

UK Smoke and Sulphur Dioxide Network

Summary Report for April 1999 - March 2000

Prepared by the National Environmental Technology Centre as part of the Air Quality Research Programme of the Department of the Environment, Transport and the Regions, the Scottish Executive, the National Assembly for Wales and the Department of 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 year April 1999 to March 2000, providing a summary of data from the 181 sites comprising the Network this year. These data are compared with the standards and objectives specified in the Air Quality Strategy, and with limit and guide values specified in the previous and most recently introduced EC Directives on sulphur dioxide and suspended particles. Concentration trends and spatial distributions throughout the UK are also discussed. This year, the report and year's dataset have been produced on CD ROM.

UK average concentrations in 1999 - 2000 were $7.5 \mu\text{g m}^{-3}$ for smoke and $16.1 \mu\text{g m}^{-3}$ for SO_2 . These averages are both slightly lower than last years' UK averages of $8.0 \mu\text{g m}^{-3}$ and $18.2 \mu\text{g m}^{-3}$ for smoke and SO_2 respectively, as measured by this Network.

The year beginning April 1999 was the seventh consecutive year in which no site exceeded any of the limit values of the original EC Directive (80/779/EEC) on Sulphur Dioxide and Suspended Particulate Matter. There was still some exceedence of the 24-hour guide values of the Directive, and a small number of sites exceeded the annual average sulphur dioxide guide values. However, the number of sites exceeding these guide values has continued to fall.

The original EC Directive (80/779/EEC) will apply in conjunction with the new "Framework Directive" on Air Quality Assessment and Management (96/62/EC), and the Daughter Directive relating to sulphur dioxide, oxides of nitrogen, PM_{10} and lead (1999/30/EC) until it is formally repealed in 2005. The limit values in the Daughter Directive are to be met by 1 January 2005. The original EC Directive will not be repealed until the target date in the Daughter Directive (1 January 2005) and until then, both Directives apply.

An analysis of data for the calendar year January to December 1999 against the Daughter Directive limit value (which is to be met by 2005), shows that six Network sites had more than three days when SO_2 concentrations exceeded the Daughter Directive 24-hour limit for SO_2 of $125 \mu\text{g m}^{-3}$. These were as follows: one in Barnsley, four in Belfast and one in Dunmurry (near Belfast).

The Air Quality Strategy (January 2000) contains a 24-hour limit for SO_2 , which is the same as the Daughter Directive 24-hour limit. The same six sites exceeded this limit on more than the permitted three occasions in the calendar year January - December 1999. The AQS objective is to be met by 31 December 2004.

Both the Daughter Directive and the Air Quality Strategy now contain the same standards and objectives for particulate matter. These specifically apply to PM_{10} , not black smoke. However, black smoke data may be used by Local and Unitary Authorities in their review and assessment of PM_{10} concentrations. It is estimated that seven Network sites are in areas where a 3rd Stage assessment for PM_{10} may be required. These are as follows: city centre sites in Bradford and Halifax, sites close to major roads in Sedgley (West Midlands) and Londonderry (Northern Ireland), and two sites in central London (at Islington and Shoreditch) which, though not close to major roads, are located in Central London where background PM_{10} concentrations are usually high. All these are in locations where traffic emissions make a substantial contribution to

ambient suspended particulate matter. The seventh site, in Strabane, Northern Ireland, is in an area with widespread domestic coal use. This is a new site with winter data only available, and further monitoring will be required to determine whether the values measured so far are typical.

This report also examines trends in smoke and SO₂ concentration over the 37 years of monitoring by this Network and its predecessor the National Survey. There is a strong correlation between total UK emissions of these pollutants, and annual mean concentrations measured by the Network. This correlation is particularly strong in the case of black smoke.

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1 Introduction

This annual report of the Smoke and Sulphur Dioxide Network presents a general description of the Network, and a summary and review of the data for the period April 1999 to March 2000. The results for 1999 - 2000 are compared with applicable air quality standards and guide values. Trends, spatial distribution of smoke and sulphur dioxide concentrations throughout the UK, data reporting commitments and data usage are discussed.

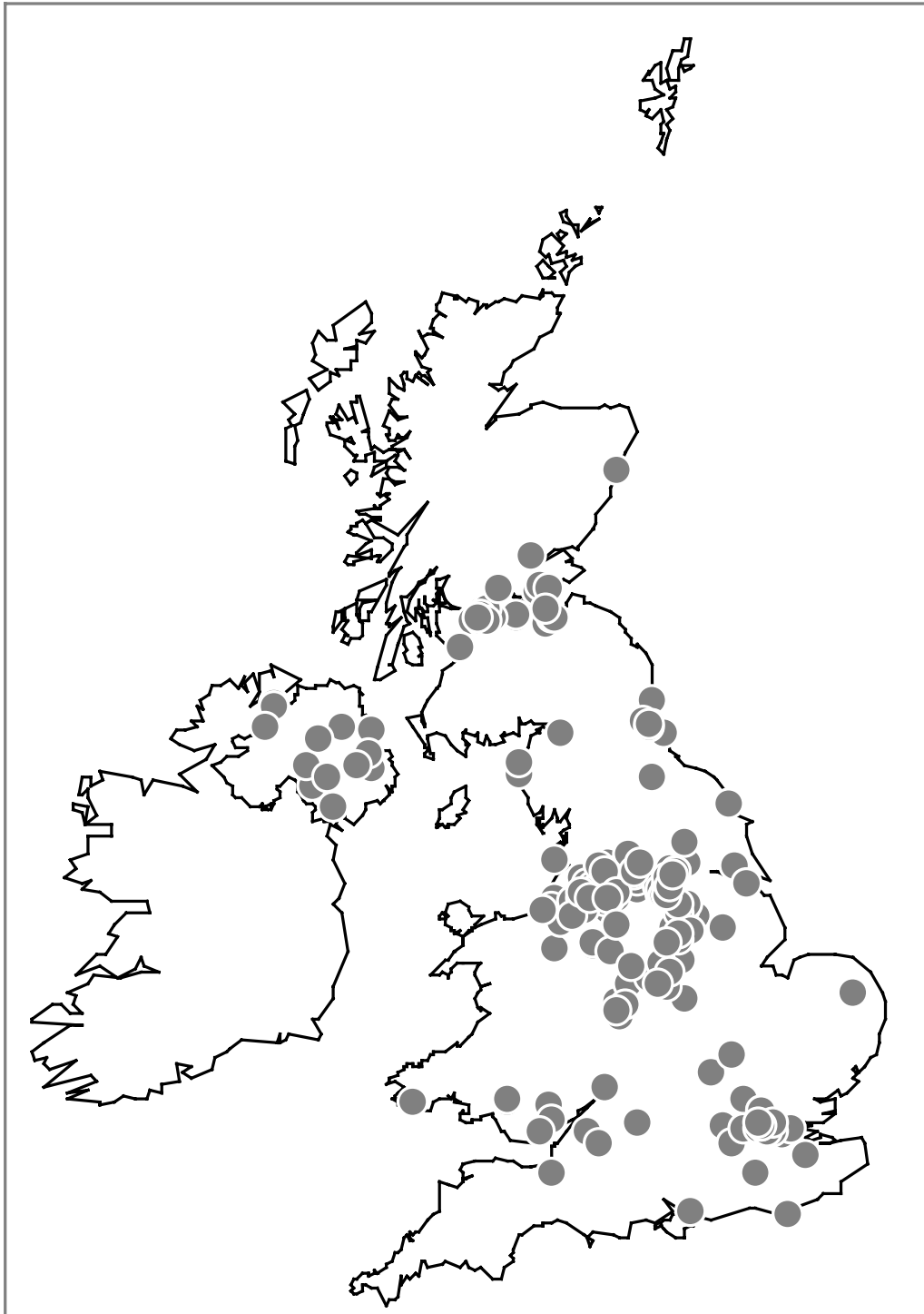
The main report is followed by Appendices providing details of the derivation and calculation of the results and statistics presented in the report (and on the DETR's Air Quality Archive on the World Wide Web at www.environment.detr.gov.uk/airq/aqinfo.htm). Appendix 2 provides an explanation of the data files which accompany this report, either on the same CD ROM or (in the case of printed copies) on the disk inserted inside the back cover.

2 Network Objectives

The UK Smoke and Sulphur Dioxide (SO₂) Network (Figure 1) serves two purposes. Firstly, the Network is intended to provide a long-term database of smoke and SO₂ measurements to assess trends in concentration and spatial distribution. For this purpose, a “core” subset of sites is used to provide a representative sample of monitoring locations in major population centres throughout the UK, with a wide spatial coverage of the whole country. A total of 181 Network sites (see Figure 1) were in operation during part or all of the period April 1999 to March 2000. Of these sites, 134 comprised the “core” subset used to provide national trend statistics (see discussion in Section 7). The above site totals include those sites operating for only part of the year, e.g. those which started or ceased operation during this period. It should be emphasised that, in formally assessing smoke and sulphur dioxide concentrations by comparison with the limit and guide values of the EC Directive, analysis of all sites in the UK is undertaken.

Secondly, the Network monitors compliance with the relevant EC Directives on sulphur dioxide and suspended particulate matter. The original Directive, 80/779/EEC¹, has been in force since 1980 but is to be superseded; the European Commission have issued a Directive on Ambient Air Quality Assessment and Management² - the so-called “Framework Directive”. A number of “Daughter Directives” covering specific pollutants will be prepared under this Directive. The first Daughter Directive³ includes limit values for SO₂ and particulate matter, which are to be met by 1 January 2005. However, the standards for suspended particulate relate to PM₁₀, not black smoke. The existing standards for monitoring of black smoke will remain in force until 2005.

Figure 1. Location of Smoke and SO₂ Network Sites



3 Data Reporting and Use

The UK Smoke and SO₂ Network and its predecessor the National Survey provide one of the longest running databases of air quality measurements in the UK. The results have shown clearly the dramatic decrease in the concentrations of these pollutants in the UK over the last 37 years. With the exception of the UK Nitrogen Dioxide Diffusion Tube Network, the Smoke and SO₂ Network still constitutes the most widespread air quality monitoring programme in the UK.

3.1 STATUTORY REPORTING: EC DIRECTIVE

The UK Smoke and Sulphur Dioxide Network fulfils the statutory monitoring requirements of the EC Directive on Sulphur Dioxide and Suspended Particulates¹. In June and July each year, the data from the previous pollution year (April - March) are analysed with respect to the requirements of the Directives. The results are supplied to the Department of the Environment, Transport and the Regions for formal submission to the European Commission. The results of this analysis for 1999 - 2000 are discussed in Section 5.

3.2 EC EXCHANGE OF INFORMATION

Under the terms of the EC Exchange of Information Decision⁴, the Department of Environment, Transport and the Regions 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://www.etcaq.rivm.nl/airbase/index.html>

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 Office⁵. Also, ad hoc requests for data are serviced by retrievals from the database held at AEA Technology's National Environmental Technology Centre (NETCEN). These are normally provided free of charge.

A comprehensive archive of air quality measurements, including smoke and SO₂ data, has been prepared. This is available via the World Wide Web, at web site:

<http://www.environment.detr.gov.uk/airq/aqinfo.htm>

Site information and summary data from 1963 onwards for the Smoke and SO₂ Network are available on the web site, with full daily data from 1990 onwards. These daily data are updated every three months; the annual statistics are updated yearly.

4 Results and Discussion

4.1 UNITS

Both smoke and sulphur dioxide concentrations are expressed in micrograms per cubic metre ($\mu\text{g m}^{-3}$) in this report and on the disk.

(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 specified. 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 by 0.85. In any communication with the European Commission, it is normal to use the OECD calibration. OECD smoke concentrations have been included in this report where applicable, and are indicated as OECD and shown in *italics*.

(ii) SO₂: In this report, SO₂ concentrations are given primarily in $\mu\text{g m}^{-3}$. However, concentrations of gaseous pollutants are sometimes expressed as parts per billion by volume (abbreviated to "ppb"). For SO₂, the conversion factor used by the EC is as follows: **1 ppb = 2.66 $\mu\text{g m}^{-3}$, at a temperature of 20°C and 1013 mb pressure.** This **only** applies to SO₂; conversion factors are different for other gaseous pollutants.

4.2 SUMMARY OF RESULTS

Summary statistics for the year 1999 – 2000 for each Network site are provided in Table 1. The sites are listed by 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. "Valid Days" denotes the number of valid days' data obtained for the year.
2. "Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

4.3 DATA CAPTURE

Table 1 shows both the number of valid days' data (in the column headed "Valid Days"), and the data capture expressed as a percentage (as Data Capt., %). Pollution Year 1999 - 2000 contained 371 days (see Appendix 1 for details of the Pollution Calendar). The minimum data capture requirement of the EC Directive is 75% - equivalent this year to 278 days.

The data capture statistics for the Network for 1999 - 2000 (excluding sites that started or ceased operation part way through the year) were as follows. 100% data capture for both pollutants was achieved at 16% of sites, while 57% of sites had over 90% data. 25% of sites had less than 75% data capture. The average data capture was 85%. These statistics indicate lower data capture than the previous year, particularly in terms of the number of sites achieving 100% data capture.

Data may be lost for a number of reasons. However, the Christmas - Millennium holidays had an impact on data capture; for many site operators it proved impossible to keep the sampler in operation over this period, due to staff shortages or lack of access to buildings. The number of sites remaining in operation over the period 21st December 1999 to 9th January 2000 was reduced to less than 140.

The data capture objective specified by Annex IV of the First Daughter Directive (1999/30/EEC) for indicative techniques is 90%; we are therefore setting this as a future target for minimum data capture in the Network. Advice for site operators on dealing with equipment faults and improving data capture are given in the Instruction Manual. Copies of the Manual are available from AEA Technology, or via the World Wide Web, at web site <http://www.aeat.co.uk/netcen/airqual/reports/smkman/shead.html>

4.4 NATIONAL AVERAGE SMOKE AND SO₂ CONCENTRATIONS

Mean UK concentrations in 1999 - 2000, based on the core subset only (134 sites), were as follows:

- Smoke: $7.5 \mu\text{g m}^{-3}$ BS ($8.9 \mu\text{g m}^{-3}$ OECD).
- SO₂: $16.1 \mu\text{g m}^{-3}$.

These values are slightly lower than the 1998-99 means of $8.0 \mu\text{g m}^{-3}$ ($9.4 \mu\text{g m}^{-3}$ OECD) and $18.2 \mu\text{g m}^{-3}$ for smoke and SO₂ respectively.

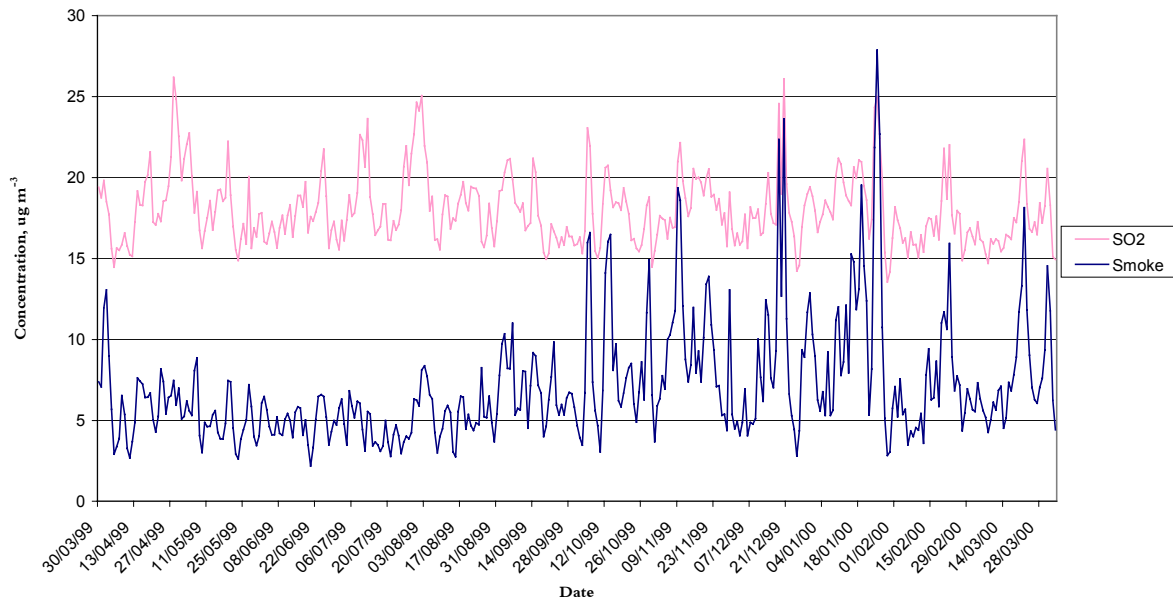
4.5 SEASONAL ANALYSIS

Smoke and SO₂ can exhibit a seasonal variation. Concentrations of both pollutants, but particularly black smoke, are typically higher in the winter months. This is partly because a major source of both pollutants is the combustion of coal and oil; this increases during winter, mainly because of domestic and industrial heating requirements. Also, cold, still weather conditions may prevent dispersion.

Figure 2 shows UK daily mean concentrations of smoke and SO₂, for the period April 1999 - March 2000. These are based on all sites in the Network. The seasonal variation for smoke is clearly visible, with daily UK mean concentrations typically 4 to $7 \mu\text{g m}^{-3}$ during the summer months, but rising to between typically between 5 and $15 \mu\text{g m}^{-3}$ during the winter. Winter peaks of over $20 \mu\text{g m}^{-3}$ occurred around the 18th to 22nd December 1999, and 24th - 26th

January 2000. For SO₂, the pattern is usually much less pronounced, and this year there was no clear seasonal variation: UK average daily means typically ranged between 15 and 20 µg m⁻³ throughout the year; UK mean values of above 25 µg m⁻³ occurred occasionally throughout the year.

Figure 2. Seasonal Variation of Smoke and SO₂, April 1999- March 2000.
All sites.



4.6 NATIONAL AND REGIONAL ANALYSIS

Figures 3 and 4 show annual means of smoke and SO₂ respectively, for the entire Network. Only sites with at least 75% data capture are shown. The data for 1999 - 2000 show a similar pattern to that observed in previous years, although annual mean concentrations are typically slightly lower. Table 2 summarises key statistics for England, Scotland, Wales and Northern Ireland.

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

	<i>England</i>	<i>Scotland</i>	<i>Wales</i>	<i>N. Ireland</i>
Number of sites	131	21	6	23
Smoke (µg m⁻³ BS)				
Min. Annual Mean	3	2	3	5
Ave. Annual Mean	8	5	6	9
Max. Annual Mean	16	10	8	16
SO₂ (µg m⁻³)				
Min. Annual Mean	3	9	4	12
Ave. Annual Mean	17	18	13	30
Max. Annual Mean	41	34	21	69

Note: Max, Min and Mean exclude any sites with less than 75% data capture.

4.6.1 England

Smoke in England: Annual mean smoke concentrations at sites in England ranged from $3 \mu\text{g m}^{-3}$ (at coastal towns or those with rural surroundings) to $16 \mu\text{g m}^{-3}$ (at BRADFORD 6 and HALIFAX 16). The highest smoke concentrations in England were measured at sites of two types: firstly, those in city centre locations where particulate emissions from traffic contribute, such as the two mentioned above. Secondly, those in areas where the use of coal for domestic heating is still prevalent (e.g. parts of South and West Yorkshire and the East Midlands). The annual mean smoke for all English sites was $8 \mu\text{g m}^{-3}$, very close to the mean of $7.5 \mu\text{g m}^{-3}$ for the whole UK based on core sites only.

SO₂ in England: The highest SO₂ concentrations in England, as measured by this Network, mainly occurred in areas where domestic coal use is prevalent. The majority of the highest SO₂ concentrations were measured in Yorkshire. The annual mean SO₂ for all English sites was $17 \mu\text{g m}^{-3}$, slightly higher than the mean of $16.1 \mu\text{g m}^{-3}$ for the whole UK, based on the core sites.

4.6.2 Scotland

Smoke in Scotland: Annual mean smoke concentrations measured in Scotland were less than $10 \mu\text{g m}^{-3}$ at all but one site. The exception was EDINBURGH 25 (annual mean $10 \mu\text{g m}^{-3}$), which is in a city centre location, close to a busy street, and traffic emissions make a significant contribution in this case. The annual mean smoke for all Scottish sites was $5 \mu\text{g m}^{-3}$.

SO₂ in Scotland: No Scottish sites exhibited particularly high annual mean SO₂ concentrations. The highest was $34 \mu\text{g m}^{-3}$, at ARMADALE 2. This is in a small town close to industrial and domestic combustion emissions. The majority of sites in Edinburgh and Glasgow, also one site in Coatbridge, had annual mean SO₂ in the range 20 to $30 \mu\text{g m}^{-3}$. Elsewhere it was below this value. The annual mean SO₂ for all Scottish sites was $18 \mu\text{g m}^{-3}$.

4.6.3 Wales

Smoke in Wales: There were only 6 sites in Wales during the 1999–2000 period, and two of these had less than 75% data capture. However, the available data indicate that smoke concentrations at sites in Wales (which are predominantly located in the urban areas of South Wales) were typically low compared to the rest of the UK. Annual means were less than $10 \mu\text{g m}^{-3}$ at all sites. The annual mean smoke for the four Welsh sites was $6 \mu\text{g m}^{-3}$ – marginally higher than that for Scotland.

SO₂ in Wales: Annual mean SO₂ concentrations in Wales ranged from $4 \mu\text{g m}^{-3}$ at NEYLAND 1 in Pembrokeshire, to $21 \mu\text{g m}^{-3}$ at CARDIFF 12 and WREXHAM 10. (An annual mean of $32 \mu\text{g m}^{-3}$ was measured at GLYNNEATH 1, near Port Talbot, but as the data capture was less than 75% at this site it is not included in the table). The low value at NEYLAND 1 reflects its coastal location and rural surroundings. GLYNNEATH 1 is situated in a small town, further inland and close to Port Talbot, with considerable domestic use of coal in the area. The overall annual mean SO₂ for all Network sites in Wales was $13 \mu\text{g m}^{-3}$, slightly higher than last year.

4.6.4 Northern Ireland

Smoke in Northern Ireland: Annual mean smoke concentrations at sites in Northern Ireland were less than $15 \mu\text{g m}^{-3}$ at all but one site, the exception being LONDONDERRY 11 ($16 \mu\text{g m}^{-3}$). This site is in a mainly residential area: however it is less than 10m from the kerbside and not far from a small roundabout. Traffic emissions are likely to be making a contribution to measured black smoke at this site. A new site, STRABANE 2, which began operation part way through the year and therefore had less than 75% data, exhibited the highest annual mean smoke concentration of $32 \mu\text{g m}^{-3}$. This is considerably higher than any other sites in the region:

this site will need careful observation until a full year's data are available. The overall annual mean smoke for Northern Ireland was $9 \mu\text{g m}^{-3}$: higher than the annual mean for the whole Network.

SO₂ in Northern Ireland: Relatively high concentrations of SO₂ have been measured in Northern Ireland, particularly Belfast, for many years. Natural gas has limited availability for domestic heating in this region, so greater use is made of coal and oil. The overall annual mean SO₂ for all Network sites in Northern Ireland was $30 \mu\text{g m}^{-3}$; considerably higher than the annual means obtained for the other Regions or for the UK as a whole. The highest annual mean SO₂ was $69 \mu\text{g m}^{-3}$, measured at DUNMURRY 2. Although this site is in a residential area where domestic coal and oil use is prevalent, SO₂ concentrations at this site appear to have increased, especially in the summer. It is thought that emissions from a nearby boiler chimney are contributing to SO₂ levels in the immediate vicinity, and this is currently being investigated.

4.7 IDENTIFICATION OF SITES WITH HIGH CONCENTRATIONS

Table 3 lists the 15 sites with the highest annual average smoke concentrations – those with an annual mean greater than $10 \mu\text{g m}^{-3}$. Sites with less than 75% data capture, i.e. 278 days' data, for the year have been excluded. As in previous years, the highest annual mean smoke concentrations were measured predominantly at sites of two types; firstly, sites in city centres or close to busy roads (e.g. BRADFORD 6, ISLINGTON 9, SEDGLEY 5 near Dudley). At such sites, traffic emissions are likely to make a contribution to ambient concentrations of dark particulate. Secondly, sites in areas where the use of coal for domestic heating is still prevalent (e.g. South and West Yorkshire, Northern Ireland, East Midlands). It should be noted that annual mean smoke concentrations are lower in general than last year, being less than $10 \mu\text{g m}^{-3}$ at the majority of sites.

The new site STRABANE 2 (Northern Ireland) does not appear in the table because it started up in October 1999 and has less than the required 75% data capture. However, this site exhibited a conspicuously high annual mean of $32 \mu\text{g m}^{-3}$ for the (winter) months in which it was in operation. The site is surrounded by domestic coal burning with no other combustion sources: it remains to be seen whether these values are typical for the site.

Table 3 Sites with Highest Annual Mean Smoke Concentrations, 1999 - 2000

<i>Site Name</i>	<i>Region</i>	<i>Annual Mean Smoke concentration $\mu\text{g m}^{-3}$ BS</i>
BRADFORD 6	Yorkshire & the Humber	16
HALIFAX 16	Yorkshire & the Humber	16
LONDONDERRY 11	Northern Ireland	16
ISLINGTON 9	London	14
SEDGLEY 5	West Midlands	13
BRISTOL 26	South West	12
OLDHAM 13	North West & Merseyside	12
CASTLEFORD 11	Yorkshire & the Humber	12
BELFAST 33	Northern Ireland	11
LISBURN 3	Northern Ireland	11
RAWTENSTALL 7	North West & Merseyside	11

Table 4 lists the 21 sites with the highest annual mean SO₂ concentrations – those with an annual mean greater than 30 µg m⁻³ or more (again, those with less than 278 days' data have been excluded). The table is dominated by sites in Northern Ireland and Yorkshire and the Humber. The most important factor here is coal and oil use. In Northern Ireland, due to limited availability of natural gas for domestic heating, use of coal and oil is higher. DUNMURRY 2, situated in a residential area where coal and oil use is widespread, had an annual mean of 69 µg m⁻³. Likewise, areas of South Yorkshire in particular have long been associated with the coal industry, and domestic coal use is relatively prevalent.

Table 4 Sites with Highest Annual Mean SO₂ Concentrations, 1999 - 2000

<i>Site Name</i>	<i>Region</i>	<i>Annual Mean SO₂ concentration µg m⁻³</i>
DUNMURRY 2	Northern Ireland	69
LONDONDERRY 11	Northern Ireland	43
BARNSELY 8	Yorkshire & the Humber	41
BELFAST 42	Northern Ireland	40
OLDHAM 13	North West & Merseyside	39
BELFAST 33	Northern Ireland	37
ALFRETON 4	East Midlands	36
TRAFFORD 1	North West & Merseyside	36
BELFAST 44	Northern Ireland	36
BELFAST 45	Northern Ireland	35
ARMADALE 2	Scotland	34
BELFAST 13	Northern Ireland	34
LONDONDERRY 12	Northern Ireland	34
CUDWORTH 2	Yorkshire & the Humber	32
MALTBY 2	Yorkshire & the Humber	32
GOLDTHORPE 1	Yorkshire & the Humber	31
HOLMFIRTH 5	Yorkshire & the Humber	31
BRAMPTON 1	Yorkshire & the Humber	31

The following sites appear in both Table 3 and Table 4, as they have relatively high concentrations of both pollutants: LONDONDERRY 11, OLDHAM 13 and BELFAST 33.

**Fig. 3 Annual Mean Smoke Concentrations. April 1999-
March 2000**

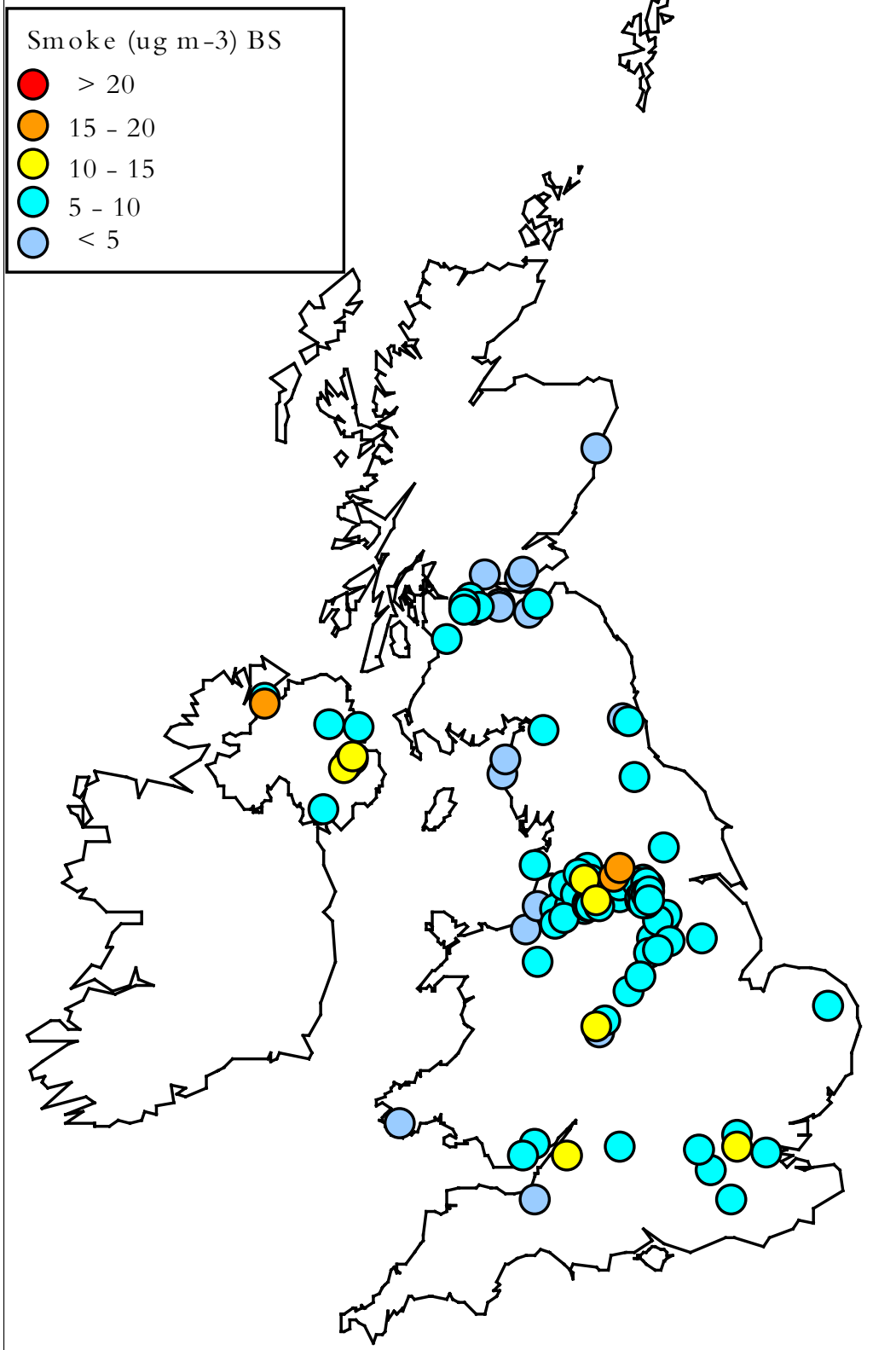
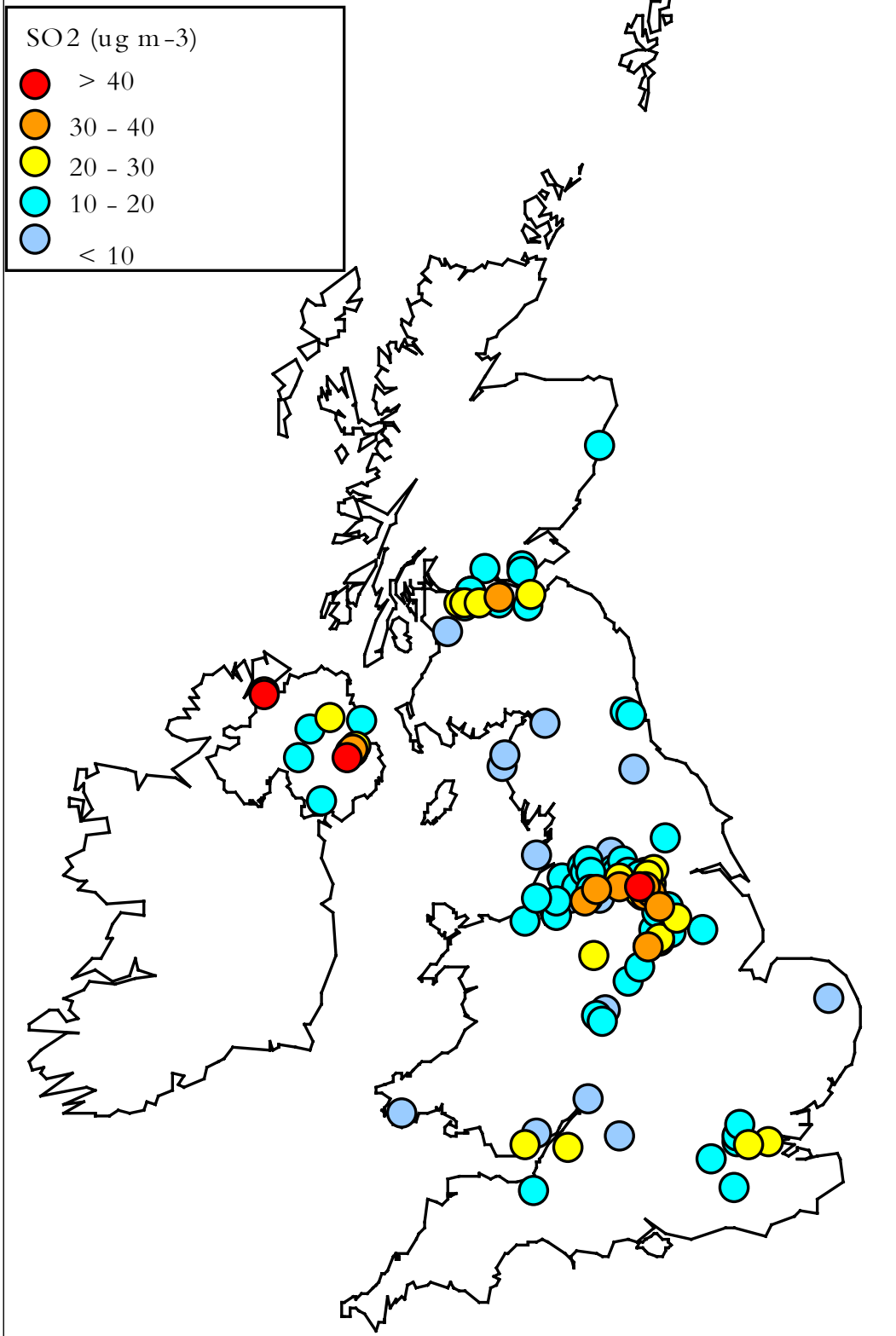


Fig. 4. Annual Mean Sulphur Dioxide Concentrations. April 1999- March 2000



5 Comparison with EC Directive Limits and Guide Values

In previous years, data from the UK Smoke and SO₂ Network have been compared with the European Council Directive¹ 80/779/EEC on sulphur dioxide and suspended particulates. This original Directive will remain in force until it is fully repealed in 2005. The current report therefore compares results from the Smoke and SO₂ Network with the relevant sections of both the original Directive and the First Daughter Directives (1999/30/EEC).

5.1 DIRECTIVE 80/779/EEC ("THE SMOKE AND SO₂ DIRECTIVE")

The limit values are presented in Table 5 below, along with the non-mandatory guide values. It should be noted that the EC Directive cites smoke concentrations calculated using the OECD Smoke Calibration Curve (OECD Publication no. 17913: 1964).

Table 5 EC Directive Limit and Guide Values for Smoke and Sulphur Dioxide: Micrograms Per Cubic Metre

<i>EC Directive Limits</i>		
<i>Reference Period</i>	<i>Smoke µg m⁻³ BS</i>	<i>Sulphur Dioxide µg m⁻³</i>
YEAR (median of daily values)	68 (80 OECD)	if smoke ≤ 34: 120 if smoke > 34: 80
WINTER (median of daily values October-March)	111 (130 OECD)	if smoke ≤ 51: 180 if smoke > 51: 130
YEAR (Peak) (98 Percentile of daily values)	213 (250 OECD)	if smoke ≤ 128: 350 if smoke > 128: 250
<i>EC Directive Guide Values</i>		
<i>Reference Period</i>	<i>Smoke µg m⁻³ BS</i>	<i>Sulphur Dioxide µg m⁻³</i>
YEAR (arithmetic mean of daily values)	34 to 51 (40 to 60 OECD)	40 to 60
24 HOURS (daily mean value)	85 to 128 (100 to 150 OECD)	100 to 150

NOTE: The Limit and Guide Values given above for smoke according to the BS calibration are calculated from the original OECD calibration figures given in the EC Directive using the relationship: BS concentration = OECD concentration multiplied by 0.85

Results from all sites operational in 1999 - 2000 were examined for compliance with the EC Directive limit and guide values. Limit values are mandatory, whereas guide values are advisory only, and are intended to serve as long term precautions for health and the environment.

It should be noted that the EC require that percentile calculations (e.g. median, 98th percentile) are calculated by their specified method. For checking formal compliance with the EC Directive, the specified Directive method has always been used. Hence, percentiles calculated by the EC Directive method are discussed in this section.

5.1.1 Exceedences of the EC Directive Limits

Analysis of the data for 1999 – 2000 shows that for the seventh year running, no site exceeded any of the limit values of the EC Directive. For information on exceedences in previous years, see last year's Annual Summary Report.

5.1.2 Sites "At Risk" of Exceeding EC Directive Limits

"At Risk" of exceeding a limit has been defined as being within 75% of the limit values. No sites were identified as being "At Risk" of exceeding the 98th percentile limit, the annual median limit, or the winter median limit.

The peroxide titration method of analysis used in the UK monitoring network is not the reference method of the Directive, but has been accepted as an equivalence method, under the terms of Article 10 of the Directive. However, under the terms of this acceptance as an equivalence method, it was agreed with the Commission in 1989, that a factor of 1.25 would be applied to the sulphur dioxide results to compensate for possible underestimation of peak values. In practice, this is done by dividing the appropriate *peak* SO₂ limits by 1.25, and comparing measured data with this adjusted limit. No sites exceeded the adjusted limit values; however, two sites (DUNMURRY 2 and BARNESLEY 8) were "At Risk" of breaching the adjusted annual 98th percentile limit for SO₂.

5.1.3 Comparison with EC Guide values

Numbers of sites exceeding the EC Directive guide values are given below. For the guide values relating to the annual arithmetic mean, numbers include only sites with the required minimum of 75% data capture.

Smoke: Annual Arithmetic Means of Daily Values

Sites with annual arithmetic mean smoke > 34 $\mu\text{g m}^{-3}$ BS: **no sites**

Sites with annual arithmetic mean smoke > 51 $\mu\text{g m}^{-3}$ BS: **no sites**

There has been only one case of a site exceeding the lower smoke guideline in the past six years.

SO₂: Annual Arithmetic Means of Daily Values

Sites with annual arithmetic mean > 40 $\mu\text{g m}^{-3}$: **3 sites**

This is a substantial decrease on last year's total of 11 sites.

Sites with annual arithmetic mean > 60 $\mu\text{g m}^{-3}$: **1 site** (DUNMURRY 2)

This is the first time in three years in which any sites have exceeded this guideline.

Smoke: 24 hour means

Sites with one or more 24 hour mean > 85 $\mu\text{g m}^{-3}$ BS: **8 sites**

This is a considerable reduction on last year's total of 17 sites, and reflects the lower smoke concentrations measured over the UK as a whole this year.

Sites with one or more 24 hour mean > 128 $\mu\text{g m}^{-3}$ BS: **1 site.**

This is a decrease on last year's total of 4 sites.

SO₂: 24 hour means

Sites with one or more 24 hour mean $> 100 \mu\text{g m}^{-3}$: **15 sites**

Last year's total was 27 sites.

Sites with one or more 24 hour mean $> 150 \mu\text{g m}^{-3}$: **8 sites**

This is a reduction on last year's total of 11 sites.

5.2 THE 1ST DAUGHTER DIRECTIVE (1999/30/EEC)

The first Daughter Directive (1999/30/EEC), covering SO₂, NO₂, PM₁₀ and lead³ was published in April 1999. This Directive contains limit values for these pollutants, aimed at protection of human health and, in some cases, of ecosystems.

Only the parts of the Daughter Directive relating to SO₂ and particulate will be discussed here; the limits are given in Table 6 and Table 7 below.

Table 6 Directive 1999/30/EEC Limit Values for SO₂

	<i>Averaging period</i>	<i>Limit value</i>	<i>Date by which limit is to be met</i>
1. Hourly limit value for protection of human health	1 hour	350 $\mu\text{g m}^{-3}$ not to be exceeded more than 24 times per calendar year	1 January 2005
2. Daily limit value for protection of human health	24 hours	125 $\mu\text{g m}^{-3}$ not to be exceeded more than 3 times per calendar year	1 January 2005
3. Limit value for the protection of ecosystems	calendar year and winter (1 Oct - 31 Mar)	20 $\mu\text{g m}^{-3}$	19 July 2001

There is also an "alert threshold" for SO₂ of 500 $\mu\text{g m}^{-3}$, measured over three consecutive hours at representative sites over at least 100 km² or an entire zone or agglomeration, whichever is smaller. Public warnings and advice are to be issued if this threshold is exceeded.

The Daughter Directive limits are accompanied by "upper and lower assessment thresholds", which specify what type of monitoring is required.

- The upper assessment threshold is the level below which a combination of measurements and modelling techniques may be used to assess air quality;
- the lower assessment threshold is the level below which modelling alone, or with objective estimation techniques, is considered sufficient for assessment of air quality.

This ensures that monitoring resources are targeted where they are most needed. Exceedence of these assessment thresholds is to be determined on the basis of data from the previous five years where available.

For the purposes of the EC Directive, an "exceedence" of an air quality limit or guide value is a concentration "greater than" the limit or guide value, as opposed to "greater than or equal to". This is the definition used in this report.

It is clearly not possible to compare data from the Smoke and SO₂ Network with the hourly limit. 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 data from the Network with the 24 hour limit, for protection of human health. In the calendar year January to December 1999, there were 6 sites with more than three days where the 24-hour average for SO₂ was greater than the limit of 125 µg m⁻³: these were as follows:

BARNSLEY 8
 BELFAST 33
 BELFAST 42
 BELFAST 44
 BELFAST 45
 DUNMURRY 2

Table 7 Directive 1999/30/EEC Limit Values for PM₁₀

	<i>Averaging period</i>	<i>Limit value</i>	<i>Date by which limit is to be met</i>
Stage 1			
1. 24-hour limit value for protection of human health	24 hour	50 µg m ⁻³ not to be exceeded more than 35 times per year	1 January 2005
2. Annual limit value for protection of human health	Calendar Year	40 µg m ⁻³	1 January 2005
Stage 2 *			
1. 24-hour limit value for protection of human health	24 hour	50 µg m ⁻³ not to be exceeded more than 7 times per year	1 January 2010
2. Annual limit value for protection of human health	Calendar Year	20 µg m ⁻³	1 January 2010

* To be reviewed in the light of further information and experience.

The Daughter Directive particulate limits relate to PM₁₀, not black smoke, and therefore Network data cannot be directly compared with these. The black smoke limits of the Smoke and SO₂ Directive will remain in force until 1 January 2005.

6 Comparison with the Air Quality Strategy

6.1 AIR QUALITY STRATEGY FOR SO₂

The Air Quality Regulations (2000) for England⁶, Wales⁷, and Scotland⁸ include standards and objectives for SO₂. These are explained in the Air Quality Strategy (January 2000)⁹, and summarised below:

- 266 $\mu\text{g m}^{-3}$ for the 15-minute mean, not to be exceeded more than 35 times per year, to be achieved by 31 December 2005.
- 350 $\mu\text{g m}^{-3}$ for the 1-hour mean, not to be exceeded more than 24 times per year, to be achieved by 31 December 2004.
- 125 $\mu\text{g m}^{-3}$ for the 24-hour mean, not to be exceeded more than 3 times per year, to be achieved by 31 December 2004.
- 20 $\mu\text{g m}^{-3}$ for the annual and winter mean, for the protection of ecosystems, to be achieved by 31 December 2000.

Data from the Smoke and SO₂ Network, which provides daily mean data, can only be directly compared with the standard for the 24-hour mean (the ecosystem limit does not apply to urban locations). This is identical to the Daughter Directive 24-hour limit. Data from *calendar* year 1 January - 31 December 1999 have been compared with this limit. Six sites had 24 hour mean SO₂ concentrations greater than the 24-hour limit on more than three days during 1999:

BARNSLEY 8
 BELFAST 33
 BELFAST 42
 BELFAST 44
 BELFAST 45
 DUNMURRY 2

As the hydrogen peroxide bubbler method of measurement used in this Network may underestimate peak SO₂ concentrations, a factor of 1.25 should be applied to *peak* data when using this relationship. Dividing the 24-hour limit of 125 $\mu\text{g m}^{-3}$ by 1.25 to account for possible under-reading by the method used gives 100 $\mu\text{g m}^{-3}$ for the maximum day. A total of nine sites had over three daily means greater than this value in calendar year January - December 1999: the above six plus BELFAST 13, BRAMPTON 1, DUNMURRY 3.

6.2 AIR QUALITY STRATEGY FOR PM₁₀

The Air Quality Strategy⁹ also provides objectives for suspended particulate matter. The particulate objectives specifically apply to PM₁₀, not black smoke, and the Strategy acknowledges that these two techniques are not the same. The Air Quality Regulations (2000) for England, Wales and Scotland contain objectives which are the same as those in the EC Daughter Directive for PM₁₀, and are as follows:

- 40 $\mu\text{g m}^{-3}$ as the annual mean, to be achieved by 31 December 2004
- 50 $\mu\text{g m}^{-3}$ as a fixed 24 hour mean, maximum of 35 exceedences per year (approximately equivalent to the 90th percentile), also to be achieved by 31 December 2004.

The above limits are based on European reference method for PM₁₀ (a gravimetric technique), or equivalent.

Although the above standards and objectives pertain to PM₁₀, black smoke data can be of use to Local Authorities in their review and assessment of PM₁₀ concentrations with respect to these limits. This is described in "Assistance with the review and assessment of PM₁₀ concentrations in relation to the proposed EU Stage 1 Limit Values"¹⁰, produced for the Department. In this document, it is stated that the AQS 24-hour objective (which is the more stringent of the two) is highly unlikely to be exceeded in any given year if the annual mean PM₁₀ for the same year does not exceed 28 $\mu\text{g m}^{-3}$. If this threshold looks likely to be exceeded in 2004, it will be necessary to undertake a 3rd Stage Review and Assessment.

Where domestic solid fuel use is likely to have a significant impact on local PM₁₀ levels, a procedure has been developed¹⁰ whereby black smoke data can be used to assess the impact of domestic solid fuel use. This is based upon an empirical relationship, and makes use of the following data:

- annual mean black smoke concentration in the area,
- Modeled 1996 annual mean background secondary PM₁₀ concentration in the area, available on the World wide Web at <http://www.aeat.co.uk/netcen/airqual>
- Estimated contribution from "coarse" PM₁₀, e.g. wind-blown dust.

Where solid fuel burning is likely to be a significant source of ambient PM₁₀, and black smoke data is available, the total annual mean PM₁₀ concentration for the year 2004 can be predicted from the following relationship:

Total annual mean PM₁₀ (2004) = 0.8 x annual mean secondary PM₁₀ (1996) + coarse PM₁₀ fraction + 0.8 x current annual mean black smoke.

The coarse component is assumed to be a constant 8 $\mu\text{g m}^{-3}$, as measured by TEOM method¹⁰. The document provides a graph from which the user can easily determine whether the predicted annual mean for 2004 exceeds 28 $\mu\text{g m}^{-3}$.

Table 8 shows the Smoke and SO₂ Network sites for which this relationship predicts possible exceedence in 2004. These sites were identified by the following procedure.

1. First, the modeled 1996 annual mean background secondary PM₁₀ concentrations were obtained from the www, for each of the 12 Government Regions. Where this value concentration varies across a region, the highest value (worst case) was initially selected.
2. Predicted total annual mean PM₁₀ for 2004 was calculated for each site, from the relationship above, and assuming the *regional worst case* 1996 annual mean background secondary PM₁₀ concentration.
3. Based on this, sites were identified at which the predicted total annual mean PM₁₀ for 2004 was greater than 28µg m⁻³. Eight sites were identified.
4. For each of these 8 sites, the modeled maps were again consulted, to determine the modeled 1996 annual mean background secondary PM₁₀ concentration at the site, (rather than the worst case for the region). Using the actual value, rather than the regional worst case, steps 2 and 3 were then repeated. This narrowed down the number of "possible exceedence" sites to 7, and these are listed in Table 8.

The total of 7 sites is less than last year's total of 11 sites, and probably reflects the small reduction in smoke concentrations over the past year. However, some of the same sites identified last year again appear in Table 8. These sites have some common features; the majority are influenced by traffic emissions. BRADFORD 6 and HALIFAX 16 are city centre sites. SEDGLEY 5 and LONDONDERRY 11 are both near main roads. Two London sites are also included; not all of these are close to main roads but this reflects the high background concentrations of PM₁₀ in London and parts of the South East. SHOREDITCH 2 has unfortunately now ceased operation.

There is only one site in Table 8 which was not identified last year. STRABANE 2 is a new site with only winter data available so far. As discussed in Section 4, it will need further observation to establish whether the data obtained so far are typical.

This assessment is of course indicative only; Local/Unitary Authorities will by now have made detailed assessments of their areas as part of the Review and Assessment process. However, it serves to highlight the type of location where problems might be expected.

Table 8 Sites for which current smoke concentrations may indicate a need for Stage 3 PM₁₀ Review and Assessment.

<i>Region</i>	<i>Number of sites</i>
Scotland	0
North East	0
North West and Merseyside	0
Yorkshire and the Humber	2 (BRADFORD 6, HALIFAX 16)
East Midlands	0
West Midlands	1 (SEDGLEY 5)
Eastern	0
London	2 (SHOREDITCH 2, ISLINGTON 9)
South East	0
South West	0
Wales	0
Northern Ireland	2 (LONDONDERRY 11, STRABANE 2*)

* *Strabane 2 is a new site with winter data only available.*

7 Trends and Comparison with Emission Estimates

The timeseries of the annual mean smoke and sulphur dioxide concentrations for the UK as a whole are provided in Figure 5a and 5b respectively. The values shown in Figure 5a and 5b are averages from all sites in the network up to 1980, and thereafter from all sites in the core subset only. As explained in Section 2, this subset is intended to provide a representative selection of monitoring sites in urban areas throughout the UK. The resulting graphs show the rapid decrease in concentrations in the 1960s and 1970s and the more gradual decrease through the 1980s and 1990s. Figure 5a and 5b also show estimated total UK annual emissions of smoke and SO₂ for years 1970 - 1998 (source: National Atmospheric Emissions Inventory). The graphs clearly show that ambient concentrations of these pollutants reflect declining emissions over this 28-year period.

The relationships between estimated annual emissions and measured annual mean concentrations have been explored further.

- **Smoke:** The plot shows a clear relationship between these two parameters over the 28 years. Regression analysis of the two parameters was carried out, giving a correlation coefficient (R^2) of 0.92. This is close to 1 and therefore indicates a very strong correlation.
- **SO₂:** The relationship between the two parameters is also strong in the case of SO₂; the correlation coefficient (R^2) of the regression equation is 0.87. The correlation is slightly weaker than for smoke, which may reflect the fact that the Network measures net acidity rather than SO₂.

Fig. 5a. Smoke only: Annual Emissions and Annual Mean Ambient Concentrations.

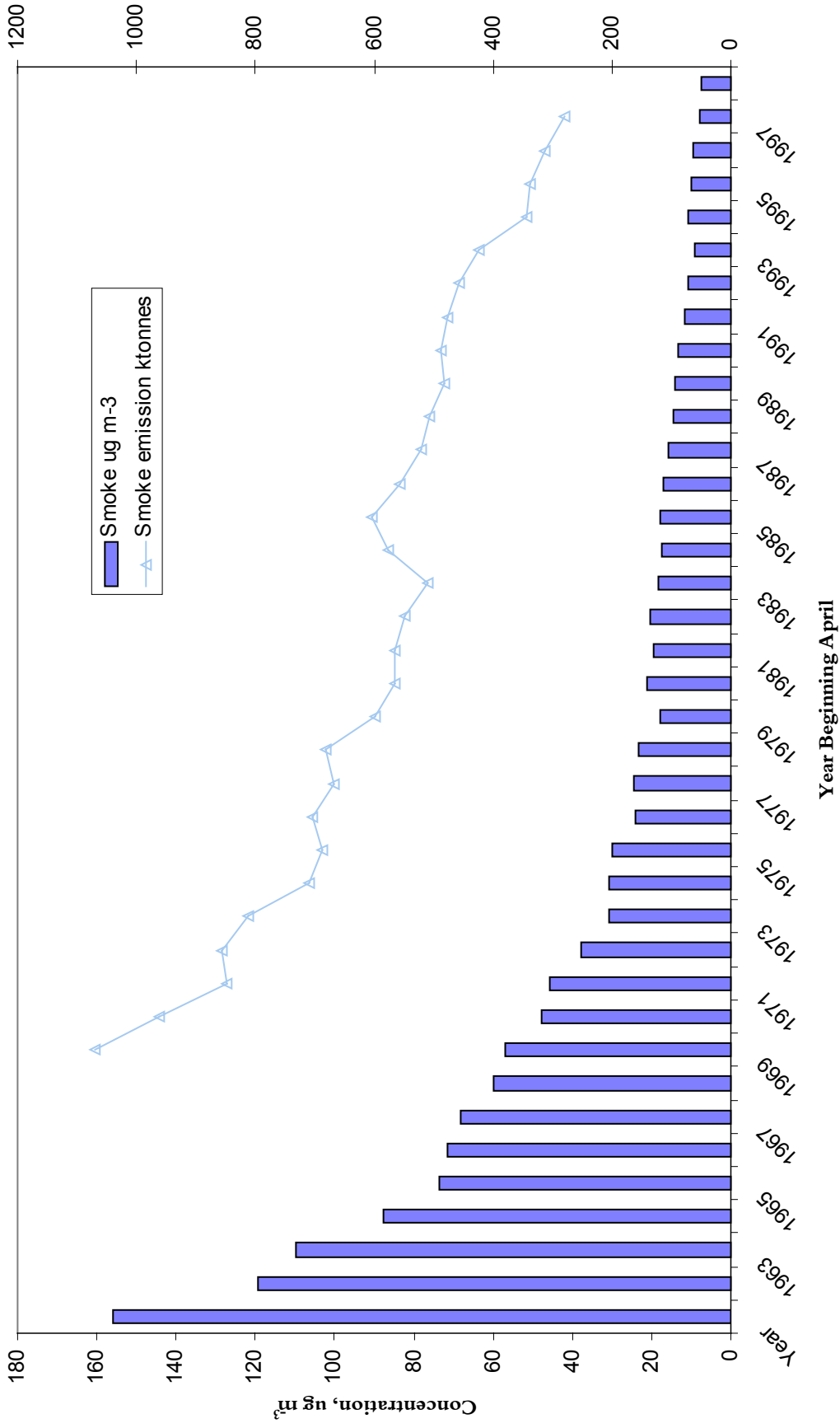
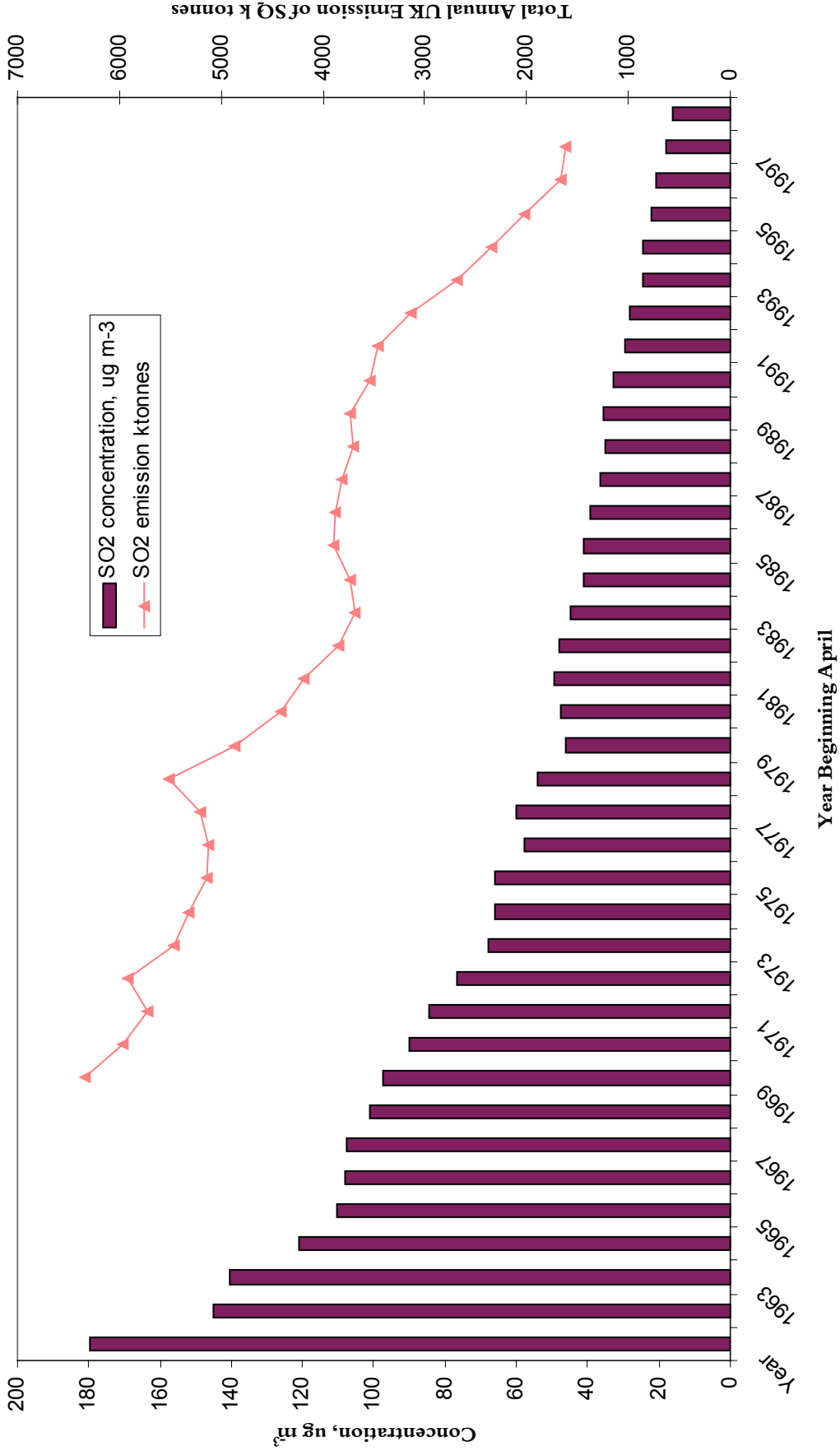


Fig. 5b. SO₂ only: Annual Emissions and Annual Mean Ambient Concentrations.



8 Acknowledgements

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9 References

1. Council of European Communities Directive on Air Quality Limit Values and Guide Values for Sulphur Dioxide and Suspended Particulates (80/779/EEC)
2. Council Directive 96/62/EC on Ambient Air Quality Assessment and Management.
3. Council Directive 1999/30/EEC relating to limit values for sulphur dioxide, nitrogen dioxide and oxides of nitrogen, particulate matter and lead in ambient air. 22 April 1999.
4. Establishing a Reciprocal Exchange of Information and of Data from the Network and Individual Stations Measuring Ambient Air Pollution in Member States. Decision 97/101/EEC.
5. Department of the Environment, Transport and the Regions: Digest of Environmental Statistics (produced annually). The Stationery Office.
6. The Air Quality (England) Regulations 2000 (Statutory Instrument 2000 No. 928), March 2000.
7. The Air Quality (Wales) Regulations 2000 (Statutory Instrument 2000 No. 1940 (W.138)), July 2000.
8. The Air Quality (Scotland) Regulations 2000 (Scottish Statutory Instrument 2000 No. 97), March 2000.
9. The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. Working Together for Clean Air. The Stationery Office, January 2000.
10. Moorcroft S, Laxen D, Stedman J, Vawda Y, Conlan B, Abbott J. Assistance with the review and assessment of PM₁₀ concentrations in relation to the proposed EU Stage 1 Limit Values. Produced for the Department of the Environment, Transport and the Regions, the Welsh Assembly and the Scottish Executive by Stanger Science and Environment, Air Quality Consultants, and NETCEN. March 1999.

Table 1.1. Summary of Smoke and Sulphur Dioxide Results for Scotland, 1999-2000. Concentrations in $\mu\text{g m}^{-3}$

Code	Site Name	Authority	O.S. Grid Ref. To 100m		Summary of Smoke Data 1999-2000						Summary of SO ₂ Data 1999-2000					
			East	North	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
10003	SCOTLAND ABERDEEN 3	Aberdeen City	3931	8062	364	98	4	3	16	38	361	97	17	12	48	65
1100025	EDINBURGH 25	City of Edinburgh	3258	6731	336	91	10	8	26	41	322	87	23	20	52	123
1300020	GLASGOW 20	City of Glasgow	2595	6653	371	100	7	7	20	49	371	100	23	21	46	60
1300051	GLASGOW 51	City of Glasgow	2533	6641	371	100	5	4	26	62	363	98	21	19	43	50
1300073	GLASGOW 73	City of Glasgow	2612	6627	364	98	7	4	43	90	354	95	17	19	31	62
1300095	GLASGOW 95	City of Glasgow	2679	6642	371	100	6	4	25	46	371	100	20	19	57	74
1300098	GLASGOW 98	City of Glasgow	2611	6678	371	100	7	4	30	67	371	100	18	19	33	153
1685002	KILMARNOCK 2	East Ayrshire	2427	6380	336	91	6	3	25	31	334	90	9	6	18	18
1725008	KIRKINTILLOCH 8	East Dumbartonshire	2670	6741	367	99	5	3	34	59	367	99	11	7	33	45
1725009	KIRKINTILLOCH 9	East Dumbartonshire	2654	6732	362	98	6	3	33	66	362	98	13	12	36	48
1725010	KIRKINTILLOCH 10	East Dumbartonshire	2659	6741	348	94	4	3	29	47	348	94	18	18	36	72
155002	BALLINGRY 2	Fife	3178	6978	356	96	2	1	3	4	356	96	14	13	25	31
820301	COWDENBEATH 1	Fife	3165	6912	371	100	2	2	4	8	371	100	15	14	27	45
1721006	KIRKCALDY 6	Fife	3265	6933	170	46	3	2	11	17	170	46	14	13	26	32
900301	DALKEITH 1	Midlothian	3341	6670	351	95	9	6	29	61	352	95	20	18	37	49
2514001	PENICUIK 1	Midlothian	3240	6606	358	96	3	3	11	45	357	96	16	13	32	44
760005	COATBRIDGE 5	North Lanarkshire	2712	6638	220	59	5	4	19	42	217	58	17	13	44	83
760011	COATBRIDGE 11	North Lanarkshire	2738	6652	292	79	6	4	21	53	288	78	26	26	59	92
3070005	STIRLING (BURGH) 5	Stirling	2797	6946	371	100	4	3	15	35	370	100	13	13	25	26
69502	ARMADALE 2	West Lothian	2945	6681	356	96	2	2	7	18	356	96	34	33	71	84
3559003	WHITBURN 3	West Lothian	2948	6650	370	100	3	3	11	27	370	100	19	19	33	39

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. "Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.2. Summary of Smoke and Sulphur Dioxide Results for the North East, 1999-2000. Concentrations in $\mu\text{g m}^{-3}$

Code	Site Name	Authority	O.S. Grid Ref. To 100m		Summary of Smoke Data 1999-2000						Summary of SO2 Data 1999-2000					
			East	North	Valid Days	Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day	Valid Days	Data Capt. %	Arith. Mean	Median	98th %ile	Max. Day
NORTH EAST																
915013	DARLINGTON 13	Darlington	4291	5145	364	98	8	6	25	29	364	98	8	6	24	53
1290010	GATESHEAD 10	Gateshead	4256	5619	160	43	4	4	11	17	160	43	13	12	23	24
2370002	NEWBURN 2	Newcastle U. Tyne	4199	5671	366	99	4	3	15	24	369	99	11	13	26	39
2390024	NEWCASTLE UPON TYNE 24	Newcastle U. Tyne	4285	5650	260	70	4	2	15	34	264	71	13	14	28	35
2390027	NEWCASTLE UPON TYNE 27	Newcastle U. Tyne	4251	5645	363	98	7	6	20	37	364	98	11	12	25	49
3170008	SUNDERLAND 8	Sunderland	4391	5585	222	60	5	4	20	32	222	60	16	13	67	88
85005	ASHINGTON 5	Wansbeck	4272	5877	244	66	4	3	12	17	243	65	15	13	33	63

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. "Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.3. Summary of Smoke and Sulphur Dioxide Results for the North West and Merseyside, 1999-2000. Concentrations in $\mu\text{g m}^{-3}$

Code	Site Name	Authority	O.S. Grid Ref. To 100m		Summary of Smoke Data 1999-2000						Summary of SO2 Data 1999-2000					
			East	North	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
NORTH WEST & MERSEYSIDE																
3700003	WORKINGTON 3	Allerdale	2999	5287	309	83	3	2	19	27	308	83	9	7	28	41
3800006	BLACKPOOL 6	Blackpool	3317	4367	363	98	7	5	26	54	364	98	9	6	18	19
4000024	BOLTON 24	Bolton	3715	4092	322	87	8	6	29	41	317	85	12	12	29	46
1230008	FARNWORTH 8	Bolton	3739	4061	264	71	7	5	26	32	254	68	12	13	32	38
1550001	HORWICH 1	Bolton	3637	4118	264	71	8	6	26	32	257	69	11	12	27	34
5000012	BURNLEY 12	Burnley	3841	4324	351	95	6	4	21	33	351	95	12	12	29	41
5100009	BURY 9	Bury	3819	4116	160	43	8	6	38	50	160	43	22	23	40	41
5550013	CARLISLE 13	Carlisle	3398	5550	356	96	7	6	28	68	356	96	3	0	7	7
7150006	CHORLEY 6	Chorley	3585	4178	334	90	8	6	34	59	327	88	11	13	32	45
3563005	WHITEHAVEN 5	Copeland	2974	5178	335	90	3	2	9	17	335	90	9	6	19	25
8400009	CREWE 9	Crewe & Nantwich	3703	3550	220	59	8	5	33	38	219	59	40	38	80	95
1130012	ELLESMERE PORT 12	Ellesmere Port	3398	3759	223	60	4	3	20	24	263	71	14	12	35	65
2781510	RUNCORN 10	Halton	3511	3833	340	92	9	8	30	50	340	92	11	7	27	27
20005	ACCRINGTON 5	Hyndburn	3758	4285	365	98	9	8	27	41	365	98	11	7	23	32
1850016	LIVERPOOL 16	Liverpool	3345	3908	346	93	5	4	15	42	346	93	20	18	36	121
2232507	MACCLESFIELD 7	Macclesfield	3926	3733	249	67	7	7	16	30	242	65	18	13	59	71
2280011	MANCHESTER 11	Manchester	3838	3981	371	100	9	8	26	49	371	100	12	12	26	50
2280015	MANCHESTER 15	Manchester	3875	3985	362	98	9	7	34	45	362	98	10	6	19	38
2280021	MANCHESTER 21	Manchester	3847	4023	361	97	8	6	33	48	361	97	9	6	19	37
2470013	OLDHAM 13	Oldham	3920	4057	371	100	12	12	25	29	370	100	39	39	72	90
2320003	MIDDLETON 3	Rochdale	3871	4063	350	94	10	9	31	55	350	94	16	18	36	38
1500005	BACUP 5	Rossendale	3868	4231	350	94	9	7	38	58	350	94	14	9	38	62
2650007	RAWTENSTALL 7	Rossendale	3812	4229	350	94	11	9	31	51	348	94	12	12	30	42
3230007	SWINTON & PENDLEBURY 7	Salford	3774	4018	366	99	4	2	16	35	360	97	8	6	19	25
8550003	CROSBY 3	Sefton	3321	3990	334	90	4	3	21	34	334	90	19	18	37	50
2800036	ST HELENS 36	St Helens	3534	3936	244	66	7	5	27	31	242	65	17	14	50	63
2800043	ST HELENS 43	St Helens	3512	3955	356	96	7	6	30	42	350	94	16	13	40	60
6250006	CHEADLE & GATLEY 6	Stockport	3859	3886	200	54	3	3	8	10	185	50	8	6	24	25
90008	ASHTON-UNDER-LYNE 8	Tameside	3939	3992	294	79	9	7	28	48	286	77	9	7	21	28
3314601	TRAFFORD 1	Trafford	3810	3958	369	99	6	4	20	42	369	99	36	33	66	86
3430017	WARRINGTON 17	Warrington	3607	3890	367	99	9	7	35	61	353	95	10	6	24	42

Table 1.3 continued over page.

Table 1.3 continued. Summary of Smoke and Sulphur Dioxide Results for the North West and Merseyside, 1999-2000. Concentrations in $\mu\text{g m}^{-3}$

Code	Site Name	Authority	O.S. Grid Ref. To 100m		Summary of Smoke Data 1999-2000						Summary of SO2 Data 1999-2000						
			East	North	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	
	NORTH WEST & MERSEYSIDE - continued																
88201	ASHTON-IN-MAKERFIELD 1	Wigan	3576	3991	238	64	6	4	23	39	238	64	8	7	27	35	
1800004	LEIGH 4	Wigan	3662	3999	325	88	7	5	31	69	325	88	9	6	28	37	
3610008	WIGAN 8	Wigan	3592	4056	319	86	6	4	30	44	319	86	8	7	23	32	
3360009	WALLASEY 9	Wirral	3316	3909	154	42	7	5	32	48	151	41	13	13	35	35	
3532002	WEST KIRBY 2	Wirral	3212	3784	334	90	3	2	8	15	320	86	19	19	51	72	

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. "Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.4. Summary of Smoke and Sulphur Dioxide Results for Yorkshire and the Humber, 1999-2000. Concentrations in ug m⁻³

Code	Site Name	Authority	Grid Ref. To 100m		Summary of Smoke Data 1999-2000						Summary of SO2 Data 1999-2000					
			East	North	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
YORKSHIRE AND THE HUMBER																
190008	BARNLEY 8	Barnsley	4348	4094	371	100	10	6	44	57	371	100	41	31	157	202
190009	BARNLEY 9	Barnsley	4370	4055	70	19	6	5	26	31	70	19	24	23	54	59
190012	BARNLEY 12	Barnsley	4342	4067	371	100	5	4	17	27	371	100	30	28	56	62
877502	CUDWORTH 2	Barnsley	4387	4091	364	98	9	7	33	49	364	98	32	28	68	90
1308701	GOLDTHORPE 1	Barnsley	4462	4043	371	100	9	7	29	49	371	100	31	26	61	97
1344002	GRIMETHORPE 2	Barnsley	4414	4091	371	100	9	7	35	50	371	100	30	27	53	69
1560006	HOYLAND NETHER 6	Barnsley	4377	4007	355	96	5	5	18	31	355	96	26	24	46	54
2208501	LUNDWOOD (BARNLEY) 1	Barnsley	4372	4069	371	100	9	7	30	50	371	100	28	26	53	67
3670002	WOMBWELL 2	Barnsley	4401	4030	357	96	9	8	29	46	357	96	23	19	38	57
3715002	WORSBROUGH BRIDGE 2	Barnsley	4356	4040	371	100	6	5	20	37	371	100	27	25	44	62
430006	BRADFORD 6	Bradford	4163	4329	351	95	16	15	39	75	341	92	14	13	31	44
1650011	KEIGHLEY 11	Bradford	4061	4412	271	73	9	8	30	66	280	75	8	7	21	27
1120002	ELLAND 2	Calderdale	4109	4209	337	91	10	9	24	42	336	91	11	12	24	56
1360016	HALIFAX 16	Calderdale	4093	4254	345	93	16	15	42	57	345	93	11	12	25	46
1690019	KINGSTON-UPON-HULL 19	Kingston Upon Hull	5082	4284	263	71	6	4	23	56	262	71	19	18	53	53
3750009	YORK 9	City & County of York	4601	4521	336	91	7	8	11	12	336	91	15	13	26	32
962512	DEWSBURY 12	Kirklees	4235	4212	365	98	6	4	23	46	363	98	18	19	38	44
1515005	HOLFIRTH 5	Kirklees	4144	4085	356	96	6	5	20	25	354	95	31	28	66	85
1570019	HUDDERSFIELD 19	Kirklees	4143	4164	371	100	7	6	24	48	366	99	21	19	48	64
1722502	KIRKHEATON 2	Kirklees	4177	4185	88	24	3	3	10	11	86	23	13	12	27	30
3027003	STALLINGBOROUGH 3	NE Lincolnshire	5208	4120	54	15	4	4	14	14	54	15	12	12	27	27
445001	BRAMPTON 1	Rotherham	4414	4019	311	84	8	7	29	48	311	84	31	32	71	97
965004	DINNINGTON 4	Rotherham	4528	3861	344	93	7	5	24	30	342	92	18	18	48	65
2270002	MALTBY 2	Rotherham	4530	3922	350	94	10	9	25	36	347	94	32	31	66	99
3465006	WATH-UPON-DEARNE 6	Rotherham	4433	4009	317	85	6	5	22	42	315	85	24	21	56	69
2639001	SCARBOROUGH 1	Scarborough	5036	4885	253	68	9	6	29	40	243	65	13	12	27	37
2872505	SELBY 5	Selby	4612	4322	273	74	4	3	22	30	273	74	11	12	24	36

Table 1.4 continued over page.

Table 1.4 continued. Summary of Smoke and Sulphur Dioxide Results for Yorkshire and the Humber, 1999-2000. Concentrations in $\mu\text{g m}^{-3}$

Code	Site Name	Authority	O.S. Grid Ref. To 100m		Summary of Smoke Data 1999-2000						Summary of SO2 Data 1999-2000					
			East	North	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
YORKSHIRE AND THE HUMBER -continued																
22501	ACKWORTH 1	Wakefield	4440	4167	371	100	7	5	25	34	371	100	21	19	43	
580010	CASTLEFORD 10	Wakefield	4437	4257	182	49	5	4	16	21	182	49	17	13	60	
580011	CASTLEFORD 11	Wakefield	4519	4255	189	51	12	10	42	50	189	51	30	26	69	
1235001	FEATHERSTONE 1	Wakefield	4429	4195	371	100	8	6	25	36	371	100	28	24	61	
1450003	HEMSWORTH 3	Wakefield	4428	4134	371	100	7	6	22	34	371	100	23	18	49	
1732003	KNOTTINGLEY 3	Wakefield	4497	4239	371	100	10	8	33	64	371	100	26	25	56	
2415004	NORMANTON 4	Wakefield	4388	4228	371	100	6	4	21	39	371	100	15	13	42	
2533509	PONTEFRACT 9	Wakefield	4455	4220	226	61	7	5	23	28	224	60	8	7	26	
2533510	PONTEFRACT 10	Wakefield	4473	4217	35	9	6	5	5	22	35	9	13	13	41	
2966301	SOUTH KIRKBY 1	Wakefield	4456	4112	371	100	9	8	29	42	371	100	23	24	43	
3350026	WAKEFIELD 26	Wakefield	4331	4208	371	100	7	5	25	43	371	100	19	19	52	

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. "Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.5. Summary of Smoke and Sulphur Dioxide Results for the East Midlands, 1999-2000. Concentrations in $\mu\text{g m}^{-3}$

Code	Site Name	Authority	O.S. Grid Ref. To 100m		Summary of Smoke Data 1999-2000						Summary of SO2 Data 1999-2000					
			East	North	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
EAST MIDLANDS																
40004	ALFRETON 4	Amber Valley	4417	3555	299	81	10	7	37	63	299	81	36	35	57	69
348001	BIRCOTES 1	Bassetlaw	4627	3920	329	89	6	5	25	38	327	88	16	13	49	61
1754501	LANGOLD (BASSETLAW) 1	Bassetlaw	4586	3873	327	88	6	5	29	50	323	87	11	13	30	41
2677503	RETFORD 3	Bassetlaw	4707	3811	364	98	5	4	20	34	363	98	29	26	63	65
395005	BOLSOVER 5	Bolsover	4475	3706	368	99	6	5	18	37	360	97	14	12	38	91
2967002	SOUTH NORMANTON 2	Bolsover	4442	3564	366	99	7	6	23	42	345	93	11	6	32	45
960024	DERBY 24	Derby City	4354	3369	313	84	8	7	26	36	285	77	15	14	27	34
1790019	LEICESTER 19	Leicester City	4588	3041	102	27	6	4	27	40	94	25	8	6	25	30
1840005	LINCOLN 5	Lincoln	4974	3714	371	100	6	4	23	33	371	100	11	12	25	44
2281010	MANSFIELD 10	Mansfield	4532	3607	359	97	9	7	27	35	359	97	21	18	48	84
2281102	MANSFIELD WOODHOUSE 2	Mansfield	4538	3642	369	99	10	8	30	61	368	99	29	26	58	90
2364502	NEW OLLERTON 2	Newark	4664	3682	366	99	8	5	29	37	353	95	19	13	73	125
577501	CASTLE DONINGTON 1	NW Leicestershire	4448	3275	33	9	11	10		41	27	7	10	7		26
750005	COALVILLE 5	NW Leicestershire	4428	3142	182	49	7	6	17	20	183	49	17	19	31	38
2324001	MOIRA (LEICS) 1	NW Leicestershire	4328	3168	25	7	8	7		20	20	5	15	13		37
2440020	NOTTINGHAM 20	Nottingham	4575	3403	269	73	7	6	26	36	266	72	18	18	34	36

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. "Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.7. Summary of Smoke and Sulphur Dioxide Results for Wales, 1999-2000. Concentrations in $\mu\text{g m}^{-3}$

Code	Site Name	Authority	O.S. Grid Ref. To 100m		Summary of Smoke Data 1999-2000						Summary of SO ₂ Data 1999-2000					
			East	North	Valid Days	Data Capture %	Arith. Mean	Median	98th%ile	Max. Day	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
540012	WALES CARDIFF 12	Cardiff County	3193	1773	371	100	8	5	25	55	371	100	21	19	32	171
1305301	GLYNNEATH 1	Neath & Port Talbot	2880	2066	267	72	4	4	12	29	266	72	32	32	64	65
2400026	NEWPORT (MON) 26	Newport	3313	1878	356	96	7	5	26	40	354	95	6	6	13	19
2414001	NEYLAND 1	Pembrokeshire	1964	2052	333	90	3	3	12	22	332	89	4	6	14	18
2540007	PONTYPOOL 7	Torfaen	3282	2009	41	11	6	6	10	10	41	11	21	21	21	28
3732510	WREXHAM 10	Wrexham County Boro	3324	3501	370	100	6	5	19	28	370	100	20	19	49	68

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. "Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.8. Summary of Smoke and Sulphur Dioxide Results for the Eastern region, 1999-2000. Concentrations in $\mu\text{g m}^{-3}$

Code	Site Name	Authority	O.S. Grid Ref. To 100m		Summary of Smoke Data 1999-2000						Summary of SO2 Data 1999-2000							
			East	North	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day		
	EASTERN																	
240010	BEDFORD 10	Bedford	5056	2486	117	32	7	7	15	15	111	30	8	7	21	21	21	21
2430007	NORWICH 7	Norwich	6233	3099	371	100	7	5	21	34	369	99	9	7	20	20	26	26
2795004	ST ALBANS 4	St Albans	5153	2073	105	28	4	3	10	12	105	28	18	20	27	27	28	28
3265013	THURROCK 13	Thurrock	5622	1791	356	96	6	4	25	51	356	96	21	20	37	37	45	45

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. "Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.9. Summary of Smoke and Sulphur Dioxide Results for the London region, 1999-2000. Concentrations in $\mu\text{g m}^{-3}$

Code	Site Name	Authority	O.S. Grid Ref. To 100m		Summary of Smoke Data 1999-2000							Summary of SO2 Data 1999-2000						
			East	North	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day		
1950016	LONDON CITY 16	City of London	5324	1814	350	94	10	9	26	37	344	93	13	12	43	56		
1060007	EALING 7	Ealing	5174	1807	256	69	9	7	30	50	212	57	5	6	19	20		
1140014	ENFIELD 14	Enfield	5338	1958	368	99	8	6	27	49	366	99	18	18	32	42		
1140015	ENFIELD 15	Enfield	5339	1955	134	36	7	5	16	18	140	38	13	12	73	88		
1343709	GREENWICH 9	Greenwich	5382	1773	277	75	6	5	20	36	264	71	20	19	43	67		
3696009	WOOLWICH 9	Greenwich	5441	1769	335	90	5	4	19	31	325	88	22	19	48	57		
1633509	ISLINGTON 9	Islington	5316	1842	346	93	14	11	55	82	346	93	16	12	37	55		
1590006	ILFORD 6	Redbridge	5440	1864	245	66	10	9	37	45	245	66	18	18	35	48		
3541517	WESTMINSTER 17	Westminster	5298	1789	245	66	8	7	29	38	242	65	9	6	25	32		

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. "Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.10. Summary of Smoke and Sulphur Dioxide Results for the South East, 1999-2000. Concentrations in $\mu\text{g m}^{-3}$

Code	Site Name	Authority	O.S. Grid Ref. To 100m		Summary of Smoke Data 1999-2000							Summary of SO2 Data 1999-2000						
			East	North	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day		
829004	SOUTH EAST CRAWLEY 4	Crawley	5273	1378	318	86	7	5	25	43	317	85	11	12	24	24		
930009	DARTFORD 9	Dartford	5543	1744	14	4	2	2	0	6	14	4	10	7	0	21		
1080005	EASTBOURNE 5	Eastbourne	5607	988	213	57	2	1	11	14	207	56	10	7	24	30		
2250008	MAIDSTONE 8	Maidstone	5754	1554	182	49	6	5	15	18	108	29	19	18	49	53		
390302	BLETCHLEY 2	Milton Keynes	4857	2337	232	63	4	3	16	20	232	63	11	12	25	38		
2560010	PORTSMOUTH 10	Portsmouth	4652	1019	219	59	6	5	21	55	218	59	14	12	25	49		
26001	ADDLESTONE 1	Runnymede	5052	1646	349	94	7	5	27	40	341	92	14	13	27	33		
2940016	SLOUGH 16	Slough	4962	1819	301	81	8	6	23	36	301	81	10	12	18	18		

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. "Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.11. Summary of Smoke and Sulphur Dioxide Results for the South West, 1999-2000. Concentrations in ug m⁻³

Code	Site Name	Authority	O.S. Grid Ref. To 100m		Summary of Smoke Data 1999-2000						Summary of SO2 Data 1999-2000					
			East	North	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day
205006	BATH 6	Bath & NE Somerset	3754	1656	238	64	10	8	39	47	237	64	12	13	26	33
470026	BRISTOL 26	Bristol	3634	1763	339	91	12	12	34	52	338	91	22	19	37	50
1305004	GLOUCESTER 4	Gloucester	3832	2179	367	99	5	4	24	55	360	97	9	6	19	26
453003	BRIDGWATER 3	Sedgemoor	3298	1373	360	97	4	3	16	48	338	91	13	12	32	38
3220002	SWINDON 2	Swindon	4147	1858	293	79	6	4	24	39	293	79	9	7	18	27

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. "Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Table 1.12 Summary of Smoke and Sulphur Dioxide Results for Northern Ireland, 1999-2000. Concentrations in $\mu\text{g m}^{-3}$

Code	Site Name	Authority	Irish Grid Ref. To 100m		Summary of Smoke Data 1999-2000							Summary of SO ₂ Data 1999-2000						
			East	North	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day	Valid Days	Data Capt. %	Arith. Mean	Median	98th%ile	Max. Day		
69701	NORTHERN IRELAND	Armagh	2877	3450	248	67	9	6	33	48	265	71	7	6	26	26		
160003	BALLYMENA 3	Ballymena	3103	4029	319	86	7	4	50	74	334	90	25	18	71	77		
270012	BELFAST 12	Belfast	3324	3737	345	93	9	6	39	83	345	93	24	25	45	82		
270013	BELFAST 13	Belfast	3357	3740	371	100	9	7	39	68	371	100	34	32	86	166		
270033	BELFAST 33	Belfast	3346	3755	357	96	11	8	40	75	357	96	37	32	95	115		
270042	BELFAST 42	Belfast	3322	3748	371	100	10	8	49	88	371	100	40	38	102	179		
270044	BELFAST 44	Belfast	3338	3740	371	100	10	8	38	88	371	100	36	32	89	223		
270045	BELFAST 45	Belfast	3335	3723	371	100	8	7	35	58	371	100	35	32	90	121		
270046	BELFAST 46	Belfast	3385	3796	371	100	5	4	17	79	371	100	27	26	67	140		
2551504	PORTADOWN 4	Craigavon	3012	3538	153	41	8	6	36	76	152	41	9	7	27	27		
1025001	DUNGANNON 1	Dungannon	2802	3629	340	92	5	4	10	40	302	81	12	12	30	51		
1757703	LARNE 3	Larne	3400	4029	364	98	9	6	34	59	364	98	17	18	30	42		
1032502	DUNMURRY 2	Lisburn	3289	3679	343	92	9	5	55	88	331	89	69	65	169	203		
1032503	DUNMURRY 3	Lisburn	3287	3875	254	68	9	5	40	82	233	63	25	19	109	156		
1845003	LISBURN 3	Lisburn	3263	3636	334	90	11	7	67	121	322	87	20	20	63	110		
2190011	LONDONDERRY 11	Derry City	2431	4170	329	89	16	13	54	73	330	89	43	43	62	68		
2190012	LONDONDERRY 12	Derry City	2438	4200	307	83	6	4	22	39	342	92	34	35	54	56		
2190014	LONDONDERRY 14	Derry City	2443	4174	271	73	6	3	33	42	271	73	32	31	49	55		
2233501	MAGHERAFELT 1	Magherafelt	2896	3901	371	100	10	8	42	62	371	100	12	12	26	37		
2410003	NEWRY 3	Newry & Mourne	3078	3268	362	98	9	5	67	91	358	96	12	12	32	33		
2412501	NEWTOWNABBEY 1	Newtownabbey	3349	3824	198	53	13	9	54	70	198	53	14	12	36	54		
2412502	NEWTOWNABBEY 2	Newtownabbey	3318	3825	235	63	15	11	59	96	235	63	11	12	21	26		
3111502	STRABANE 2	Strabane	2351	3972	170	46	32	28	96	129	170	46	11	7	21	28		

The following abbreviations are used in Table 1:

1. "Valid Days" denotes the number of valid days' data obtained for the year.
2. "Data Capt. %" is the percentage of the year for which valid data was obtained.
3. "Arith. Mean" is the arithmetic mean of all daily values, calculated by the usual method, as described in Appendix 1.
4. "Median" is the median, or 50th percentile, of all daily values. See Appendix 1.
5. "98th %ile" is the 98th percentile of all daily values, see Appendix 1.
6. "Max. Day" is the maximum daily value measured during the year.

Appendices

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APPENDIX 1

CALCULATION OF RESULTS AND STATISTICS

CONTENTS

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Period Covered by Observations

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. The twelve ‘months’ of observations covered by this report are:

APRIL	99	30 March	-	3 May	(5 weeks)
MAY	99	4 May	-	31 May	(4 weeks)
JUNE	99	1 June	-	28 June	(4 weeks)
JULY	99	29 June	-	2 August	(5 weeks)
AUGUST	99	3 August	-	30 August	(4 weeks)
SEPTEMBER	99	31 August	-	27 September	(4 weeks)
OCTOBER	99	28 September	-	1 November	(5 weeks)
NOVEMBER	99	2 November	-	29 November	(4 weeks)
DECEMBER	99	30 November	-	3 January	(5 weeks)
JANUARY	00	4 January	-	31 January	(4 weeks)
FEBRUARY	00	1 February	-	28 February	(4 weeks)
MARCH	00	29 February	-	3 April	(5 weeks)

Derivation of Results

The data have been obtained by computer, from daily observations made for the United Kingdom Smoke and Sulphur Dioxide Monitoring Network. The formulae used for calculation of smoke concentrations, i.e. for relating blackness of the filter to the weight of smoke per unit volume of air samples, are those which have been used for the National Survey Smoke and Sulphur Dioxide tables published since Winter 1961-62. The formula used for calculating SO₂ concentrations has never been changed.

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

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.

Formulae used in Calculating Concentrations

(a) 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 micrograms 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

12.80 for 4 inch clamp

R = reflectometer reading

This formula represents the calibration curve to within $\pm 1.3\%$ 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.

(b) Sulphur Dioxide

Sulphur dioxide concentrations have been calculated by the method described in BS 1747: Part 3: 1991. The formula used to calculate sulphur dioxide concentrations is:

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

where

C = concentration in micrograms per cubic metre

m = volume of 0.002M (N/250) di-sodium tetraborate used, in millilitres,

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)

Formulae Used In Calculating Annual Statistics

(a) 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

N is number of results available for the year

(b) Percentiles (50%, 98% etc.) Note - the median is the 50th percentile.

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

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

where

P_i is the percentile for the i th concentration in the sorted set, that is, $P_i\%$ of the concentrations will be **equal to or less than** C_i

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

$$P_1, P_2, \dots, P_i, \dots, 98.8, 99.3, \dots, P_N$$

$$C_1, C_2, \dots, C_i, \dots, 150, 160, \dots, C_N$$

the 99th percentile would be $154 \mu\text{g m}^{-3}$

Units

The unit employed for expressing both smoke and sulphur dioxide concentrations from this Network, both in this report and on the disk, is the microgram per cubic metre ($\mu\text{g m}^{-3}$). 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 micrograms per cubic metre (for SO_2 only)

- at a temperature of 25°C and 1013 mb pressure.

1 ppb = 2.66 micrograms 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 2

DATA FILES FOR 1999-2000

CONTENTS

Data Files

Data Files

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

1. file "site9900": a summary of site details. The data is tabulated in rows, one per site, with columns as follows.

- Site code - the site's unique identification number of upto 7 digits.
 - Site name and number - the name and number by which the site is usually known, eg. "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 DETR Site Type. The Smoke and SO₂ Network site classifications differ considerably from those used by the DETR to categorise their automatic sites. However, the nearest equivalent is given here. Smoke and SO₂ sites of types A1, A2, and A3 will mostly fall into DETR 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 “smk9900”: full daily black smoke data, 30 March 1999 to 3 April 2000, for all sites. One column per site, with one row per day. Values are in $\mu\text{g m}^{-3}$. 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 “so29900”: full daily sulphur dioxide data, 30 March 1999 to 3 April 2000, for all sites. One column per site, with one row per day. Values are in $\mu\text{g m}^{-3}$.

4. file “smksumm9900”: this contains the smoke summary data as in Table 1, but in CSV format. The data is tabulated as follows. The top row contains column headings.

- 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 “so2summ9900”: this contains the SO₂ summary data as in Table 1, but in CSV format. The data is tabulated in the same manner as the smoke data in "smksumm9900.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 3

SITES COMPRISING 'CORE' SUBSET

CONTENTS

10003 ABERDEEN 3
20005 ACCRINGTON 5
26001 ADDLESTONE 1
69701 ARMAGH 1
85005 ASHINGTON 5
90008 ASHTON-UNDER-LYNE 8
150005 BACUP 5
160003 BALLYMENA 3
190012 BARNESLEY 12
205006 BATH 6
240010 BEDFORD 10
270013 BELFAST 13
270042 BELFAST 42
270046 BELFAST 46
380006 BLACKPOOL 6
390302 BLETCHLEY 2
395005 BOLSOVER 5
400024 BOLTON 24
430006 BRADFORD 6
453003 BRIDGWATER 3
470026 BRISTOL 26
500012 BURNLEY 12
507513 BURTON-UPON-TRENT 13
510009 BURY 9
540012 CARDIFF 12
555013 CARLISLE 13
577501 CASTLE DONINGTON 1
580010 CASTLEFORD 10
580011 CASTLEFORD 11
625006 CHEADLE & GATLEY 6
715006 CHORLEY 6
750005 COALVILLE 5
760011 COATBRIDGE 11
829004 CRAWLEY 4
840009 CREWE 9
855003 CROSBY 3
915013 DARLINGTON 13
930009 DARTFORD 9
960024 DERBY 24
1025001 DUNGANNON 1
1032503 DUNMURRY 3
1060007 EALING 7
1080005 EASTBOURNE 5
1100025 EDINBURGH 25
1130012 ELLESMERE PORT 12
1140014 ENFIELD 14
1140015 ENFIELD 15
1230008 FARNWORTH 8
1290010 GATESHEAD 10
1300020 GLASGOW 20
1300051 GLASGOW 51
1300073 GLASGOW 73
1300095 GLASGOW 95
1300098 GLASGOW 98
1305004 GLOUCESTER 4
1343709 GREENWICH 9
1360016 HALIFAX 16

1450003 HEMSWORTH 3
1515005 HOLMFIRTH 5
1550001 HORWICH 1
1570019 HUDDERSFIELD 19
1590006 ILFORD 6
1633509 ISLINGTON 9
1650011 KEIGHLEY 11
1685002 KILMARNOCK 2
1690019 KINGSTON-UPON-HULL 19
1721006 KIRKCALDY 6
1757703 LARNE 3
1790019 LEICESTER 19
1800004 LEIGH 4
1840005 LINCOLN 5
1845003 LISBURN 3
1850016 LIVERPOOL 16
1950016 LONDON CITY 16
2190011 LONDONDERRY 11
2190012 LONDONDERRY 12
2232507 MACCLESFIELD 7
2233501 MAGHERAFELT 1
2250008 MAIDSTONE 8
2270002 MALTBY 2
2280011 MANCHESTER 11
2280015 MANCHESTER 15
2280021 MANCHESTER 21
2281010 MANSFIELD 10
2320003 MIDDLETON 3
2324001 MOIRA (LEICS) 1
2370002 NEWBURN 2
2390024 NEWCASTLE UPON TYNE 24
2390027 NEWCASTLE UPON TYNE 27
2400026 NEWPORT (MON) 26
2412501 NEWTOWNABBEY 1
2412502 NEWTOWNABBEY 2
2414001 NEYLAND 1
2430007 NORWICH 7
2440020 NOTTINGHAM 20
2470013 OLDHAM 13
2533509 PONTEFRACT 9
2533510 PONTEFRACT 10
2540007 PONTYPOOL 7
2551504 PORTADOWN 4
2560010 PORTSMOUTH 10
2650007 RAWTENSTALL 7
2677503 RETFORD 3
2752503 ROWLEY REGIS 3
2781510 RUNCORN 10
2795004 ST ALBANS 4
2800036 ST HELENS 36
2800043 ST HELENS 43
2839001 SCARBOROUGH 1
2870005 SEDGLEY 5
2872505 SELBY 5
2940016 SLOUGH 16
3027003 STALLINGBOROUGH 3
3070005 STIRLING (BURGH) 5

3090020 STOKE-ON-TRENT 20
3111502 STRABANE 2
3220002 SWINDON 2
3230007 SWINTON & PENDLEBURY 7
3265013 THURROCK 13
3314601 TRAFFORD 1
3342501 UTTOXETER 1
3350026 WAKEFIELD 26
3360009 WALLASEY 9
3380018 WALSALL 18
3430017 WARRINGTON 17
3470002 WEDNESFIELD 2
3532002 WEST KIRBY 2
3541517 WESTMINSTER 17
3610008 WIGAN 8
3670002 WOMBWELL 2
3696009 WOOLWICH 9
3700003 WORKINGTON 3
3732510 WREXHAM 10
3750009 YORK 9