Report

UK Smoke and Sulphur Dioxide Network 2003

Report prepared by Netcen as part of the Air Quality Research Programme of the Department for Environment, Food and Rural Affairs, Scottish Executive, Welsh Assembly Government and Department of the Environment in Northern Ireland

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Executive Summary

This report presents the results from the UK Smoke and Sulphur Dioxide Network for the calendar year 1st January to 31st December 2003. This network measures two pollutant parameters; particulate matter as black smoke, and net gaseous acidity, expressed as SO_2 equivalent. This report provides a summary of data from the 137 sites comprising the Network in 2003. These data are compared with the standards and objectives specified in the Air Quality Strategy, and with limit and guide values specified in applicable EC Directives on sulphur dioxide and suspended particles. Concentration trends and spatial distributions throughout the UK are also discussed.

UK average concentrations for calendar year 2003, based on "core" sites, were 7.1μg m^{-3} and 15.5μg m^{-3} for smoke and net acidity respectively. These concentrations are both slightly higher than the averages reported for calendar year 2002, which were 6.8 μg m^{-3} for smoke and 13.9 μg m^{-3} (SO_2 equivalent) for net acidity.

Data for the calendar year 2003 were compared with the 1st Daughter Directive (1999/30/EEC) 24-hour limit value for SO_2 (to be met by 1st January 2005), and the identical Air Quality Strategy 24-hour objective, (to be met by 31st December 2004). One Network site exceeded the AQS 24-hour mean SO_2 objective of 125μg m^{-3} on more than the three permitted occasions: BARNSLEY 8. However, further investigation revealed that nearby emission sources had begun to directly affect this site, and the Local Authority consequently relocated it.

Data for calendar year 2003 were also compared with the Stage 1 limit values and objectives for particulate matter contained in the 1st Daughter Directive and the Air Quality Strategy, (which are to be met by 1st January 2005 and 31st December 2004 respectively). These specifically apply to PM_{10}, not black smoke, and the latest Technical Guidance does not recommend that black smoke data are routinely used to assess compliance with AQS objectives. However, black smoke can be considered a subset of PM_{10}, so if black smoke exceeds an objective it is reasonable to suspect that total PM_{10} has also exceeded. There were no sites in the Network at which the daily mean black smoke concentration exceeded the 24-hour limit of 50 μg m^{-3} for PM_{10} on more than the 35 permitted occasions.

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1 Introduction

This is the annual summary report for the Smoke and Sulphur Dioxide Network, for the calendar year 2003. This report presents a description of the Network, and a summary and review of the data for 2003. Results are compared with applicable air quality limit values and objectives. Trends, spatial distribution of smoke and sulphur dioxide concentrations throughout the UK, data reporting commitments and data usage are discussed. The main report is followed by Appendices, which provide details of the derivation and calculation of the statistics presented in the report.

2 Network Objectives

The UK Smoke and Sulphur Dioxide (SO_2) Network (Figure 1) measures two pollutant parameters; particulate matter as black smoke, and net gaseous acidity, expressed as SO_2 equivalent. The Network, and its predecessor the National Survey, has been in operation for over 40 years. During 2003 it had two main objectives.

The first objective was to monitor compliance with the original European Council Directive on Sulphur Dioxide and Suspended Particles (80/779/EEC)[1]. This Directive was in force from 1980 to the 1st January 2005, when it was fully repealed. Its standards for particulate matter and SO_2, which in the UK are measured as smoke and net acidity, remained in force throughout the period covered by this report. Comparison of Network data with this Directive is now reported to Defra separately from this report. Directive 80/779/EEC has now been superseded: the European Commission issued a Directive on Ambient Air Quality Assessment and Management[2] - the so-called "Framework Directive" in 1996. Under this framework, a number of "Daughter Directives" covering specific pollutants are being prepared. The first Daughter Directive (1999/30/EEC)[3] came into force in July 2001 and includes limit values for SO_2 and particulate matter as PM_{10}, to be met by 1 January 2005.

Secondly, the Network provides a long-term database of smoke and net acidity measurements, used to assess trends in concentration and spatial distribution. For this purpose, a "core" subset of sites is used, which is intended to provide (as far as possible) a representative sample of monitoring locations in major population centres throughout the UK. A total of 137 Network sites were in operation during part or all of 2003. Of these sites, 91 comprised the "core" subset used to provide national trend statistics (see discussion in Section 4).

It is not envisaged that the repeal of 80/779/EEC will lead to the end of this monitoring in the UK. Although the importance of the net acidity measurements has diminished, the scientific community remains interested in black smoke as a useful particulate metric. As summarised in last year's report, numerous scientific studies have found that black smoke is linked to health impacts, even at today's relatively low concentrations. While no decision has yet been made, these factors, together with the value of the long-term historic database, indicate that some smoke monitoring at least is likely to continue for research purposes.

Figure 1 shows the location of all sites in the UK. Sites are not evenly distributed throughout the country. This is partly because the Network's historical compliance-monitoring role has concentrated sites in areas where smoke and SO_2 levels have been traditionally highest.

Figure 1: Locations of Smoke & Sulphur Dioxide Network Monitoring Sites, 2003

3 Data Reporting and Use

The Smoke and SO_2 Network, and its predecessor the National Survey, together provide one of the longest running databases of air quality measurements in the UK, having been in operation as a coordinated national network for over 40 years. The results have shown clearly the dramatic decrease in the concentrations of these pollutants in the UK over this period. At a local level, many Local Authorities, particularly in areas where levels of these pollutants are relatively high, find the smoke and net acidity methods to be a useful and relatively low-cost supplement to expensive automatic techniques.

3.1 STATUTORY REPORTING: EC DIRECTIVE

The Smoke and SO_2 Network has successfully fulfilled the statutory monitoring requirements of EC Directive 80/779/EEC[1], until its repeal in 2005. In July each year, the data from the previous pollution year (April - March) have been compared with the requirements of the Directive. The results are supplied to the Department for Environment, Food and Rural Affairs (Defra) for formal submission to the European Commission.

3.2 EC EXCHANGE OF INFORMATION

Under the terms of the EC Exchange of Information Decision[4], Defra has agreed to supply to the Commission, full daily data for all sites in the Network, from 1997 onwards. The data are supplied to the European Topic Centre on Air Quality, for inclusion in their "AIRBASE" database, at http://bettie.rivm.nl/etc-acc/appletstart.html (Note: in AIRBASE, the term "Strong Acidity" is used for net gaseous acidity).

3.3 PUBLIC DISSEMINATION

This report provides a major route for public dissemination of data from the Network. However, data are also summarised in the Digest of Environmental Statistics, published annually by the Stationery Office[5]. Also, ad hoc requests for data are serviced by retrievals from the database held at Netcen. These are normally provided free of charge.

A comprehensive archive of air quality measurements, including data from the Smoke and SO_2 Network, is available on the World Wide Web, via Defra's Air Quality Archive at www.airquality.co.uk. Daily data from 1961 onwards are available, and are updated regularly.

3.4 REVIEW AND ASSESSMENT

Black smoke and net acidity measurements are of limited use in the Review and Assessment process[6]. In the case of black smoke, there is no simple or universally applicable relationship between this parameter and PM_{10}, so smoke data cannot be used as a substitute for PM_{10} measurements. However, existing smoke monitoring sites may be useful in identifying areas of high particulate pollution, which can then be targeted for PM_{10} monitoring. Also, net acidity data can be used to predict possible exceedence of the 24-hour objective for SO_2.

4 Results and Discussion

4.1 METHODS AND UNITS

Both smoke and sulphur dioxide concentrations are expressed in microgrammes per cubic metre (μg m^{-3}) in this report.

(i) Smoke: In the UK, smoke concentrations are usually calculated according to the British Standard Smoke Stain (BS) Calibration. This report primarily uses the BS calibration, and all black smoke concentrations are in this form except where stated. However, elsewhere in Europe, the Organisation for Economic Co-operation and Development (OECD) Smoke Calibration Curve (OECD Publication no. 17913: 1964) is used. Concentrations given according to the BS calibration can be converted to OECD by dividing the BS concentrations by 0.85. In any communication with the European Commission, it is normal to use the OECD calibration. Where OECD smoke concentrations appear in this report, they are indicated as OECD and shown in *italics.*

(ii) SO_2: This network uses the peroxide bubbler method to determine the total concentration of strong acidic gases in the air; the results are by convention expressed as SO_2 equivalents. The units used in this report for net acidity as SO_2 equivalents are μg m^{-3}. However, concentrations of gaseous pollutants are sometimes expressed as parts per billion by volume (abbreviated to "ppb"). For SO_2, the conversion factor used by the EC is as follows: **1 ppb = 2.66 μg m^{-3}, at a temperature of 20°C and 1013 mb pressure** (this only applies to SO_2; conversion factors are different for other gaseous pollutants).

During the earlier years of the Network, ambient levels of sulphur dioxide were considerably higher that they are now, and SO_2 comprised a larger proportion of the total concentration of strongly acidic gases in ambient air. Therefore, net acidity measurements were usually a good indicator of actual SO_2 concentration. However, ambient concentrations of SO_2 have fallen substantially in recent years, and other strongly acidic gases, such as NO_2, now make a more significant contribution to the net acidity measurement. As discussed in the 2002 report, it can no longer be assumed that net acidity is equivalent to SO_2.

Data from the small number of Smoke and SO_2 Network sites that are co-located with (or very close to) Automatic Urban and Rural Network (AURN) sites, indicate that:

1. net acidity measurements appear still to provide a useful indication of peak daily average SO_2 concentrations. This is because these peak measurements often correspond to winter pollution episodes, where the majority of the gaseous acidity measured is in fact SO_2.
2. However, the net acidity method now tends to overestimate the annual mean SO_2 substantially. For this reason, this report makes it clear that annual mean statistics in particular are net acidity data.

The net acidity method remains a useful indicative technique for peak 24-hour mean SO_2 concentrations, particularly in areas where coal and oil use are still widespread. However, with SO_2 concentrations still decreasing in the UK, its application is likely to become more limited in the longer term.

4.2 SUMMARY OF RESULTS

Summary statistics for the year 2003 for each Network site are provided in Table 1. The sites are listed by Government region (Scotland, the North East, North West and Merseyside, Yorkshire and the Humber, East Midlands, West Midlands, Wales, Eastern, London, South East, South West and Northern Ireland). Table 1 is subdivided into 12 separate Tables, 1.1 to 1.12, for the 12 regions. ***As Table 1 is large, it has been placed at the end of the text.*** Within each region, sites are grouped by the Local or Unitary Authority in whose area they are situated. In most cases, this Authority is responsible for the operation of the site, although a small number are operated by other organisations such as universities.

For sites in England, Wales and Scotland, Table 1 gives the location as an Ordnance Survey grid reference, to the nearest 100m. For sites in Northern Ireland, the Irish Grid is used.

The following abbreviations are used in Table 1:

1. **" Data Capt. %"** is percentage data capture – the number of days in the calendar year for which valid data was obtained, expressed as a percentage.
2. **"Arith. Mean"** is the arithmetic mean of all daily values (see Appendix A).
3. **"Median"** is the median, or 50th percentile, of all daily values (see Appendix A).
4. **"98th %ile"** is the 98th percentile of all daily values (see Appendix A).
5. **"Max. Day"** is the maximum daily value measured during the year.

4.3 DATA CAPTURE

The data capture objective specified by Annex IV of the First Daughter Directive (1999/30/EEC)[3] for indicative techniques is 90%; therefore this is the target for minimum data capture in the Network. The number of sites in operation for the whole year was 120 (this excludes those which started up or closed down during this period, and so could not have achieved 90% data capture). The average data capture for these sites was 86% for smoke, and 84% for net acidity. Data capture for net acidity is usually slightly lower, as this parameter can be affected by factors such as alkaline interference, which are beyond the site operator's control. 62% of the 120 sites in operation for the full year achieved the data capture target of 90%.

These data capture statistics represent a small improvement on 2002. However, data capture remains an area where improvement is needed. Advice for site operators on dealing with equipment faults and improving data capture are given in the Network's Instruction Manual. Every site operator should have an up-to-date copy of the Manual to hand: it can be downloaded from http://www.aeat.co.uk/Netcen/airqual/reports/smkman/shead.html. Alternatively printed copies are available from Netcen. Site operators are welcome to contact Netcen for advice on any aspect of smoke or net acidity monitoring.

4.4 UK AVERAGE SMOKE AND NET ACIDITY CONCENTRATIONS

Annual mean UK smoke and net acidity are estimated on the basis of a "core" subset of sites. There were 105 sites in the "core" subset during 2003. Annual mean concentrations, calculated by averaging the annual means from all core sites, excluding any with data capture of less than 70%, and for 2003 were as follows:

- Smoke: 7.1 μg m^{-3} BS *(8.3 $\mu g\ m^{-3}$ OECD); and*
- Net acidity: 15.5 μg m^{-3}.

Both the annual mean smoke and net acidity concentrations for 2003 were slightly higher than the annual means for 2002 (which were 6.8μg m^{-3} and 13.9μg m^{-3} respectively).

As noted in Section 4.1 above, the net acidity method is likely to over-estimate network average SO_2 concentrations, due to the contribution from other acidic gases. Annual mean net acidity concentrations, as measured by this Network, have been compared to annual mean SO_2 concentrations for 2003, measured at Automatic Urban and Rural Network (AURN) sites.

Most sites in the Smoke and SO_2 Network are in locations which would be classified as urban background or suburban. Three categories of AURN sites were therefore considered - see below.

- Suburban: there were just five AURN sites in this category during 2003, and their annual mean SO_2 concentrations ranged from 6 to 10 μg m^{-3}, with a mean of 8.8 μg m^{-3}.
- Urban background (38 sites in 2003). Annual mean SO_2 concentrations at these sites ranged from 3 to 19 μg m^{-3}, with a mean of 7.6 μg m^{-3}.
- Urban non-roadside, (i.e. urban background, urban centre, suburban and urban industrial; 72 sites in 2003). Annual mean SO_2 concentrations at these sites ranged from 3 to 19 μg m^{-3}, with a mean of 7.8 μg m^{-3}.

The annual mean SO_2 concentration at urban sites therefore appears to be around 8 μg m^{-3} compared with 15.5 μg m^{-3} for net acidity; that is, SO_2 may account as little as half the net acidity measurement. However, it should be remembered that many Smoke and SO_2 Network sites are located in areas where SO_2 may be higher than UK average, so any comparison between the two Networks should be treated with caution.

4.5 NATIONAL AND REGIONAL ANALYSIS

Figures 2 and 3 show annual means of smoke and net acidity respectively, for the entire Network. Only sites with at least 75% data capture are shown.

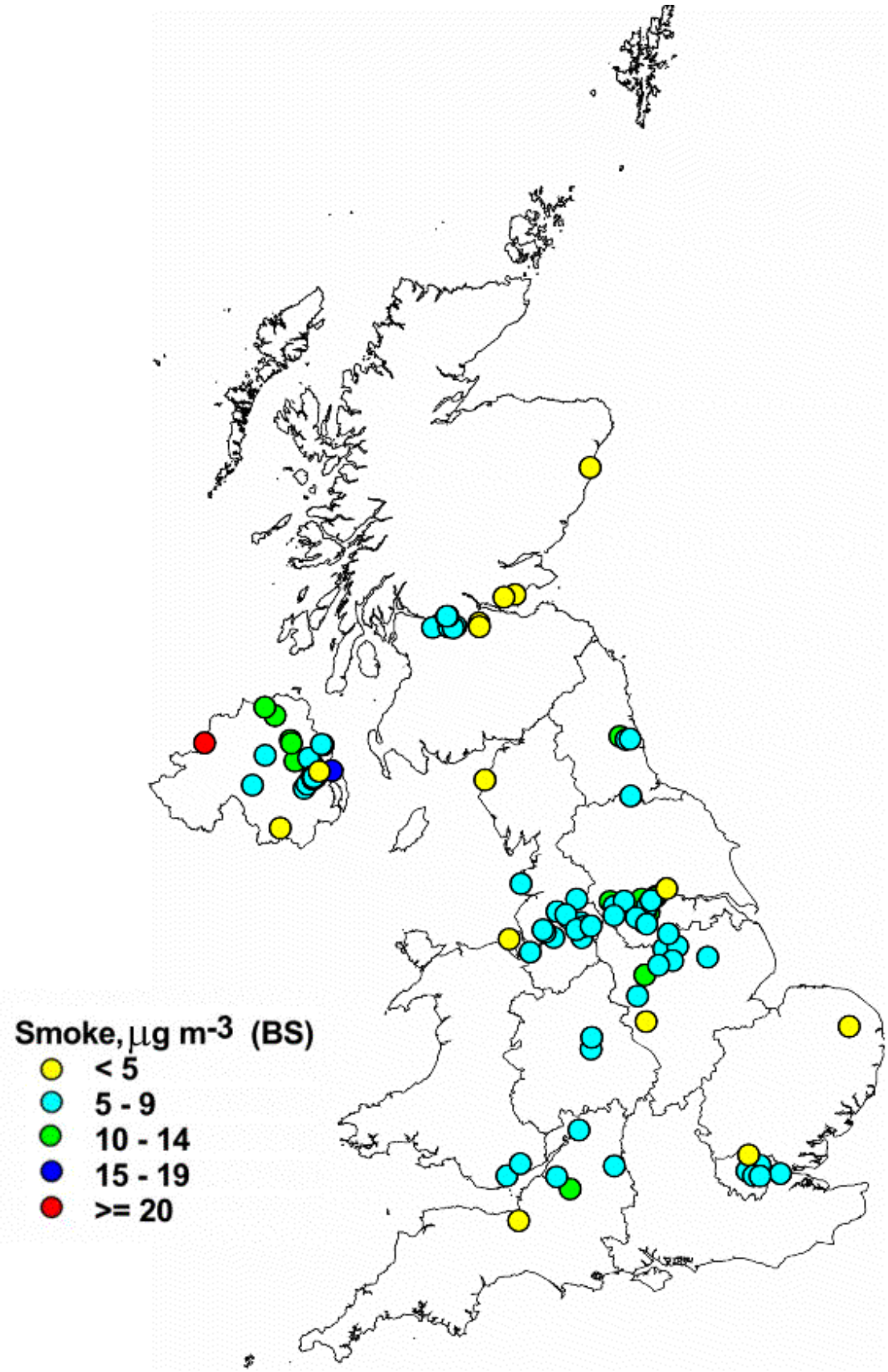

Figure 2: Annual Mean Smoke Concentrations, 2003

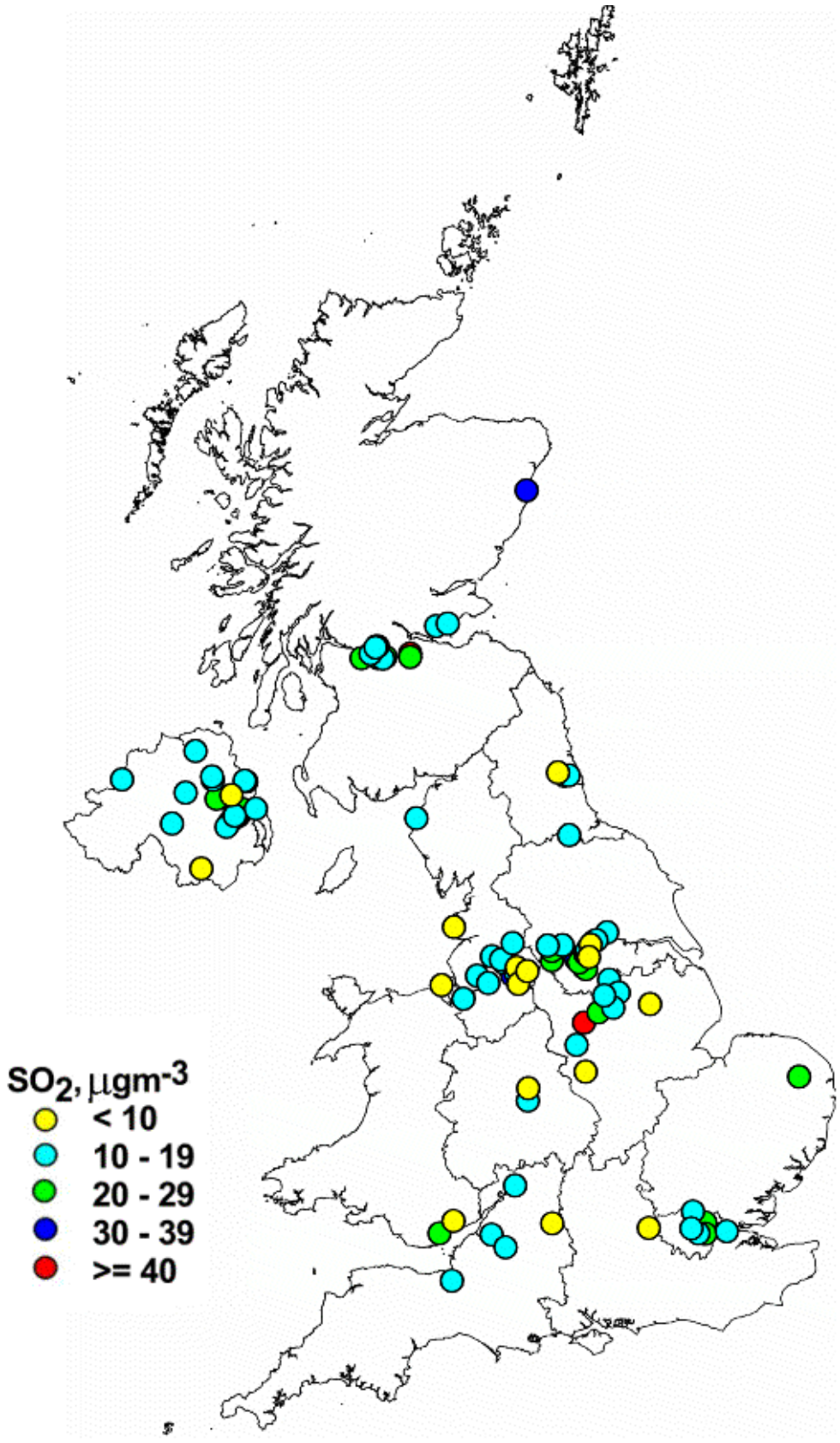

Figure 3: Annual Mean Concentrations of Net Acidity, 2003

Table 2 summarises key statistics for England, Scotland, Wales and Northern Ireland. Please note that these statistics are not necessarily representative of the region as a whole. Spatial distribution across the UK is not even, and monitoring sites are concentrated in urban areas, particularly where levels of smoke and SO_2 are likely to be highest. In particular, there are now very few monitoring sites in Wales, so the statistics shown should not be assumed to represent Wales as a whole.

Table 2: Statistical Summary for England, Scotland, Wales and Northern Ireland.

	England	Scotland	Wales	N. Ireland
Smoke				
Number of sites with > 75% data	61	13	2	22
Minimum Annual Mean (µg m^{-3} BS)	2	2	7	3
Average Annual Mean (µg m^{-3} BS)	7	6	*(8)*	9
Maximum Annual Mean (µg m^{-3} BS)	12	12	8	21
Net Acidity				
Number of sites with > 75% data	60	13	2	21
Minimum Annual Mean (µg m^{-3})	2	10	6	4
Average Annual Mean (µg m^{-3})	15	22	*(13)*	18
Maximum Annual Mean (µg m^{-3})	48	46	20	29

Note: All statistics in Table 2 are based only on sites with at least 75% data capture.

4.5.1 England

Smoke in England: Annual mean smoke at English sites ranged from 2 - 12 μg m^{-3}. Few sites recorded annual mean smoke concentrations greater than 10 μg m^{-3} in 2003, and most of these were either in Yorkshire and the Humber region, or else in cities such as Newcastle, Manchester or Bath. The average for all sites in England was 7 μg m^{-3}. This is consistent with the mean of 7 μg m^{-3} for the whole UK, based on core sites.

Net acidity in England: Few sites had annual means greater than 30 μg m^{-3} in 2003, but those that did, including BARNSLEY 12 and CUDWORTH 2 in the Barnsley area, BRAMPTON 1 (near Rotherham), and ALFRETON 4 (in Amber Valley) were all in areas where domestic coal use remains relatively widespread. The annual mean net acidity for all English sites was 15 μg m^{-3}. Again, this is consistent with the mean of 15 μg m^{-3} for the whole UK (based on core sites only).

4.5.2 Scotland

Smoke in Scotland: Annual mean smoke concentrations measured in Scotland were all 10 μg m^{-3} or less. The annual mean smoke concentration for all Scottish sites was 6 μg m^{-3}; this is slightly lower than the Network average of 7 μg m^{-3}.

Net acidity in Scotland: By contrast, net acidity concentrations in Scotland continue to be typically higher than the Network average. The highest annual mean was 46 μg m^{-3}, measured at ARMADALE 2. This site is close to industrial and domestic emission sources; high net acidity concentrations have been measured here in previous years. Only one other site, ABERDEEN 3, had an annual mean greater than 30 μg m^{-3}. Measured net acidity concentrations at this site, particularly during the summer, have increased in recent years; it is strongly suspected that this is due to a local emission source (a swimming pool boiler chimney), though this has not yet been confirmed. The mean for

Scotland was 22 μg m^{-3} – considerably higher than the average of 15 μg m^{-3} measured for the whole Network. However, it is not necessarily the case that net acidity concentrations in Scotland are higher than in the rest of the UK: the number of sites is relatively small, and they are located in Scotland's most built-up areas.

4.5.3 Wales

Smoke in Wales: There were only three sites in Wales during 2003, of which only two had at least 75% data capture. The limited number of sites in Wales means that these statistics are unlikely to be representative of all urban areas in Wales. However, these two sites recorded annual means of 7 μg m^{-3} and 8 μg m^{-3}.

Net acidity in Wales: Annual mean net acidity concentrations at the three sites in Wales ranged from 6 - 20 μg m^{-3}.

4.5.4 Northern Ireland

Smoke in Northern Ireland: Annual mean smoke concentrations in Northern Ireland (with one exception) ranged from 3 - 21 μg m^{-3}. The average for Northern Ireland was 9 μg m^{-3}; slightly higher than the Network average of 7 μg m^{-3}. STRABANE 2 recorded the highest annual mean smoke concentration 21 μg m^{-3}, but showed a reduction of 6 μg m^{-3} compared to 2002. This site has recorded unusually high smoke concentrations ever since it started operation in 2000, and investigations indicate that the results are genuine. The site is located on a housing estate with considerable domestic coal and oil burning, and local topography may impede dispersion.

Net acidity in Northern Ireland: Relatively high concentrations of net acidity have been measured in Northern Ireland, particularly Belfast, for many years. Availability of natural gas has historically been limited in this region, so greater use is made of coal and oil. However, the overall annual mean net acidity for all Network sites in Northern Ireland appears to be falling: from 27 μg m^{-3} in 2000, 22 μg m^{-3} in 2001, 18 μg m^{-3} in 2002, and 18 μg m^{-3} in 2003.

4.6 SEASONAL VARIATION & POLLUTION EPISODES

It has been reported that 2003 was an unusual (although not exceptional) year in terms of air pollution[7]. The summer was particularly hot and sunny, and there were several periods when meteorological conditions resulted in long-range transport of polluted air masses from mainland Europe, and on occasion, long-range transport of Saharan dust particles. Together, these factors resulted in several episodes of poor air quality (particularly in the spring and summer). However, the pollutants concerned were primarily oxides of nitrogen, PM_{10} and (especially in the summer months) ozone. We would not necessarily expect these episodes to be evident in data from the Smoke and SO_2 Network. PM_{10} peaks may be caused by secondary particulate matter (e.g. particulate nitrate and sulphate), which is detectable as PM_{10} but not by the black smoke method, due to its lighter colour.

Figures 4a and 4b show daily mean concentrations of black smoke and net acidity (as SO_2) respectively. For this purpose, rather than dividing the UK into its constituent counties, it has been divided into five parts:

- Southern England (South East, South West, London and Eastern regions);
- Northern England (North East, North West and Merseyside, Yorkshire and the Humber);
- The Midlands and Wales;
- Scotland; and
- Northern Ireland.

Figure 4a shows how daily mean black smoke concentrations in each of these areas varied over 2003. Black smoke concentration demonstrated a typical seasonal pattern, with highest levels and most peaks occurring during the winter months. However, four peaks are evident in the early part of the year: approximately 4th –12th January (predominantly Scotland and Northern Ireland), 13th February – 3rd March, 12th –28th March, and around 16th April (South). The latter three of these (in February, March and April) roughly coincide with PM_{10} "episodes" recorded by the UK Automatic Urban and Rural Network (AURN), as follows:

1. 17th February – 2nd March (especially 21st – 23rd February)[8]: high PM_{10}. Air masses from mainland Europe increased concentrations of secondary PM_{10}. Where wind speeds were low, local sources added a significant primary PM_{10} contribution. It is likely that this local contribution is showing up as black smoke.
2. 15th – 30th March[9]: a combination of air masses from mainland Europe, together with local emissions of particulate, brought higher concentrations of PM_{10} to Scotland, Northern Ireland and the north of England.
3. 12th – 30th April[9]: easterly winds from mainland Europe and transport of Saharan dust (14th – 18th April) brought high levels of both ozone (O_3) and PM_{10} to the UK. The Saharan dust was light in colour, so its contribution to black smoke would have been limited.

These three peaks are relatively small (the regional averages did not exceed 35 μg m^{-3}). However, they are of interest as they coincide with PM_{10} episodes, and it is likely that the black smoke data are showing the contribution to these episodes from local, primary emissions of particulate matter (from combustion sources, vehicles etc).

Also, a distinct "spike" is visible in the dataset for Northern Ireland only, on 12th July. This is a public holiday in Northern Ireland, and is often marked by bonfires.

Figure 4b shows daily mean net acidity for the same five large areas of the UK. The most noticeable feature is the fact that average levels of net acidity in Scotland appear to be higher than those measured in any other region during the months April to October. This is the third consecutive year in which Scotland has on average shown high levels of net acidity during the summer. Three sites in particular showed this pattern, all sites with relatively high net acidity concentrations. These were ARMADALE 2, ABERDEEN 3 and GLASGOW 95. ARMADALE 2 is in an area known to be affected by industrial emissions, and ABERDEEN 3 may also be influenced by emissions from a nearby boiler chimney. However, the majority of sites in Scotland do not show such seasonal variation.

There were four AURN automatic sites in Scotland monitoring SO_2 during 2003. Of these, Glasgow Centre and Aberdeen recorded slightly higher SO_2 concentrations during the spring and summer of 2003, compared with the rest of the year. However, this is not thought to be typical of Scotland as a whole.

Small peaks in net acidity occurred around the following dates:

- 17th February (particularly Scotland and the North of England). This coincided with a PM_{10} episode, as discussed above[8]);
- 18th March (particularly Scotland and the North of England). This coincided with the pollution episode of 15th – 30th March[9], when air masses from mainland Europe brought higher concentrations of PM_{10} to Scotland, Northern Ireland and the north of England;
- 14th-17th July (particularly Scotland and the North): this peak roughly coincided with a period of high ozone over 13th – 16th July, caused by air masses recirculating over the UK, during hot sunny weather[10]; and

- 4^{th}-10^{th} August. This peak fell within a period when intense sunlight and recirculation of air over UK, northern Germany and France caused high concentrations of O_3, particularly in London, the South East, and the Midlands. The period of high ozone was 1^{st} – 15^{th} August (peaking 9^{th} August) [11].

Thus it appears that the meteorological conditions causing "episodes" of high PM_{10} or ozone (such as long-range transport of polluted air from mainland Europe, or re-circulation of already polluted air masses over the UK) also produced more modest peaks in black smoke and/or net acidity.

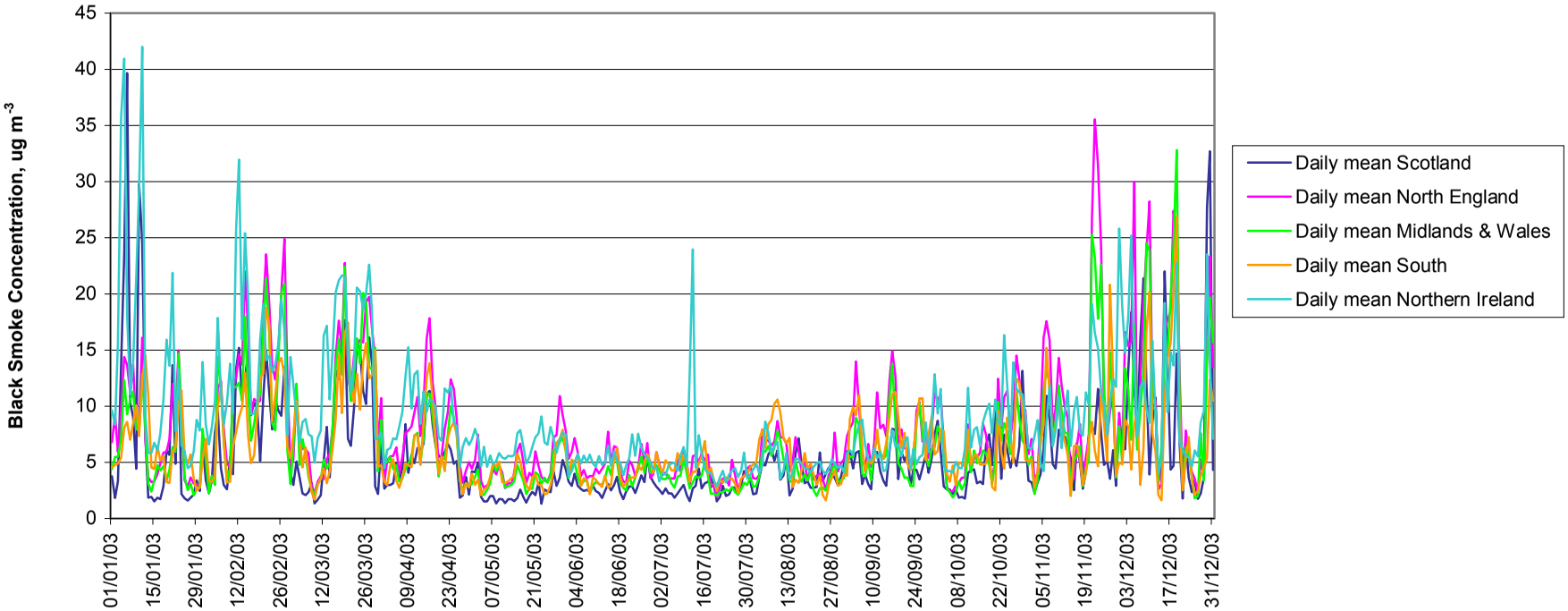

Figure 4a: Seasonal Variation in Daily Mean Smoke Concentration

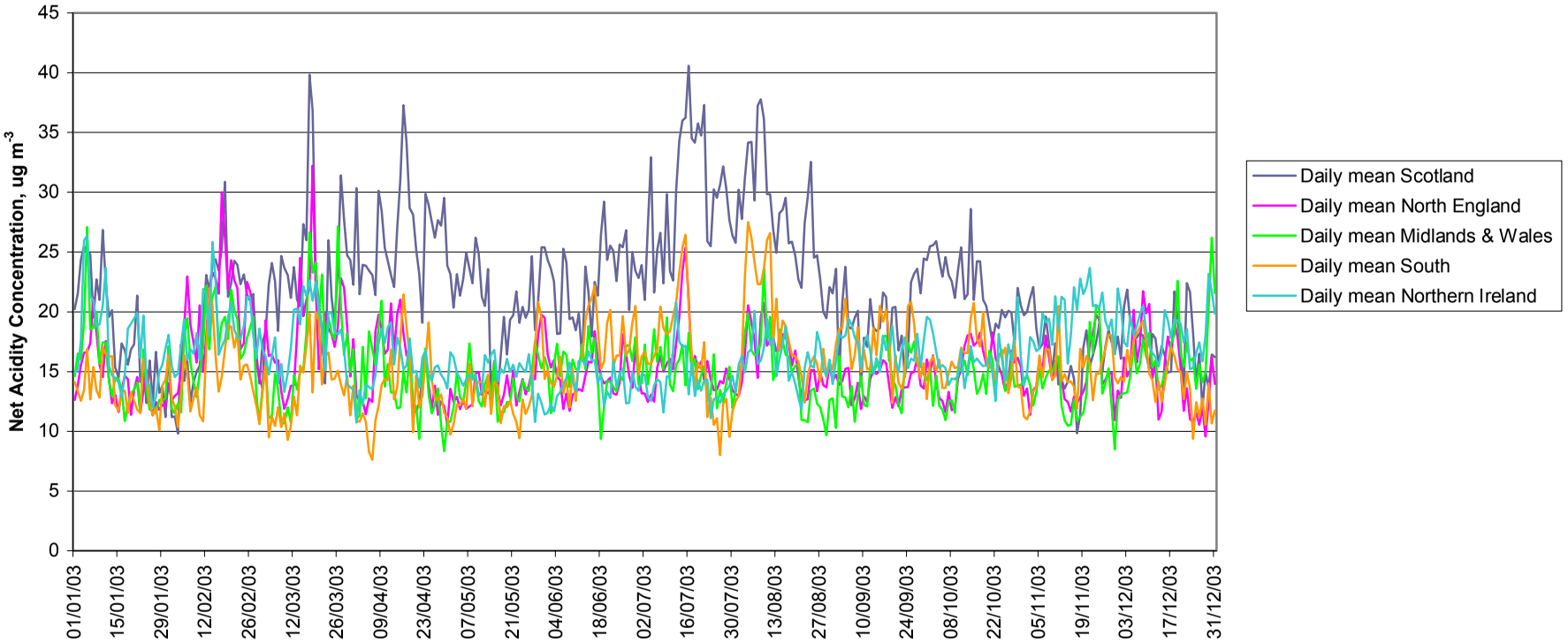

Figure 4b: Seasonal Variation in Daily Mean Net Acidity Concentration

5 Comparison with Air Quality Limit Values and Objectives

In previous years, data from the UK Smoke and SO_2 Network have been compared with the European Council Directive[1] 80/779/EEC on sulphur dioxide and suspended particulates. The limits of this older Directive are less stringent than those in the later 1st Daughter Directive and have been fully met throughout the UK since the early 1990s. Now that Network data are reported on a calendar year basis, comparison of results from the Smoke and SO_2 Network with this original Directive are reported separately to Defra each year. This report therefore compares results from the Smoke and SO_2 Network, for calendar year 2003, with applicable parts of the First Daughter Directive (1999/30/EEC)[3].

In both the 1st Daughter Directive and the Air Quality Strategy, an "exceedence" of an air quality limit or guide value is defined as a concentration "greater than" the limit or guide value, as opposed to "greater than or equal to". This definition - "greater than" is therefore used in this report.

5.1 LIMITS AND OBJECTIVES FOR SO_2

Within Europe, sulphur dioxide is covered by the 1st Daughter Directive (1999/30/EC)[3]. This Directive, covering SO_2, NO_2, PM_{10} and lead was published in April 1999 and came into force in July 2001. In the UK, the Air Quality Regulations (2000) for England[12], Wales[13], and Scotland[14], and (2002) for Northern Ireland[15] include standards and objectives for SO_2. These are explained in the Air Quality Strategy for England, Scotland, Wales and Northern Ireland (January 2000)[16]. The EC Limit Values, and Air Quality Strategy Standards and Objectives for sulphur dioxide, are summarised in Table 3. All these limits are for the protection of human health except where stated.

Table 3: Limit Values and Objectives for Sulphur Dioxide

Averaging Period	Limit Value	No. of Permitted Exceedances	To be achieved by
EC 1st Daughter Directive (1999/30/EC)			
1 hour	350 $\mu g\ m^{-3}$	24 per year	1 January 2005
24 hour	125 $\mu g\ m^{-3}$	3 per year	1 January 2005
Calendar year and winter (1st October – 31st March), for protection of vegetation (relevant in rural areas)	20 $\mu g\ m^{-3}$	-	19 July 2001
Air Quality Strategy Objectives			
15 minute	266 $\mu g\ m^{-3}$	35 per year	31 December 2005
1 hour	350 $\mu g\ m^{-3}$	24 per year	31 December 2004
24 hour	125 $\mu g\ m^{-3}$	3 per year	31 December 2004
Calendar year and winter (1st October – 31st March), for protection of vegetation (relevant in rural areas)	20 $\mu g\ m^{-3}$	-	31 December 2000

It is clearly not possible to compare data from the Smoke and SO_2 Network with the limit values or objectives relating to the 15-minute or hourly average SO_2 concentration. Nor is it relevant to compare data from this urban network with the annual and winter limits for protection of ecosystems, which are intended for protection of rural areas. However, it is possible to compare the daily net acidity data from the Network with the 24 hour limit.

In last year's report, it was reported that 2003 was the first year in which no sites had more than three days where the 24-hour average net acidity was greater than the Daughter Directive Limit Value and AQS Standard for SO_2 of 125 μg m^{-3}. However, in 2003 one Network site had daily mean net acidity concentrations exceeding the AQS objective of 125 μg m^{-3} for 24-hour mean SO_2 on more than the three permitted occasions: BARNSLEY 8.

By convention, a factor of 1.25 should be applied to *peak* data obtained using the net acidity method, when comparing it with limit values relating specifically to SO_2. This is intended to take into account any additional uncertainty of the net acidity method at higher concentrations. However, application of this factor did not increase the number of sites exceeding the AQS objective of 125 μg m^{-3} for 24-hour mean SO_2 on more than the three permitted occasions.

Most of the days on which the Daughter Directive Limit Value and AQS Standard of 125 μg m^{-3} was exceeded at BARNSLEY 8 occurred during February and early March 2003. This site is located in a housing estate where solid fuels are widely used, and has always recorded relatively high concentrations. However, the Local Authority operating this site had already concluded that emissions from a nearby chimney had begun to directly affect its results to an unacceptable extent, and in June 2003 it was re-located at their own instigation.

5.2 LIMITS AND OBJECTIVES FOR SMOKE

The Daughter Directive particulate limits relate to PM_{10}, not black smoke, and therefore Network data cannot be directly compared with these. However, where domestic coal and oil combustion are prevalent, black smoke measurements can be useful for highlighting areas where high concentrations of PM_{10} may occur: these areas can then be targeted for more detailed investigation.

The Air Quality Strategy[16] also provides objectives for suspended particulate matter. These objectives also specifically apply to PM_{10}, not black smoke, and the Strategy acknowledges that these two techniques are not the same. Following a recent consultation process, in August 2003 Defra announced some changes to the AQS objectives, including the setting of further PM_{10} objectives for 2010. The new objectives include separate PM_{10} objectives specifically for London, (in acknowledgement of the capital's higher levels of industrial and transport activity), and for Scotland where PM_{10} concentrations are generally lower.

The EC Directive Limit Values and AQS Objectives for PM_{10} are summarised in Table 4. All limits and objectives are based on European reference method for PM_{10} (a gravimetric technique), or equivalent. Black smoke data are therefore not directly comparable.

LAQM.TG(03), available via the Defra web site http://www.defra.gov.uk/environment/airquality/laqm/guidance/index.htm , does not recommends that black smoke data are routinely used to assess compliance with the AQS Objectives above. This is because there is no simple relationship between black smoke and PM_{10}, which is applicable to every site. However, as black smoke can be considered a subset of PM_{10}, if black smoke exceeds either of the above limits, it is very likely that total PM_{10} has also done so. This was not the case for any Network sites during 2003.

Table 4: Limit Values and Objectives for Particulate Matter as PM_{10}

Averaging Period	Limit Value	Number of Permitted Exceedances	To be achieved by
EC 1st Daughter Directive (1999/30/EC) Stage 1			
24 hour	50 $\mu g\ m^{-3}$	35 per year	1st January 2005
Annual Mean	40 $\mu g\ m^{-3}$	-	1st January 2005
EC 1st Daughter Directive (1999/30/EC) Stage 2 (to be confirmed)			
24 hour	50 $\mu g\ m^{-3}$	7 per year	1st January 2010
Annual Mean	20 $\mu g\ m^{-3}$	-	1st January 2010
Air Quality Strategy			
24 hour	50 $\mu g\ m^{-3}$	35 per year	31st December 2004
Annual Mean	40 $\mu g\ m^{-3}$	-	31st December 2004
Air Quality Strategy, England (except London) and Wales			
24 hour	50 $\mu g\ m^{-3}$	7 per year	31st December 2010
Annual Mean	20 $\mu g\ m^{-3}$	-	31st December 2010
Air Quality Strategy, Scotland			
24 hour	50 $\mu g\ m^{-3}$	7 per year	31st December 2010
Annual Mean	18 $\mu g\ m^{-3}$	-	31st December 2010
Air Quality Strategy, London			
24 hour	50 $\mu g\ m^{-3}$	10 per year	31st December 2010
Annual Mean	23 $\mu g\ m^{-3}$	-	31st December 2010

Note: All limit values refer to gravimetric equivalent measurements.

6 Trends and Comparison with Emission Estimates for Recent Years

Previous reports in this series have presented time series graphs showing:

- total estimated UK annual emissions of black smoke, taken from the National Atmospheric Emissions Inventory for 1970 onwards;
- total estimated UK annual emissions of sulphur dioxide, taken from the National Atmospheric Emissions Inventory for 1970 onwards; and
- UK annual mean concentrations of smoke and net acidity, as measured by the Smoke and SO_2 Network.

These reports have highlighted that, over the past 30 years, there is a strong correlation between the total annual emission of sulphur dioxide and the UK annual mean concentration of net acidity. There is a similarly strong correlation between the total estimated annual emission of black smoke and the measured UK annual mean black smoke concentration.

This report takes a more detailed look at the most recent part of this long period: years 1990 onwards. The time series of the annual mean black smoke and net acidity concentrations for the UK as a whole (based on the core subset) are provided in Figure 5a and 5b respectively. The values shown in Figure 5a and 5b are means from all sites in the core subset only. For consistency with trend analyses in previous report, the annual means shown in these figures are based upon the old "pollution calendar" years, which ran from April to March. The most recent annual means shown are for years April 2003-March 2004, which are 6.6μg m^{-3} and 15.2μg m^{-3} for smoke and net acidity respectively. (It should be noted that these are slightly different from the calendar year means discussed earlier in this report).

Figures 5a and 5b also show estimated total UK annual emissions of smoke and SO_2 for calendar years 1990 - 2002 (data for 2003 are not yet available), taken from the National Atmospheric Emissions Inventory. It should be noted however that, as PM_{10} has superseded black smoke as a measure of airborne particulate material in many areas, there is now very little emission measurement data of black smoke for recent years. As a result, historical emission factors have had to be used. It is known that the blackening effect from sources has changed with time, and this gives rise to significant uncertainties in the black smoke emission estimates- particularly for more recent years. Therefore, the UK black smoke emission estimates shown here should be treated with caution.

Figure 5a shows that measured annual mean concentrations, of black smoke have continued to decrease gradually throughout the 1990s, and are now approximately 7 μg m^{-3} compared with 14 μg m^{-3} in 1990. Estimated emissions (which, as noted above are subject to increased uncertainty in recent years) show a similar decline from around 500 Ktonnes to around 250 Ktonnes. Regression analysis of the two parameters gives a correlation coefficient (R^2) of 0.85. This indicates a good correlation between the two parameters.

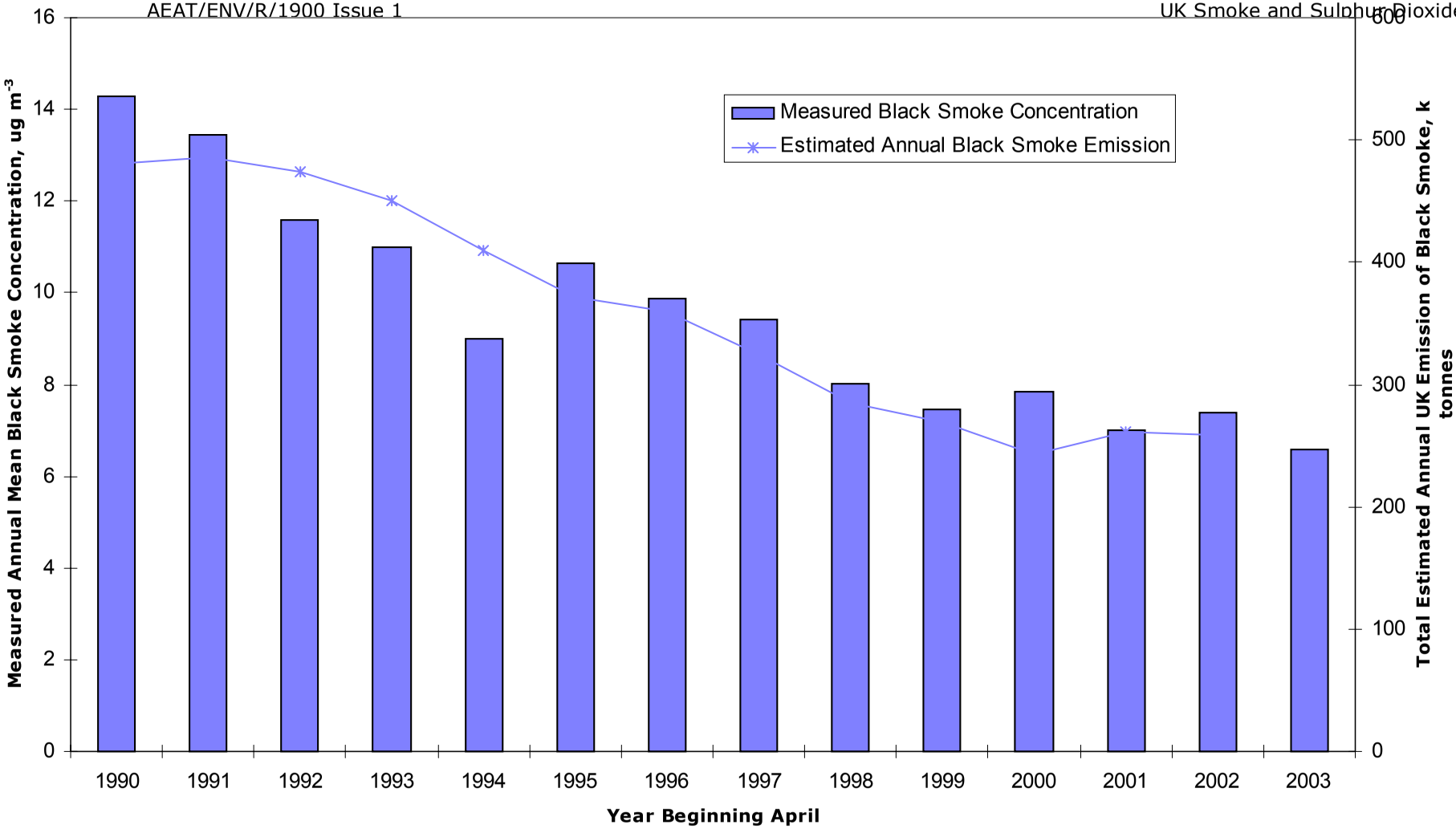

Figure 5a: Estimated Annual UK Emission and Measured Annual Ambient Concentration of Black Smoke

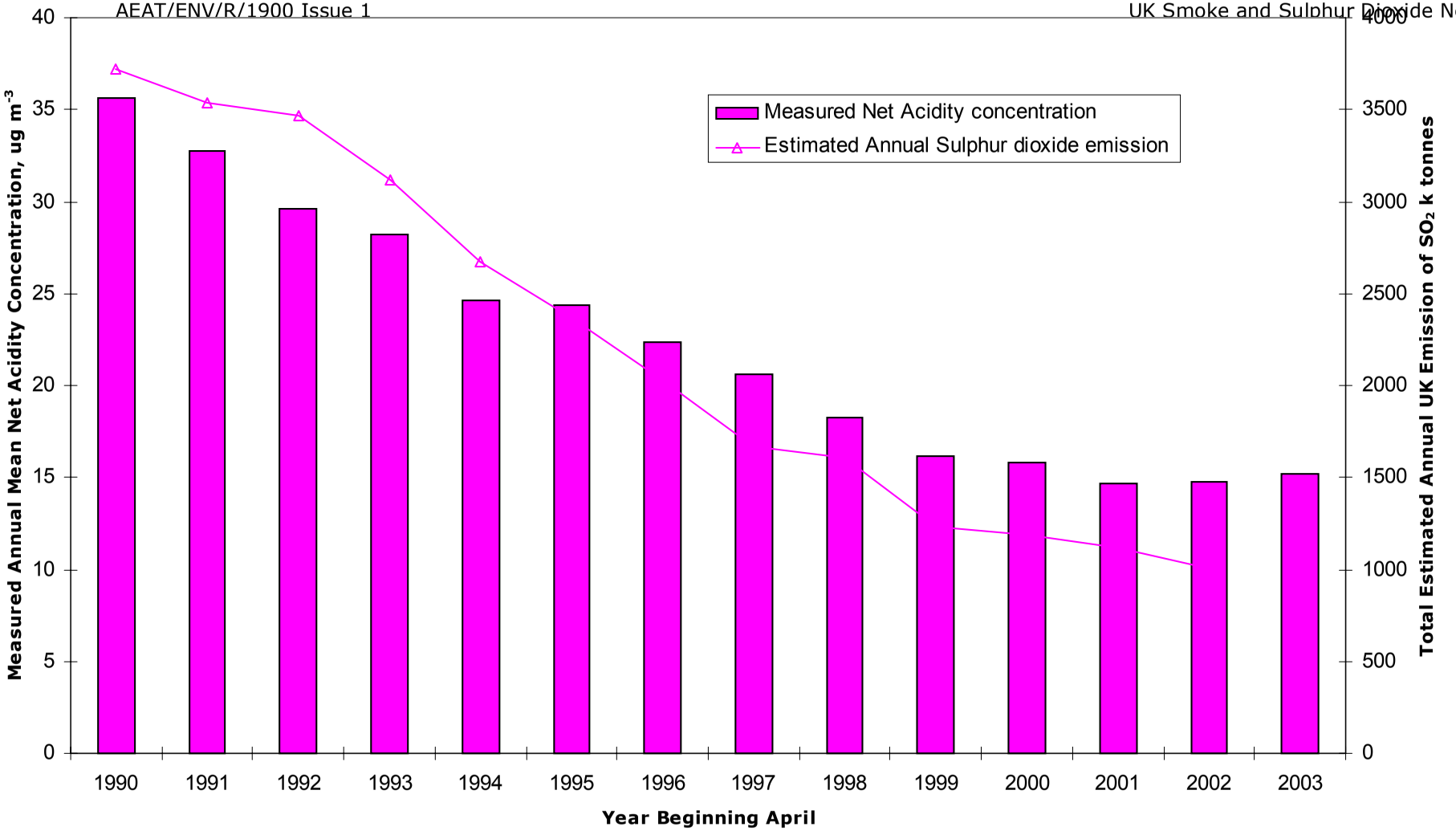

Figure 5b: Estimated Annual UK Emission of SO_2 and Measured Annual Mean Concentration of Net Acidity

Figure 5b shows that measured mean net acidity concentrations continued to decrease throughout the 1990s. However, there is some indication that the downward trend has leveled off at approximately 15μg m^{-3} since 2000. Estimated total emissions of SO_2 have substantially decreased, by approximately 70% since 1990. Regression analysis of the two parameters gives a correlation coefficient (R^2) of 0.97. This indicates that there is a very strong correlation between the two parameters. This is despite the fact that (as reported in the 2002 report) net acidity measurements are now over-estimating mean SO_2 concentrations considerably in some locations, due to the fact that acidic gases other than SO_2 now make a significant contribution to results obtained using the net acidity method.

The limit of detection of the net acidity method is 6-7 μg m^{-3}. Its resolution is typically similar. Mean UK levels of net acidity have now decreased to concentrations at which this is likely to significantly affect the accuracy of measurements.

7 Acknowledgements

All data presented in this report have been obtained by participating Local Authorities and supplied to Netcen as part of this study. This contribution and cooperation from the Local Authorities is gratefully acknowledged. The central organisation of the study, analysis and quality assurance of the data by Netcen has been funded by the Department for Environment, Food and Rural Affairs, the Scottish Executive, the Welsh Assembly Government and Department of the Environment in Northern Ireland as part of their Air and Environmental Quality research programme (Contract No. EPG 1/3/71 (A)).

8 References

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14. The Air Quality (Scotland) Regulations 2000 (Scottish Statutory Instrument 2000 No. 97), March 2000.

15. The Air Quality Limit Values Regulations (Northern Ireland) 2002 (Statutory Rule 2002 No. 94), May 2002.

16. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Working Together for Clean Air. The Stationery Office, January 2000.

Table 1.1: Summary of Smoke and Net Acidity (SO_2 equivalent) Results for Scotland, 2003

Code	Site Name	Authority	OS Grid Ref to 100m East	OS Grid Ref to 100m North	Summary of Smoke Data in 2003 Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day	Summary of SO_2 Data 2003 Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day
	SCOTLAND													
10003	ABERDEEN 3	Aberdeen	3931	8062	100	4	2	15	25	100	36	32	93	106
1100025	EDINBURGH 25	City of Edinburgh	3258	6731	44	6	6	13	30	37	29	29	65	122
1300051	GLASGOW 51	City of Glasgow	2533	6641	86	8	5	28	60	91	26	26	52	71
1300069	GLASGOW 69	City of Glasgow	2568	6663	15	12	7	51	83	15	28	27	60	60
1300073	GLASGOW 73	City of Glasgow	2612	6627	59	7	4	28	46	65	21	20	47	55
1300095	GLASGOW 95	City of Glasgow	2679	6642	86	7	4	33	62	92	29	30	73	86
1300098	GLASGOW 98	City of Glasgow	2611	6678	79	10	8	34	55	88	17	14	47	105
1725008	KIRKINTILLOCH 8	East Dumbartonshire	2670	6741	100	6	4	24	62	100	10	6	30	61
1725009	KIRKINTILLOCH 9	East Dumbartonshire	2654	6732	100	6	4	32	64	100	13	13	31	63
1725010	KIRKINTILLOCH 10	East Dumbartonshire	2659	6741	100	5	3	21	50	100	16	13	35	75
820301	COWDENBEATH 1	Fife	3165	6912	100	2	2	4	6	100	15	14	27	35
1721006	KIRKCALDY 6	Fife	3265	6933	91	4	4	15	18	88	12	12	24	37
760011	COATBRIDGE 11	North Lanarkshire	2738	6652	100	8	5	29	60	99	24	25	44	62
760012	COATBRIDGE 12	North Lanarkshire	2715	6637	90	6	5	23	48	88	19	18	42	54
69502	ARMADALE 2	West Lothian	2945	6681	80	2	2	8	11	80	46	44	89	124
3559003	WHITBURN 3	West Lothian	2948	6650	90	2	2	8	12	90	27	25	43	56

All concentrations in $\mu g\ m^{-3}$.

The following abbreviations are used in Table 1:

1. " Data Capt. %" is the percentage of the year for which valid data was obtained.
2. "Arith. Mean" is the arithmetic mean of all daily values, calculated as described in Appendix A.
3. "Median" is the median, or 50^{th} percentile, of all daily values, calculated as described in Appendix A.
4. "98th %ile" is the 98th percentile of all daily values, see Appendix A.
5. "Max. Day" is the maximum daily value measured during the year.

Table 1.2: Summary of Smoke and Net Acidity (SO_2 equivalent) Results for the North East, 2003

Code	Site Name	Authority	OS Grid Ref to 100m East	OS Grid Ref to 100m North	Summary of Smoke Data in 2003 Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day	Summary of SO_2 Data 2003 Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day
	NORTH EAST													
915013	DARLINGTON 13	Darlington	4291	5145	100	5	4	22	52	99	10	12	20	27
1290010	GATESHEAD 10	Gateshead	4256	5619	36	3	3	9	14	35	14	13	26	27
2370003	NEWBURN 3	Newcastle Upon Tyne	4195	5674	100	11	10	31	60	100	9	7	26	39
2390024	NEWCASTLE UPON TYNE 24	Newcastle Upon Tyne	4285	5650	100	5	3	20	63	100	10	7	33	39
2390027	NEWCASTLE UPON TYNE 27	Newcastle Upon Tyne	4251	5645	77	9	7	29	47	77	14	12	42	42
3170008	SUNDERLAND 8	Sunderland	4391	5585	58	7	5	25	34	58	19	18	36	37

All concentrations in $\mu g\ m^{-3}$.

The following abbreviations are used in Table 1:

1. " Data Capt. %" is the percentage of the year for which valid data was obtained.
2. "Arith. Mean" is the arithmetic mean of all daily values, calculated as described in Appendix A.
3. "Median" is the median, or 50^{th} percentile, of all daily values, calculated as described in Appendix A.
4. "98th %ile" is the 98th percentile of all daily values, see Appendix A.
5. "Max. Day" is the maximum daily value measured during the year.

Table 1.3: Summary of Smoke and Net Acidity (SO_2 equivalent) Results for the North West and Merseyside, 2003

Code	Site Name	Authority	OS Grid Ref to 100m East	OS Grid Ref to 100m North	Summary of Smoke Data in 2003 Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day	Summary of SO_2 Data 2003 Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day
	NORTH WEST & MERSEYSIDE													
3700003	WORKINGTON 3	Allerdale	2999	5287	92	3	2	15	23	92	11	12	20	24
380006	BLACKPOOL 6	Blackpool	3317	4367	100	6	4	23	34	100	6	6	13	19
400024	BOLTON 24	Bolton	3715	4092	100	7	5	25	52	100	12	13	32	45
1230008	FARNWORTH 8	Bolton	3739	4061	92	9	6	39	56	92	13	13	33	40
1550001	HORWICH 1	Bolton	3637	4118	75	9	6	36	60	75	15	14	32	34
500012	BURNLEY 12	Burnley	3841	4324	43	12	10	34	36	43	15	12	48	49
715006	CHORLEY 6	Chorley	3585	4178	62	9	7	25	40	64	2	0	14	20
840009	CREWE 9	Crewe and Nantwich	3703	3550	41	8	6	27	33	38	12	12	30	53
1130012	ELLESMERE PORT 12	Ellesmere Port & Neston	3398	3759	99	8	5	35	57	98	10	7	25	38
20005	ACCRINGTON 5	Hyndburn	3758	4285	72	10	7	33	44	72	16	14	35	54
2280011	MANCHESTER 11	Manchester	3838	3981	96	12	9	42	102	96	11	13	25	32
2280015	MANCHESTER 15	Manchester	3875	3985	100	6	5	29	53	100	10	12	24	25
2280021	MANCHESTER 21	Manchester	3847	4023	100	7	5	33	55	100	8	6	13	19
2470013	OLDHAM 13	Oldham	3920	4057	32	13	12	24	27	32	35	38	69	77
2320003	MIDDLETON 3	Rochdale	3871	4063	48	6	5	17	22	42	18	12	68	99
150005	BACUP 5	Rossendale	3868	4231	63	8	6	23	29	63	9	7	19	31
2650007	RAWTENSTALL 7	Rossendale	3812	4229	82	8	6	28	86	82	10	12	19	25
855003	CROSBY 3	Sefton	3321	3990	54	7	4	30	54	54	22	21	42	45
2800036	ST HELENS 36	St Helens	3534	3936	88	9	6	42	64	88	9	6	19	25
2800043	ST HELENS 43	St Helens	3512	3955	87	7	5	32	49	87	9	7	20	20
625006	CHEADLE & GATLEY 6	Stockport	3859	3886	100	7	5	27	61	100	6	6	19	19
90008	ASHTON-UNDER-LYNE 8	Tameside	3939	3992	81	5	3	16	21	81	2	0	14	26
3314601	TRAFFORD 1	Trafford	3810	3958	100	5	3	28	51	100	32	31	50	69
3430017	WARRINGTON 17	Warrington	3607	3890	94	9	7	34	67	92	11	7	26	33
3532002	WEST KIRBY 2	Wirral	3212	3874	98	2	2	8	25	95	7	6	19	19

All concentrations in $\mu g\ m^{-3}$.

The following abbreviations are used in Table 1:

1. " Data Capt. %" is the percentage of the year for which valid data was obtained.
2. "Arith. Mean" is the arithmetic mean of all daily values, calculated as described in Appendix A.
3. "Median" is the median, or 50^{th} percentile, of all daily values, calculated as described in Appendix A.
4. "98th %ile" is the 98th percentile of all daily values, see Appendix A.
5. "Max. Day" is the maximum daily value measured during the year.

Table 1.4: Summary of Smoke and Net Acidity (SO_2 equivalent) Results for Yorkshire and the Humber, 2003

Code	Site Name	Authority	OS Grid Ref to 100m East	OS Grid Ref to 100m North	Summary of Smoke Data in 2003 Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day	Summary of SO_2 Data 2003 Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day
	YORKSHIRE & THE HUMBER													
190008	BARNSLEY 8	Barnsley	4348	4094	42	14	11	39	51	42	50	42	127	135
190012	BARNSLEY 12	Barnsley	4342	4067	100	7	5	27	41	100	33	31	60	77
877502	CUDWORTH 2	Barnsley	4387	4091	100	9	7	28	44	100	35	34	61	86
1308701	GOLDTHORPE 1	Barnsley	4462	4043	11	9	7	23	24	11	18	13	51	67
2208502	LUNDWOOD (BARNSLEY) 2	Barnsley	4372	4067	99	12	8	42	71	99	27	21	67	100
3710012	WORKSOP 12	Bassetlaw	4585	3787	79	9	7	32	48	79	11	12	30	31
430006	BRADFORD 6	Bradford	4163	4329	52	9	6	24	43	52	13	12	33	51
1650011	KEIGHLEY 11	Bradford	4061	4412	39	10	7	28	42	37	18	17	47	59
1120002	ELLAND 2	Calderdale	4109	4209	96	10	8	29	42	96	16	13	33	72
1360016	HALIFAX 16	Calderdale	4093	4254	15	19	18	41	52	15	18	13	51	78
1360017	HALIFAX 17	Calderdale	4091	4240	65	9	7	30	41	65	15	13	32	39
962512	DEWSBURY 12	Kirklees	4235	4212	98	7	4	31	41	98	18	18	37	45
1515005	HOLMFIRTH 5	Kirklees	4144	4085	95	6	4	23	32	95	28	26	51	70
1570019	HUDDERSFIELD 19	Kirklees	4143	4164	98	9	5	36	98	98	22	19	47	82
445001	BRAMPTON 1	Rotherham	4414	4019	97	8	5	36	55	97	38	33	88	122
3465006	WATH-UPON-DEARNE 6	Rotherham	4433	4009	95	7	5	32	50	96	28	24	67	85
2839001	SCARBOROUGH 1	Scarborough	5036	4885	11	12	12	22	27	11	14	13	25	26
2872505	SELBY 5	Selby	4612	4322	100	4	2	15	18	100	19	19	37	71
22501	ACKWORTH 1	Wakefield	4440	4167	100	9	6	32	74	99	10	7	25	44
580011	CASTLEFORD 11	Wakefield	4519	4255	96	11	8	39	64	96	13	13	40	71
1235001	FEATHERSTONE 1	Wakefield	4429	4195	42	11	9	29	63	42	18	18	42	65
1450003	HEMSWORTH 3	Wakefield	4428	4134	100	10	8	29	45	100	12	12	31	62
1732003	KNOTTINGLEY 3	Wakefield	4497	4239	99	11	8	36	47	99	14	13	32	51
2415004	NORMANTON 4	Wakefield	4388	4228	75	10	6	32	50	74	9	6	31	55
2533510	PONTEFRACT 10	Wakefield	4473	4217	99	8	5	31	45	99	9	7	26	43
2966301	SOUTH KIRKBY 1	Wakefield	4456	4112	100	12	9	38	58	99	16	13	37	56
3350027	WAKEFIELD 27	Wakefield	4346	4216	42	10	6	44	50	40	7	6	25	31

All concentrations in $\mu g\ m^{-3}$.

The following abbreviations are used in Table 1:

1. " Data Capt. %" is the percentage of the year for which valid data was obtained.
2. "Arith. Mean" is the arithmetic mean of all daily values, calculated as described in Appendix A.
3. "Median" is the median, or 50^{th} percentile, of all daily values, calculated as described in Appendix A.
4. "98th %ile" is the 98th percentile of all daily values, see Appendix A.
5. "Max. Day" is the maximum daily value measured during the year.

Table 1.5: Summary of Smoke and Net Acidity (SO_2 equivalent) Results for the East Midlands, 2003

Code	Site Name	Authority	OS Grid Ref to 100m		Summary of Smoke Data in 2003					Summary of SO_2 Data 2003				
			East	North	Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day	Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day
	EAST MIDLANDS													
40004	ALFRETON 4	Amber Valley	4417	3555	96	12	8	42	67	96	48	50	75	88
348001	BIRCOTES 1	Bassetlaw	4627	3920	93	7	4	28	55	90	19	19	39	91
2677503	RETFORD 3	Bassetlaw	4707	3811	99	7	5	27	47	99	16	13	37	52
960024	DERBY 24	Derby	4354	3369	88	8	7	20	31	86	10	7	21	28
1790019	LEICESTER 19	Leicester	4588	3041	46	5	3	16	17	45	7	6	18	19
1840005	LINCOLN 5	Lincoln	4974	3714	99	5	4	19	25	99	7	6	13	44
2281010	MANSFIELD 10	Mansfield	4532	3607	67	6	3	28	35	67	24	21	47	61
2281102	MANSFIELD WOODHOUSE 2	Mansfield	4538	3642	99	5	3	24	37	91	22	19	46	61
2364502	NEW OLLERTON 2	Newark	4664	3682	100	7	5	24	39	98	12	12	37	56
750005	COALVILLE 5	North West Leicestershire	4428	3142	92	2	2	8	10	91	9	6	24	30

All concentrations in $\mu g\ m^{-3}$.

The following abbreviations are used in Table 1:

1. " Data Capt. %" is the percentage of the year for which valid data was obtained.
2. "Arith. Mean" is the arithmetic mean of all daily values, calculated as described in Appendix A.
3. "Median" is the median, or 50^{th} percentile, of all daily values, calculated as described in Appendix A.
4. "98th %ile" is the 98th percentile of all daily values, see Appendix A.
5. "Max. Day" is the maximum daily value measured during the year.

Table 1.6: Summary of Smoke and Net Acidity (SO_2 equivalent) Results for the West Midlands, 2003

Code	Site Name	Authority	OS Grid Ref to 100m East	OS Grid Ref to 100m North	Summary of Smoke Data in 2003 Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day	Summary of SO_2 Data 2003 Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day
	WEST MIDLANDS													
995002	DUDLEY 2	Dudley MBC	3940	2897	87	6	4	20	41	87	10	12	19	25
2752503	ROWLEY REGIS 3	Sandwell	3964	2879	2	9	9	18	19	2	14	13	24	25
3090020	STOKE-ON-TRENT 20	Stoke-On-Trent	3888	3475	63	9	6	41	77	Smoke-only site.				
3380018	WALSALL 18	Walsall	4014	2987	61	5	4	15	27	61	6	6	22	37
3470002	WEDNESFIELD 2	Wolverhampton	3946	3002	99	5	3	18	46	98	6	0	31	49

All concentrations in $\mu g\ m^{-3}$.

The following abbreviations are used in Table 1:

1. " Data Capt. %" is the percentage of the year for which valid data was obtained.
2. "Arith. Mean" is the arithmetic mean of all daily values, calculated as described in Appendix A.
3. "Median" is the median, or 50^{th} percentile, of all daily values, calculated as described in Appendix A.
4. "98th %ile" is the 98th percentile of all daily values, see Appendix A.
5. "Max. Day" is the maximum daily value measured during the year.

Table 1.7: Summary of Smoke and Net Acidity (SO_2 equivalent) Results for Wales, 2003

Code	Site Name	Authority	OS Grid Ref to 100m East	OS Grid Ref to 100m North	Summary of Smoke Data in 2003 Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day	Summary of SO_2 Data 2003 Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day
	WALES													
540012	CARDIFF 12	Cardiff	3193	1773	96	8	6	24	37	96	20	19	36	37
2400026	NEWPORT (MON) 26	Newport	3313	1878	96	7	5	22	38	96	6	6	14	18
3732510	WREXHAM 10	Wrexham Maelor	3324	3501	42	3	3	9	12	42	17	18	37	43

All concentrations in $\mu g\ m^{-3}$.

The following abbreviations are used in Table 1:

1. " Data Capt. %" is the percentage of the year for which valid data was obtained.
2. "Arith. Mean" is the arithmetic mean of all daily values, calculated as described in Appendix A.
3. "Median" is the median, or 50^{th} percentile, of all daily values, calculated as described in Appendix A.
4. "98th %ile" is the 98th percentile of all daily values, see Appendix A.
5. "Max. Day" is the maximum daily value measured during the year.

Table 1.8: Summary of Smoke and Net Acidity (SO_2 equivalent) Results for the Eastern Region, 2003

Code	Site Name	Authority	OS Grid Ref to 100m		Summary of Smoke Data in 2003					Summary of SO_2 Data 2003				
			East	North	Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day	Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day
	EASTERN													
2430007	NORWICH 7	Norwich	6233	3099	96	4	3	16	27	96	21	19	41	52
3265013	THURROCK 13	Thurrock	5622	1791	94	6	5	20	26	93	14	12	25	31

All concentrations in $\mu g\ m^{-3}$.

The following abbreviations are used in Table 1:

1. " Data Capt. %" is the percentage of the year for which valid data was obtained.
2. "Arith. Mean" is the arithmetic mean of all daily values, calculated as described in Appendix A.
3. "Median" is the median, or 50^{th} percentile, of all daily values, calculated as described in Appendix A.
4. "98th %ile" is the 98th percentile of all daily values, see Appendix A.
5. "Max. Day" is the maximum daily value measured during the year.

Table 1.9: Summary of Smoke and Net Acidity (SO_2 equivalent) Results for London, 2003

Code	Site Name	Authority	OS Grid Ref to 100m East	OS Grid Ref to 100m North	Summary of Smoke Data in 2003 Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day	Summary of SO_2 Data 2003 Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day
	LONDON													
1950016	LONDON CITY 16	City of London	5324	1814	85	7	6	19	28	88	10	6	31	44
1140014	ENFIELD 14	Enfield	5338	1958	86	4	3	8	9	86	12	12	19	26
1343709	GREENWICH 9	Greenwich	5382	1773	99	7	6	22	37	99	15	12	31	49
3696009	WOOLWICH 9	Greenwich	5441	1769	98	6	4	19	28	97	22	21	41	54
1590006	ILFORD 6	Redbridge	5440	1864	82	8	6	28	56	82	22	20	33	53
3541517	WESTMINSTER 17	Westminster	5298	1789	38	12	9	33	36	Smoke-only site.				

All concentrations in $\mu g\ m^{-3}$.

The following abbreviations are used in Table 1:

1. " Data Capt. %" is the percentage of the year for which valid data was obtained.
2. "Arith. Mean" is the arithmetic mean of all daily values, calculated as described in Appendix A.
3. "Median" is the median, or 50^{th} percentile, of all daily values, calculated as described in Appendix A.
4. "98th %ile" is the 98th percentile of all daily values, see Appendix A.
5. "Max. Day" is the maximum daily value measured during the year.

Table 1.10: Summary of Smoke and Net Acidity (SO_2 equivalent) Results for the South East, 2003

Code	Site Name	Authority	OS Grid Ref to 100m		Summary of Smoke Data in 2003					Summary of SO_2 Data 2003				
			East	North	Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day	Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day
	SOUTH EAST													
2940016	SLOUGH 16	Slough	4962	1819	21	11	10	19	24	21	6	6	13	13

All concentrations in $\mu g\ m^{-3}$.

The following abbreviations are used in Table 1:

1. " Data Capt. %" is the percentage of the year for which valid data was obtained.
2. "Arith. Mean" is the arithmetic mean of all daily values, calculated as described in Appendix A.
3. "Median" is the median, or 50^{th} percentile, of all daily values, calculated as described in Appendix A.
4. "98th %ile" is the 98th percentile of all daily values, see Appendix A.
5. "Max. Day" is the maximum daily value measured during the year.

Table 1.11 Summary of Smoke and Net Acidity (SO_2 equivalent) Results for the South West, 2003. All concentrations in $\mu g\ m^{-3}$.

Code	Site Name	Authority	OS Grid Ref to 100m East	OS Grid Ref to 100m North	Summary of Smoke Data in 2003 Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day	Summary of SO_2 Data 2003 Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day
	SOUTH WEST													
205006	BATH 6	Bath	3754	1656	93	10	8	28	44	92	15	13	27	52
470026	BRISTOL 26	Bristol	3634	1763	91	5	3	16	29	91	15	13	33	99
1305004	GLOUCESTER 4	Gloucester	3832	2179	97	6	5	24	34	97	12	12	24	36
453003	BRIDGWATER 3	Sedgemoor	3298	1373	81	3	2	10	16	77	18	18	37	43
3220002	SWINDON 2	Swindon	4147	1858	77	6	4	26	46	79	8	6	18	19

All concentrations in $\mu g\ m^{-3}$.

The following abbreviations are used in Table 1:

1. " Data Capt. %" is the percentage of the year for which valid data was obtained.
2. "Arith. Mean" is the arithmetic mean of all daily values, calculated as described in Appendix A.
3. "Median" is the median, or 50^{th} percentile, of all daily values, calculated as described in Appendix A.
4. "98th %ile" is the 98th percentile of all daily values, see Appendix A.
5. "Max. Day" is the maximum daily value measured during the year.

Table 1.12: Summary of Smoke and Net Acidity (SO_2 equivalent) Results for Northern Ireland, 2003

			Irish Grid Ref to 100m		Summary of Smoke Data in 2003					Summary of SO_2 Data 2003				
Code	Site Name	Authority	East	North	Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day	Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day
	NORTHERN IRELAND													
68851	ANTRIM 1	Antrim Borough Council	3162	3869	99	13	8	57	124	99	23	24	43	79
69701	ARMAGH 1	Armagh	2877	3450	61	20	18	48	63	59	12	13	19	19
160005	BALLYMENA 5	Ballymena	3109	4053	96	11	11	19	25	95	13	13	25	30
160006	BALLYMENA 6	Ballymena	3120	4026	95	11	10	22	28	94	15	13	31	37
161504	BALLYMONEY 4	Ballymoney	2954	4259	100	13	8	66	204	100	11	13	20	45
270012	BELFAST 12	Belfast	3324	3737	97	9	5	42	70	97	18	18	36	66
270013	BELFAST 13	Belfast	3357	3740	100	7	5	28	43	100	27	26	45	51
270033	BELFAST 33	Belfast	3346	3755	99	8	5	27	52	99	29	32	45	51
270042	BELFAST 42	Belfast	3322	3748	98	8	5	29	64	98	28	26	51	64
270044	BELFAST 44	Belfast	3338	3740	99	5	4	14	25	99	25	26	38	45
270045	BELFAST 45	Belfast	3335	3723	100	7	5	23	38	100	28	26	49	57
270046	BELFAST 46	Belfast	3803	3334	100	4	3	14	25	98	21	19	38	45
768003	COLERAINE 3	Coleraine	2861	4328	82	10	9	34	55	72	9	6	19	48
797501	COOKSTOWN 1	Cookstown	2774	3806	56	13	10	56	98	42	rejected			
2551506	PORTADOWN 6	Craigavon	3004	3548	45	6	4	23	58	52	10	12	30	36
1025001	DUNGANNON 1	Dungannon	2802	3629	80	5	4	14	24	79	17	18	31	45
1757704	LARNE 4	Larne	3386	4037	98	6	5	18	51	96	17	18	30	36
1757705	LARNE 5	Larne	3401	4033	100	7	6	24	43	97	18	20	27	40
1032503	DUNMURRY 3	Lisburn	3287	3875	84	8	5	24	82	84	21	20	36	48
1845003	LISBURN 3	Lisburn	3263	3636	85	9	7	30	109	84	19	19	34	41
3325001	TWINBROOK 1	Lisburn	3281	3689	24	7	5	16	17	24	20	18	29	29
2190014	LONDONDERRY 14	Derry City Council	2443	4174	47	4	3	11	14	37	16	13	45	58
2233501	MAGHERAFELT 1	Magherafelt	2896	3901	99	9	5	39	61	99	11	13	27	27
512601	BUSHMILLS 1	Moyle District Council	2941	4409	56	14	12	30	77	50	4	0	18	25
512602	BUSHMILLS 2	Moyle District Council	2941	4407	22	7	6	16	26	21	2	0	12	13
2410003	NEWRY 3	Newry and Mourne	3078	3268	98	3	1	23	60	95	4	0	13	13
2412503	NEWTOWNABBEY 3	Newtownabbey	3321	3851	73	8	6	24	88	55	4	0	13	14
2412504	NEWTOWNABBEY 4	Newtownabbey	3283	3907	99	8	4	37	59	81	4	6	13	19
165005	BANGOR (CO DOWN) 5	North Down	3497	3810	85	16	10	62	90	85	18	18	52	71
1517501	HOLYWOOD 1	North Down	3397	3784	62	9	7	32	112	62	16	14	28	47
3111502	STRABANE 2	Strabane	2351	3972	96	21	16	80	146	96	11	13	20	21

Net acidity data from COOKSTOWN 1 has been rejected because of suspected alkaline interference. All concentrations in $\mu g\ m^{-3}$.
The following abbreviations are used in Table 1:

1. " Data Capt. %" is the percentage of the year for which valid data was obtained.
2. "Arith. Mean" is the arithmetic mean of all daily values, calculated as described in Appendix A.
3. "Median" is the median, or 50^{th} percentile, of all daily values, calculated as described in Appendix A.
4. "98th %ile" is the 98th percentile of all daily values, see Appendix A.
5. "Max. Day" is the maximum daily value measured during the year.

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Appendix A
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A1. Period Covered by Observations

This report covers the calendar year 1st January to 31st December 2003. The UK Smoke and Sulphur Dioxide Network is operated on the basis of the "Pollution Calendar". The pollution year always begins on the Tuesday nearest to 1 April, and contains twelve months, each of exactly 4 or 5 weeks, all beginning on Tuesdays. Pollution months April to September make up the summer period, and October to March constitute the winter period. While this "Pollution Calendar" is for operational purposes, to conveniently divide the year up into 'months' comprising whole numbers of weeks (as the samplers are normally visited weekly), data are now reported on a calendar year basis, in line with all other Networks operated on behalf of Defra. Details of the pollution calendar are available from Netcen on request.

A2. Derivation of Results

The data are processed by computer, from daily measurements made by the participating Local Authorities and other organisations. The formulae used for calculation of smoke concentrations, i.e. for relating blackness of the filter to the mass of smoke per unit volume of air sampled, have been used since winter 1961-62. The formula used for calculating SO_2 equivalent concentrations has never been changed.

As in previous years, the validity of the original readings has been checked by means of an editing program.

A3. Significance of Results

It is important to note that in making comparisons of pollution in different towns, careful account must be taken of the details of the sites for which measurements are available in relation to the geographical structure of the town. That is, to the situation, extent and types of industrial, residential and commercial areas. Local variations in fuel type and quality can also have a significant effect on the measurements.

A4. Formulae used in Calculating Concentrations

A4.1 Smoke

Smoke concentrations have been calculated by the use of the British Standard Smoke Calibration Curve (BS 1747: Part 2: 1991).

For reflectometer readings of 40 to 99 the following formula is used:

$$C = \frac{F}{V}(91{,}679.22 - 3{,}332.0460\ R + 49.618884\ R^2 - 0.35329778\ R^3 + 0.0009863435\ R^4)$$

Where:

C = concentration in microgrammes per cubic metre;
V = volume of air sampled, in cubic feet (in the majority of cases, a metric meter is used, and the volume in cubic metres is converted to cubic feet by multiplying by 35.315);
F = a factor relating to the sampler clamp size, as follows:
0.288 for $^1/_2$ inch clamp;
1.00 for 1 inch clamp;
3.68 for 2 inch clamp; or
12.8 for 4 inch clamp.

R = reflectometer reading.
This formula represents the calibration curve to within ± 1.3% over the range of reflectometer readings between 40 and 90. When used to calculate concentrations from reflectometer readings between 91 and 98 the results may be underestimated by as much as 6%.

For darker stains with reflectometer readings between 40 and 20 the formula used is:

$$C = \frac{F}{V}(214{,}245.1 - 15{,}130.512\ R + 508.181\ R^2 - 8.831144\ R^3 + 0.0628057\ R^4)$$

For stains with reflectometer readings of less than 20 this formula gives only an approximation to the concentration, the result being well below the true value. Reflectometer readings of less than 10 are impossible to assess accurately and hence the results are calculated as if the reading had been 10, which at least gives a minimum value. However, such low reflectometer readings, corresponding to very high smoke concentrations, are now rare in the UK.

A4.2 Sulphur dioxide

Sulphur dioxide concentrations have been calculated by the method described in BS 747: Part 3: 1991. The formula used to calculate sulphur dioxide concentrations is:

$$C = \frac{4520 \times m}{V}$$

where:
C = concentration in microgrammes per cubic metre;
m = volume of 0.002M (N/250) di-sodium tetraborate used, in millilitres; and
V = volume of air sampled, in cubic feet (again, in the majority of cases, a metric meter is used, and the volume in cubic metres is converted to cubic feet by multiplying by 35.315)

A5. Formulae used in Calculating Annual Statistics

A5.1 Arithmetic Mean (AM)

$$AM = \frac{\sum_{i=1}^{N} C_i}{N}$$

where:

AM is annual arithmetic mean;
C_i is daily concentration for day i; and
N is number of results available for the year.

A5.2 Percentiles

Note - The median is the 50th percentile.

Daily concentrations are sorted into ascending order of concentration value, C_1, C_2, C_3, .., C_i, ..., C_N and the associated percentile value for each concentration value is found from:

$$P_i = \left(\frac{i}{N+1}\right)100$$

where:

Pi is the percentile for the ith concentration in the sorted set, that is, Pi% of the concentrations will be equal to or less than Ci; and
N is the number of results available for the year.

The concentration values for the fixed percentile values quoted are obtained by linear interpolation between the concentration values for the nearest percentile values on either side.

For example, in the sets
P_1, P_2, ..., P_i, ..., 98.8, 99.3, ..., P_N
C_1, C_2, ..., C_i, ..., 150, 160, ..., C_N
the 99th percentile would be 154 μg m^{-3}

A6. Units

The unit employed for expressing both smoke and sulphur dioxide concentrations from this Network, both in this report and on the CD, is microgramme per cubic metre (μg m^{-3}). However, concentrations of gaseous pollutants such as SO_2 are sometimes expressed as parts per billion by volume (abbreviated to "ppb").

For SO_2, the conversion factor is as follows:

1 ppb = 2.62 microgrammes per cubic metre (for SO_2 only) at a temperature of 25°C and 1013 mb pressure; or
1 ppb = 2.66 microgrammes per cubic metre (for SO_2 only) at a temperature of 20°C and 1013 mb pressure.

The conversion factor is different for other gaseous pollutants.

Appendix B
Data Files for 2003

Data Files

The full year's dataset, for all Network sites, is supplied on the same CD as this report (or for printed copies, on the disk inside the back cover). The data are presented in **comma separated value** (CSV) format, a form which can be input into most spreadsheets. The data are provided in five files as follows:

1. File "site2003": a summary of site details. The data are tabulated in rows, one per site, with columns as follows:-

- Site code - the site's unique identification number of up to 7 digits.
- Site name and number - the name and number by which the site is usually known, e.g. "ABERDEEN 3".
- Grid reference easting, given to the nearest 100m.
- Grid reference northing, given to the nearest 100m. Note; for sites in Northern Ireland the grid reference refers to the Irish Grid, and both the easting and northing are preceded by a "9" to indicate this.
- Site address.
- Site Environment. The surroundings of each site are classified by a code according to the following scheme:
  - A1 Residential area with high-density housing (probably terraced), or with medium-density housing in multiple occupation, in either case surrounded by other built-up areas.
  - A2 Predominantly A1, but interspersed with some industrial undertakings.
  - A3 Residential area with high-density housing or medium-density housing in multiple occupation surrounded by, or interspersed with, other areas with low potential air pollution output (parks, fields, coast).
  - B1 Residential area with medium-density housing, typically an inner suburb or housing estate, surrounded by other built-up areas.
  - B2 Predominantly B1, but interspersed with some industrial undertakings.
  - B3 Residential area with medium-density housing surrounded by or interspersed with areas with low potential air pollution output (parks, fields, coast), or any residential area with low-density housing.
  - C1 Industrial area without domestic premises.
  - C2 Industrial area interspersed with domestic premises of high density or in multiple occupation.
  - D1 Commercial area or one with predominantly central heating.
  - D2 Town centre with limited commercial area, possibly mixed with old residential housing and/or minor industry.
  - E Smoke control area or smokeless zone (the letter to be added to the primary classification).
  - R Rural community.
  - O1 Open country but not entirely without source(s) of pollution, e.g. airfields.
  - O2 Completely open country; no sources within at least 400 metres.
  - X Unclassified site, or mixed area.
- Equivalent Defra Site Type. The Smoke and SO_2 Network site classifications differ considerably from those used by Defra to categorise their automatic sites. However, the nearest equivalent is given here. Smoke and SO_2 sites of types A1, A2, and A3 will mostly fall into Defra site types Suburban (SU) or Urban Background (U4), being predominantly in urban residential areas. B1, B2 and B3 will be Suburban (SU). C1 and C2 will be roughly equivalent to Urban Industrial (U5), and D1 and D2 Urban Centre (U3) or Urban Background (U4). R, O1 and O2 sites can all be treated as Rural (R).

- Unitary Authority. The name of the Local or Unitary Authority in whose area the site lies. In most cases this Authority is responsible for the operation of the site, although a small number of sites are operated by other organisations such as universities.
- Government Region Code. The twelve regions are assigned code numbers from 1 to 12.
- Government Region Name.
- County name. The name of the county in which the site lies.

2. File "smk2003": full daily black smoke data, 1st January to 31st December 2003, for all sites. One column per site, with one row per day. Values are in μg m^{-3}. Black smoke concentrations have been calculated according to the British Standard calibration, as used in the UK. For communications with organisations elsewhere in Europe, the concentrations should be converted to the OECD calibration, by dividing by 0.85

3. File "so22003": full daily net acidity data, as sulphur dioxide equivalent, 1st January to 31st December 2003, for all sites. One column per site, with one row per day. Values are in μg m^{-3}.

4. File "smksumm2003": this contains the smoke summary data as in Table 1, but in CSV format. The data are tabulated as follows:-

- Site code number.
- Site name.
- Region name (e.g. North East).
- Local or Unitary Authority in whose area the site lies.
- Grid reference easting.
- Grid reference northing.
- Number of valid days' smoke data.
- Data capture expressed as a percentage.
- Arithmetic mean of daily smoke measurements.
- Median (50th percentile) of daily smoke measurements.
- 98th percentile of daily smoke measurements.
- Maximum daily value.

There is one row of data per site, and they are presented by region.

5. File "so2summ2003": this contains the net acidity summary data (expressed as SO_2 equivalent) as in Table 1, but in CSV format. The data are tabulated in the same manner as the smoke data in "smksumm2003.csv" described above. Again, the top row contains column headings. All these details are also given in the text file "readme.txt" which is also provided on disk.

Appendix C
Sites Comprising "Core" Subset

10003	ABERDEEN 3
20005	ACCRINGTON 5
40004	ALFRETON 4
69701	ARMAGH 1
90008	ASHTON-UNDER-LYNE 8
150005	BACUP 5
160005	BALLYMENA 5
190012	BARNSLEY 12
205006	BATH 6
270013	BELFAST 13
270042	BELFAST 42
270046	BELFAST 46
380006	BLACKPOOL 6
400024	BOLTON 24
430006	BRADFORD 6
453003	BRIDGWATER 3
470026	BRISTOL 26
500012	BURNLEY 12
540012	CARDIFF 12
580011	CASTLEFORD 11
625006	CHEADLE & GATLEY 6
715006	CHORLEY 6
760011	COATBRIDGE 11
840009	CREWE 9
855003	CROSBY 3
915013	DARLINGTON 13
960024	DERBY 24

995002	DUDLEY 2
1025001	DUNGANNON 1
1032503	DUNMURRY 3
1100025	EDINBURGH 25
1130012	ELLESMERE PORT 12
1140014	ENFIELD 14
1230008	FARNWORTH 8
1290010	GATESHEAD 10
1300051	GLASGOW 51
1300073	GLASGOW 73
1300095	GLASGOW 95
1300098	GLASGOW 98
1305004	GLOUCESTER 4
1343709	GREENWICH 9
1360016	HALIFAX 16
1360017	HALIFAX 17
1450003	HEMSWORTH 3
1515005	HOLMFIRTH 5
1550001	HORWICH 1
1570019	HUDDERSFIELD 19
1590006	ILFORD 6
1650011	KEIGHLEY 11
1757704	LARNE 4
1790019	LEICESTER 19
1840005	LINCOLN 5
1845003	LISBURN 3
1950016	LONDON CITY 16

2280011	MANCHESTER 11
2280015	MANCHESTER 15
2280021	MANCHESTER 21
2281010	MANSFIELD 10
2320003	MIDDLETON 3
2370003	NEWBURN 3
2390024	NEWCASTLE UPON TYNE 24
2390027	NEWCASTLE UPON TYNE 27
2400026	NEWPORT (MON) 26
2410003	NEWRY 3
2412503	NEWTOWNABBEY 3
2430007	NORWICH 7
2470013	OLDHAM 13
2533510	PONTEFRACT 10
2551506	PORTADOWN 6
2650007	RAWTENSTALL 7
2677503	RETFORD 3
2800036	ST HELENS 36
2800043	ST HELENS 43
2839001	SCARBOROUGH 1
2872505	SELBY 5
2940016	SLOUGH 16
3090020	STOKE-ON-TRENT 20
3170008	SUNDERLAND 8
3220002	SWINDON 2
3265013	THURROCK 13
3314601	TRAFFORD 1

3350027	WAKEFIELD 27
3380018	WALSALL 18
3430017	WARRINGTON 17
3470002	WEDNESFIELD 2
3532002	WEST KIRBY 2
3541517	WESTMINSTER 17
3696009	WOOLWICH 9
3700003	WORKINGTON 3
3710012	WORKSOP 12
3732510	WREXHAM 10