Appendices

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Appendix 1
Calculation of Results and Statistics

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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	97	1 April	- 28 April	(4 weeks)
MAY	97	29 April	- 2 June	(5 weeks)
JUNE	97	3 June	- 30 June	(4 weeks)
JULY	97	1 July	- 28 July	(4 weeks)
AUGUST	97	29 July	- 1 September	(5 weeks)
SEPTEMBER	97	2 September	- 29 September	(4 weeks)
OCTOBER	97	30 Septemer	- 3 November	(5 weeks)
NOVEMBER	97	4 November	- 1 December	(4 weeks)
DECEMBER	97	2 December	- 29 December	(4 weeks)
JANUARY	98	30 December	- 2 February	(5 weeks)
FEBRUARY	98	3 February	- 2 March	(4 weeks)
MARCH	98	3 March	- 30 March	(4 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, ie 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 SO_2 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
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 ± 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

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)   Winter Median (WMD)

Daily concentrations from the winter period (October - March) are sorted into ascending order of concentration value, C_1, C_2, C_3, ..., C_i, ..., C_N
If N is even,

$$WMD = \left[C_{N/2} + C_{(N/2+1)} \right] / 2$$

or if N is odd,

$$WMD = C_{(N/2+0.5)}$$

where
WMD is winter median
C_i is ith daily concentration in the ascending set
N   is number of results available for the winter period

(c) Percentiles (50%, 99%, etc)

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

P_i is the percentile for the ith 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, ..., 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}

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 (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 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 on Disk

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Files on Disk

The disk supplied with this report contains the year's full dataset, for all Network sites. 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 "site9798": 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 Classification code. 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, eg airfields.

O2   Completely open country; no sources within at least 400 metres.

X   Unclassified site, or mixed area.

- Site address.

The site classifications differ considerably from those used by the DETR to categorise their automatic sites. However, Smoke and SO_2 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 mostly 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).

2. file "smk9798": full daily black smoke data, 1 April 1997 to 30 March 1998, 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 "so29798": full daily sulphur dioxide data, 1 April 1997 to 30 March 1998, for all sites. One column per site, with one row per day. Values are in μg m^{-3}.

4. file "summ9798": this contains the summary data as in Table 1, but in CSV format. The data is tabulated as follows:

- site name
- region (eg. North West)
- Local or Unitary Authority in whose area the site lies.
- Grid reference easting
- Grid reference northing,

(the same convention applies to the grid references as in Table 1 and "site9798").

- Smoke summary data (columns H to M)
- SO_2 summary data (columns O to T)

One row of data per site.

5. file "m9798smk"

This file contains smoke data summarised for 1997-98 pollution calendar months, and (together with m9798so2) replaces the old style summary tables printed at the end of reports for years upto 1995-96. Data is tabulated in columns, one column per site with headings in column A. The sites are ordered alphabetically, left to right. Data is presented as follows:

- monthly smoke means (rows 5 to 16).
- Summer, winter, and annual means (rows 18 to 20).
- Highest day in each month (rows 24 to 35).
- Summer, winter and annual highest day (rows 37 to 39).
- Winter and annual medians (rows 43 and 44).

Data capture criteria have been applied in the reporting of this data: these are similar to those used in the old summary tables, and are as follows:

- monthly means are not included if less than 21 daily results are available in a 4-week month, or less than 27 daily results are available in a 5-week month.
- Likewise, seasonal statistics are not included where less than 110 daily results are available in a summer or winter period.
- 'N' indicates the above conditions were not met.

m9798so2:
Monthly SO$_2$ data for all sites. Data layout and data capture criteria as for "m9798smk.

All these details are also given in the text file "readme.txt" which is also provided on disk.

Appendix 3
Sites Comprising 'Core' Subset

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