for children in the UK. The England and Wales building regulations are statutory instruments which seek to make certain that the policies set out in the Building Act 1984 are carried out in the construction of new buildings. Building regulations approval is required for most building work in the UK including schools and applies to both Local Education Authority (LEA) maintained schools and to independent schools in England and Wales; Scotland has its own Building (Scotland) Act and buildings standards regulations, as does Northern Ireland.

The School Premises Regulations 1999 with regards to ventilation in England and Wales are as follows:

- All occupied areas in a school building shall have controllable ventilation at a minimum rate of 3 litres of fresh air (i.e. outdoor air) per second for each of the maximum number of persons the area will accommodate
- All teaching accommodation, medical examination or treatment rooms, sick rooms, isolation rooms, sleeping and living accommodation shall also be capable of being ventilated at a minimum rate of 8 litres of fresh air per second for each of the usual number of people in those areas when such areas are occupied
- All washrooms shall also be capable of being ventilated at a rate of at least six air changes an hour
- Adequate measures shall be taken to prevent condensation in, and remove noxious fumes from, every kitchen and other room in which there may be steam or fumes.

3.1.2 Building Regulations (Northern Ireland) Order 1979

The Building Regulations (Northern Ireland) Order 1979 (as amended) is the primary legislation for building regulations in Northern Ireland and came into operation in 1980. Secondary legislation or statutory rules for building regulations in Northern Ireland include the Building Regulations (NI) 2000, Part K of which refers to ventilation.

3.1.3 Building Bulletin 101 Ventilation of School Buildings

The Department for Education and Skills (DfES) Building Bulletin 101 deals with the design of school buildings to meet the ventilation requirements of both The School Premises Regulations and the Building Regulations Part F (Ventilation). It outlines specific performance related standards for teaching and learning spaces required for future schools. It states that: "Ventilation should be provided to limit the concentration of carbon dioxide in all teaching and learning spaces. When measured at head height, during the continuous period between the start and finish of teaching on any day, the average concentration of carbon dioxide should not exceed 1500 parts per million (ppm)." This recommendation is based on the need to control CO_2 resulting from occupant respiration. In addition school design should meet the following advisory performance standards, which reflect the needs of the School Premises Regulations:

- The maximum concentration of CO_2 should not exceed 5000 ppm during the teaching day, and
- At any occupied time, including teaching, the occupants should be able to lower the CO_2 concentration to 1000 ppm

These ventilation rates may not be adequate for areas used for special activities such as laboratories. Details of guidelines which should be applied in these cases are outlined in the Building Bulletin (DfES, 2005).

3.1.4 The Housing Health and Safety Rating System

The Housing Health and Safety Rating System is a risk assessment approach to assessing the hazards to health and safety in homes. Twenty nine hazards are assessed and include such environmental hazards as damp and mould growth, CO and fuel combustion products, uncombusted fuel gas and VOCs. The assessment of the risk considers those most vulnerable to the risk, based mostly on age. Should the inspecting officer think that there are risks to the health and safety of occupants, then the landlord or owners will be required to address these risks (DCLG, 2006c).

3.1.5 Gas Safety

The Gas Safety (Installation and Use) Regulations came into force in October 1998 and provide legislation to control the installation and use of gas. The regulations aim to prevent injury to consumers and public from either CO poisoning or fire/explosion caused by faulty gas appliances and are particularly important where children are concerned as they are more susceptible to the effects of CO. It places responsibilities on gas consumers, installers, landlords and suppliers and link with other safety controls relating to combustion equipment such as the Building Regulations standards for ventilation and flues.

The Gas Safety (Installation and Use) Regulations state that:

- Anyone carrying out work on a gas appliance or fittings as part of their business must be competent and registered with the Council for Registered Gas Installers (CORGI)
- Only a competent person can carry out work on gas appliances or fittings
- Individuals must not use any gas appliances or fittings they know or suspect to be unsafe
- Landlords have a responsibility to make sure that fittings and flues are maintained in good order and that gas appliances and flues are checked for safety once in a 12 month period. They must also keep a record of safety checks for at least two years and issue tenants with a gas safety certificate
- With the exception of the room-sealed type, there are restrictions on the installation of gas appliances such as boilers and heaters in sleeping accommodation.
- It is illegal to install instantaneous water heaters which are not room-sealed or fitted with a safety device which automatically turns the gas supply off before a dangerous level of poisonous fumes builds up
- Mains gas transporters and emergency service providers must make safe an emergency situation

3.2 Current Status

3.2.1 Building Schools for the Future

Building Schools for the Future is a Government initiative aimed at re-building or renewing every secondary school in England over the next 10–15 years. The environmental design and performance of the school will be considered, part of which will take into account the ventilation systems. As a result, this initiative is likely to lead to improved IAQ in schools.[1] A similar programme ' Building Better Schools for Wales' is underway.

3.2.2 The Inventory of European Research on the Indoor Environment

The Inventory of European Research on the Indoor Environment (IERIE) is a database produced and maintained by IEH. Similarly to APRED, the database can be used to access up-to-date information on research activities throughout Europe relating to the indoor environment, together with details of researchers and their organisations.

Of the projects listed, only a small number relate directly to indoor air and children and focus particularly on the effects on IAQ on asthma. Two completed studies of particular interest examined air quality in schools. The first examined CO_2 levels in UK schools in an attempt to see if there is a problem with high level, while the second examined ventilation and IAQ in schools.[2] Coley and Beisteiner measured CO_2 levels in classrooms in four schools and found that CO_2 concentrations were beyond the guideline value of 1000ppm and in some classrooms concentrations exceeded the range of the detector (4000ppm) (Coley & Beisteiner 2002). The also aimed to assess whether the naturally ventilated classrooms could in fact be efficiently ventilated. The study concluded that adequate fresh air was not being provided despite the fact that the

[1] *Building Schools for the Future,* available [May 2007] at: http://www.bsf.gov.uk/index.html
[2] IEH (2006) *The Inventory of European Research on the Indoor Environment*, available [May 2007] at: http://ieh.cranfield.ac.uk/

classroom designs allow adequate ventilation to be provided. Anecdotal evidence from the classroom teachers suggest that the reason enough fresh air is not being provided was due to the siting of the windows and that the staff themselves do not make use of the windows. The results of this study show that with careful planning and use of the windows, natural ventilation in schools can provide sufficient fresh air to keep CO_2 levels within the guidance values.

Venn *at al* (2003) conducted a study aimed at determining the independent effects of VOC's and other common environmental exposures in the home on the risk and severity of persistent wheezing illness in children. The study identified a significant effect of formaldehyde concentrations in the home on symptom exacerbation among children with wheezing illness. Exposure-response relations were also observed between measured damp and the risk of persistent childhood wheezing illness and symptom frequency among those with wheezing illness. The study concluded that exposure to VOC's as a whole did not appear to be a determinant of the risk or severity of childhood wheezing illness, despite formaldehyde association with increased symptom severity.

3.2.3 Gas Safety

Although the Gas Safety Regulations do not cover owner occupiers, homeowners are advised to have regular gas safety checks carried out by a CORGI registered gas installer. A gas safety leaflet is also available on the HSE website and outlines danger signs to be aware of along with advice on maintaining the safety of gas appliances in the home.

During 2004/2005, the Health and Safety Executive recorded 117 incidents (where an incident may involve multiple individuals) involving CO poisoning, up from 91 incidents in the previous year. The number of fatalities from CO poisoning in 2004/2005 was 18, up from 11 deaths the previous year. It is not clear however, how many of the cases involved children. Non-fatal cases of CO poisoning increased from 171 to 214 cases in 2004/2005.[1]

Between 1995 and 2005 there were a total of 240 deaths from the toxic effects of CO in England Wales in children between 0–19 years of age (Figure 3.1). The number of deaths has declined consistently since 1995. In Scotland the number of deaths attributable to the toxic effects of CO was lower, with only a single death recorded for 0–19 year olds in 2004 (Figure 3.2).

[1] HSE (2007) *Gas Safety – Statistics*, available [May 2007] at: http://www.hse.gov.uk/

Figure 3.1 Deaths from the toxic effects of carbon monoxide (ICD-10 T58 and ICD-9 986) in children aged 0–19 years old in England and Wales, 1995–2005

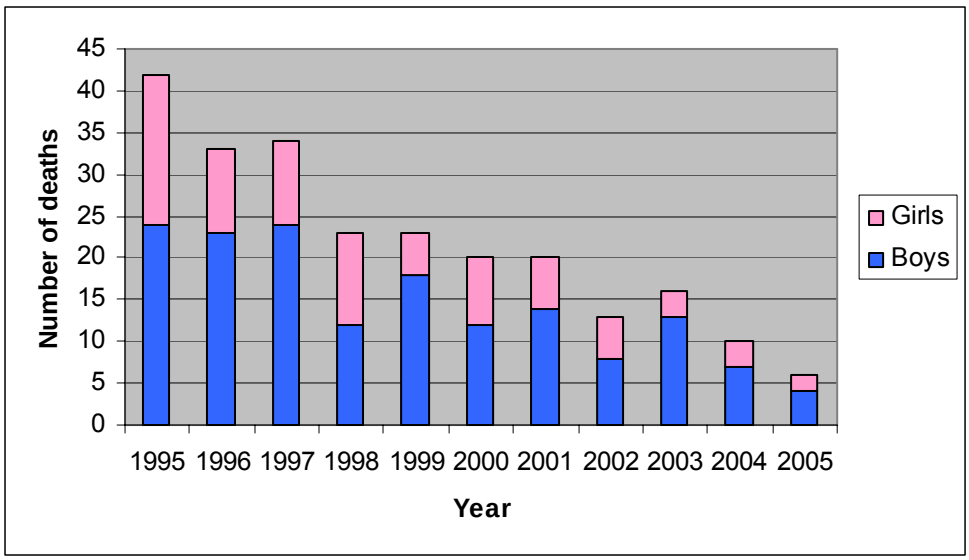
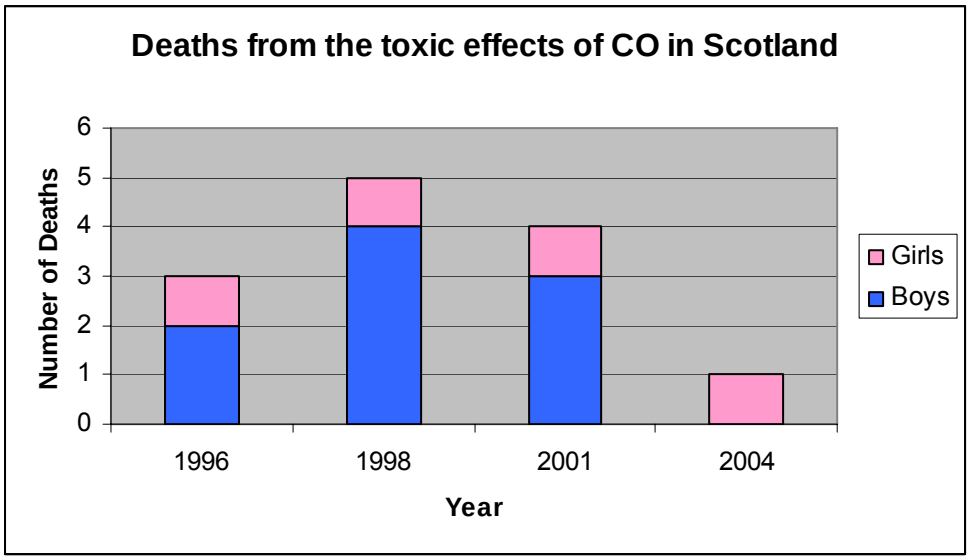


Figure 3.2 Deaths from the toxic effects of carbon monoxide (ICD-10 T58 and ICD-9 986) in children aged 0–19 years old in Scotland



In 2002, the Building Regulations Division of the Office of the Deputy Prime Minister (ODPM) now the Department for Communities and Local Government (DCLG) asked the Building Research Establishment (BRE) to monitor ventilation and IAQ in a representative sample of new primary school buildings. In schools CO_2 is the main indicator of air quality and thus of ventilation performance. BRE carried out CO_2 monitoring in 16 primary school classrooms in eight schools, all with natural ventilation, between September 2002 and November 2003. In addition the ventilation rates in the classrooms were measured (BRE 2006).

The study found that on most days the average CO_2 levels were below the Building Bulletins 101 maximum guideline value of 1500 ppm. More than half the classrooms however exceeded the daily average on at least one day in the school week. In all schools there were times when the ventilation rates were lower than the required 3l/s/person required. Ventilation rates recorded ranged from 0.5l/s/person at the lowest to 20.9l/s/person at the highest. In total approximately 50% of measurements were below 3l/s/person and 93% were below the maximum ventilation rate of 8l/s/person.

Table 3.1 Average daily CO_2 levels (ppm) measured over the school day

School and classroom	Average daily CO_2 level ppm				
	Mon	Tues	Weds	Thurs	Fri
E classE1	2457	1887	2521	1727	990
E class E2	1243	1742	1520	1385	1197
D class D2	758	1778	816	1519	1005
D class D1	1362	1778	1821	1794	1467
F class F1	1003	912	1038	869	-
F class F2	1069	835	588	571	-
B Class B1	1036	1038	1014	1051	1183
B class B2	1835	911	1506	1042	1164
G Class G1	1098	606	662	991	1316
G Class G2	345	358	688	1352	-
A class A1	817	659	399	677	643
A Class A2	481	340	480	604	676
C class C2	1756	1060	1193	1491	1137
C class C1	1812	1680	2784	1936	1745
H class H2	2711	1936	3248	1494	3026
H class H1	2292	2284	2422	2237	1909

Table 3.2 Short-term Ventilation Rates

School	N*	Ventilation rates					
		<3 l/s per person	%	<8 l/s per person	(%)	Maximum rate recorded l/s/person	Minimum rate recorded l/s/person
1	10	3	30	9	80	8.7	1.6
2	10	2	20	10	100	6.5	1.8
3	9	4	44	9	100	7.7	1.3
4	10	9	90	9	90	12.1	0.5
5	7	4	57	6	85	20.9	0.9
6	8	4	50	7	87	8.6	1.3
7	10	3	30	10	100	7.9	0.9
8	8	7	87	8	100	3.6	0.5
All results	72	35	49	67	93	20.9	0.5

The study concluded that naturally ventilated schools are capable of achieving the suggested performance standard of 1500 ppm daily average CO_2. However some teachers are reluctant to open windows due to noise and distraction from outside sources and to conserve energy from heat loss. Careful design of the ventilation provision is required to ensure performance standards are met and occupants should have easy and suitable control of the system.

3.2.4 Mould and Indoor Air Quality

There are believed to be about 1.5 million species of fungi and about 1000 species which have evolved to exploit man-made spatial ecosystems of the built environment. Many of these found in buildings are collectively known as mould, a common term for multicellular fungi. Fungi produce large numbers of spores, which when airborne can be inhaled. Repeated exposure to large amounts of particular fungi increases the risk of developing specific allergic reactions. Several health effects have been associated with fungus in the indoor environment including rhinitis, upper respiratory symptoms and asthma, with systemic effects including allergic skin reactions, lethargy and headaches. There is consistent evidence of an association between damp and mouldy conditions and reports of respiratory conditions in children. Temperature and relative humidity appear to be major factors influencing the levels of fungi in the indoor environment. Pekkanen *et al* (2006) conducted a case control study of newly diagnosed childhood asthma and assessed the severity and location of moisture damage in their homes. An association was observed between the risk of developing new asthma among children aged 1-6 years and moisture damage in the home. The study noticed that only moisture damage in the main living quarters or in the child's bedroom was associated with asthma. The study concluded that although moisture damage and mould growth with the risk of asthma are unknown, the results underline a need to improve building design, construction and maintenance practices in order to prevent moisture damage and the health risks to occupants.

3.2.5 Indoor Air Quality in Swimming Pools

Chlorination has long been the method of choice to destroy microbiological pathogens and organic matter in swimming pools. The most commonly used product is sodium or calcium hypochlorite which releases hypochlorous acid in water. When reacting with organic matter hypochlorous acid generates a complex mixture of potentially harmful

disinfection by-products, including trihalomethanes, trihaloacetic acids and chloramines which may be inhaled by swimmers. Bernard *et al* (2003) conducted a study to examine whether exposure to nitrogen trichloride in indoor chlorinated pools may affect the respiratory epithelium of children and increase the risk of some lung diseases such as asthma. COMEAP members were asked to examine the paper, which was then discusses at the COMEAP meeting in June 2003. Members concluded that the paper reported a carefully conducted study which appeared to show an association between attendance at swimming pools and asthma prevalence. Overall members felt that the study was of interest and that research in this area should be taken further.

3.3 Gaps and Areas for Concern

While landlords are responsible for the safety of gas appliances in their properties and those working with gas appliances or fittings must be registered with CORGI, there is similar legislation regarding owner occupiers. However, the HSE advises that owner occupiers should maintain all appliances and flues and that a CORGI registered installer should carry out safety checks every 12 months, this is not a legal requirement. Although the law states that anyone working with gas appliances or fittings must be CORGI registered, non registered plumbers still work with gas appliances and fittings and home owners are not always aware of what to look for when hiring gas fitters or plumbers. The problem with illegal installers is currently unquantified and the current regulatory burden falls on legal operatives.

The competency of a CORGI registered installer may also give cause for concern but currently the only way of addressing this is if a customer makes a complaint directly to CORGI, who will then investigate the complaint and provided the gas installer was CORGI registered, they can be instructed by the gas inspector to rectify any problems.

A Review of Domestic Gas Safety conducted by the HSE found that public awareness of the dangers of CO appeared low and suggested that more work was needed to increase awareness of the importance of properly maintaining gas appliances. Carbon Monoxide monitors are inexpensive aids which all gas consumers should be encouraged to have, however they are not a replacement for gas safety checks. A way forward may be to propose the installation of CO monitors as standard during the annual gas safety checks.[1]

[1] Health and Safety Commission Gas Safety Review. Annexe 1 [May 2007] at: http://www.hse.gov.uk/

4 SMOKING AND ENVIRONMENTAL TOBACCO SMOKE

4.1 Legislation

4.1.1 Smoking in enclosed spaces and workplaces

The Health Act 2006 makes provision for the prohibition of smoking in enclosed or substantially enclosed public places and workplaces (with a few exceptions, such as prisons and oil rigs). The law aims to protect workers and the general public from the harmful effects of environmental tobacco smoke (ETS) and requires that no smoking signs be prominently displayed in smoke-free premises; those failing to display adequate signage or enforce the smoke-free policies will liable to a fine. In Wales this came into effect on 2 April 2007, while in England it came into force on 1 July 2007. The Welsh Assembly Government estimates that this legislation will prevent 400 deaths each year among non-smokers in Wales from heart disease, cancer, stroke and respiratory illness.

Scotland introduced a ban on smoking in public places in March 2006. The Smoking, Health and Social Care (Scotland) Act 2005 aims to protect the general public from the harmful effects of passive smoking. The new law bans smoking in 'no-smoking premises' by:

- creating an offence of permitting others to smoke in no-smoking premises;
- creating an offence of smoking in no-smoking premises;
- creating an offence of failing to display warning notices in no-smoking premises;
- setting out the powers of enforcement officers to enter no-smoking premises; and
- creating an offence of failing without reasonable cause to give one's name and address on request by an enforcement officer.

The types of premises covered by the smoking ban include hotels, restaurants, bars and hospitals. Environmental Health Officers have the power to check whether no-smoking premises are complying with the legislation and can prosecute or issue fixed penalty notices to anyone believed to not complying with the legislation.[1]

Similarly, the Smoking (Northern Ireland) Order 2006 was passed in the House of Lords on the 9 November 2005. Enclosed and substantially enclosed public spaces and work places in Northern Ireland have been smoke-free from 30 April 2007.

4.1.2 Tobacco Advertising

Tobacco advertising is on of the most highly regulated forms of marketing, along with alcohol advertising, and has been banned in many countries for a number of years, including the UK. In the UK there has been a ban on television advertising of cigarettes since 1965, with advertising of loose tobacco and cigars banned in 1991. Although non television advertising was allowed, this came under strict guidelines which prevented adverts from actually showing a person smoking. As part of their 1997 election

[1] Healthier Scotland (2007) *Clearing the Air Scotland*, available [May 2007] at: http://www.clearingtheairscotland.com/

campaign the UK Government pledged to ban all advertising of tobacco products resulting in the passing of the Tobacco Advertising and Promotions Act 2002 (2002, c36). The Act banned most of the remaining forms of tobacco advertising including promotions, sponsorship of sporting events within the UK and brand sharing. Some exemptions however allow advertising within the tobacco industry and advertisements in publications not aimed at the British market.

The European Union and World Health Organization (WHO) have both specified that the advertising of tobacco should be banned. The WHO Framework Convention on Tobacco Control[1] came into action in February 2004 and requires that the 168 WHO member countries that agreed to the treaty (which includes the UK) must ban tobacco advertising unless their constitution forbids it. The UK Government ratified the treaty in December 2004.

Tobacco packaging warning messages have been implemented in an effort to improve public knowledge about the dangers of smoking. In the UK the warning must cover at least 30% of the package surface and includes such child specific warnings as “smoking when pregnant harms your baby” and “protect children: don’t make them breathe your smoke”.

4.2 Current Status

4.2.1 Tobacco Action Plans

To tackle the death and illness caused by smoking the Department for Health, Social Services and Public Safety (Northern Ireland; DHSSPS) published a Tobacco Action plan in 2003; the overall aim of the plan is to create a tobacco-free society. The specific objectives include preventing people from taking up smoking, helping smokers to quite and protecting non-smokers from tobacco smoke. Key target groups have been identified as groups needing particular action, two of these groups are children and young people and pregnant women who smoke. A survey found that 35% of pupils aged between 11 and 16 years have smoked tobacco and the proportion of 16-19 year old women who smoke has increased from 19% to 27%. Further survey work found that 35% of mothers smoked before pregnancy with 22% continuing to smoke during pregnancy. The action plan outlines a variety of approaches to reduce smoking levels including enforcement of legislation which restricts sales of tobacco to children, raising awareness of the health risks, access to support and advice for young people wishing to give up smoking and the provision of advice and support to pregnant women (DHSSPS, 2003).

4.2.2 Exposure to Environmental Tobacco Smoke

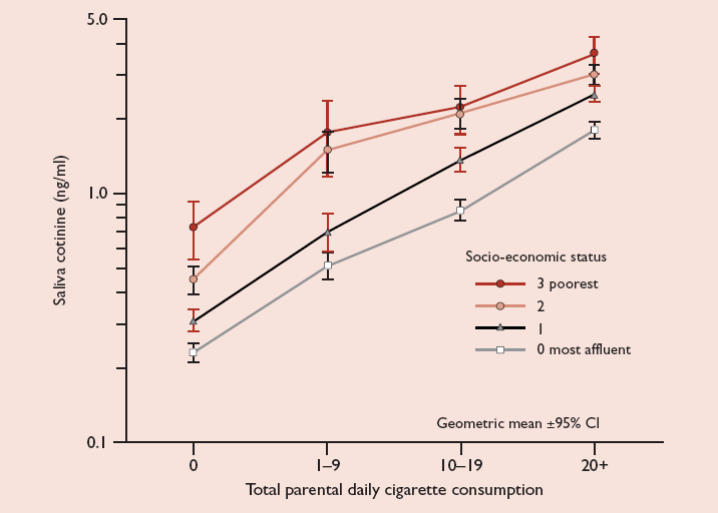
Parental smoking is the principal determinant of a child’s exposure with studies showing raised cotinine concentrations in children with smoking parents. Maternal smoking is usually the largest source of ETS because of the cumulative effect of exposure during pregnancy and close proximity to the mother during early life. Despite the fact that children’s exposure to ETS in England has approximately halved, up to 4 million people

[1] WHO (2003) *The WHO Framework Convention on Tobacco Control*, available at: http://www.fco.gov.uk/

in the UK still continue to smoke near children. This reduction can partly be explained by the fall in percentage of parents smoking and may also reflect a decline in smoking in public places. Evidence suggests that children's exposure to ETS has been declining for some years. Jarvis et al (2000) used data collected as part of the national surveys of secondary school children which surveyed 11-15 year olds. They found that the geometric mean cotinine in non-smoking children from non-smoking homes reduced by almost a half between 1988 and 1998 (Jarvis *et al.*, 2000). More recently the Health Survey for England show that this decline has continued but at a slower rate, with suggestions that children's exposure to ETS could be reduced by the implementation of smoking policies limiting smoking to outside the home (Edwards & Coleman, 2005). The 2003 Scottish Health Survey asked respondents whether they were regularly exposed to other peoples tobacco smoke. Approximately two thirds of children aged 8-15 years reported being exposed to ETS in their own homes or in the homes of others.[1]

Another factor influencing exposure to ETS is socio-economic status, with the levels of cotinine being higher in children from deprived backgrounds. Figure 4.1 shows the geometric mean saliva cotinine in non-smoking children by total parental cigarette consumption and by socio-economic status.

Figure 4.1 Geometric Mean saliva cotinine in non-smoking by total parental cigarette consumption and socio-economic status



Source: Health Survey for England 1996-2000 combined.

4.2.3 Health Effects

There is evidence to suggest that exposure to ETS can result in a variety of health effects including bronchitis, pneumonia, coughing and wheezing, asthma attacks, middle ear infection, cot death (Sudden Infant Death Syndrome; SIDS) and possibly cardiovascular and neurobiological impairment in children. Environmental tobacco

[1] ScotPHO (2007) *Tobacco use: environmental tobacco smoke,* available [May 2007] at: **http://www.scotpho.org.uk/**

smoke is also associated with decreased lung function and an increased risk of pneumonia and bronchitis.

A report by the Scientific Committee on Tobacco and Health indicated ETS to carry significant health risk. The report suggested that non-smokers have a 24% increased risk of heart disease[1]. Research published by the Scottish Executive which reports on findings from New Zealand and USA concluded that the relative risk of experiencing a stroke from exposure to passive smoking was 29%[2].

Sudden Infant Death Syndrome is currently defined as the sudden death of an infant that remains unexplained by clinical or autopsy evidence. A number of risk factors have been identified by epidemiological studies and include maternal smoking in pregnancy, parental smoking and smoking by others in the household. In fact smoking has been targeted as one of the most important factors for public health. A systematic, quantitative review of epidemiological evidence relating to parental smoking and SIDS examined the separate roles of prenatal and postnatal exposure. Thirty nine studies were reviewed and all but one showed a positive association between prenatal smoking and SIDS, often with odds ratios of over 3. The association between prenatal exposure and SIDS is more difficult to determine as most mothers who smoke through pregnancy continue to do so afterwards, thus the independent effect of prenatal smoking is difficult to ascertain (Andersen & Cook, 1997).

4.3 Current and Planned Initiatives

The National Healthy Schools program, funded by the Department for Education and Skills (DfES), aims to have every school working towards achieving national healthy school status by 2009. One of the criteria which must be achieved in order to obtain healthy school status is that school environments must be smoke-free. There are four core themes in the national healthy schools program, tobacco falls under the theme 'personal, social and health education' and in order to achieve healthy school status schools will be required to demonstrate evidence that a whole-school approach to meeting the criteria has been implemented and that the specific criterion have been met. Schools must either have a smoke-free policy in place, or be able to show that they are working towards a smoke-free policy by September 2007. In Wales, the Welsh Network of Healthy School Schemes, has similar requirements.

The sale of tobacco products to children under the age of sixteen has been illegal since 1908. The UK Government will rise the legal minimum age at which people can buy cigarettes from 16 to 18 years. This will apply to England and Wales and will come into on the 1 October 2007. Scotland will also raise the legal minimum age of purchase from 16 to 18.[3] The Smoking (Northern Ireland) Order 2006 contains a power to raise the age of sale of tobacco products to young people in Northern Ireland. There are no plans to

[1] Scientific committee on Tobacco and Health (SCOTH), second hand smoke: Review of evidence since 1998 (November 2004)

[2] Passive smoking and associated causes of death in adults in Scotland available [May 2007] www.healthscotland.com/

[3] Department of Health (2007) *Consultation on changing the age of sale for tobacco*: *Report on consultation*, available [May 2007] at: http://www.dh.gov.uk/

change the age of sale at present in Northern Ireland and the Government has taken this power to enable a future devolved administration to decide best how to proceed.

Various advertising campaigns have also been implemented which highlight the various health effects of cigarette smoking, including advertisements aimed at emphasising the effect of passive smoking on children. An NHS stop smoking campaign produced a series of adverts including billboard posters, press releases and radio and television adverts. They have also established a support groups and networks for those wishing to give up smoking. The 'Smoking near children' campaign was designed to raise the general public's awareness of the health risks to children of second-hand smoke. The hard-hitting messages "If you smoke, I smoke" and "If you smoke, your children smoke too" were used throughout the campaign to emphasis the need to protect young children from the effects of passive smoking. The campaign was run during 2003 and re-launched in 2005 in support of World No Tobacco Day.[1] In Northern Ireland since 2003, smoking cessation services have been developed. The Up-2-You website has been developed by the Health Promotion Agency for Northern Ireland and is part of the HPA's drive to reduce smoking among young people.[2] Information relating to smoke-free legislation and information campaigns in Northern Ireland is available from the Space to Breathe website.[3]

Figure 4.2 National Health Service advertising campaign aimed at highlighting the effects of smoking on children

Source: Department of Health

[1] NHS second-hand smoke media campaign at: http://www.givingupsmoking.co.uk/
[2] Up 2 You (2007) *Welcome to Up 2 You*, available [May 2007] at: http://www.up-2-you.net
[3] *Space to Breathe for Northern Ireland,* available [May 2007] at*:* http://www.spacetobreathe.org.uk

Figure 4.3 National Health Service anti-smoking advertising campaign focusing on children

Source: http://www.givingupsmoking.co.uk/

The National Institute for Health and Clinical Excellence (NICE) conducted a "review of reviews" examining the effectiveness of public health interventions for preventing and reducing exposure to ETS (Taylor *et al.*, 2005). The review aimed to:

- Identify all relevant systematic reviews, syntheses, meta-analyses and review level papers on public health interventions relating to ETS.
- Review the papers and highlight the effective measures for preventing and reducing exposure to ETS with particular emphasis on the disadvantaged and vulnerable
- Highlight gaps in the evidence base and provide recommendation for future research

The key findings from this review are outlined below:

Home Based Interventions

The results from this review suggests that home-based interventions delivered by a clinician and including advice and printed literature on how to create a smoke free environment are effective in reducing children's exposure to ETS. Home based counselling sessions delivered by nurses to mothers/parents also met with some success, though this may be the result of self reporting bias than the interventions themselves. Home based intervention consisting of home visits, telephone support and worksheets provided by a public health nurse, although again this may be the result of self reporting bias as cotinine measurements showed this method to be ineffective. Overall home-based interventions seemed to successfully reduce children's exposure to ETS, however as many of the studies reviewed employed self reporting methods of assessment it is possible that there is a degree of self reporting bias occurring. Cotinine measurements are a more accurate indicator of exposure to ETS; however there is a lack of home based studies using cotinine measures to assess intervention effectiveness. Indeed only one review showed evidence that home based interventions effectively reduce exposure.

Clinic Based Interventions

Methods for clinic based interventions include motivational interviewing, counselling sessions, personalised letters detailing children's cotinine levels and the provision of oral and written advice. Currently there is conflicting evidence as to the efficacy of such interventions in reducing children's exposure to ETS.

Educational Interventions

It would appear that educating parents about the hazards to their children's health of ETS influences the smoking behaviour of smoking parents and thus reduces exposure.

In the main however there is a lack of review evidence to support interventions that concentrate on providing advice on how to reduce exposure or to create smoke free school or home environments.

Overall the review found that a variety of interventions were effective, such as various home and clinic based interventions, educational approaches and motivational interviewing.

4.4 Gaps and Areas for Concern

Implementation of a smoking ban in public places and workplaces has the potential to reduce smoking prevalence and protect the health or workers and the public (including children). However, there is some concern that a ban on smoking in public places may lead to a transfer of smoking behaviour to the home. There is little evidence on the overall effect due to the small number of places that have had a long-term prohibition on smoking in public places. A study in the Republic of Ireland reported a decrease in the percentage of smokers allowing smoking in their homes. Fong *et al.* (2006) found no evidence that the reduction in smoking in public venues resulted in an increase in smoking in private venues. The study found that there was in fact a significant decrease in the proportion of Irish homes where smoking was allowed inside. In Australia, the introduction of legislation for smoke-free workplaces during the 1990's was accompanied by a steep increase in the proportion of adults who avoided exposing children to tobacco smoke at home. Among households with children, the proportion with smoking restrictions more than doubled, from 25% in 1989 to 59% in 1997. After two years of smoke-free public places in New York City, exposure to second-hand smoke in the home had decreased by 35% (ASH Scotland). The National Health Service Scotland is currently funding a study to examine the effects of the smoking ban on children's exposure and similar studies should be carried out in England and Wales. A similar study has also been commissioned by the Welsh Assembly Government.

It is important that the potential effects on those most vulnerable to the effects of passive smoking are considered. Continued efforts should be made to educate adults as to the effects of smoking on the health of children. Further research is also required on the effects the smoking ban may have on exposure to environmental tobacco smoke in the home.

The review of interventions conducted by NICE suggests that it may be possible to reduce children's exposure to environmental tobacco smoke through various methods. This review highlighted several gaps and provided a list of recommendations. The review examined the effects of health inequalities and the cost effectiveness of interventions. However there was a lack of evidence as to the efficacy of interventions in the low socio-economic groups. As socio-economic status is one of the primary determinants of children's exposure to environmental tobacco smoke, it was not possible to determine whether interventions were a viable approach to reducing children's exposure to environmental tobacco smoke.

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APPENDIX A Activities and initiatives addressing the Children's Environment and Health Action Plan for Europe Regional Priority Goal III

Children's Environment and Health Action Plan Regional Priority Goal	Lead Government body	Current actions	Notes
Regional Priority Goal III. We aim to prevent and reduce respiratory disease due to outdoor and indoor air pollution, thereby contributing to a reduction in the frequency of asthmatic attacks, in order to ensure that children can live in an environment with clean air. We aim to achieve a substantial reduction in the morbidity and mortality from acute and chronic respiratory disorders in children and adolescents by:			
(a) developing indoor air quality strategies that take into account the specific needs of children;	Department for Communities and Local Government (DCLG)	Building Regulations 2000 Approved Document F – Ventilation (ODPM, 2006)	
		Ventilation and Indoor Air Quality in Schools – Guidance Report (ODPM, 2006)	
	Department for Children, Families and Schools (DCFS)	Building Bulletin 101 Ventilation of School Buildings (DfES, 2005)	
		The Education (School Premises) Regulations 1999	
	Department for Business, Enterprise and Regulatory Reform (BERR)	UK Fuel Poverty Strategy (DTI, 2001)	
	Scottish Building Standards Association (SBSA)	Building (Scotland) Regulations 2004 (as amended)	
(b) implementing the Framework Convention on Tobacco Control, by legislative measures, through the drafting and enforcement of the necessary regulations and by setting up health promotion programmes that will reduce smoking prevalence and the exposure of pregnant women and children to environmental tobacco smoke;	Department of Health	Choosing Health: making healthier choices easier – Government White Paper (2004)	
	Department of Health, Social Services and Public Safety, Northern Ireland	A Five Year Tobacco Action Plan 2003-2008 (2003)	
	Scottish Executive	Towards a Healthier Scotland: A White Paper on Health (1999)	
		The Smoking, Health and Social Care (Scotland) Act 2005	Introduced a ban on smoking in all substantially enclosed public places in Scotland

Children's Environment and Health Action Plan Regional Priority Goal	Lead Government body	Current actions	Notes
	UK Government	Health Act 2006	Introduced a ban on smoking in England, Northern Ireland and Wales in all substantially enclosed public places
(c) improving access of households to healthier and safer heating and cooking systems as well as cleaner fuel;	DCLG	Housing, Health and Safety Rating System (England) Regulations 2005	
	BERR	Fuel Poverty Strategy (DTI, 2001)	
		The General Product Safety Regulations 2005	
(d) applying and enforcing building regulations to improve indoor air quality, especially in housing, child care centres and schools, with particular reference to construction and furnishing materials;*	DCLG	Housing, Health and Safety Rating System (England) Regulations 2005	
	SBSA	Building (Scotland) Regulations 2004 (as amended)	
	DCFS	Building Schools for the Future	
		The Education (School Premises) Regulations 1999	
(e) reducing emissions of outdoor air pollutants from transport-related, industrial and other sources through appropriate legislation and regulatory measures which ensure that air quality standards such as those developed under EU legislation take into account the values set by the existing WHO air quality guidelines for Europe. In particular we call upon car manufacturers to equip all new diesel motor vehicles with particle filters or other appropriate technologies in order to reduce drastically emissions of particles, and to that effect we will continue to develop legislative and regulatory measures as well as economic incentives.	Environment Agency	Better Environment, Healthier People (2005)	
	Department of the Environment, Food and Rural Affairs, Scottish Executive, Welsh Assembly Government and the Department of the Environment Northern Ireland	The Air Quality Strategy for England, Scotland, Wales and Northern Ireland (2007)	
	Scottish Environment Protection Agency	SEPA Three Year Corporate Plan April 2005-March 2008 (2005)	

* **ODPM suggest amendment** "applying and enforcing building regulations to improve indoor air quality, especially in *new* housing, child care centres and schools" They also suggest omitting constructions materials over which there is no control.

APPENDIX B Clean Air Act

The Clean Air Act 1956 was implemented as a result of the Great London Smog episode of 1952. The aim of the Act was to control domestic sources of smoke pollution by introducing smokeless zones. In these areas, smokeless fuels had to be burnt. The Clean Air Act focused on reducing smoke pollution, but the introduction of cleaner coals and the increased usage of electricity and gas actually helped to reduce sulphur dioxide levels at the same time. In 1968 the Clean Air Act was amended and extended and in 1993 the 1956 and 1968 Clean Air Acts were consolidated to form a single Clean Air Act governing air pollution as well as encompassing clean air legislation that previously been governed by other Acts. The Clean Air Act however did not cover industrial processes which were covered under the 1990 Environmental Protection Act, which has since been superseded by the 1999 Pollution Prevention and Control Act. Industrial processes in Northern Ireland are covered by the Pollution Prevention and Control Regulations (Northern Ireland) 2003 issued under the Environment (Northern Ireland) Order.

APPENDIX C European Union and equivalent national legislation

European Union Directive	National legislation	Main provisions
Integrated Pollution Prevention and Control Directive (Directive 96/61/EC)	Pollution Prevention and Control (England and Wales) Regulations 2000 Pollution Prevention and Control (Northern Ireland) Regulations 2003 Pollution Prevention and Control (Scotland) Regulations 2000	Aims to achieve integrated prevention and control of pollution to all media arising from certain industrial activities. It sets out measured designed to prevent or, where it is not practicable, to reduce emissions to the air, water and land (including measures to deal with waste)
Waste Incineration Directive (Directive 2000/76/EC)	Waste Incineration (England and Wales) Regulations 2002 The Waste Incineration Regulations (Northern Ireland) 2003 Waste Incineration (Scotland Regulations 2003	Aims to prevent or limit the negative effects on the environment, in particular pollution emissions into air, soil, surface water and groundwater, and the resulting risks to human health, from the incineration and co-incineration of waste.
Large Combustion Plants Directive (Directive 2001/80/EC))	The Large Combustion Plants (England and Wales) Regulations 2002 The Large Combustion Plant (Scotland) Regulations 2000 Large Combustion Plants Regulations (Northern Ireland) 2003	Aims to reduce acidification, ground level ozone and particles throughout Europe by controlling emissions of sulphur dioxide (SO2), nitrogen oxides (NOx) and particulate matter from large combustion plants.
Solvent Emissions Directive (Directive 1999/13/EC)	Solvent Emissions (Scotland) Regulations 2004 Pollution Prevention and Control (England and Wales) Regulations 2000 Pollution Prevention and Control (Scotland) Regulations 2000 The Environment (Northern Ireland) Order 2002 The Solvent Emissions Regulations (Northern Ireland) 2004	The limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations through authorisations and permits.
Paints Directive (Directive 2004/42/EC)	The Volatile Organic Compounds in Paints, Varnishes and Vehicle Refinishing Products Regulations 2005	To reduce emissions of volatile organic compounds by limiting the total content of VOCs in certain paints and coatings.
The Sulphur Content of Liquid Fuels Directive (Directive 1999/32/EC)	The Sulphur Content of Liquid Fuels (England and Wales) Regulations 2000 The Sulphur Content of Liquid Fuels (Scotland) Regulations 2000 The Sulphur Content of Liquid Fuels Regulations (Northern Ireland) 2007	To reduce emissions of sulphur dioxide resulting from the combustion of heavy fuel oil and gas oil.
Petrol vapour recovery – Stage 1 controls (Directive 94/63/EC)	The Environmental Protection (Prescribed Processes and Substances etc.) (Amendment) (Petrol Vapour Recovery) Regulations 1996 Industrial Pollution Control (Prescribed Processes and Substances) (Amendment) Regulations (Northern Ireland)1998	To control the emissions of VOCs resulting from the storage of petrol and its distribution from terminals to service stations.
United Nations Economic Commission for Europe Protocol on Long-Range Transboundary Air Pollution Concerning the Control of Emissions of VOCs or other Transboundary Fluxes	Pollution Prevention and Control (England and Wales) (Amendment) Regulations 2006 Pollution Prevention and Control (Amendment) Regulations (Northern Ireland) 2007 Scottish amendment regulations should follow in 2007	To control the emissions of VOCs resulting from the filling of vehicle petrol tanks at service stations

APPENDIX D Trends in UK air pollution

Particulates

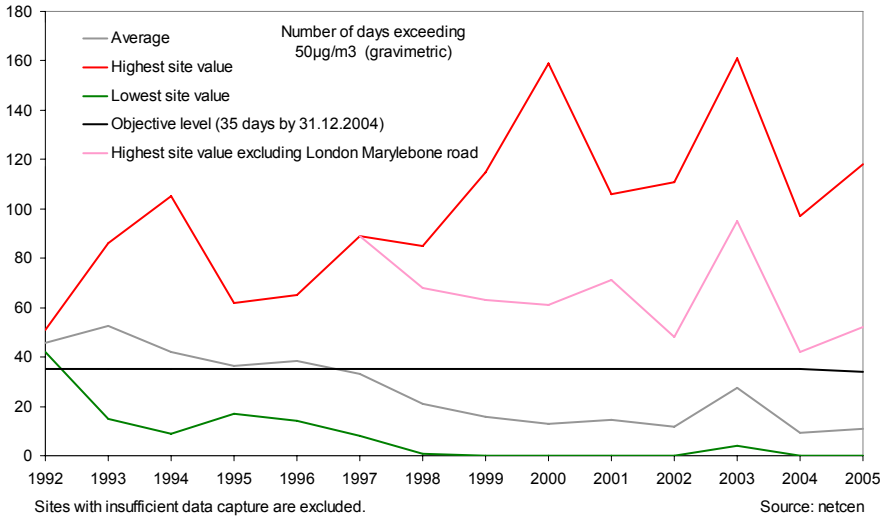
The original air quality objective for particles stated that by the end of 2004, the 24 hour mean should not exceed 50 µg m^3 more than 35 times and that the annual mean should not exceed 40 µg m^3. In 2004 24-hour means exceeded the 50 µg m^3 more than 35 times at three sites in the UK while the London Marylebone Road monitoring site was the only site to exceed the 40 µg m^3 annual mean.

Table D.1 Particulate emissions by source for the United Kingdom

Source	Mass (thousand tonnes)								
	1970	1980	1990	2000	2001	2002	2003	2004	2005
Road transport	42	51	60	39	38	37	36	36	34
Residential	209	94	50	29	32	30	22	22	21
Energy industries	83	83	74	25	19	11	11	11	12
Other	164	121	121	91	91	83	86	86	84
Total	499	349	305	184	180	160	155	154	150

Source: Defra (2007) *Key Facts About Air Quality,* available [May 2007] at: http://www.defra.gov.uk/

Figure D.1 Number of days exceeding 50 µg/m^3 (particles) compared with health objective for 2004: Urban UK Sites 1992–2005



From: Defra (2007) *E-digest Statistics about: Air Quality. Particles,* available [May 2007] at: http://www.defra.gov.uk/

Nitrogen Oxides

Total nitrogen oxides emissions fell by 45% between 1990 and 2004 to 1621 thousand tonnes. The combustion of diesel, petrol and coal are the major sources of NO_x emissions, with road transport accounting for 37% and energy industries contributing another 27% of the total emissions.

Table D.2 Nitrogen oxide emissions by source 1970–2005 for the UK (thousand tonnes)

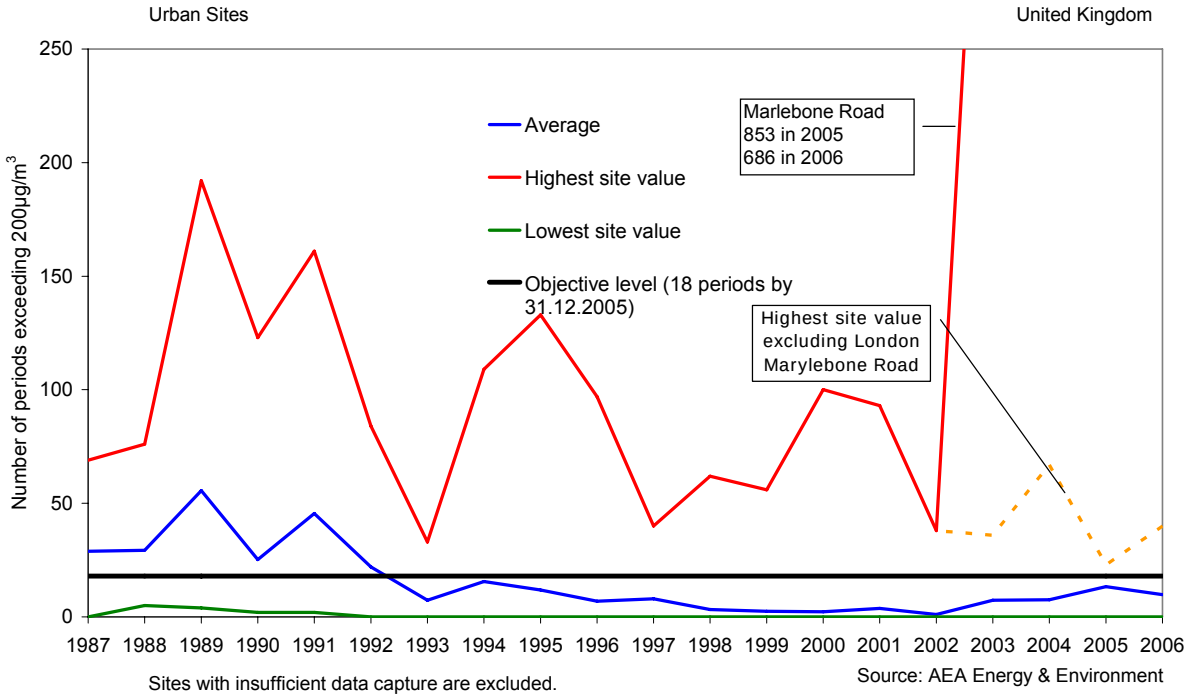
	1970	1980	1990	2000	2001	2002	2003	2004	2005

Road transport	765	989	1,324	818	749	692	636	597	1124
Energy industries	1333	936	852	421	444	440	467	454	361
Other	1032	847	790	658	635	589	625	613	931
Total	3130	2772	2966	1897	1828	1721	1728	1664	2417

Source: Defra (2007) *Key facts about: Air quality*, available [May 2007] at: http://www.defra.gov.uk/

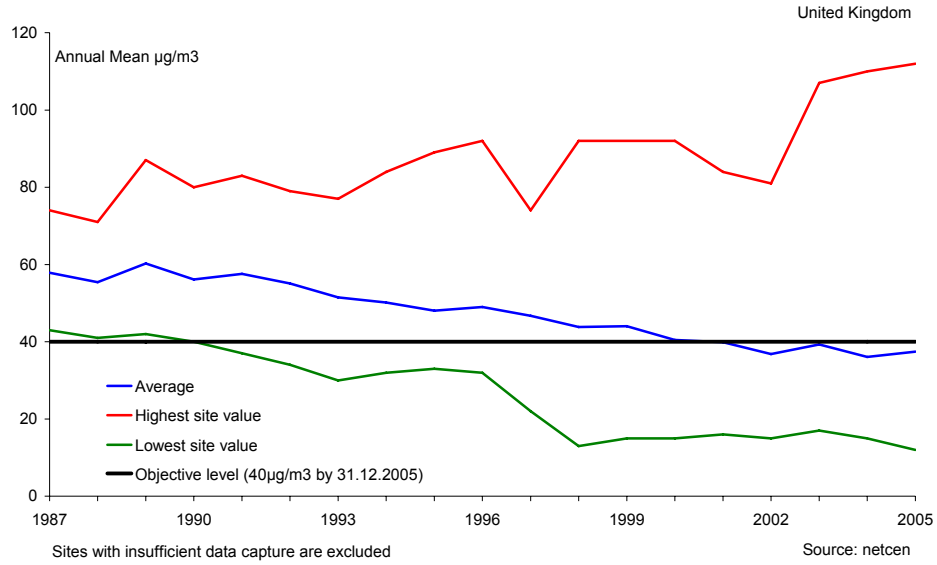
The UK Air Quality Strategy health objective states that the 1 hour mean should not exceed 200 µg/m^3 more than 18 times a year by 2005. Only one site did not meet this objective: the London Marylebone Road kerbside site. The Marylebone Road site recorded 853 exceedances on 155 separate days. The health objective that the annual mean should not exceed 40 µg/m^3 to be met by 2005 was achieved by 75% of the sites in 2005. Figure 4.3 and Figure 4.5 show trends in exceedances at urban sites of the objective levels for the 1-hour and health-based annual mean respectively. There were six sites where hourly concentrations reached 'moderate' levels in 2005. The roadside site on the London A3 exceeded the EC Alert Threshold on one day.

Figure D.2 Nitrogen Dioxide 1 hour mean: Number of periods exceeding 200 µg/m^3 compared with health objective for 2005, Urban Sites: 1987–2005



From: Defra (2007) *E-digest Statistics about: Air Quality. Nitrogen Dioxide,* available [Aug 2007] at: http://www.defra.gov.uk/

Figure D.3 Nitrogen Dioxide annual mean: Comparison with health objective for 2005, Urban Sites: 1987–2005



From: Defra (2007) *E-digest Statistics about: Air Quality. Nitrogen Dioxide,* available [May 2007] at: http://www.defra.gov.uk/

Carbon Monoxide

Carbon Monoxide emissions fell by 65% between 1990 and 2004. The major source of CO in the UK is road transport and emissions from this source fell by 75% between 1990 and 2004 as a result of the introduction of catalytic converters on petrol vehicles. Carbon Monoxide emissions from residential fossil fuel use fell by 57% in the same period due to the decline in use of solid fuels in favour of gas and electricity.

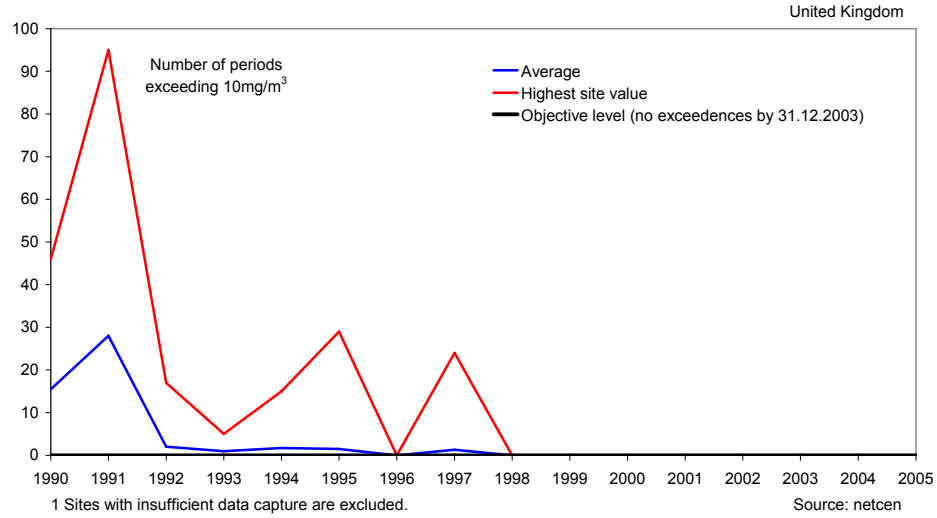
Table D.3 Carbon Monoxide Emissions by Source for the UK (thousand tonnes)

	1970	1980	1990	2000	2003	2004	2005
Road Transport	5353	5390	5480	2500	1594	1366	1124
Residential	4504	2152	1197	651	458	431	361
Other	2215	1658	1615	1142	895	914	931
Total	12,072	9201	8292	4293	2947	2711	2417

Source: http://www.defra.gov.uk/environment/statistics/airqual/kf/aqkf22.htm

In 2005 the CO air quality objective of 10 µg m^3 was met at all monitoring sites in the UK (Table 4.2).

Figure D.4 Carbon Monoxide running 8 hour mean: Number of periods exceeding 10mg/m^3 compared with objective for 2003: Urban sites 1990-2005



From: Defra (2007) *E-digest Statistics about: Air Quality. Carbon Monoxide,* available [May 2007] at: http://www.defra.gov.uk/

Sulphur Dioxide

Sulphur dioxide emissions fell by 77% between 1990 and 2004, with power station emissions falling by 82%, primarily due to the reduction in the use of coal. Following a reduction in the sulphur content of fuels, road transport emissions decreased by 85% since 1998 and emissions from residential fuel fell by 71% between 1990 and 2004.

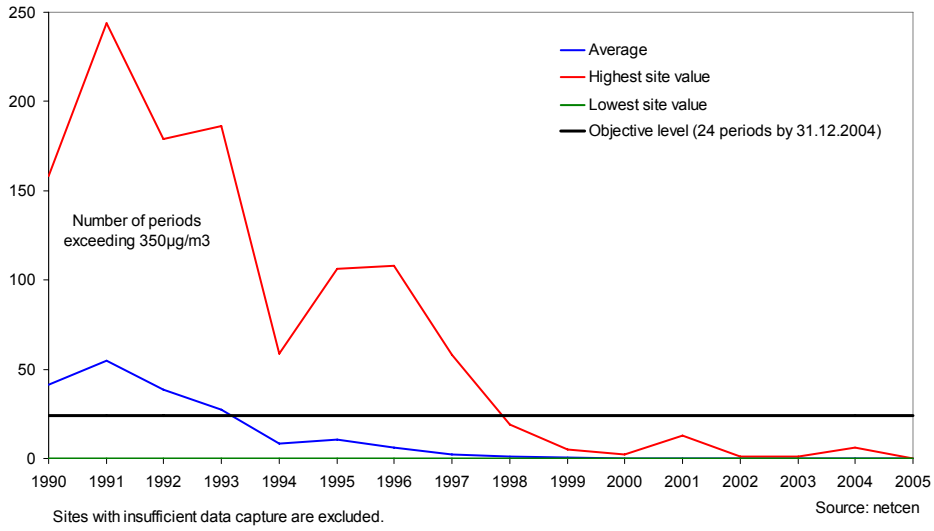
Table D.4 Sulphur dioxide emissions by source for the UK (thousand tonnes)

	1970	1980	1990	2000	2003	2004	2005
Large combustion plants	3732	3457	2934	873	715	539	370
Total emissions	6407	4838	3699	1173	991	836	706

Source: Defra (2007) Key Facts About Air Quality, available [May 2007] at: http://www.defra.gov.uk/

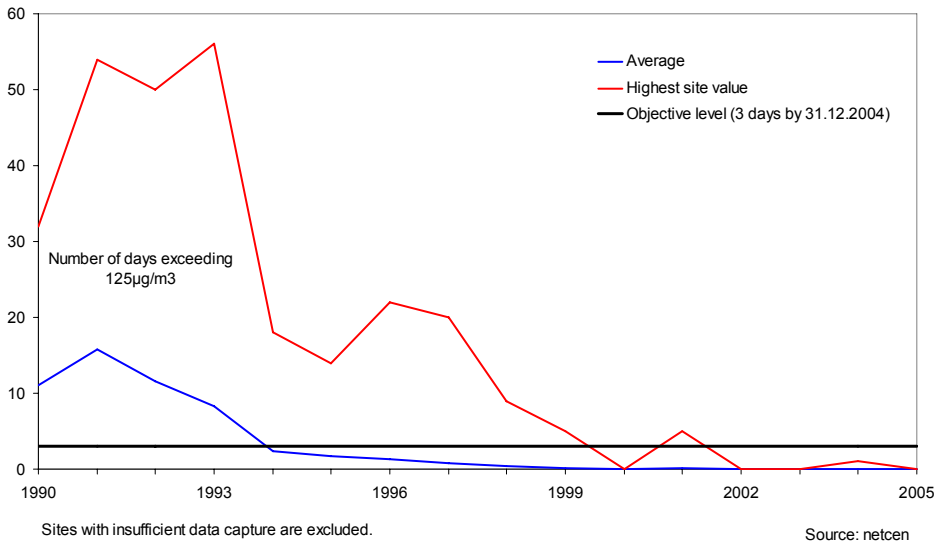
In 2005 all monitoring sites met the air quality objective that the 1 hour mean should not exceed 350 µg m^3 more than 24 times a year. Similarly the 24 hour mean objective (125 µg m^3 should not be exceeded more than 35 times a year) was met at all sites and the 15 minute mean (266 µg m^3 should not be exceeded more than 35 times a year) was exceeded at only three sites in 2005.

Figure D.5 Sulphur Dioxide 1 hour mean for the UK: Number of periods exceeding 350 µg/m^3 compared with air quality objective for 2004, Urban Sites: 1990–2005



From Defra (2007) *E-digest Statistics about: Air Quality. Sulphur Dioxide,* available [May 2007] at: http://www.defra.gov.uk/

Figure D.5 Sulphur dioxide 24 hour mean for the UK: Number of days exceeding 125µg/m^3 compared with health objective for 2004, Urban Sites: 1990-2005



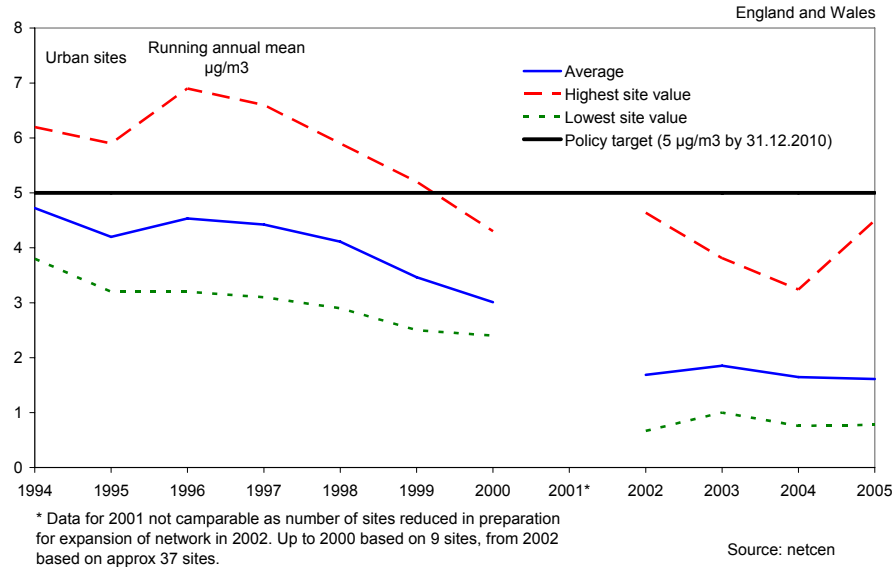
From Defra (2007) *E-digest Statistics about: Air Quality. Sulphur Dioxide,* available [May 2007] at: http://www.defra.gov.uk/

Volatile Organic Compounds

Total VOC emissions fell by 57% between 1990 and 2004 with road transport emissions falling by 83% over the same period, primarily as a result of the introduction of catalytic converters for petrol cars.

Benzene emissions fell by 74% between 1990 and 2004 and by 42% between 1999 and 2000 alone, largely due to a reduction in the benzene content of petrol as well as the ongoing effect of catalytic converters. Emissions of 1,3-butadiene fell by 73% between 1990 and 2004. The objectives that the maximum running annual means for benzene should not exceed 16.25 µg m^3 and for 1,3-butdiene should not exceed 2.25 µg m^3 by the end of 2003 were met at all sites in 2004.

Figure D.6 Benzene annual mean (England and Wales): Comparison with health objective for 2003: 1994–2005

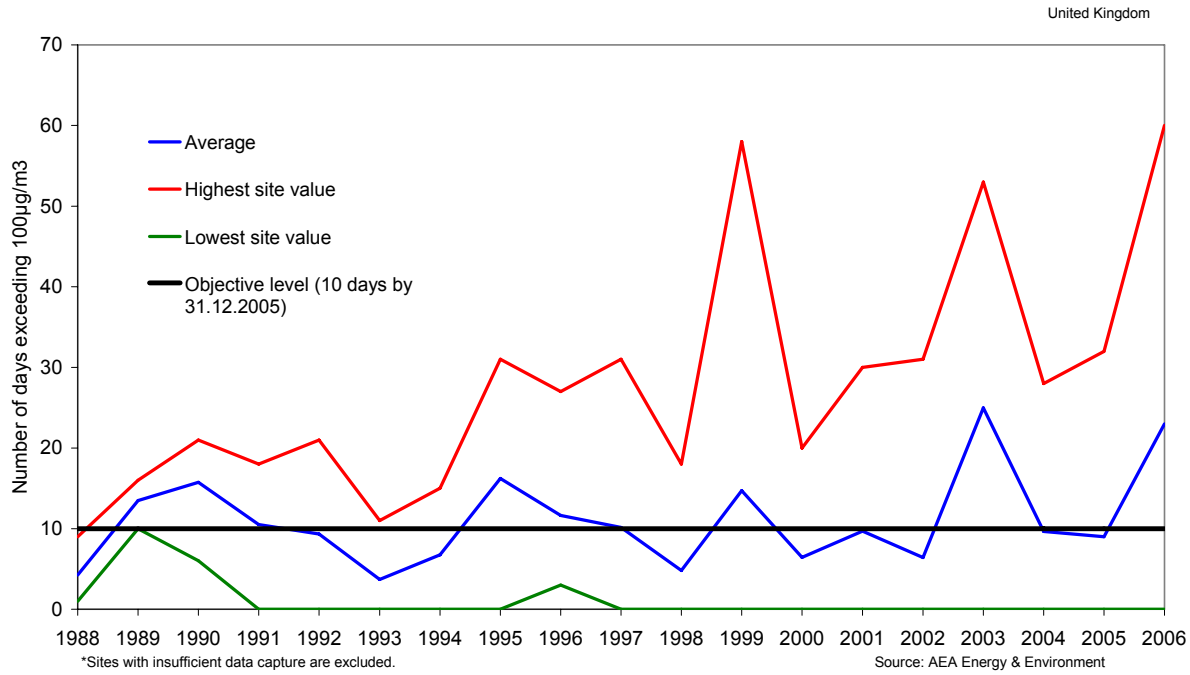


From: Defra (2007) *E-digest Statistics about: Air Quality,* available [May 2007] at: http://www.defra.gov.uk/

Ozone

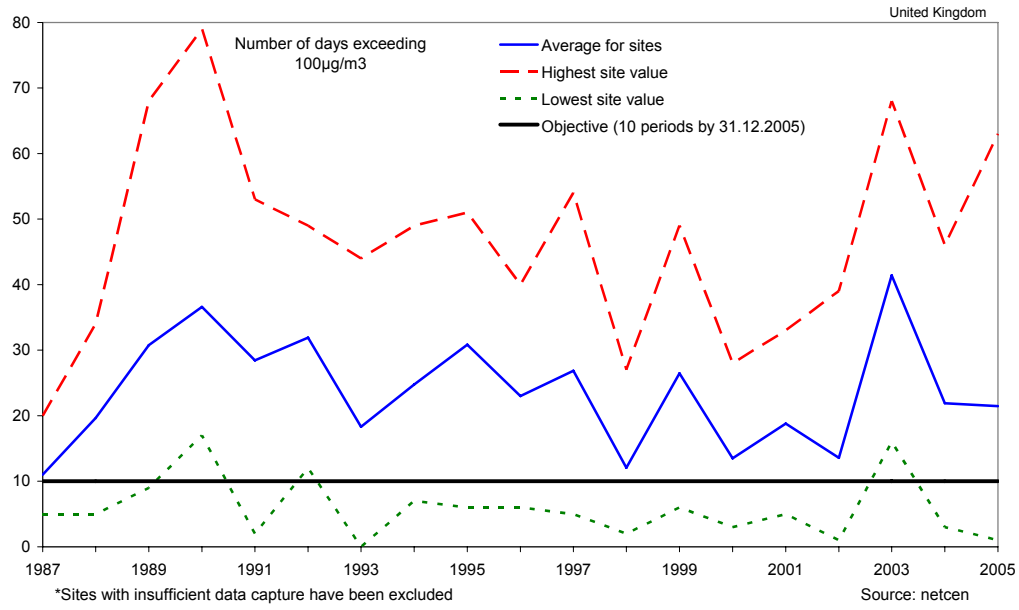
There is evidence that near ground level ozone concentrations of typically 20 to 30 µg m^3 per annum have doubled over the past 100 years to the current levels of approximately 70 µg m^3 per annum over the UK. The objective that the daily maximum of running 8 hour means should not exceed 100 µg m^3 more than 10 times a year by the end of 2005 was met by 44% of sites in 2004. All sites apart from Brighton Preston Park and London Marylebone Road recorded some moderate hourly ozone levels.

Figure D.7 Ozone daily maximum of running 8 hour means (urban sites): Number of days exceeding 100µg/m^3 compared with health objective for 2005: 1988–2006



From: Defra (2007) *E-digest Statistics about: Air Quality, Ozone,* available [May 2007] at: http://www.defra.gov.uk/

Figure D.8 Ozone daily maximum of running 8 hour means (Rural Sites): Number of days exceeding 100 µg/m^3 compared with health objective for 2005: 1987-2005



From: Defra (2007) *E-digest Statistics about: Air Quality. Ozone,* available [Aug 2007] at: http://www.defra.gov.uk/

High levels were recorded at 12 sites out of 85. Ozone concentrations recorded at rural sites are generally higher than those at urban sites due to the presence of other pollutants in urban areas such as nitric oxide which reacts with ozone to form NO_2.