REPORT

Ratification of data produced by the UK Ambient Automatic Hydrocarbon Air Quality Network, 1 January 2005 to 31 March 2005

A report produced for the Department for Environment, Food and Rural Affairs, the Scottish Executive, the Welsh Assembly Government and the Department of the Environment in Northern Ireland

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1 Introduction

This report contains information on the quality and statistical parameters associated with ratified data from the UK Ambient Automatic Hydrocarbon Air Quality Network (The UK Hydrocarbon Network). The presented information and data cover the period 1 January 2005 to 31 March 2005. The ratified data have been made available on the World Wide Web at http://www.airquality.co.uk/archive/data_and_statistics_home.php

This report contains:

- The definition of a Data Quality Code for each reported hydrocarbon.
- The Data Quality Codes assigned to the data presented on the web.
- A list of periods of data loss, reasons for data loss and descriptions of the most significant causes of data loss.
- Statistical information for each measured hydrocarbon.
- The results of audits carried out at the Cardiff, Glasgow and Harwell monitoring sites.

In this report the unit used for expressing concentrations of gases is micrograms per cubic metre ($\mu g/m^3$), where some earlier reports have used parts per billion (ppb). This allows comparison to the relevant Air Quality Standards that are now expressed in micrograms per cubic metre ($\mu g/m^3$).

2 Hydrocarbon Data Quality

All hydrocarbon data are assigned a quality value. In general ratified hourly data have an uncertainty (at 95% confidence) of ±10% for values above 0.5 μg/m^3 and ±0.05 μg/m^3 for values below 0.5 μg/m^3. These data are termed 'good quality'.

In some cases, because of instrument problems, data cannot be described as 'good' quality, but the data may still be of use to modellers and is therefore included in the archive. This is termed 'acceptable' quality data, and has an uncertainty (at 95% confidence) of ± 25% above 0.5 μg/m^3 and ± 0.1 μg/m^3 below 0.5 μg/m^3.

Data that do not meet either the 'good' or 'acceptable' criteria do not appear in the archive.

Previous reports have used five separate data quality codes to describe the data. The separate quality codes are derived on the basis of the proportion of monthly data that is deemed either 'good' or 'acceptable'. These codes are shown below:-

A. all 'good' quality data
B. most (> 75%) data points 'good', remainder 'acceptable' quality
C. roughly equal numbers of 'good' and 'acceptable' quality data
D. some (< 25%) data points 'good' quality; remainder 'acceptable' quality
E. all points 'acceptable' quality

On examination of data reported since 2002, predominantly data codes A and E have been used. On this basis a decision has been made to rationalise on the data codes used and all future data will be reported according to the following data codes: -

A. all 'good' quality data
B. all points 'acceptable' quality

3 Summary of Site Operational Issues

The following section provides a summary of data gaps and the main site operational problems during this reporting period. The number of hours and percentage of data lost is also given.

Table 1. Summary of data gaps

Site	Reason	Start date	End date	Hours	% Total hours
Cardiff	Calibrations			18	0.8
	Carrier gas supply fault	03/03/05	09/03/05	141	6.5
	Miscellaneous			5	0.2
Glasgow	Calibrations			32	1.5
	Analyser power supply fault	23/02/05	24/02/05	27	1.3
	PC/GC communication problem	18/03/05	21/03/05	64	3.0
	Miscellaneous			3	0.1
Harwell	Calibrations			26	1.2
	Blown fuse	01/01/05	04/01/05	86	4.0
	Blown fuse analyser changed	23/03/05	29/03/05	149	6.9
	Miscellaneous			12	0.6
Marylebone Road	Calibrations			32	1.5
	Power supply fault	30/01/05	02/02/05	73	3.4
	Sample pump failure	07/03/05	10/03/05	70	3.2
	Miscellaneous			5	0.2
Eltham	Calibrations			29	1.3
	PC/GC communication problem	27/01/05	27/01/05	7	0.3
	CMCU service visit	24/02/05	24/02/05	4	0.2
	Miscellaneous			18	0.8

'Miscellaneous' is undocumented gaps in the data usually caused by computer systems resets or data deleted during the ratification process. These gaps are of short duration and typically ≤ 2 hours.

4 Data Capture and Ratified Data

4.1 DATA CAPTURE TARGETS

The data capture values in previous reports have been presented as the number of ratified hourly data values expressed as a percentage of the total number of hours in the specified period. The EU Framework Directive 96/62/EC on ambient air quality assessment and management and it's associated Daughter Directives states that in calculating data capture, losses of data due to the regular calibration or normal maintenance of the instrument should not be considered. The periods where the instruments have been calibrated and routine maintenance undertaken have, therefore, been included in the total data capture of the period.

The 3rd Daughter Directive relating to ozone in ambient air, states that volatile organic compounds (VOCs) should be monitored to assess their concentrations as ozone precursor. A data capture target is not specified for ozone precursor VOCs, however, it is important to achieve high data capture for all measured VOCs. The 2nd daughter directive relating to limit values for benzene and carbon monoxide in ambient air, sets the benzene minimum data capture target at 90%. The UK Air Quality Strategy suggests 1,3-butadiene data capture also be set to 90%. Defra have specified that all other VOC compounds have a minimum data capture of 50%.

Tables 1 to 5, Appendix 1 contain statistical information relating to the ratified data, for each measured hydrocarbon, over the period 1 January 2005 to 31 March 2005. The tables list the percentage data capture, maximum concentration, mean concentration and minimum concentration of each hydrocarbon.

4.2 THE RATIFIED DATA

The data capture and data quality codes for each site for benzene and 1,3-butadiene are summarised in table 2 below. For comparison the calculations of data capture using the previous method has been included.

Table 2. Data capture summary

Site	Pollutant	Data capture % (previously reported)	Data capture % (DD3)	Data Quality Code
Cardiff	Benzene	92.41	93.21	A
	1,3-Butadiene	92.41	93.21	B
Glasgow	Benzene	94.17	95.67	A
	1,3-Butadiene	94.17	95.67	A
Harwell	Benzene	87.36	88.56	A
	1,3-Butadiene	87.36	88.56	B
Marylebone Road	Benzene	90.93	92.43	A
	1,3-Butadiene	91.39	92.89	A
Eltham	Benzene	97.08	98.38	A
	1,3-Butadiene	94.21	95.51	A

4.2.1 Cardiff

For the Cardiff site the data capture for benzene was 93.21% and for 1,3-butadiene was 93.21%. Data quality code B is applied to 1,3-butadiene and quality code A for all other compounds for this quarter.

In March a fault occurred with the nitrogen carrier gas supply. Before the carrier gas supply was restored 141 hours of data were lost.

There have been no significant problems for the period covered by this report.

4.2.2 Glasgow

For the Glasgow site the data capture for benzene was 95.67% and for 1,3-butadiene was 95.67%. Data quality code A is applied to all compounds for this quarter.

There have been no significant problems for the period covered by this report.

It should be noted that the hydrocarbon instrumentation at the Glasgow site samples air through a separate inlet from that used for the inorganic measurements. The inlet for the inorganic measurements is within one metre from the kerb and hence these are classed as kerbside measurements. The sample inlet for the hydrocarbon measurements is more than one metre from the kerb (but less than five metres) and hence these are classed as roadside measurements.

4.2.3 Harwell

For the Harwell site the data capture for benzene was 88.56% and for 1,3-butadiene was 88.56%. Data quality code B is applied to 1,3-butadiene and quality code A for all other compounds for this quarter.

Due to problems with the power supply on the motherboard of the analyser, 235 hours of data were lost this quarter. A replacement analyser was installed at the site on 23rd March 2005. The analyser could not be repaired by the CMCU and was returned to the manufacturer for repair.

There have been no other significant problems for the period covered by this report.

4.2.4 Marylebone Road

For the Marylebone Road site the data capture for benzene was 92.43% and for 1,3-butadiene was 92.89%. Data quality code A is applied to all compounds for this quarter.

There have been no significant problems for the period covered by this report.

4.2.5 Eltham

For the Eltham site the data capture for benzene was 98.38% and for 1,3-butadiene was 95.51%. Data quality code A is applied to all compounds for this quarter.

Data capture for 1,3,5-Trimethylbenzene failed to reach 50%. This was attributed to poor integration of the peak due to excessive noise.

There have been no significant problems for the period covered by this report.

4.3 1,3-BUTADIENE DATA FOR THE VOC71M

During the process of calculating response factors for the data covered in this report it was observed that the 1,3-butadiene peak had merged with a neighbouring peak, trans-2-butene, in the chromatograms of the calibration samples. The reported peak areas for 1,3-butadiene in the standards were therefore, overestimated. As a result an accurate response factor for 1,3-butadiene could not be generated, as the degree of overestimation could not be accurately quantified.

An alternative approach was used to generate the response factor for 1,3-butadiene. The response factor for cis-2-butene, a well-resolved peak, was used to derive a response factor for 1,3-butadiene. The relative response factors for 1,3-butadiene and cis-2-butene are fairly constant over time when both peaks are well resolved. The cis-2-butene response factor and relative response factor were used to derive a response factor for 1,3-butadiene.

It is likely that this approach generates a relatively accurate response factor for 1,3-butadiene. However due to the increased uncertainty associated with this method, all the 1,3-butadiene data at Cardiff and Harwell has been assigned data quality code B.

4.4 CONCENTRATION TRENDS

The periods when data for benzene and 1,3-butadiene were available, for all the sites, are plotted graphically in Figures 1 to 10, Appendix 2. The measured concentrations of 1,3-butadiene fell below 0.02 $\mu g/m^3$ on a number of occasions see Figures 2, 4, 6 and 8, Appendix 2. Where concentrations fell below 0.02 $\mu g/m^3$ the ratified concentrations have been reported as 0.00 $\mu g/m^3$.

At Cardiff, Harwell and Eltham the measured concentrations of hydrocarbons were low for most of the period covered by this report. At these urban background and rural sites there tends to be a pattern of seasonal variation with higher levels during the winter when dispersion is generally poorer and photochemical removal is at a minimum.

The Glasgow and Marylebone Road data tend to exhibit higher levels with less seasonal variation than is apparent in data from the other three sites. The measured concentrations and trends are typical of sites close to busy roads where the source of the measured hydrocarbons is close to the monitoring location, and they will have had little time to mix and react in the atmosphere. The measured concentrations at Marylebone Road for January to March 2005 exhibited no significant episodes of elevated concentrations. There is insufficient information to provide an explanation of the observed difference in the trends from site to site, although spatial variations in meteorological conditions may well be the cause. The variation in trends from site to site is probably due to variations in atmospheric dispersion.

A comparison between Marylebone road and Eltham has been made to look at the relationship between a roadside site and an urban background site, measuring the same air mass. Figure 4, Appendix 3, shows that the ratio between the compounds measured is very similar at both sites, with levels at Eltham approximately half of those at Marylebone Road.

4.5 COMPARISON WITH AIR QUALITY OBJECTIVES

The Air Quality Strategy for the UK has set Air Quality Objectives for benzene and 1,3-butadiene. The Air Quality Objective for benzene in the UK is 16.25 μg/m^3 expressed as a running annual mean to be met by 31 December 2003. In England and Wales there is an additional objective for benzene of 5 μg/m^3 expressed as an annual mean to be met by end of 2010. In Scotland a more stringent objective has been set for benzene of 3.25 μg/m^3 to be met by the end of 2010. The Air Quality Objective for 1,3-butadiene is specified as a running annual mean of 2.25 μg/m^3 to be met by the end of 2003.

The annual means for benzene and 1,3-butadiene for 2001, 2002, 2003 and 2004 together with the quarterly mean for the first quarter of 2005 are given in Tables 3 and 4 below and can be seen graphically in Appendix 3. For benzene the annual means for 2001, 2002, 2003 and 2004 were well below the Air Quality Objective of 16.25 μg/m^3 to be met by the end of 2003. The annual means for 2004 were also below the Air Quality Objective to be met by 2010 for the respective region.

With the exception of Marylebone Road, the means for benzene for quarter 1, 2005 were slightly higher than the annual means for 2004. Measured 1,3-butadiene for quarter 1, 2005 was slightly lower than the annual means for 2004.

Table 3. Means of measured benzene concentrations (μg/m^3) at each of the UK Automatic Hydrocarbon Sites.

Monitoring Site	2001 Annual Mean	2002 Annual Mean	2003 Annual Mean	2004 Annual Mean	Quarter 1 2005 Mean
Cardiff Centre	$$	1.22$	1.17	0.84	0.84
Glasgow	$$$	2.33 $	1.82	1.40	1.49
Harwell	0.62	0.60	0.59	0.40	0.58
Marylebone Road	4.55	3.91	3.32	2.75	2.14
Eltham	$$$$	$$$$	$$$$	0.76	0.97

$ Annual means calculated from significantly less than 12 months data.
$$ The Cardiff Centre site was installed on 5th September 2002.
$$$ The Glasgow site was installed on 1st August 2002.
$$$$ The Eltham site was installed on 17th October 2003.

Table 4. Means of measured 1,3-butadiene concentrations (μg/m^3) at each of the UK Automatic Hydrocarbon Sites.

Monitoring Site	2001 Annual Mean	2002 Annual Mean	2003 Annual Mean	2004 Annual Mean	Quarter 1 2005 Mean
Cardiff Centre	$$	0.15$	0.15	0.11	0.07
Glasgow	$$$	0.36$	0.42	0.28	0.20
Harwell	0.11	0.04	0.03	0.02	0.02
Marylebone Road	1.12	0.95	0.64	0.56	0.43
Eltham	$$$$	$$$$	$$$$	0.15	0.13

$ Annual means calculated from significantly less than 12 months data.
$$ The Cardiff Centre site was installed on 5th September 2002.
$$$ The Glasgow site was installed on 1st August 2002.
$$$$ The Eltham site was installed on 17th October 2003.

5 Audit results

The following tables show the results of audits carried out at the Cardiff, Glasgow and Harwell monitoring sites. The audit was carried out using a certified National Physics Laboratory (NPL) cylinder of known hydrocarbon concentrations.

Provisional data is calculated using a fixed response factor derived from the results of the preceding routine calibration. This represents the data as it would be disseminated to the public on the day of the audit. Ratified data is calculated using a response factor based on the trend in response between calibrations. Tables 5 to 7 below show the calculated values of the audit cylinder before and after ratification and the percentage difference from the actual audit cylinder concentration. 1,3-butadiene concentrations at Cardiff and Harwell have been calculated using the response factors and concentrations for cis-2-butene (see section 4.3). This produces the relative percentage difference for 1,3-butadiene. Audits of the Marylebone Road and Eltham sites are scheduled for the summer of 2005.

Table 5. Cardiff site audited 4th February 2005.

Compound	Audit cylinder concentration (ppb)	Calculated audit concentration using provisional response factors	% Difference	Calculated audit concentration using ratified response factors	% Difference
1,3-Butadiene	2.89	2.83	-2.21	2.92	1.16
Benzene	6.26	6.38	1.86	6.47	3.31
Toluene	4.84	4.92	1.60	5.03	3.97
Ethylbenzene	1.98	2.01	1.74	2.08	5.06
(m+p)-Xylene *	2.46	2.36	-4.05	2.47	0.32
o-Xylene	1.62	1.39	-14.12	1.59	-1.57

Table 6. Glasgow site audited 9th March 2005.

Compound	Audit cylinder concentration (ppb)	Calculated audit concentration using provisional response factors	% Difference	Calculated audit concentration using ratified response factors	% Difference
1,3-Butadiene	2.89	3.22	11.31	3.19	10.43
Benzene	6.26	6.51	3.98	6.59	5.31
Toluene	4.84	4.89	1.11	5.03	3.88
Ethylbenzene	1.98	1.88	-5.21	1.97	-0.34
(m+p)-Xylene *	2.46	2.32	-5.61	2.44	-0.78
o-Xylene	1.62	1.48	-8.85	1.57	-3.23

Table 7. Harwell site audited 1st April 2005.

Compound	Audit cylinder concentration (ppb)	Calculated audit concentration using provisional response factors	% Difference	Calculated audit concentration using ratified response factors	% Difference
1,3-Butadiene	2.89	2.80	-3.10	2.94	1.59
Benzene	6.26	6.23	-0.43	6.37	1.75
Toluene	4.84	4.61	-4.69	4.90	1.31
Ethylbenzene	1.98	1.77	-10.63	1.99	0.38
(m+p)-Xylene *	2.46	2.18	-11.55	2.47	0.41
o-Xylene	1.62	1.36	-15.92	1.62	-0.08

From the tables above, all three analysers show good agreement between the calibration standard and the audit standard when the ratified response factors are applied. The one exception to this is the result for 1,3 butadiene at the Glasgow site. In general, if the reported value of the audit cylinder is within 10% of the stated concentration, then the ratified data is considered to be within the stated accuracy. The 1,3 butadiene result for Glasgow shows a difference of 10.43%. The most likely reason behind this result is that the 1,3 butadiene component of the calibration standard has decayed in the cylinder. This result will be confirmed at the next audit, due in August 2005. If the 1,3 butadiene result is found to be the same at the next audit, then a new concentration value will be attributed to the calibration standard. If the result cannot be reproduced then the calibration standard will be replaced.

Appendices

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Appendix 1 Summary Statistical Information

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Table 1. Percentage data capture, maximum, mean and minimum values of the ratified data from the Cardiff site of the UK Hydrocarbon Network, for the period 1 January 2005 to 31 March 2005

Compound	% Data capture	Maximum hourly concentration ($\mu g/m^3$)	Mean concentration ($\mu g/m^3$)	Minimum hourly concentration ($\mu g/m^3$)
1,3-Butadiene	93.21	1.91	0.07	0.00
Benzene	93.21	6.39	0.84	0.06
Toluene	93.21	46.25	2.87	0.19
Ethylbenzene	78.72	25.16	0.62	0.04
(m+p)-Xylene *	90.71	76.77	1.90	0.04
o-Xylene	83.90	16.53	0.84	0.04

* (m+p)-Xylene data are reported as the sum of the 2 individual components due to the fact that they are not sufficiently well resolved in the chromatogram.

Table 2. Percentage data capture maximum, mean and minimum values of ratified data from the Glasgow site of the UK Hydrocarbon Network, for the period 1 January 2005 to 31 March 2005

Compound	% Data capture	Maximum hourly concentration ($\mu g/m^3$)	Mean concentration ($\mu g/m^3$)	Minimum hourly concentration ($\mu g/m^3$)
1,3-Butadiene	95.67	2.04	0.20	0.00
Benzene	95.67	24.81	1.49	0.16
Toluene	95.67	104.77	4.32	0.27
Ethylbenzene	86.69	16.66	0.84	0.04
(m+p)-Xylene *	94.93	57.69	2.82	0.13
o-Xylene	89.32	19.48	1.59	0.18

* (m+p)-Xylene data are reported as the sum of the 2 individual components due to the fact that they are not sufficiently well resolved in the chromatogram.

Table 3. Percentage data capture, maximum, mean and minimum values of ratified data from the Harwell site of the UK Hydrocarbon Network, for the period; 1 January 2005 to 31 March 2005

Compound	% Data capture	Maximum hourly concentration ($\mu g/m^3$)	Mean concentration ($\mu g/m^3$)	Minimum hourly concentration ($\mu g/m^3$)
1,3-Butadiene	88.56	0.83	0.02	0.00
Benzene	88.56	6.75	0.58	0.00
Toluene	88.14	6.62	0.88	0.04
Ethylbenzene	55.27	1.32	0.18	0.04
(m+p)-Xylene *	79.21	2.86	0.44	0.04
o-Xylene	56.71	1.19	0.18	0.04

* (m+p)-Xylene data are reported as the sum of the 2 individual components due to the fact that they are not sufficiently well resolved in the chromatogram.

Table 4. Percentage data capture, maximum, mean and minimum values of ratified data from the Marylebone Road site affiliated to the UK Hydrocarbon Network for the period; 1 January 2005 to 31 March 2005

Compound	% Data capture	Maximum hourly concentration ($\mu g/m^3$)	Mean concentration ($\mu g/m^3$)	Minimum hourly concentration ($\mu g/m^3$)
Ethane	93.17	94.33	10.83	3.18
Ethene	93.12	20.26	4.11	0.36
Propane	93.17	158.43	6.35	1.34
Propene	93.17	10.41	2.01	0.16
Ethyne	93.12	23.00	4.06	0.67
2-Methylpropane	93.12	28.60	4.75	0.65
n-Butane	93.17	52.26	8.71	1.06
trans-2-Butene	93.17	2.77	0.58	0.14
1-Butene	93.03	2.44	0.51	0.05
cis-2-Butene	92.89	2.26	0.40	0.07
2-Methylbutane	93.17	50.83	7.63	0.57
n-Pentane	93.17	11.91	2.36	0.33
1,3-Butadiene	92.89	1.84	0.43	0.04
trans-2-Pentene	92.10	3.70	0.55	0.03
cis-2-Pentene	87.66	2.10	0.32	0.03
2-Methylpentane	93.03	16.38	2.54	0.18
3-Methylpentane	92.75	9.80	1.54	0.07
Isoprene	85.20	0.99	0.25	0.03
n-Hexane	86.18	6.65	1.14	0.04
n-Heptane	91.31	7.98	0.67	0.04
Benzene	92.43	12.58	2.14	0.23
Toluene	93.03	64.53	8.87	0.42
Ethylbenzene	92.98	10.27	1.45	0.04
(m+p)-Xylene *	92.19	35.21	4.89	0.13
o-Xylene	93.07	12.08	1.90	0.04
1,3,5-Trimethylbenzene	92.56	4.34	0.65	0.05
1,2,4-Trimethylbenzene	92.98	14.87	2.34	0.10

* (m+p)-Xylene are reported as the sum of the 2 individual components due to the fact that they are not sufficiently well resolved in the chromatogram.

Table 5. Percentage data capture, maximum, mean and minimum values of ratified data from the Eltham site affiliated to the UK Hydrocarbon Network for the period; 1 January 2005 to 31 March 2005

Compound	% Data capture	Maximum hourly concentration ($\mu g/m^3$)	Mean concentration ($\mu g/m^3$)	Minimum hourly concentration ($\mu g/m^3$)
Ethane	94.40	47.80	6.51	1.46
Ethene	87.69	19.23	1.39	0.03
Propane	97.27	22.76	3.68	0.62
Propene	92.18	10.69	0.61	0.00
Ethyne	97.04	5.09	1.01	0.15
2-Methylpropane	97.50	19.15	2.12	0.22
n-Butane	97.55	32.82	3.67	0.02
trans-2-Butene	97.74	1.54	0.19	0.05
1-Butene	88.99	2.21	0.19	0.00
cis-2-Butene	97.83	1.09	0.12	0.00
2-Methylbutane	96.90	25.80	2.33	0.06
n-Pentane	98.24	7.72	0.93	0.09
1,3-Butadiene	95.51	2.18	0.13	0.00
trans-2-Pentene	90.42	1.22	0.09	0.00
cis-2-Pentene	82.41	0.64	0.06	0.00
2-Methylpentane	98.01	5.51	0.61	0.04
3-Methylpentane	95.84	4.51	0.43	0.00
Isoprene	86.44	1.30	0.08	0.00
n-Hexane	96.67	5.11	0.32	0.04
n-Heptane	93.11	5.86	0.33	0.04
Benzene	98.38	7.69	0.97	0.26
Toluene	90.84	30.07	2.64	0.08
Ethylbenzene	82.18	4.27	0.53	0.00
(m+p)-Xylene *	76.07	14.54	1.45	0.04
o-Xylene	83.15	5.77	0.48	0.00
1,3,5-Trimethylbenzene	46.21	3.89	0.45	0.00
1,2,4-Trimethylbenzene	80.93	10.28	0.80	0.15

* (m+p)-Xylene are reported as the sum of the 2 individual components due to the fact that they are not sufficiently well resolved in the chromatogram.

Appendix 2
Time Series Plots of Hydrocarbon Concentrations

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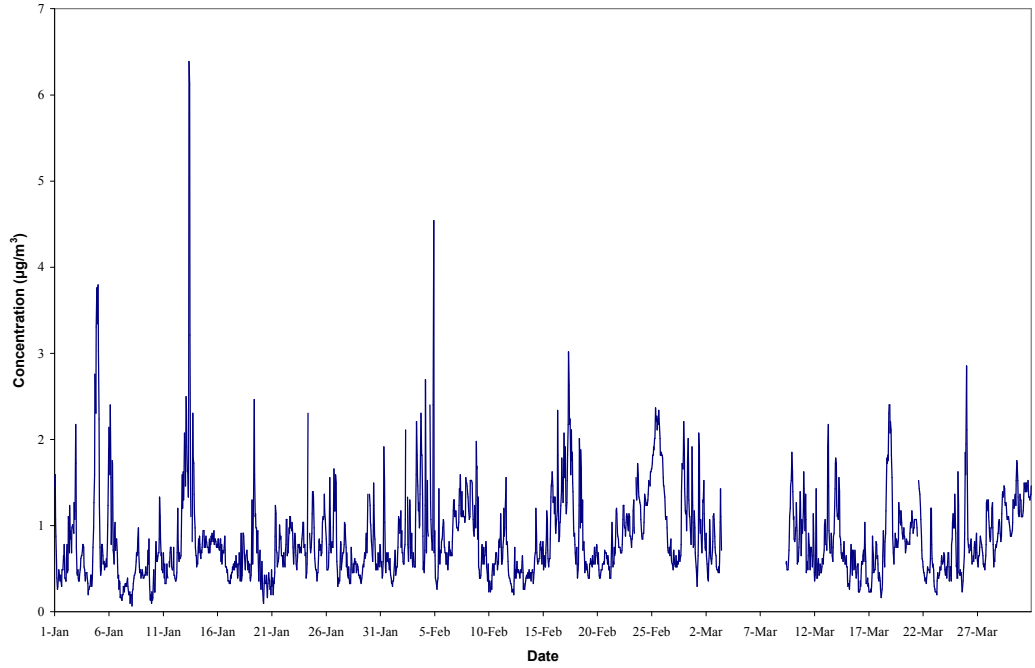

Figure 1. Time series plot of the ratified benzene data from the Cardiff site of the UK Hydrocarbon Network, for the period; 1 January 2005 to 31 March 2005

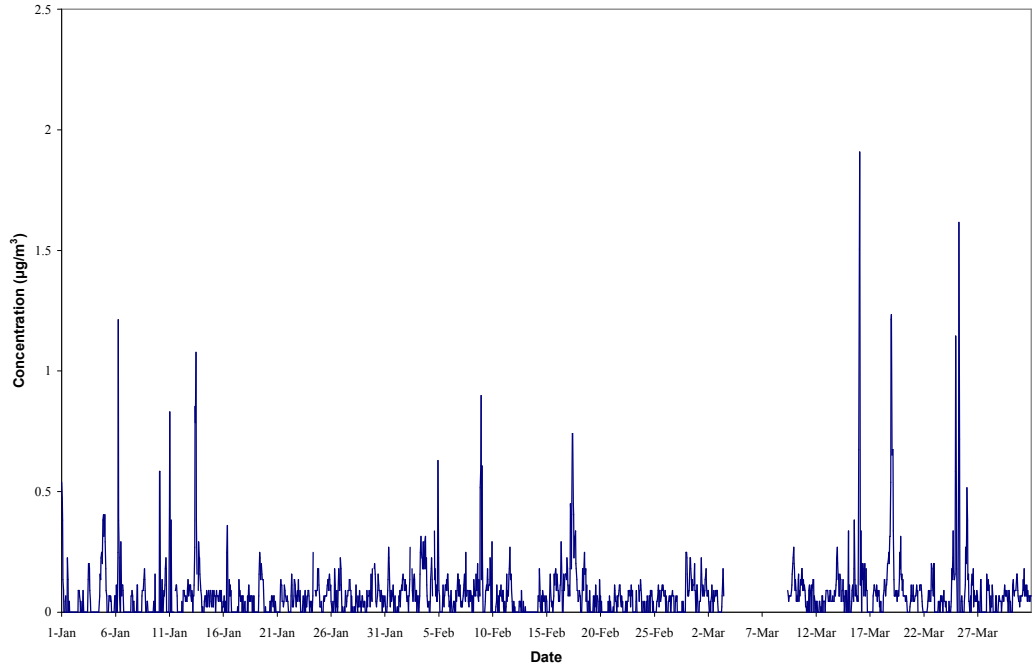

Figure 2. Time series plot of the ratified 1,3-butadiene data from the Cardiff site of the UK Hydrocarbon Network, for the period; 1 January 2005 to 31 March 2005

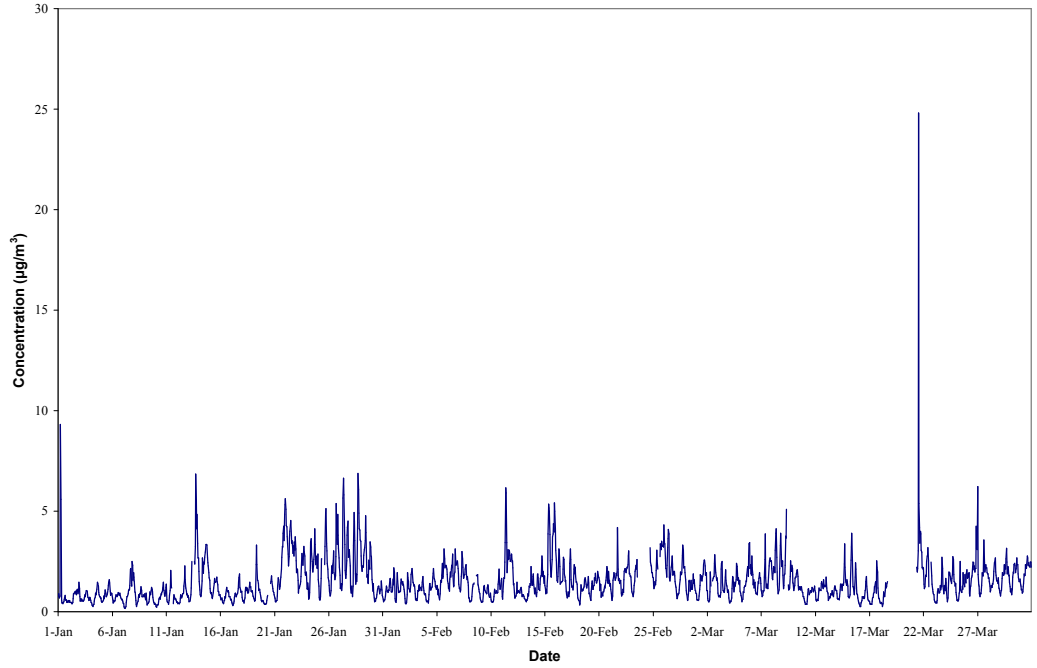

Figure 3. Time series plots for the ratified benzene data from the Glasgow site of the UK Hydrocarbon Network, for the period; 1 January 2005 to 31 March 2005

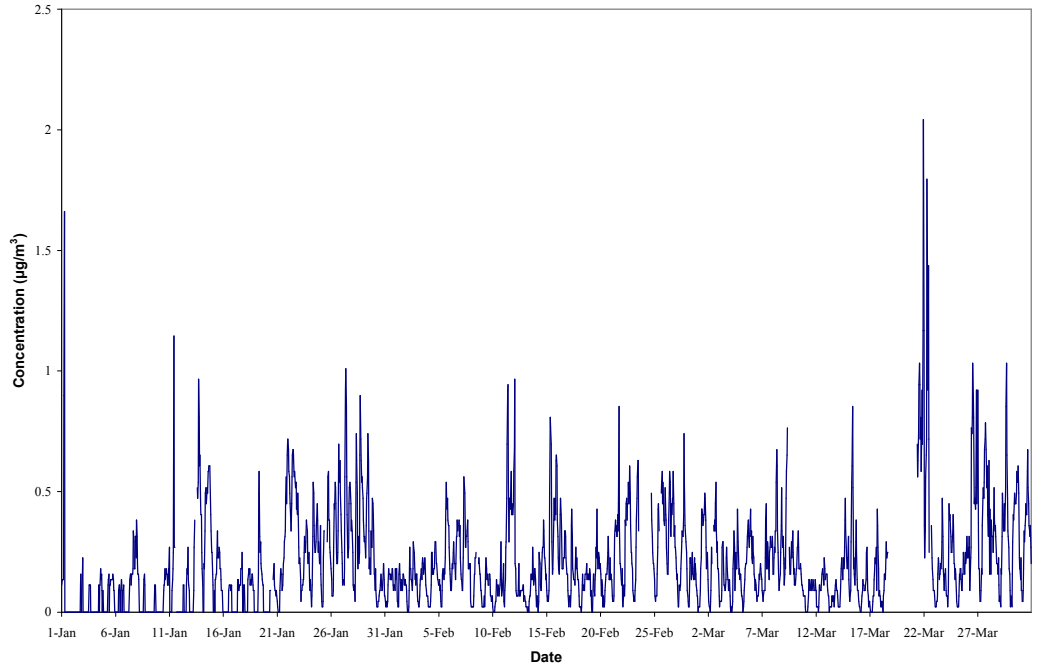

Figure 4. Time series plots for the ratified 1,3-butadiene data from the Glasgow site of the UK Hydrocarbon Network, for the period; 1 January 2005 to 31 March 2005

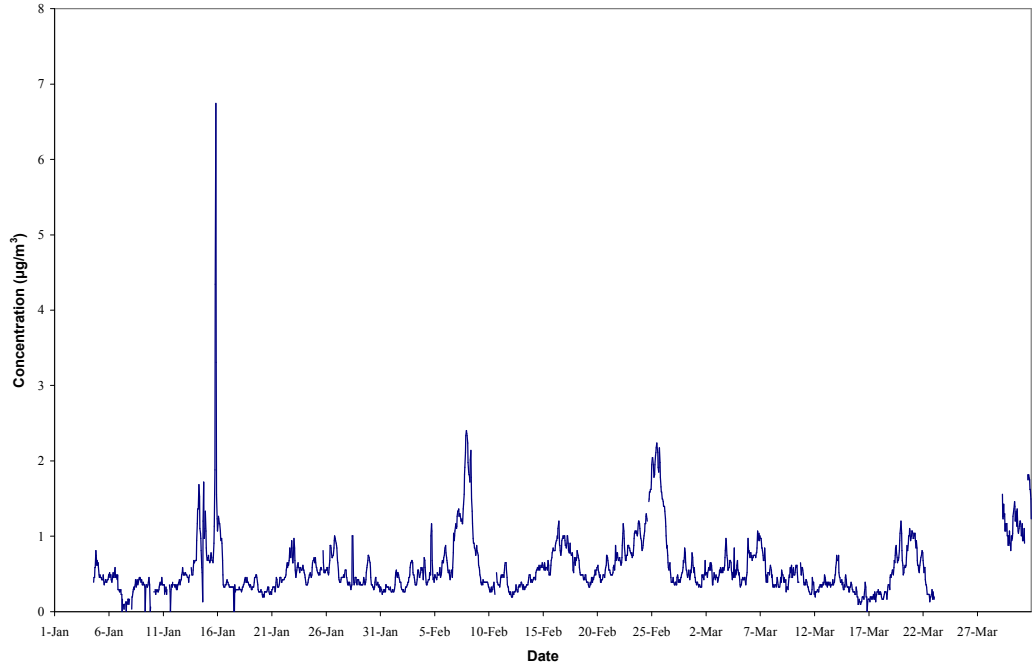

Figure 5. Time series plots for the ratified benzene data from the Harwell site of the UK Hydrocarbon Network, for the period; 1 January 2005 to 31 March 2005

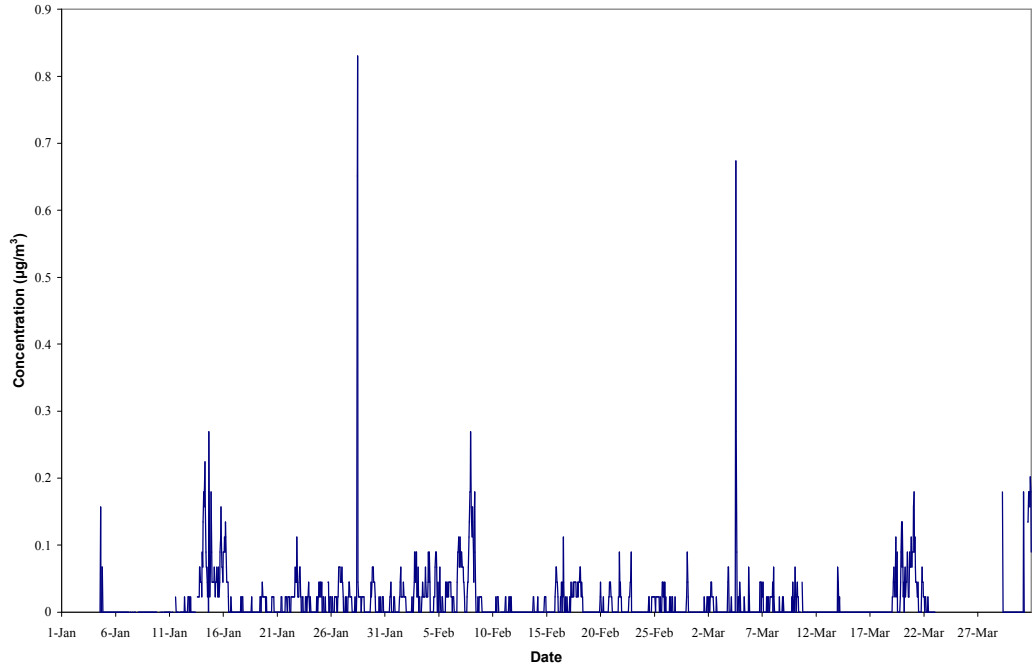

Figure 6. Time series plots for the ratified 1,3-butadiene data from the Harwell site of The UK Hydrocarbon Network, for the period; 1 January 2005 to 31 March 2005

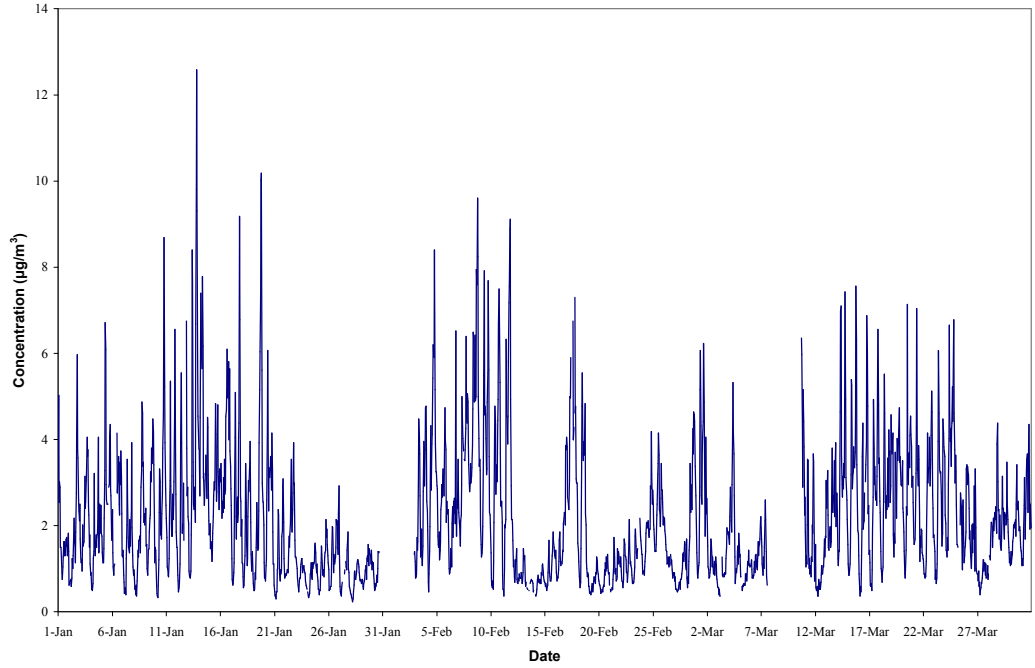

Figure 7. Time series plots for the ratified benzene data from the Marylebone Road site affiliated to the UK Hydrocarbon Network, for the period; 1 January 2005 to 31 March 2005

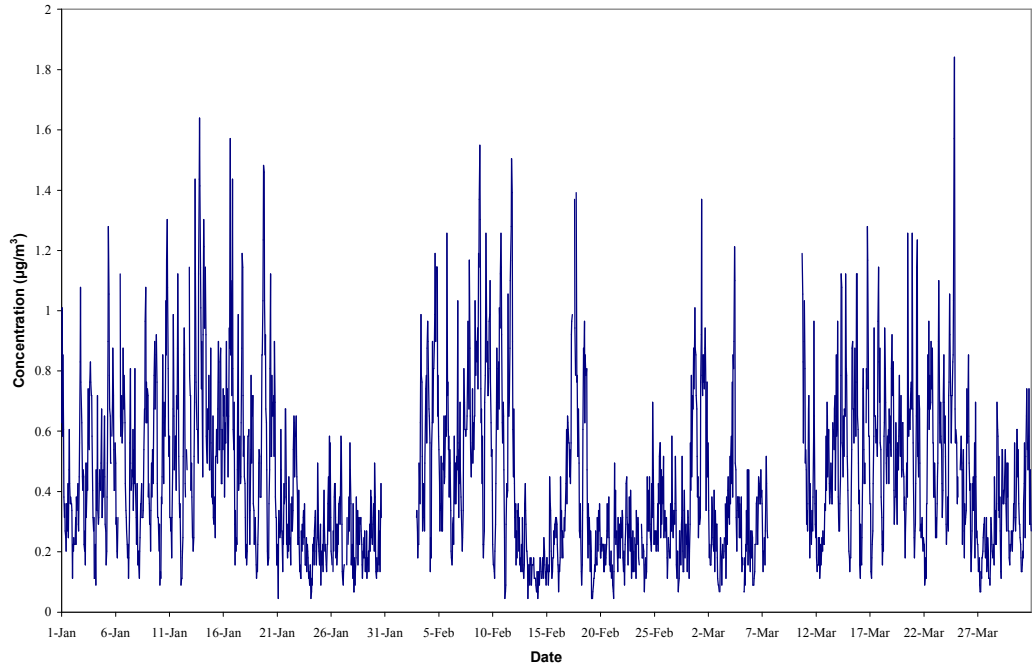

Figure 8. Time series plots for the ratified 1,3-butadiene data from the Marylebone Road site affiliated to the UK Hydrocarbon Network, for the period; 1 January 2005 to 31 March 2005

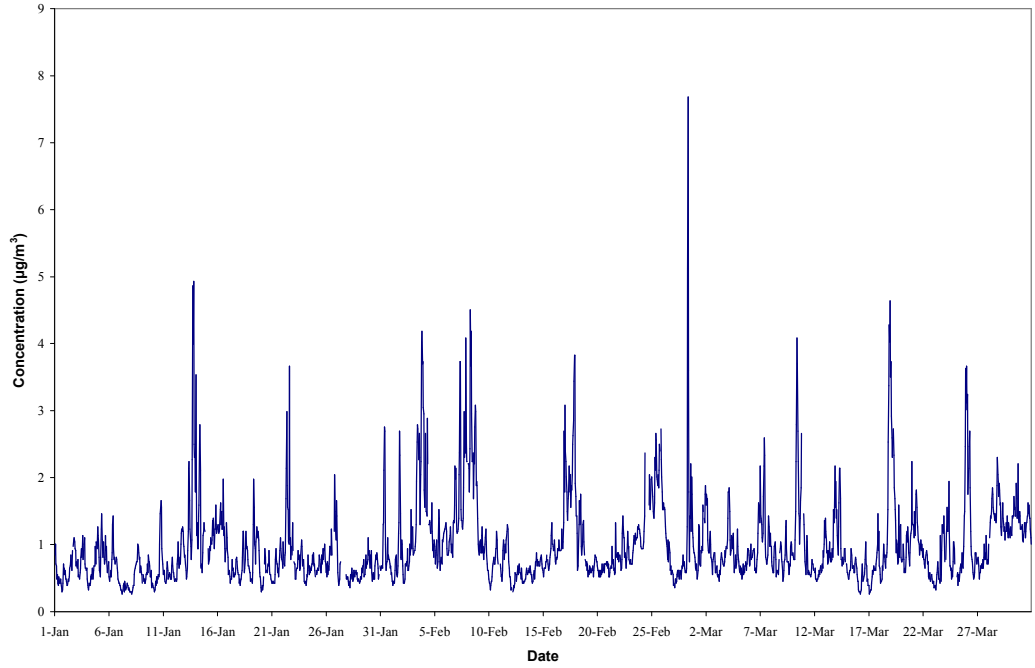

Figure 9. Time series plots for the ratified benzene data from the Eltham site affiliated to the UK Hydrocarbon Network, for the period; 1 January 2005 to 31 March 2005

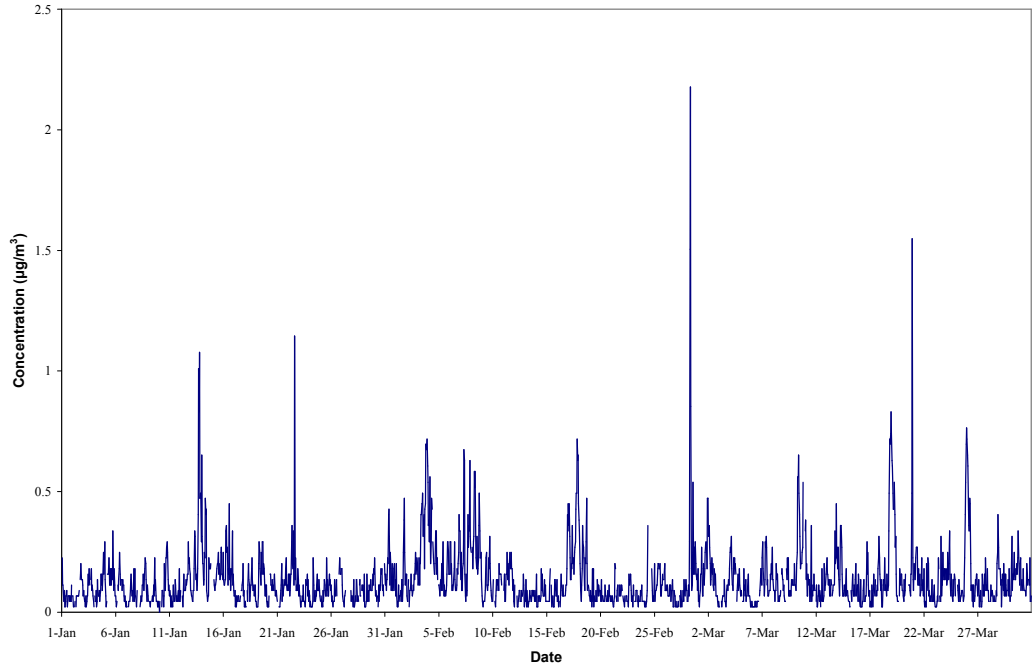

Figure 10. Time series plots for the ratified 1,3-butadiene data from the Eltham site affiliated to the UK Hydrocarbon Network, for the period; 1 January 2005 to 31 March 2005

Appendix 3
Annual and Quarterly Mean Plots

CONTENTS

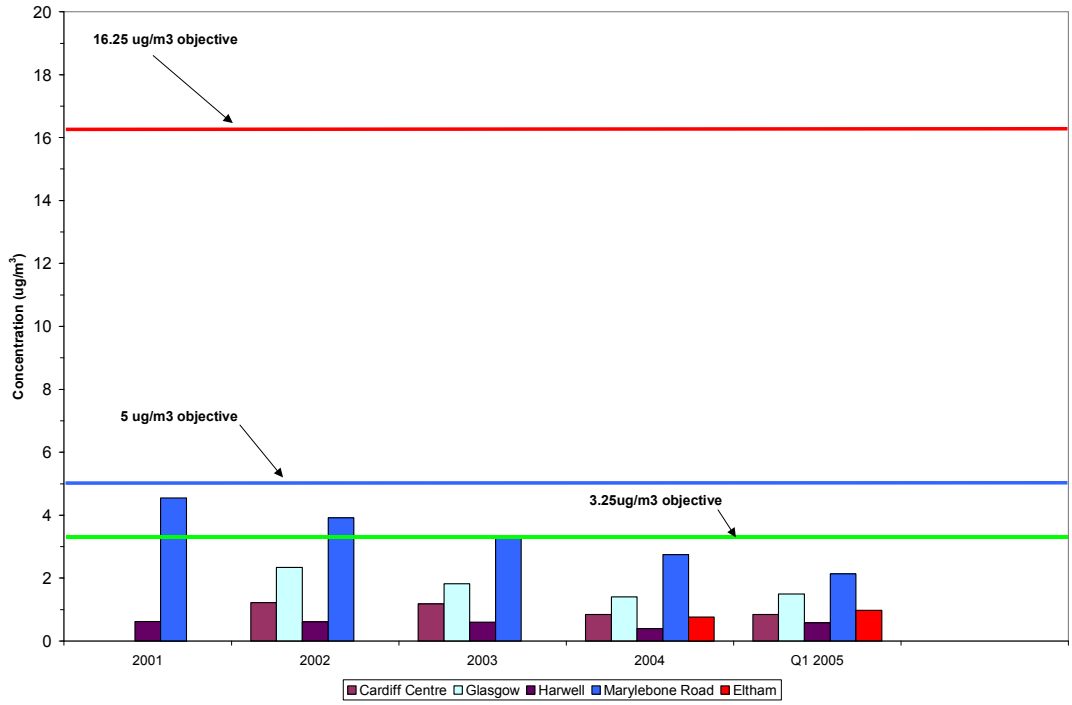

Figure 1. Mean benzene concentrations for the UK Automatic Hydrocarbon Network, 2001-2004 and quarter 1, 2005

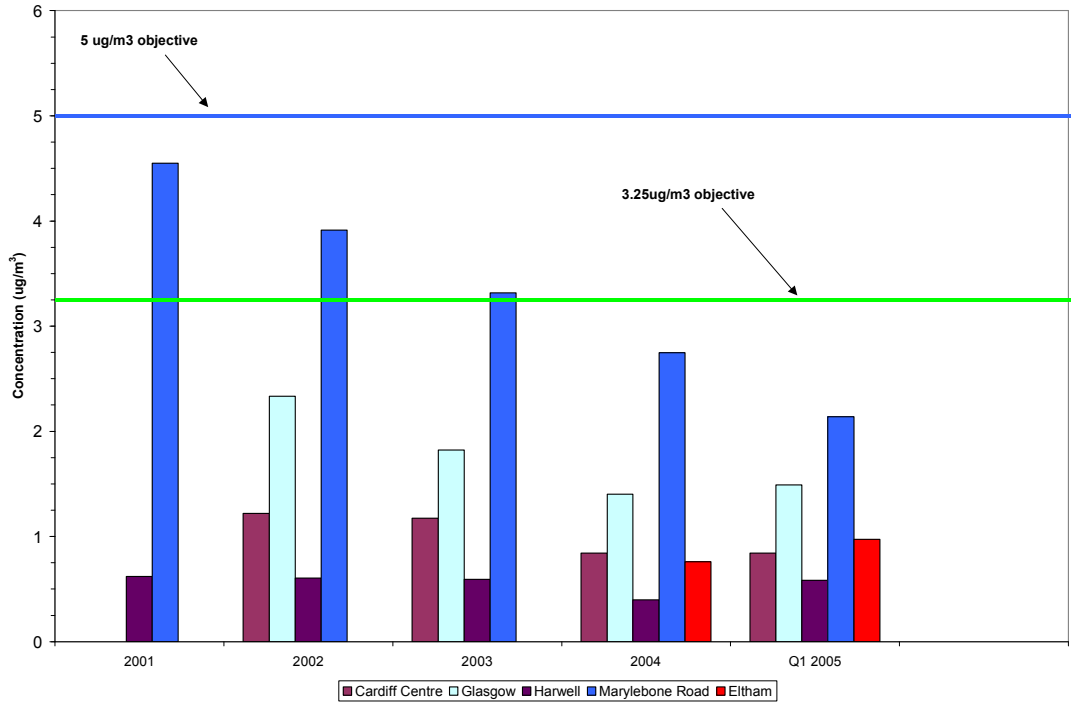

Figure 2. Mean Benzene concentrations for the UK Automatic Hydrocarbon Network, 2001-2004 (magnified y-axis) and quarter 1, 2005

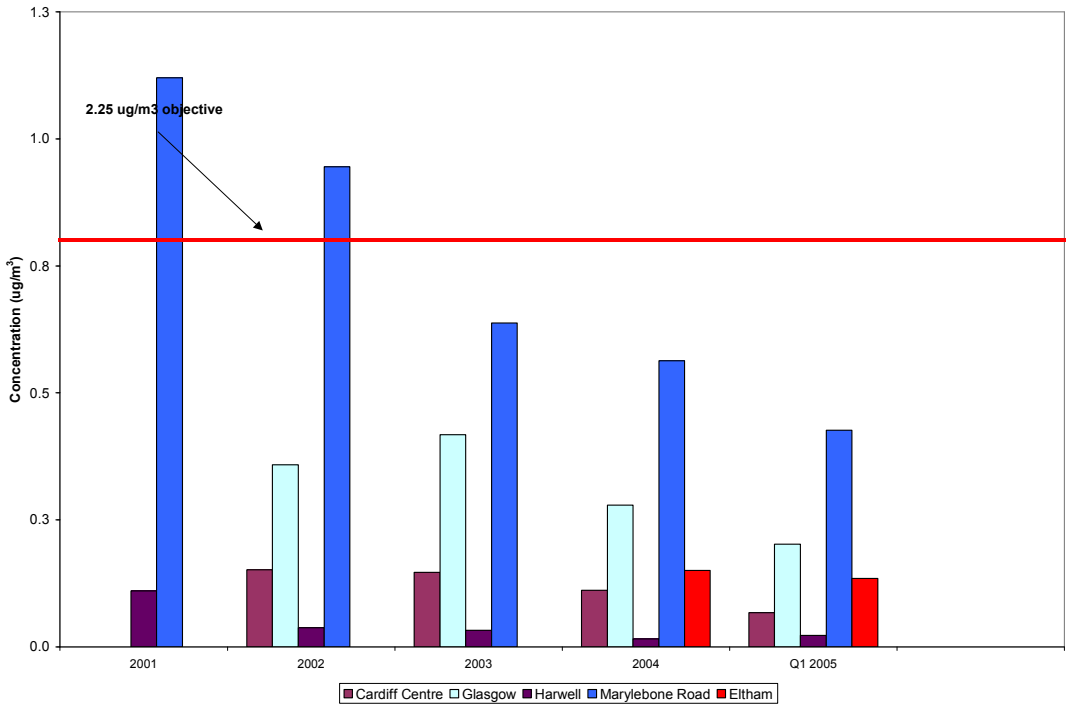

Figure 3. Mean 1,3-Butadiene concentrations for the UK Automatic Hydrocarbon Network, 2001-2004 and quarter 1, 2005

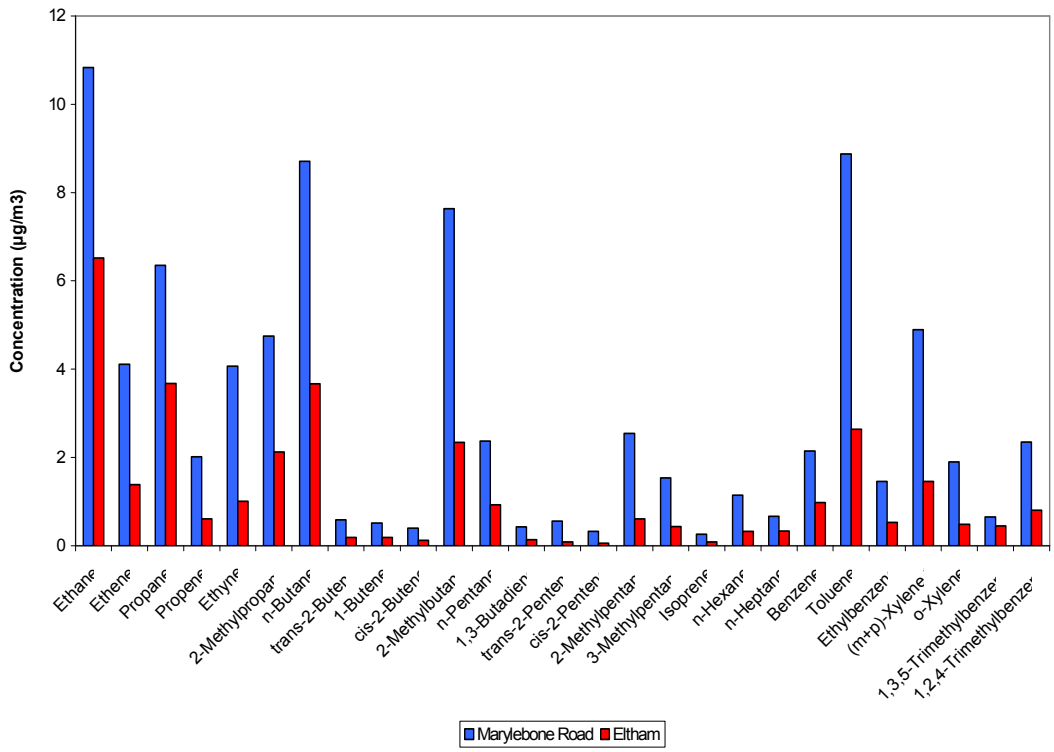

Figure 4. Mean concentrations for all compounds measured at Marylebone road and Eltham for the UK Automatic Hydrocarbon Network, for the period; 1 January 2005 to 31 March 2005