QA/QC Data Ratification Report for the Automatic Urban and Rural Network, January-March 2013, and Intercalibration Report, Winter 2013

Report for Department for Environment, Food and Rural Affairs, The Scottish Government, The Welsh Government, The Northern Ireland Department of Environment

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Executive summary

Ricardo-AEA carries out the quality assurance and control (QA/QC) activities for the Automatic Urban and Rural Monitoring Network (AURN) on behalf of the UK Department for Environment, Food and Rural Affairs (Defra), Scottish Government, Welsh Government and Department of Environment (DoE) in Northern Ireland.

Ratified hourly average data capture for the network averaged 92.8% for all pollutants (O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$) during the 3-month reporting period January-March 2013. Data capture for all pollutants were above 90%. There were 21 sites with data capture less than 90% for the period.

A total of 133 monitoring sites in the AURN operated during this quarter, of which 74 are Local Authority owned sites affiliated to the national network. Some are co-located and separately named gravimetric particulate analysers at sites with automatic analysers. Many affiliated sites have additional Defra-funded analysers installed on site.

The main reasons for data loss at the sites have been provided and these were predominantly due to instrument faults, response instability or problems associated with the replacement of analysers and infrastructure. A summary of recommendations to help improve network performance is given in Appendix 1.

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SECTION A Data Ratification Report, January-March 2013

1 Introduction

This quarterly report covers the Quality Assurance and Control (QA/QC) activities undertaken by Ricardo-AEA to ratify automatic monitoring data from Defra and the Devolved Administrations' urban and rural air quality monitoring network (AURN) for the period 1 January-31 March 2013. During this quarter there were a total of 133 operational monitoring sites in the Network of which there were 98 urban sites, 27 rural sites and a further 8 sites in the London Air Quality Monitoring Network (LAQN) which are affiliated into the national network. There were 61 Defra-funded sites and 72 affiliate sites, although many affiliate sites have fully-funded PM_{10} and/or $PM_{2.5}$ analysers. Eleven sites have non-automatic particulate samplers (Partisols); some of these are co-located with FDMS analysers at Auchencorth Moss, Harwell, London North Kensington and Marylebone Road for both PM_{10} and $PM_{2.5}$, plus PM_{10} at Port Talbot Margam.

1.1 Overview of Network Performance

Ratified hourly average (daily average for Partisols) data capture for the network averaged 92.8% for all pollutants (O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$) during the 3 month reporting period January-March 2013 (see Table 1.1). All species achieved 90% or higher data capture on average. Data capture rates are calculated using the actual data capture as hourly averages (daily for Partisol) against the total number of hours (or days) in the relevant period; service and maintenance are counted as lost data. It is permissible to discount routine service and calibration from achievable data capture targets, but this is not yet calculated. For sites starting or closing during the period, the data capture is based on the actual date starting or closing.

Table 1.1: AURN Ratified Data Capture (%) by Quarter, January-December 2013

	CO	PM_{10}	$PM_{2.5}$	NO_2	O_3	SO_2	Mean
Q1 2013	95.6	91.6	94.3	92.9	93.9	92.9	92.8

Overall, 320 out of the 379 analysers (84%) achieved data capture levels above the required 90% target during this reporting period. Table 1.2 shows the number of analysers which did not meet the target.

Table 1.2: Number of Analysers with Data Capture below 90%

Total Number Of Analysers		Q1 Jan-Mar 2013 (No. below 90%)
CO	11	1
NO_2	116	16
O_3	82	10
PM_{10} [1]	67	15
$PM_{2.5}$ [1]	77	13
SO_2	33	4
Total <90%		59

[1] Includes FDMS, BAM and Partisol analysers.

In total, 21 out of the 133 operational network sites in the quarter (16%) had an average data capture rate below the required 90% level for the January-March 2013 period. Of these, 13 were below 85%.

1.2 Changes to Ratified Data

The following data from previous quarters have been changed as a result of the ratification process for this quarter:

Market Harborough	NOx deleted from 26 July 2012, sampling fault
	O_3 deleted from 1 January 2012, sampling fault

2 Changes in the Network for Directive Compliance

No new sites were commissioned during this period:

3 Generic Data Quality Issues

3.1 FDMS Performance Issues

At the time of writing, there are a number of FDMS performance issues being investigated by the QA/QC unit. Most significant is the apparent baseline offset, which can result in data being higher or lower than might be expected. In order to determine this, zero checks are being carried out by placing a filter over the inlet and leaving for several days. This method does allow the determination of the analyser “zero” but requires a visit by QA/QC staff and the LSO, and therefore it will take time to complete all sites. The findings and implications of these tests are described in Section 5.

3.2 Internal Sampling

Following recommendations made by the QA/QC Unit in 2010, many sites had the sample inlet manifold removed and individual PTFE sample lines for each analyser fitted inside the sample inlet. It had come to light that under certain circumstances at some sites, air from inside the hut was being blown up the inlet tube and affecting the air being sampled. At the time, Equipment Support Units (ESUs) were instructed to seal the inlet tube around the sample lines to prevent this; however, considerable data loss occurred at Mold and Preston, and Wirral Tranmere as described on the October-December 2012 report.

During the ratification of the January-March 2013 Market Harborough dataset, elevated levels of NO_2 were noticed since 2010. Investigations on site revealed that the sample tubes had slipped down inside the inlet pipe allowing partial sampling of cabin air. Unfortunately, it is likely that both the NO_2 and ozone sampling had been compromised and both datasets have been deleted since 2010 up to the repair in June 2013.

It is recommended that ESUs check the integrity of sample inlets at services, particularly following the replacement of the sample lines.

4 Site Specific Issues

In this section, we now discuss in turn specific site issues for sites in the following geographic groupings – London, England (excluding London), Scotland, Northern Ireland and Wales. Where analysers were commissioned during the period, the stated data capture for these instruments is calculated from the date of commissioning. Further details on individual analyser performance issues are given in the relevant CMCU reports.

4.1 London

4.1.1 Data Capture

The data capture for sites in London (within the M25) for the period January-March 2013 is given in Table 4.1:

Table 4.1 Data Capture for London, January-March 2013

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Camden Kerbside		99.5	98.6	99.4			99.2
Haringey Roadside		93.3	99.6	99.3			97.4
London Bexley			99.3	96.9		94.1	96.8
London Bloomsbury		98.4	95.8	98.6	98.2	98.2	97.9
London Eltham			82.2	99.2	99.6		93.7
London Harlington		97.8	98.4	97.2	96.7		97.5
London Harrow Stanmore			99.6				99.6
London Hillingdon				97.8	98.2		98.0
London Marylebone Road	99.6	90.4	99.1	98.2	97.2	98.3	97.1
London Marylebone Road Partisol		96.7	98.9				97.8
London N. Kensington	98.4	96.2	96.9	98.4	98.1	98.5	97.7
London N. Kensington Partisol		98.9	98.9				98.9
London Teddington			96.9	98.1	92.6		95.8
London Westminster			87.8	98.1	98.5		98.1
Southwark A2 Old Kent Road		98.9		99.4			99.1
Tower Hamlets Roadside				99.5			99.5
Number Of Sites	**2**	**9**	**13**	**13**	**8**	**4**	**16**
Number Of Sites < 90%	**0**	**0**	**2**	**0**	**0**	**0**	**0**
Network Mean	**99.0**	**96.7**	**96.3**	**98.5**	**97.4**	**97.3**	**97.8**

4.1.2 Site Specific Issues

.All sites reported data capture above 90% this quarter.

4.2 England (excluding London)

4.2.1 Data Capture

The data capture for sites in England for the period January-March 2013 is given in Table 4.2:

Table 4.2 Data Capture for England, January-March 2013

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Barnsley Gawber				97.4	98.2	97.9	97.9
Bath Roadside				97.6			97.6
Billingham				98.6			98.6
Birmingham Acocks Green			87.7	98.5	98.6		94.9
Birmingham Tyburn		97.4	99.0	99.4	99.4	99.4	98.9
Birmingham Tyburn Roadside		65.6	98.5	98.3	98.3		90.2
Blackburn Darwen Roadside				93.1			93.1
Blackpool Marton			95.4	98.6	98.6		97.5
Bottesford					99.6		99.6
Bournemouth			97.8	98.3	98.5		98.4
Brighton Preston Park			100.0	97.5	92.4		95.1
Bristol St Paul's		94.1	98.0	97.9	98.0		97.0
Cambridge Roadside				98.5			98.5
Canterbury				98.3	98.6		98.4
Carlisle Roadside		82.1	99.6	98.7			93.5
Charlton Mackrell				94.7	98.7		96.7
Chatham Centre Roadside		92.3	98.6	98.4			96.4
Chesterfield		89.6	85.8	87.6			87.7
Chesterfield Roadside		87.7	76.1	96.9			86.9
Coventry Memorial Park			79.4	49.3	98.7		75.8
Eastbourne		99.5	99.1	89.8			96.1
Exeter Roadside				98.5	98.8		98.6
Glazebury				98.6	98.4		98.5
Great Dun Fell					93.4		93.4
Harwell		93.8	99.2	93.2	97.4	96.7	96.1
Harwell		95.6	98.9				97.2
High Muffles				98.1	98.5		98.3
Honiton				98.6			98.6
Horley				94.1			94.1
Hull Freetown		97.1	97.0	95.0	95.3	90.1	94.9
Ladybower				98.7	98.7	98.7	98.7
Leamington Spa		99.3	99.2	99.3	99.5	99.4	99.3
Leamington Spa Rugby Road		97.4	98.0	97.1			97.5
Leeds Centre	97.2	92.1	92.0	97.3	97.5	97.1	95.5
Leeds Headingley		29.0	98.2	99.7			75.6

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Kerbside							
Leicester Centre		97.5	22.6	87.3	80.8		72.0
Leominster				97.3	96.5		96.9
Lincoln Canwick Road				99.6			99.6
Liverpool Queen's Drive Roadside				61.0			61.0
Liverpool Speke		97.0	97.0	96.9	97.2	97.1	97.0
London Haringey Priory Park South				99.2	97.8		98.5
Lullington Heath				96.5	97.2	96.5	96.7
Manchester Piccadilly			80.2	97.7	97.7	97.6	93.3
Manchester South				98.7	98.8		98.7
Market Harborough				0.0	0.0		0.0
Middlesbrough		98.4	99.2	93.9	97.6	97.0	97.2
Newcastle Centre		95.6	96.9	97.3	97.3		96.8
Newcastle Cradlewell Roadside				98.1			98.1
Northampton Kingsthorpe			92.2	98.4	98.5		98.3
Norwich Lakenfields		84.9	97.3	98.7	98.7		94.9
Nottingham Centre		96.2	94.5	97.0	97.1	97.1	96.4
Oxford Centre Roadside				98.4			98.4
Oxford St Ebbes		93.9	96.4	97.6			96.0
Plymouth Centre		66.7	98.6	98.6	98.7		90.6
Portsmouth		70.9	95.4	78.6	100.0		86.2
Preston			98.0	98.6	98.6		98.4
Reading New Town		98.5	98.2	98.8	98.8		98.6
Rochester Stoke		99.2	99.5	66.9	95.9	96.1	91.5
Salford Eccles		98.6	98.8	94.9	95.1		96.8
Saltash Callington Road		99.0	98.4				98.7
Sandy Roadside		87.0	95.7	98.6			93.8
Scunthorpe Town		90.8		96.7		89.6	92.4
Sheffield Centre		97.0	89.6	81.3	96.5		91.1
Sheffield Tinsley				97.3			97.3
Sibton					82.1		82.1
Southampton Centre		91.6	98.3	96.6	97.1	97.2	96.2
Southend-on-Sea			72.8	84.8	84.0		80.5
St Osyth				98.4	98.6		98.5
Stanford-le-Hope Roadside		99.3	98.2	99.0			98.9
Stockton-on-Tees Eaglescliffe		97.4	95.4	97.8			96.9
Stoke-on-Trent Centre		89.2	95.1	94.0	97.5		94.0
Storrington Roadside		98.9	95.4	99.8			98.0
Sunderland Silksworth			99.1	99.7	97.3		98.7
Thurrock		99.2		97.9	98.0	97.7	98.2
Walsall Woodlands				66.8	99.4		83.1
Warrington		75.2	99.4	99.4			91.4

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Weybourne					89.4		89.4
Wicken Fen				98.6	99.8	0.0	66.1
Wigan Centre			98.3	98.6	98.3		98.4
Wirral Tranmere			98.3	63.1	65.9		75.8
Yarner Wood				98.1	94.5		96.3
York Bootham		93.0	99.4				96.2
York Fishergate		99.3	96.8	99.6			98.6
No of Sites	**1**	**40**	**50**	**76**	**54**	**17**	**83**
No <90%	**0**	**11**	**8**	**12**	**6**	**2**	**14**
No <85%	**0**	**7**	**5**	**9**	**5**	**1**	**10**
Average	**97.2**	**90.7**	**93.8**	**93.0**	**94.4**	**90.9**	**92.6**

4.2.2 Site Specific Issues

Birmingham Tyburn Roadside

The PM_{10} FDMS was fond to have a very low flowrate (~1litre/min) at an engineer's visit on 8 February, caused by a leaking filter holder. Data have been deleted from 8 January-8 February.

Chesterfield

During early January, the NOx data was unstable up to the LSO calibration on 17 January, and have been deleted. In addition, both FDMS units required attention on 24 January; the $PM_{2.5}$ received a replacement drier. Some data have been lost from both instruments.

Chesterfield Roadside

The $PM_{2.5}$ FDMS was unstable from 8 to 27 January, with some large spurious peaks; these data have been deleted. Some periods of PM_{10} data have also been lost

Coventry Memorial Park

An unspecified NOx analyser fault produced n elevated baseline which could not be corrected by ratification. Data from 18 October to 15 February have been deleted. In addition, some $PM_{2.5}$ data were lost due to instrument instability.

Leeds Headingly Kerbside

Throughout the quarter, $PM_{2.5}$ concentrations were consistently higher than the PM_{10} concentrations. The PM_{10} data have been deleted from 27 January up to (and beyond) the end of the quarter.

Leicester Centre

The site suffered a number of power failures during the period 1-8 January (and during the preceding month). As a result of this, a number of communication problems were encountered, and in addition, the $PM_{2.5}$ FDMS lost its programming. The ESU ultimately removed the analyser for workshop repair, and monitoring was not restarted until 11 March.

Liverpool Queens Drive Roadside

The poor analyser performance of the NOx analyser seen in the last quarter of 2012 continued into this quarter. The sample flowrate was found to be close to zero at the audit in January; a leak caused by a chipped sample filter glass was found at the service. Data from this site have therefore been deleted from 25 July 2012 to 4 February 2013.

Market Harborough

See section 3.2

Sibton

A failure of the sample pump resulted in the loss of data from 16 to 31 January.

Southend-on-Sea

The site was turned off for seven days for safety reasons due to a water leak on 14 February. On 21 March, the power tripped out, and the $PM_{2.5}$ FDMS analyser lost its programming. This was not repaired until 12 April.

Walsall Woodlands

A suspected sample leak in the Nox analyser resulted in the data being deleted from the service on 19 February to the LSO calibration on 20 March.

Weybourne

The site suffered a power failure on 22 January; upon restoration on 25 January, the modem was corrupted and could not be fixed by the LSO. The problem was compounded by the telephone cable being cut. Data from 22 January to 31 January.

Wicken Fen

Poor quality SO_2 data continued to be observed following on from December 2012. As of 31 March the fault had not been rectified, and hence all SO_2 data have been deleted for the quarter.This fault persists onto the second quarter of 2013

Wirral Tranmere

During the ratification of the January-March 2012 Wirral Tranmere dataset, elevated levels of NO_2 were noticed since 2010. Investigations on site revealed a sealing plug of Blu-Tac had dropped out allowing cabin air to leak out. Unfortunately, it is likely that both the NO_2 and ozone sampling had been compromised and both datasets have been deleted since 2010 up to the repair in January.

4.3 Scotland

4.3.1 Data Capture

The data capture for sites in Scotland for the period January-March 2013 is given in Table 4.3.

Table 4.3 Data Capture for Scotland, January-March 2013

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Aberdeen		99.6	99.6	0.0	99.8		74.8
Aberdeen Union Street Roadside				99.9			99.9
Auchencorth Moss		40.0	96.7		97.5		95.3
Auchencorth Moss		97.1	97.1				97.1
Bush Estate				98.8	98.8		98.8
Dumbarton Roadside				92.3			92.3
Dumfries				98.2			98.2

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Edinburgh St Leonards	98.3	95.1	96.7	98.0	92.9	89.7	95.1
Eskdalemuir				98.1	99.6		98.8
Fort William				69.8	98.7		84.2
Glasgow Kerbside		94.9	89.2	95.7			93.3
Grangemouth		93.4	99.1	98.6		98.6	97.4
Grangemouth Moray				99.4			99.4
Inverness		93.3	93.3	92.5			92.5
Lerwick					99.6		99.6
Peebles				93.7	98.6		96.1
Strath Vaich					86.1		86.1
No of Sites	**1**	**7**	**7**	**13**	**9**	**2**	**17**
No <90%	**0**	**1**	**1**	**2**	**1**	**1**	**3**
No <85%	**0**	**1**	**0**	**2**	**0**	**0**	**2**
Average	**98.3**	**87.6**	**95.9**	**87.3**	**96.8**	**94.1**	**94.0**

4.3.2 Site Specific Issues

Aberdeen

The NOx converter was found to be less than 90% efficient at the winter 2013 audit on 6 February. The ESU did not attend to repair until 28 March, and then the engineer discovered he had the incorrect part to repair it. The analyser was then removed for workshop repair. The analyser was reinstalled on 8 April; all NO_2 data have been lost from 12 December to 8 April.

Fort William

An unspecified analyser fault resulted in poor quality NOx data from 24 January to 19 February; these have been deleted.

Strath Vaich

Data have been deleted between 29 January and 9 February due to low sample flow and ozone generator faults.

4.4 Wales

4.4.1 Data Capture

The data capture for sites in Wales for January-March 2013 is given in Table 4.4.

Table 4.4 Data Capture for Wales, January-March 2013

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Aston Hill				94.7	98.7		96.7
Cardiff Centre	83.1	87.4	91.1	90.5	93.2	84.4	88.3
Chepstow A48		99.5	99.7	99.3			99.5
Cwmbran				99.6	94.9		97.3
Mold				35.8	98.0		66.9
Narberth		91.2		96.7	96.6	96.5	95.3
Newport		97.0	94.6	99.8			97.1
Port Talbot Margam		96.7					96.7
Port Talbot Margam	98.1	99.4	99.6	98.2	86.5	98.1	96.7
Swansea Roadside		97.2	98.1	98.4			97.9
Wrexham		97.8	91.1	97.6		97.6	97.5
No of Sites	**2**	**8**	**6**	**10**	**6**	**4**	**11**
No <90%	**1**	**1**	**0**	**1**	**1**	**1**	**2**
No <85%	**1**	**0**	**0**	**1**	**0**	**1**	**1**
Average	**90.6**	**95.8**	**95.7**	**91.1**	**94.7**	**94.2**	**93.6**

Shaded boxes are for data capture < 90%

4.4.2 Site Specific Issues

Cardiff Centre

The site suffered a number of power cuts due to a wiring fault.

.**Mold**

The NOx converter was found to have failed at the audit on 21 January 2013. The converter was found to be partially blocked at the following service. Data have been deleted from 8 October (where a step change in response was noted) up to the service on 21 February.

4.5 Northern Ireland (including Mace Head)

4.5.1 Data Capture

The data capture for sites in Northern Ireland (including Mace Head in the Republic of Ireland) for the period January-March 2013 is given in Table 4.5.

Table 4.5 Data Capture for Ireland, January-March 2013

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Armagh Roadside		76.1		96.0			86.1
Ballymena Ballykeel						91.4	91.4
Belfast Centre	94.5	91.9	83.6	90.0	89.6	93.6	90.5
Derry		96.1	83.4	98.5	98.9	97.5	94.9

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Lough Navar		85.9			99.9		92.9
Mace Head					99.9		99.9
No of Sites	**1**	**4**	**2**	**3**	**4**	**3**	**6**
No <90%	**0**	**2**	**2**	**1**	**1**	**0**	**1**
No <85%	**0**	**1**	**2**	**0**	**0**	**0**	**0**
Average	**94.5**	**87.5**	**83.5**	**94.8**	**97.1**	**94.2**	**92.6**

4.5.2 Site Specific Issues

Armagh Roadside

The PM_{10} analyser has historically been a source of problems and much of the data from the quarter have been deleted. Problems continue early in 2013 with anomalously low sample dewpoints being recorded.

4.6 Overall Data Capture

Overall data capture for each pollutant across the network for the quarter is given in Table 4.6.

Table 4.6 Overall Data Capture, January-March 2013

Site	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Site Average
Number of sites	7	68	78	115	81	30	133
Number of sites < 90%	1	15	13	16	10	4	21
Number of sites < 85%	1	9	8	12	5	2	13
Network Mean (%)	95.6	91.5	94.3	92.9	93.9	92.8	92.8

5 FDMS Baseline Checks

As part of the QA/QC remit for continuous improvement, an ad hoc study of PM analyser baseline response has been undertaken for the past 2 years. This study has been coordinated following investigations of issues identified both by CMCU during routine operation and by QA/QC unit during the ratification process.

The study initially concentrated on FDMS analysers, examining the baseline profile of the reference channels and the relationship with other neighbouring monitoring stations. It has become clear that, on a daily mean basis, regional reference PM concentrations regularly reach a minimum value that approaches 0 μgm^{-3}.

With this information, sites where this observation was not true were “zero calibrated” using high efficiency scrubbers installed on the sample inlets. The results of these calibrations have been used to compare against the analyser baseline responses and, in all comparisons, calibration and baseline show excellent agreement.

The detection limit is calculated by multiplying the standard deviation of the zero calibration by 3.3. Typical results show that a healthy FDMS should have a detection limit of less than 5μgm^{-3}.

Recent European guidance (CEN TS16450) provides a recommendation that zero tests on PM analysers should yield a result no higher than 3 μgm^{-3}, which provides the AURN with a robust performance limit for data ratification.

As the zero calibration and baseline correlation is so strong, QA/QC will be setting up a mechanism for calibration of PM analysers, to coincide with the routine 6 month service exercise. It is likely that this will require careful coordination of LSO CMCU and ESU effort to achieve this cost effectively, so it will not be rolled out until the summer service round.

6 LSO Manual and AURN Hub

The QA/QC Unit has revised and reissued the LSO manual in light of procedural changes and the introduction of new types of analysers employed. This manual is available via the AURN Hub at http://uk-air.defra.gov.uk/reports/empire/lsoman/lsoman.html

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Section B – Intercomparison Report, Winter 2013

7 Introduction

During January to March 2013, Ricardo-AEA undertook an intercalibration of 135 monitoring stations in operation in the Defra and the Devolved Administrations Automatic Urban and Rural Monitoring Network. The intercalibration exercise is a vital step in the process of data ratification. The audits are used to undertake a number of analyser and infrastructure performance checks that cannot be performed by Local Site Operators, with a view to ensuring confidence in the accuracy, consistency and traceability of air pollution measurements made at all the monitoring stations. There has been some restructuring of the network since the summer intercalibration:

- Glasgow Centre is closed pending relocation
- Bury Roadside is closed pending relocation
- Barnsley 12, Bristol Old Market and London Cromwell Road 2 have all permanently closed, following reassessment of network requirements
- Saltash Callington Road commenced operation

The intercalibration requires the coordination and close cooperation of QA/QC unit, Management Units, ESU's and LSO's in making sure the entire operation runs smoothly and is the result of many months of planning. Leading up to the intercalibration, a draft schedule of visits is prepared and circulated to MU's and ESU's for approval. ESU ozone photometers are calibrated at Ricardo-AEA and all QA/QC equipment and cylinders are tested, calibrated and verified before use.

QA/QC visits are always undertaken before any ESU visits, to allow the performance of the sites to be quantified for the six month period prior to the visit. During the QA/QC visit, the LSO usually attends to demonstrate their competence in performing routine calibrations. The audits are used to transport independent calibration standard gases and test apparatus to all of the sites, to quantify the performance of the entire measurement process at the monitoring stations. The results obtained from these tests are fed into the ratification process, where any correction of datasets can be applied to account for any performance anomalies.

ESU visits are normally undertaken within a three week period following the QA/QC visit. At this time, the analysers and sampling systems are all cleaned and serviced in accordance with manufacturer's specifications. The analysers are then set up ready for the following six month period, until the next round of intercalibrations and servicing.

This scheduling has proven to be very successful in delivering reliable operation of monitoring stations and high quality data. The programme is iterative: improvements and enhancements are continually added to further improve performance and analyse results.

8 Scope of Intercalibration Exercise

The QA/QC visits fulfil a number of important functions:

- A “health check” on the production of provisionally scaled data, which is rapidly disseminated to the public soon after collection.
- Identification of poorly performing analysers and infrastructure, together with recommendations for corrective action.
- A measure of network performance, by examining for example, how different NOx analysers around the network respond to a common gas standard. This test checks how “harmonised” UK measurements are; ie that a 200ppb NO_2 pollution episode in Belfast would be reported in exactly the same way at every other site in the UK, regardless of the location or the analyser used to record the event.
- Assessment of the area around the monitoring station: has the environment changed in the last six months? Is the location still representative of the site classification?

The QA/QC audits test the following aspects of analyser performance:

1. Analyser accuracy and precision. These are basic checks to ensure analysers respond to known concentrations of gases in a reliable manner.
2. Instrument linearity. This test refines the response checks on analysers, by assessing whether doubling a concentration of gas to the analyser results in a doubling of the analyser signal response. If an analyser’s response characteristics are not linear, data cannot be reliably scaled into concentrations.
3. Instrument signal noise. This test checks that an analyser responds to calibration gases in a stable manner with time. A “noisy” analyser may not provide high quality data which may be difficult to process at lower concentrations.
4. Analyser response time. This test checks that the analyser responds quickly to a change in gas concentrations. If analyser response is too slow, data may not accurately reflect ambient concentrations.
5. Leak and flow checks. These tests ensure that ambient air reaches the analysers, without being compromised in any way. Leaks in the sampling system can affect the ability of the analyser to sample ambient air reliably.
6. NOx analyser converter efficiency. This test evaluates the ability of the analyser to measure NO_2. An inefficient converter severely compromises the data from the analyser.
7. FDMS k_0 evaluation. The analyser uses this factor to calculate mass concentrations, so the value is calculated to determine its accuracy compared to the stated value.
8. Particulate analyser flow rate checks. These tests ensure that the flow rates through critical parts of the analyser are within specified limits. There are specific analyser flow rates that are set to make sure particle size fractions and mass concentration calculations are performed correctly.
9. SO_2 analyser hydrocarbon interference. This test evaluates the analyser’s ability to remove interfering hydrocarbon gases from the sample gas. A failed test could have significant implications for analyser data.
10. Evaluation of site cylinder concentrations. These tests use a set of Ricardo-AEA certified cylinders that are taken to all the sites. The concentrations of the site cylinders are used to scale pollution datasets, so it is important to ensure that the concentrations of gases in the cylinders do not change.

11. Competence of Local Site Operators (LSO) in undertaking calibrations. As it is the calibrations by the LSO's that are used to scale pollution datasets, it is important to check that these are undertaken competently.

Once all data have been collected, a "Network Intercomparison" is conducted. This utilises the audit gas cylinders transported to each site in the Network. These cylinders are recently calibrated by the Calibration Laboratory at Ricardo-AEA, and allow us to examine how different site analysers respond when they are supplied with the same gas used at other sites. For ozone analysers, the calibration is undertaken with recently calibrated ozone photometers.

The technique used to process the intercomparison results is broadly as follows:

- The analyser responses to audit gas are converted into concentrations, using provisional calibration factors obtained from the Management Units on the day of the intercalibration. These factors are also used for the provisional data supplied to the web/interactive TV services.
- These individual results are tabulated, and statistical analyses undertaken (e.g. network average result, network standard deviation, deviation of individual sites from the network mean etc.).

These results are then used to pick out problem sites, or "outliers", which are investigated further to determine reasons and investigate possible remedies for the outliers. The definition of an outlier is an analyser result that falls outside the following limits:

- ±10% of the network average for NOx, CO and SO_2 analysers,
- ±5% of the reference standard photometer for Ozone analysers,
- ±2.5 % of the stated ko value for FDMS analysers,
- ±10% for particulate analyser flow rates,
- ±10% for the recalculation of site cylinder concentrations.

Thus, the intercalibration investigates the quality of provisional data output by the Management Units for use in forecasting, interactive television services and the web. It also provides input into the ratification process by highlighting sites where close scrutiny of datasets is likely to be required.

Any outliers that are identified are rigorously checked to determine the cause, and any required corrective action to be taken, if necessary. There are a number of likely main causes for outlier results, as discussed below:

- Drift of an analyser between scheduled LSO calibrations. This is by far the most common cause of an outlier result, and one that is simply corrected for during ratification of data.
- Drift of site cylinder concentrations between intercalibrations. Site cylinders can sometimes become unstable, especially at low pressures. All site cylinder concentrations are checked every six months, and are replaced as necessary.
- Erroneous calibration factors. It can occasionally happen that an analyser calibration is unsuccessful, and results in unsuitable scaling factors being used to produce pollution datasets. These are identified and corrected during ratification.
- Pressurisation of the sampling system at the audit. Occasionally, an analyser can be very sensitive to small changes in applied flow rates of calibration gas. This is more difficult to identify and correct, and may have consequences for data quality.
- Leaks, sample switching valves, etc. Outliers can be generated if an analyser is not sampling ambient air properly. It is likely that if a leaking analyser is identified, data losses will result.

9 Results

The results section has been restructured to allow easier regional analysis. As well as a detailed national summary, a regional summary and breakdown outlier analysis is provided.

9.1 National Network Overview

9.1.1 Summary

The results of the intercalibration are summarised in Table 9.1 below:

Table 9.1 - Summary of audited analyser performance – 135 UK stations

Parameter	Number of outliers	Number in network	% outliers in total
NOx analyser	26	117	22%
CO analyser	0	9	0%
SO_2 analyser	6	30	20%
Ozone analyser	17	82	21%
FDMS and BAM analysers	1 k_0, 4 flow	58 FDMS PM_{10} 2 BAM PM_{10} 69 FDMS $PM_{2.5}$ 2 BAM $PM_{2.5}$	4%
Gravimetric PM analysers	0 flow	9 PM_{10} 9 $PM_{2.5}$	0%
Total	54	387	14.0%

Two of the 135 sites were not in operation at the time of the intercalibration. Replacement locations are currently being sought for the sites at Bury Roadside and Glasgow Centre.

A new site at Saltash Callington Road was commissioned, to replace the old Saltash Roadside location.

Great Dun Fell was not visited, due to the cold winter – the site was snowbound from November 2012 until May 2013

There are currently no gravimetric measurements of PM_{10} or $PM_{2.5}$ at either of the Glasgow monitoring stations.

The number of analyser outliers identified is worse than the previous exercise. At the Summer 2012 intercalibration 12.0% of the analysers in use were identified as outliers.

The procedures used to determine network performance are documented in Ricardo-AEA Work Instructions. These methods are regularly updated and improved and are evaluated by the United Kingdom Accreditation Service (UKAS). Ricardo-AEA holds ISO17025 accreditation for the on-site calibration of all the analyser types (NOx, CO, SO_2, O_3) and for the determination of the FDMS k_0 factor and particulate analyser flow rates used in the network. An ISO17025 certificate of calibration (Calibration Laboratory number 0401) for the analysers in the AURN is appended to this report.

9.1.2 Network Intercomparisons

The concentration of the audit cylinders was calculated averaged across all monitoring sites using the zero and scaling factors provided by the CMCU on the day of audit. How close the result is to the stated cylinder concentration is a good indication of the accuracy of the provisional results across the entire network. The results are given in Table 9.2. Certified cylinder concentrations are normalised for this purpose as several cylinders are used.

Table 9.2 Audit Cylinder Results

Parameter	Network Mean	Audit reference concentration	Network Accuracy %	%Std Dev
NO	458 ppb	452 ppb	1.3	4.2
NO_2	447 ppb	429 ppb	-4.0	4.9
CO	19.9 ppm	20.2 ppm	-1.6	2.7
SO_2	469 ppb	456 ppb	2.9	4.4

- Oxides of Nitrogen.

  A total of 26 outliers (22%) were identified during this intercalibration. This is worse than the previous exercise - 17% of the analysers were identified as outliers in the summer exercise.

  There were three converters which fell outside the ±5% acceptance limits. In addition, there were 7 converters identified where the initial result was outside the ±2% trigger for NO_2 rescaling. Additional analysis showed that a total of four outlier converters required rescaling or data deletion to be undertaken.

- Carbon Monoxide

  There were no outliers identified at this intercalibration. Just one outlier was identified at the previous exercise.

- Sulphur Dioxide

  A total of six outliers (21%) were identified at this intercalibration. This is an improvement from the summer exercise, when 9 analysers were found to be outside the acceptance limits. All m-xylene interference tests were less than 16ppb, compared to 26ppb in summer 2012.

- Ozone

  A total of 17 outliers (21%) were identified during the summer exercise. This is identical to the previous intercalibration, where 17 analysers were also found to be outside the ±5% acceptance criterion.

- Particulate Analysers

  Just one calculated k_0 determination was outside the required ±2.5% of the stated values. Two outliers were identified at the previous exercise.

  Four FDMS main flows were found to be outside the ±10% acceptance limits. This is worse than the previous exercise; just one analyser was identified in the summer.

  All Partisol analyser total flows were within the acceptance limits.

- Site Cylinder Concentrations

  9 of the 273 site cylinders (3.3%) used to scale ambient pollution data were found to be outside the ±10% acceptance limit, an improvement over the 4.3% identified in the summer.

9.2 London Sites

The results of the intercomparison for the 15 London sites in operation at the time of the intercalibration are summarised below:

Table 9.3 - Summary of audited analyser performance – London Sites

Parameter	Number of outliers	Number in region
NOx analyser	1	13
NOx converter	0	
CO analyser	0	3
SO_2 analyser	2	4
Ozone analyser	2	9
FDMS and BAM analysers	0 k_0, 1 flow	6 FDMS PM_{10} 10 FDMS $PM_{2.5}$
Gravimetric PM analysers	0	2 PM_{10} 3 $PM_{2.5}$
Cylinders	1	37

9.3 Scottish Sites

The results of the intercomparison for the 18 Scottish sites are summarised below:

Table 9.4 - Summary of audited analyser performance – Scottish Sites

Parameter	Number of outliers	Number in region
NOx analyser	1	14
NOx converter	2	
CO analyser	0	2
SO_2 analyser	0	3
Ozone analyser	2	10
FDMS and BAM analysers	0 k_0, 0 flow	6 FDMS PM_{10} 6 FDMS $PM_{2.5}$
Gravimetric PM analysers	0	4 PM_{10} 4 $PM_{2.5}$
Cylinders	0	33

9.4 Welsh Sites

The results of the intercomparison for the 10 Welsh sites are summarised below:

Table 9.5 - Summary of audited analyser performance – Welsh Sites

Parameter	Number of outliers	Number in region
NOx analyser	3	10
NOx converter	2	
CO analyser	0	2
SO_2 analyser	0	4
Ozone analyser	1	6
FDMS and BAM analysers	0 k_0, 1 flow	5 FDMS PM_{10} 1 BAM PM_{10} 3 FDMS $PM_{2.5}$ 1 BAM $PM_{2.5}$
Gravimetric PM analysers	0	2 PM_{10} 1 $PM_{2.5}$
Cylinders	2	26

9.5 Northern Ireland Sites (incl. Mace Head)

The results of the intercomparison for the 5 Northern Irish sites and Mace Head are summarised below:

Table 9.6 - Summary of audited analyser performance – Northern Irish Sites

Parameter	Number of outliers	Number in region
NOx analyser	1	3
NOx converter	0	
CO analyser	0	1
SO_2 analyser	0	3
Ozone analyser	0	4
FDMS and BAM analysers	0 k_0, 0 flow	4 FDMS PM_{10} 1 FDMS $PM_{2.5}$
Gravimetric PM analysers	0	0 PM_{10} 0 $PM_{2.5}$
Cylinders	0	9

9.6 English Sites

The results of the intercomparison for the 87 English sites are summarised below:

Table 9.7 - Summary of audited analyser performance – English Sites

Parameter	Number of outliers	Number in region
NOx analyser	20	76
NOx converter	6	
CO analyser	0	1
SO_2 analyser	4	16
Ozone analyser	12	53
FDMS and BAM analysers	1 k_0, 2 flow	37 FDMS PM_{10} 1 BAM PM_{10} 46 FDMS $PM_{2.5}$ 1 BAM $PM_{2.5}$
Gravimetric PM analysers	0	1 PM_{10} 4 $PM_{2.5}$
Cylinders	6	191

As noted earlier, the results from the intercalibration exercises are used to inform the entire data ratification process. Any actions required as a result of the intercalibration findings are discussed in the ratification section of this report.

10 Site Cylinder Concentrations

During the intercalibration, the concentrations of the on-site cylinders were evaluated using the audit cylinder standards. The calculated results showed that 9 of the 273 cylinders (3.3%) used to scale analyser data into concentrations (NO, CO and SO_2) were outside the ±10% acceptance criterion. This is better than the summer exercise, where 4.3% (13) of the scaling cylinders were outside the acceptance limits. There were six NO cylinders and three SO_2 cylinders identified as outliers.

In addition, the concentrations of 35 NO_2 cylinders appear to have drifted by more than 10%. NO_2 cylinders are not used for the scaling of data and so will not be replaced at this time. Hence, a total of 44 of the 273 cylinders (16.2%) were outside the acceptance limits. This is worse than the previous intercalibration, when 14.8% of cylinders were found to be outside the 10% acceptance.

One of the six NO cylinders (London Westminster) appears to have been contaminated; significant oxidation of the NO into NO_2 has occurred since the last intercalibration. The cylinder has been replaced and the performance of the new cylinder will be closely monitored at subsequent audits.

The remainder of the cylinders will be checked at the next audits and appropriate action taken if necessary.

11 Site Information

All site information is now uploaded to CMCU and UK-Air archive for dissemination using Google Earth. Ricardo-AEA makes considerable effort in ensuring that site locations are accurate on the new Google Earth site information and UK-Air archive pages. All future additions to the AURN will include accurate positioning using Google Earth.

12 CEN

The European Committee for Normalisation (CEN) have prepared a series of documents prescribing how analysers must be operated, to produce datasets that conform to the Data Quality Objectives of the EC Directives. The CEN documents for operation of air pollution analysers; BS EN14211:2005 (NOx), BS EN14212:2005 (SO_2), BS EN14626:2005 (CO) and BS EN14625:2005 (O_3) set out a series of performance criteria for analysers which must be achieved, both in the field and under laboratory conditions. The test requirements have been extensively reported in previous intercalibration summaries and should be referenced for further information.

The CEN operating methodologies are incorporated into the requirements of the air quality Directive 2008/50/EC. Member States had until June 2010 to ensure their monitoring networks are compliant. Older, non-compliant equipment still on site after this date will need to be replaced before June 2013. Ricardo-AEA has taken steps to ensure the procedures used in the UK comply with the requirements ahead of any imposed deadlines. To this end, the procedures used for the intercomparisons have been fully compliant with the CEN protocols since January 2006.

To comply with the Directive, the uncertainty for gaseous analyser measurements must be less than ±15%. For sites that have CEN-compliant gaseous instrumentation, it is possible to calculate the overall uncertainty of measuring air quality. This information is site and analyser specific and presented in the table below:

Table 12.1 – Analyser measurement uncertainties (%)

Date	Site	O_3	CO	SO_2	NO_2 hour	NO_2 ann	PM_{10}*	$PM_{2.5}$*
09-Jan	Barnsley Gawber	10.7		13.4	10	10		
15-Feb	Bath Roadside				13.5	14		
22-Jan	Billingham				13.5	14		
16-Jan	Birmingham Acocks Green	12.4			13.5	14		16.4
17-Jan	Birmingham Tyburn	8.7		12.3	11.8	11.8	8.7	16.4
17-Jan	Birmingham Tyburn Roadside	12.4			14.4	14.8	8.7	16.4
08-Jan	Blackburn Darwen Roadside				10.5	10.5		
07-Jan	Blackpool Marton	10.7			10	10		16.4
18-Feb	Bottesford	10.7						
05-Feb	Bournemouth	12.4			13.5	14		11
26-Feb	Brighton Preston Park	12.4			13.5	14		11
15-Feb	Bristol St Paul's	12.4			13.5	14	8.7	16.4
07-Feb	Cambridge Roadside				10.5	10.5		
06-Feb	Camden Kerbside				10.5	10.5	8.7	16.4
21-Feb	Canterbury	12.4			13.5	14		
08-Jan	Carlisle Roadside				14.6	14.6	8.7	16.4
15-Jan	Charlton Mackrell	11.8			13.5	14		
18-Feb	Chatham Centre Roadside				13.5	14	8.7	16.4
08-Jan	Chesterfield				13.5	14	8.7	16.4
08-Jan	Chesterfield Roadside				13.5	14	8.7	16.4
15-Jan	Coventry Memorial Park	10.7			10	10		16.4
27-Feb	Eastbourne				13.5	14	8.7	16.4
13-Feb	Exeter Roadside	8.7			11.8	11.8		
30-Jan	Glazebury	12.4			13.5	14		
	Great Dun Fell	No test						
05-Feb	Haringey Roadside				10.5	10.5	8.7	16.4
08-Jan	Harwell	12.4		13.4	13.5	14	8.7	16.4
08-Jan	Harwell PARTISOL						8	11
29-Jan	High Muffles	12.4			13.5	14		

Date	Site	O_3	CO	SO_2	NO_2 hour	NO_2 ann	PM_{10}*	$PM_{2.5}$*
14-Feb	Honiton				13.5	14		
25-Feb	Horley				10.5	10.5		
18-Jan	Hull Freetown	10.7		13.4	10	10	8.7	16.4
30-Jan	Ladybower	12.4		13.4	13.5	14		
15-Jan	Leamington Spa	12.4		13.4	13.5	14	8.7	16.4
14-Jan	Leamington Spa Rugby Road				13.5	14	8.7	16.4
17-Jan	Leeds Centre	10.7	9.5	13.4	10	10	8.7	16.4
17-Jan	Leeds Headingley Kerbside				13.5	14	8.7	16.4
16-Jan	Leicester Centre	10.7			10	10	8.7	16.4
14-Jan	Leominster	12.4			13.5	14		
19-Feb	Lincoln Canwick Road				13.5	14		
24-Jan	Liverpool Queen's Drive Roadside				13.5	14		
23-Jan	Liverpool Speke	10.7		13.4	13.5	14	8.7	16.4
11-Feb	London Bexley			13.4	13.5	14		16.4
12-Feb	London Bloomsbury	12.4		13.4	13.5	14	8.7	16.4
24-Jan	London Eltham	11.8			10.5	10.5	8.7	16.4
05-Dec	London Haringey	11.8			13.5	14		
31-Jan	London Harlington	12.4			13.5	14	8.7	16.4
06-Feb	London Harrow Stanmore							16.4
30-Jan	London Hillingdon	10.7			10	10		
21-Jan	London Marylebone Road	12.4	9.5	13.4	14.3	14.8	8.7	16.4
21-Jan	London Marylebone Road PARTISOL						8	11
22-Jan	London N. Kensington	12.4	9.5	13.4	13.5	14	8.7	16.4
22-Jan	London N. Kensington PARTISOL						8	11
08-Feb	London Teddington	12.4			13.5	14		16.4
28-Jan	London Westminster	12.4			13.5	14		11
17-Jan	Lullington Heath	12.4		13.4	13.5	14		
31-Jan	Manchester Piccadilly	10.7		13.4	10	10		16.4

Date	Site	O_3	CO	SO_2	NO_2 hour	NO_2 ann	PM_{10}*	$PM_{2.5}$*
30-Jan	Manchester South	12.4			13.5	14		
17-Jan	Market Harborough	10.7			10	10		
22-Jan	Middlesbrough	12.4		13.4	13.5	14	8.7	16.4
21-Jan	Newcastle Centre	10.7			10	10	8.7	16.4
21-Jan	Newcastle Cradlewell Roadside				13.5	14		
14-Jan	Northampton Kingsthorpe	8.7			11.8	11.8	8	
05-Feb	Norwich Lakenfields	10.7			10	10	8.7	16.4
18-Feb	Nottingham Centre	10.7		13.4	10	10	8.7	16.4
09-Jan	Oxford Centre Roadside				13.5	14		
09-Jan	Oxford St Ebbes				13.5	14	8.7	16.4
14-Feb	Plymouth Centre	10.7			10	10	8.7	16.4
28-Feb	Portsmouth	10.7			11.8	11.8	8.7	16.4
07-Jan	Preston	10.7			10	10		16.4
07-Jan	Reading New Town	10.7			10	10	8.7	16.4
18-Feb	Rochester Stoke	Not approved		13.4	13.5	14	8.7	16.4
29-Jan	Salford Eccles	11.8			10.5	10.5	8.7	16.4
23-Jan	Saltash Callington Road						8.7	16.4
06-Feb	Sandy Roadside				13.5	14	8.7	16.4
18-Jan	Scunthorpe Town			11	10.5	10.5	8.7	
07-Jan	Sheffield Centre	10.7			10	10	8.7	16.4
08-Jan	Sheffield Tinsley				13.5	14		
04-Feb	Sibton	12.4						
13-Feb	Southampton Centre	10.7		**22.2**	**23.9**	**23.9**	8.7	16.4
07-Mar	Southend-on-Sea	10.7			10	10		16.4
29-Jan	Southwark A2 Old Kent Road				13.5	14	8.7	
20-Feb	St Osyth	10.7			10	10		
19-Feb	Stanford-le-Hope Roadside				Not approved		8.7	16.4
23-Jan	Stockton-on-Tees Eaglescliffe				13.5	14	9.3	12.6
29-Jan	Stoke-on-Trent Centre	10.7			10	10	8.7	16.4

Date	Site	O_3	CO	SO_2	NO_2 hour	NO_2 ann	PM_{10}*	$PM_{2.5}$*
26-Feb	Storrington Roadside				10	10	8.7	16.4
23-Jan	Sunderland Silksworth	12.4			13.5	14		16.4
19-Feb	Thurrock	Analysers not approved					8.7	
13-Feb	Tower Hamlets Roadside		13.9		10.5	10.5		
23-Jan	Walsall Woodlands	12.4			13.5	14		
24-Jan	Warrington				10.5	10.5	8.7	16.4
05-Feb	Weybourne	10.7						
06-Feb	Wicken Fen	12.5		13.4	13.5	14		
28-Jan	Wigan Centre	10.7			10.5	10.5		16.4
22-Jan	Wirral Tranmere	10.7			10	10		16.4
07-Feb	Yarner Wood	12.4			13.5	14		
08-Jan	York Bootham						8.7	16.4
08-Jan	York Fishergate				10.5	10.5	8.7	16.4
08-Feb	Mace Head	Not approved						
15-Feb	Armagh Roadside				13.5	14	8.7	
04-Feb	Ballymena Ballykeel			No test				
06-Mar	Belfast Centre	No test	9.5	13.4	10	10	8.7	16.4
06-Feb	Derry	12.4		13.4	13.5	14	8.7	16.4
07-Feb	Lough Navar	12.4					8.7	
06-Feb	Aberdeen	12.4			13.5	14	8.7	16.4
05-Feb	Aberdeen Union Street Roadside				13.5	14		
30-Jan	Auchencorth Moss	12.4					8	11
30-Jan	Auchencorth Moss PM_{10} PM_{25} (FDMS)						8.7	16.4
30-Jan	Bush Estate	12.4			13.5	14		
23-Jan	Dumbarton Roadside				10.5	10.5		
28-Jan	Dumfries				13.5	14		
01-Feb	Edinburgh St Leonards	12.4	9.5	13.4	13.5	14	8.7	16.4
28-Jan	Eskdalemuir	12.4			13.5	14		
23-Jan	Fort William	12.4			13.5	14		
14-Jan	Glasgow Kerbside				10	10	8.7	16.4

Date	Site	O_3	CO	SO_2	NO_2 hour	NO_2 ann	PM_{10}*	$PM_{2.5}$*
22-Jan	Grangemouth			11	10.5	10.5	8.7	16.4
22-Jan	Grangemouth Moray				10.5	10.5		
08-Feb	Inverness				13.5	14	8	11
07-Feb	Lerwick	12.4						
29-Jan	Peebles	12.4			13.5	14		
08-Feb	Strath Vaich	12.4						
06-Feb	Aston Hill	12.4			13.5	14		
28-Feb	Cardiff Centre	12.4	9.5	13.4	13.5	14	8.7	16.4
04-Mar	Chepstow A48				11.6	11.7	8.7	16.4
01-Mar	Cwmbran	10.7			11.8	11.8		
20-Feb	Mold	No test			13.5	14		
25-Feb	Narberth	12.4		13.4	13.5	14	8.7	
26-Feb	Newport				13.5	14	8.7	16.4
27-Feb	Port Talbot Margam	10.7	9.5	13.4	13.5	14	8.7	16.4
27-Feb	Port Talbot Margam PM_{10} $PM_{2.5}$						8	
27-Feb	Swansea Roadside				13.5	14	9.3	12.6
21-Jan	Wrexham			13.4	13.5	14	8	11

This table is updated and extended after every intercalibration to include upgraded sites and replacement analysers. *Uncertainty calculations for PM_{10} and $PM_{2.5}$ are reported as best measurement capability (BMC).

The poor results for the SO_2 and NOx analysers at Southampton are believed to be due to failed linearity tests, rather than genuine non-linear responses from the instruments. This will be checked at the next intercalibration visit.

The ozone analysers at Rochester Stoke, and Mace Head are not CEN compliant models and therefore no generic performance data have been calculated.

The NOx analyser at Stanford-Le-Hope and the NOx, SO_2 and O_3 analysers at Thurrock are reported to be Environnement analysers, which are not CEN compliant models and therefore no generic performance data have been calculated. These observations will be confirmed at the next intercalibration and fully assessed during ratification.

13 Certification

The Network Certificate of Calibration is presented in Appendix 4. This certificate presents the results of the individual analyser scaling factors on the day of the audit, as calculated by Ricardo-AEA using the audit cylinder standards, in accordance with our ISO17025 accreditation.

14 Summary

The intercalibration exercise demonstrates its ongoing value as an effective tool in determining overall site performance and assessing the reliability and traceability of air quality measurements from a large scale network. The results from this intercalibration have been used to assess data quality during the ratification of the network datasets for the period October 2012 to March 2013.

Appendices

Appendix 1: Recommendations for Upgrade or Replacement of Equipment
Appendix 2: Partisol Data – October – December 2013
Appendix 3: Information for New Sites
Appendix 4: Certificate of Calibration

Appendix 1 - Recommendations for Upgrade or Replacement of Equipment

As requested by Defra, QA/QC Unit has provided a list of suggestions for equipment that may need replacing or upgrading in the network. The following provides a summary of the outstanding issues to date. Recommendations have been prioritised as follows:

Priority	Definition	Time-scale
High*	Immediate action necessary to avoid compromising data capture/quality or safety.	Within 2 weeks
Medium	Essential but not immediate	3-6 months
Low	Desirable but not essential	As appropriate

*Note – QA/QC Unit's practice is to notify CMCU immediately of any high priority issues at the time of the event.

Table A1 Recommendations.

Recommendations February 2012	Priority	Action
ESUs are reminded of the importance of supplying service records for Partisol samplers to QA/QC Unit.	High	ESU
Zero air scrubbers to be changed for zero air cylinders at all sites (where possible).	Medium	QA/QC ESU
Recommendations August 2008	**Priority**	**Action**
Many sites require modifications to permit safe roof access for measuring PM analyser flows.	High	CMCU
Recommendations January 2008	**Priority**	**Action**
It is recommended that LSOs continue to pay particular attention to the NO_2 calibration results, to see whether the NO response is significantly higher (>10ppb) than that obtained for the zero calibration. These observations should be reported to CMCU as soon as possible.	High	LSO
It is strongly recommended that ESUs clean all NOx analyser switching valves during servicing, and ensure the valve is leak checked afterwards. Suspect leaking valves are highlighted by the QA/QC Unit during audits.	High	ESU
Recommendations January 2007		
ESUs to ensure all NOx converter software settings to be 100%.	High	ESUs to check at service

Appendix 2

Partisol Data: January-March 2013

Table A2: Principal Reasons for Data Loss (below 90%), Partisols

Site	PM_{10}	PM_{25}	Reason
Auchencorth Moss	40%		Repeated water ingress
London Westminster		88%	Filter exchange failures

Appendix 3

Site Details

Details of all site locations can be found at http://uk-air.defra.gov.uk/interactive-map

Appendix 4

Certificate of Calibration

0401 **CERTIFICATE OF CALIBRATION**

Ricardo-AEA, Gemini Building, Fermi Avenue Harwell, Didcot, Oxfordshire OX11 0QJ

Telephone 01235 753212

Certificate Number: 02824
Ricardo-AEA Calibration ID Number: ED57002030

Authorised Signatories: S Eaton

B Stacey

Signed:

Date of Issue: 21 2013

Customer Name and Address: Emily Connolly

Science and Evidence Team
Atmosphere and Local Environment (ALE) Programme
Department for Environment, Food and Rural Affairs
Area 5E Ergon House, 17 Smith Square, London, SW1P 3JR

Date of Calibration: January-March 2013

Description: Calibration factors for monitoring stations in the UK Automatic Urban and Rural Monitoring Network

The reported expanded uncertainties are based on a standard uncertainty multiplied by a coverage factor k=2 providing a level of confidence of approximately 95% The uncertainty evaluation has been carried out in accordance with UKAS requirements.

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to the SI system of units and/or to units of measurement realised at the National Physical Laboratory or other recognised national metrology institutes. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory

RICARDO-AEA

1. Northern Ireland Sites (including Mace Head)

Carbon Monoxide

2013	Site	Analyser number	[1]Zero output	Uncertainty (ppm)	[2]Calibration Factor	Uncertainty (%)	*Maximum Residual (%)
06-Mar	Belfast Centre	462	1	0.2	1.077	2.2	1.7

Sulphur Dioxide

2013	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max Residual (%)	*m-xylene interference (ppb)
04-Feb	Ballymena Ballykeel	632		analyser	fault	at	audit	
06-Mar	Belfast Centre	1766	14	2.6	0.722	3	1.8	-0.6
06-Feb	Derry	1697	2	2.5	0.967	3.7	3.1	12.1

Ozone

2013	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max Residual (%)
06-Mar	Belfast Centre	cm08060038	analyser	not present	at audit		
06-Feb	Derry	1586	-2	3	1.040	3.1	0.6
07-Feb	Lough Navar	1640	2	3	1.020	3.1	0.8
08-Feb	Mace Head	77086-385	0	3	1.026	3.1	0.5

Oxides of Nitrogen

2013	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max residual (%)	*Converter efficiency (%)
15-Feb	Armagh Roadside	NO	1011845	0	2.7	1.105	3.5	0.7	
		NOx		1	2.7	1.106	3.5	0.4	99.5
06-Mar	Belfast Centre	NO	08050074	0	2.6	1.084	3.6	2.8	
		NOx		0	2.6	1.082	3.6	2.5	98.7
06-Feb	Derry	NO	2130	2	3.4	2.506	4.1	6.1	
		NOx		2	3.4	2.527	4.1	6.1	99.0

Particulate Analysers

2013	Site		Analyser number	Calculated Spring Constant k_0	Uncertainty (%)	[4]k_0 accuracy (%)	[3]Measured Main Flow (l/min	Uncertainty (%)	[3]Measured Total Flow (l/min)	Uncertainty (%)
15-Feb	Armagh Roadside	PM10	2000	13532	1	-0.3	2.80	2.2	15.74	2.2
06-Mar	Belfast Centre	PM10	24423	14226	1	0.2	2.91	2.2	15.39	2.2
06-Mar	Belfast Centre	PM25	26565	15598	1	-0.8	2.89	2.2	15.32	2.2
06-Feb	Derry	PM10	2701	16071	1	1.7	3.05	2.2	16.31	2.2
06-Feb	Derry	PM25	21313	10827	1	-0.6	2.99	2.2	15.95	2.2
07-Feb	Lough Navar	PM10	21196	12977	1	1.2	not	tested	18.19	2.2

2. Scottish Sites

Carbon Monoxide

2013	Site	Analyser number	[1]Zero output	Uncertainty (ppm)	[2]Calibration Factor	Uncertainty (%)	*Maximum Residual (%)
01-Feb	Edinburgh St Leonards	159	1	0.2	1.000	2.1	0.9

Sulphur Dioxide

Date Year =2013	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max Residual (%)	*m-xylene interference (ppb)	Analyser number
01-Feb	Edinburgh St Leonards	84	-3	2.5	0.985	3.4	1.9	9.2
22-Jan	Grangemouth	1211322	0	2.5	0.914	3	1.0	11.0

Ozone

2013	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max Residual (%)
06-Feb	Aberdeen	800	6	3	1.031	3.2	1.7
30-Jan	Auchencorth Moss	1646	-3	3	1.044	3.1	1.5
30-Jan	Bush Estate	1645	2	3	0.998	3.1	0.4
01-Feb	Edinburgh St Leonards	136	4	3	1.110	3.1	1.0
28-Jan	Eskdalemuir	158	1	3	1.038	4.0	0.5
23-Jan	Fort William	1023	0	3	1.063	3.1	0.7
07-Feb	Lerwick	2433	4	3	1.016	3.2	3.9
29-Jan	Peebles	2449	-3	3	1.010	3.1	1.6
08-Feb	Strath Vaich	279	-1	3	1.118	3.8	3.4

Oxides of Nitrogen

2013	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max residual (%)	*Converter efficiency (%)
06-Feb	Aberdeen	NO	519	4	2.7	1.340	3.5	0.5	
		NOx		5	2.8	1.329	3.5	0.3	88.4
05-Feb	Aberdeen Union	NO	299	0	2.7	1.187	3.5	0.5	
	Street Roadside	NOx		0	2.7	1.187	3.5	0.6	99.1
30-Jan	Bush Estate	NO	2244	1	2.5	1.043	3.5	1.5	
		NOx		2	2.5	1.031	3.5	1.5	100.8
23-Jan	Dumbarton	NO	1011833	0	2.6	1.102	3.5	1.9	
	Roadside	NOx		1	2.6	1.118	3.5	1.3	99.1
28-Jan	Dumfries	NO	1494	1	2.5	1.028	3.5	0.9	
		NOx		1	2.6	1.030	3.5	0.8	98.0
01-Feb	Edinburgh St	NO	73	0	2.6	1.066	3.5	3.2	
	Leonards	NOx		0	2.6	1.047	3.5	3.1	98.8
28-Jan	Eskdalemuir	NO	347	1	2.5	0.953	3.5	0.7	
		NOx		0	2.5	0.955	3.5	0.4	98.6
23-Jan	Fort William	NO	344	0	2.5	1.019	3.5	1.4	
		NOx		-2	2.5	0.965	3.5	1.4	100.8
14-Jan	Glasgow Kerbside	NO	08050061	0	2.6	1.279	3.5	1.1	
		NOx		1	2.7	1.282	3.5	1.0	98.2
22-Jan	Grangemouth	NO	1011836	0	2.5	1.039	3.6	2.0	

2013	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	[*]Max residual (%)	[*]Converter efficiency (%)
		NOx		1	2.7	1.052	3.5	2.1	98.5
22-Jan	Grangemouth	NO	1011852	0	2.5	1.061	3.5	0.6	
	Moray	NOx		0	2.5	1.079	3.5	0.7	98.7
08-Feb	Inverness	NO	1489	0	2.9	1.590	3.5	1.4	
		NOx		1	2.9	1.577	3.5	0.4	96.5
29-Jan	Peebles	NO	2213	1	2.5	1.043	3.5	1.4	
		NOx		2	2.7	1.037	3.5	0.7	101.8

Particulate Analysers

2013	Site		Analyser number	Calculated Spring Constant k_0	Uncertainty (%)	[4]k_0 accuracy (%)	[3]Measured Main Flow (l/min	Uncertainty (%)	[3]Measured Total Flow (l/min)	Uncertainty (%)
06-Feb	Aberdeen	PM10	24427	11644	1	0.7	3.31	2.2	16.04	2.2
06-Feb	Aberdeen	PM25	27368	12101	1	-1.0	2.94	2.2	15.57	2.2
30-Jan	Auchencorth Moss	PM10	26039	13009	1	-1.4	**2.75**	**2.2**	**16.41**	**2.2**
30-Jan	Auchencorth Moss	PM25	26033	13694	1	-2.3	**2.93**	**2.2**	**16.76**	**2.2**
30-Jan	Auchencorth Moss Partisol	PM10							analyser	fault
30-Jan	Auchencorth Moss Partisol	PM25	21548						16.16	2.2
01-Feb	Edinburgh St Leonards	PM10	27227	13547	1	-1.1	3.01	2.2	15.84	2.2
01-Feb	Edinburgh St Leonards	PM25	27233	16940	1	-0.4	3.07	2.2	15.45	2.2
14-Jan	Glasgow Kerbside	PM10	27344	14435	1	-1.0	**2.92**	**2.2**	**16.39**	**2.2**
14-Jan	Glasgow Kerbside	PM25	27337	15086	1	-0.2	**2.97**	**2.2**	**16.42**	**2.2**
22-Jan	Grangemouth	PM10	27228	15842	1	-0.5	3.06	2.2	16.46	2.2
22-Jan	Grangemouth	PM25	27259	13644	1	-0.9	2.99	2.2	15.74	2.2
08-Feb	Inverness	PM10	21555						16.86	2.2
08-Feb	Inverness	PM25	21861						16.69	2.2

3. Welsh Sites

Carbon Monoxide

2013	Site	Analyser number	[1]Zero output	Uncertainty (ppm)	[2]Calibration Factor	Uncertainty (%)	[*]Maximum Residual (%)
28-Feb	Cardiff Centre	14333	0	0.2	0.990	2.2	3.1
27-Feb	Port Talbot Margam	ch0	1	0.2	0.976	2.1	0.0

Sulphur Dioxide

Date Year =2013	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	[*]Max Residual (%)	[*]m-xylene interference (ppb)	Analyser number
28-Feb	Cardiff Centre	14319	-1	2.6	1.151	3.2	0.9	2.4
25-Feb	Narberth	14896	2	2.5	0.889	3.4	2.6	2.7
27-Feb	Port Talbot Margam	ch1	0	2.5	0.953	3.1	1.2	1.0
21-Jan	Wrexham	1181	-1	2.5	0.826	3	0.9	3.5

Ozone

2013	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	[*]Max Residual (%)
06-Feb	Aston Hill	14337	-1	3	0.990	3.3	0.4
28-Feb	Cardiff Centre	14348	-4	3	0.964	3.1	0.7
01-Mar	Cwmbran	2	0	3	0.963	3.1	1.9
20-Feb	Mold	17499		analyser	fault		
25-Feb	Narberth	10280	0	3	1.008	3.2	1.2
27-Feb	Port Talbot Margam	ch3	1	3	1.077	3.1	0.7

Oxides of Nitrogen

2013	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	[*]Max residual (%)	[*]Converter efficiency (%)
06-Feb	Aston Hill	NO	17677	1	2.6	1.129	3.5	0.8	
		NOx		1	2.6	1.123	3.5	0.6	98.6
28-Feb	Cardiff Centre	NO	14325	1	2.5	0.906	3.5	1.9	
		NOx		1	2.5	0.914	3.5	0.9	97.9
04-Mar	Chepstow A48	NO	1011828	0	2.7	1.156	3.5	1.1	
		NOx		1	2.6	1.223	3.5	0.7	100.0
01-Mar	Cwmbran	NO	1	1	2.5	0.992	3.5	0.9	
		NOx		1	2.5	0.993	3.5	0.4	94.5
20-Feb	Mold	NO	345	9	3.3	2.005	3.6	2.3	
		NOx		9	3.6	2.485	3.5	1.2	92.5
25-Feb	Narberth	NO	14311	0	2.5	0.995	3.5	1.6	
		NOx		-1	2.5	0.979	3.5	0.6	99.2
26-Feb	Newport	NO	1011829	0	2.6	1.132	3.5	0.6	
		NOx		0	2.6	1.134	3.5	0.9	97.9
27-Feb	Port Talbot	NO	ch2	2	2.5	1.009	3.5	1.3	
	Margam	NOx		2	2.5	0.991	3.5	1.7	99.7
27-Feb	Swansea	NO	16695	1	3.4	2.480	3.5	1.2	
	Roadside	NOx		1	3.4	2.432	3.5	1.4	98.3
21-Jan	Wrexham	NO	1490	0	2.5	1.027	3.5	1.3	
		NOx		1	2.6	1.039	3.5	0.4	98.3

Particulate Analysers

2013	Site		Analyser number	Calculated Spring Constant k_0	Uncertainty (%)	[4]k_0 accuracy (%)	[3]Measured Main Flow (l/min	Uncertainty (%)	[3]Measured Total Flow (l/min)	Uncertainty (%)
28-Feb	Cardiff Centre	PM10	25499	13793	1	-0.6	2.91	2.2	15.23	2.2
28-Feb	Cardiff Centre	PM25	24449	11048	1	0.5	2.00	2.2	13.52	2.2
04-Mar	Chepstow A48	PM10	27242	14123	1	-0.4	**2.92**	**2.2**	**16.06**	**2.2**
04-Mar	Chepstow A48	PM25	27223	15976	1	-0.1	**2.80**	**2.2**	**15.37**	**2.2**
25-Feb	Narberth	PM10	26563	13880	1	0.1	3.00	2.2	15.70	2.2
26-Feb	Newport	PM10	22589	13752	1	-1.7	**3.02**	**2.2**	**16.72**	**2.2**
26-Feb	Newport	PM25	27252	16604	1	-0.1	analyser	fault	10.06	2.2
27-Feb	Port Talbot Margam	PM10	27217	13957	1	0.2	2.99	2.2	15.36	2.2
27-Feb	Port Talbot Margam	PM25	25081	10523	1	-0.3	not	tested	15.86	2.2
	Port Talbot Margam Partisol	PM10							not	tested
27-Feb	Swansea Roadside	PM10	20072						13.88	2.2
27-Feb	Swansea Roadside	PM25	20071						14.98	2.2
21-Jan	Wrexham	PM10	21224						13875	2.2
21-Jan	Wrexham	PM25	21011						12108	2.2

4. London Sites

Carbon Monoxide

2013	Site	Analyser number	[1]Zero output	Uncertainty (ppm)	[2]Calibration Factor	Uncertainty (%)	[*]Maximum Residual (%)
21-Jan	London Marylebone Road	652	1	0.2	1.116	2.3	3.7
22-Jan	London N. Kensington	2313	0	0.2	1.000	2.7	2.7

Sulphur Dioxide

Date Year =2013	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	[*]Max Residual (%)	[*]m-xylene interference (ppb)	Analyser number
11-Feb	London Bexley	318	9	2.5	0.813	3.4	2.5	-8.4
12-Feb	London Bloomsbury	74	10	2.5	0.825	3.3	3.5	5.4
21-Jan	London Marylebone Rd	2644	1	2.5	1.030	3.5	2.3	10.5
22-Jan	London N. Kensington	2576	2	2.5	0.979	3.1	0.9	9.2

Ozone

2013	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	[*]Max Residual (%)
12-Feb	London Bloomsbury	435	0	3	1.079	3.2	1.2
24-Jan	London Eltham	1111938	0	3	1.024	3.1	1.0
05-Dec-12	London Haringey Priory Park South	953	0	3	0.953	3.1	1.5
31-Jan	London Harlington	107	-1	3	0.992	3.2	0.8

2013	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max Residual (%)
30-Jan	London Hillingdon	8060034	0	3	1.028	3.1	0.4
21-Jan	London Marylebone Road	2432	2	3	1.020	3.1	1.8
22-Jan	London N. Kensington	189	5	3	1.055	3.1	0.1
08-Feb	London Teddington	2447	-2	3	1.053	3.1	0.9
28-Jan	London Westminster	879	0	3	0.994	3.1	1.0

Oxides of Nitrogen

2013	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max residual (%)	*Converter efficiency (%)
06-Feb	Camden Kerbside	NO	1011846	-1	2.8	1.067	3.5	0.2	
		NOx		2	2.9	1.079	3.5	0.3	100.0
05-Feb	Haringey	NO	1011827	0	2.5	1.074	3.5	0.7	
	Roadside	NOx		2	2.7	1.077	3.5	0.8	100.4
11-Feb	London Bexley	NO	327	0	2.6	1.110	3.5	0.4	
		NOx		0	2.6	1.099	3.5	0.7	100.3
12-Feb	London	NO	74	1	2.9	1.711	3.5	0.4	
	Bloomsbury	NOx		2	3.0	1.711	3.5	0.1	101.0
24-Jan	London Eltham	NO	1011834	0	2.5	1.045	3.5	1.8	
		NOx		2	2.8	1.054	3.5	2.4	98.8
05-Dec-12	London Haringey	NO	11392	0	2.5	1.013	3.5	3.1	
	Priory Park South	NOx		0	2.5	0.994	3.5	3.3	98.7
31-Jan	London Harlington	NO	1090	0	2.6	1.173	3.8	5.2	
		NOx		-1	3.3	1.164	3.7	4.9	99.0
30-Jan	London Hillingdon	NO	8050017	0	2.5	0.918	3.5	2.7	
		NOx		0	2.5	0.911	3.5	2.3	100.0
21-Jan	London	NO	3366	4	2.7	1.337	3.8	1.7	
	Marylebone Road	NOx		2	2.7	1.315	6.9	5.2	100.1
22-Jan	London N.	NO	3273	2	2.6	1.191	3.5	1.6	
	Kensington	NOx		3	2.6	1.205	3.5	2.2	99.1
08-Feb	London	NO	3406	1	2.6	1.212	3.5	0.5	
	Teddington	NOx		-1	3.3	1.232	3.5	1.5	100.9
28-Jan	London	NO	571	2	2.8	1.496	3.5	1.0	
	Westminster	NOx		3	2.8	1.512	3.5	0.8	99.8
29-Jan	Southwark A2	NO	1954	-12	3.3	1.057	3.5	3.4	
	Old Kent Road	NOx		-29	4.0	1.044	3.5	1.0	98.6
13-Feb	Tower Hamlets	NO	1011838	0	2.6	1.267	3.5	0.3	
	Roadside	NOx		1	3.4	1.287	3.5	0.3	100.0

Particulate Analysers

2013	Site		Analyser number	Calculated Spring Constant k_0	Uncertainty (%)	[4]k_0 accuracy (%)	[3]Measured Main Flow (l/min	Uncertainty (%)	[3]Measured Total Flow (l/min)	Uncertainty (%)
06-Feb	Camden Kerbside	PM10	21159	11996	1	0.1	3.05	2.2	16.19	2.2
06-Feb	Camden Kerbside	PM25	21391	12956	1	1.6	3.08	2.2	15.83	2.2
05-Feb	Haringey Roadside	PM10	27338	15291	1	0.2	3.26	2.2	16.86	2.2
05-Feb	Haringey Roadside	PM25	27278	13713	1	-0.6	3.04	2.2	17.95	2.2
11-Feb	London Bexley	PM25	25007	11511	1	-0.7	2.90	2.2	15.08	2.2
12-Feb	London Bloomsbury	PM10	24446	13650	1	-0.7	3.03	2.2	15.50	2.2
12-Feb	London Bloomsbury	PM25	27240	14729	1	-0.2	3.03	2.2	15.71	2.2
24-Jan	London Eltham	PM25	2000	13849	1	0.2	2.98	2.2	16.54	2.2
31-Jan	London Harlington	PM10	24902	12168	1	-1.0	2.94	2.2	15.85	2.2
31-Jan	London Harlington	PM25	23959	12811	1	0.0	2.95	2.2	15.77	2.2
06-Feb	London Harrow Stanmore	PM25	27274	16081	1	-1.0	3.03	2.2	15.82	2.2
21-Jan	London Marylebone Road	PM10	27230	16770	1	-1.0	3.11	2.2	16.38	2.2
21-Jan	London Marylebone Road	PM25	27239	12977	1	1.3	3.03	2.2	17.29	2.2
21-Jan	London Marylebone Road PARTISOL	PM10	20943						16.55	2.2
21-Jan	London Marylebone Road PARTISOL	PM25	21221						16.35	2.2
22-Jan	London N. Kensington	PM10	27391	12822	1	1.2	2.95	2.2	16.38	2.2
22-Jan	London N. Kensington	PM25	21342	15788	1	0	2.95	2.2	16.32	2.2
22-Jan	London N. Kensington PARTISOL	PM10	21015						16.44	2.2
22-Jan	London N. Kensington PARTISOL	PM25	21019						16.55	2.2
08-Feb	London Teddington	PM25	25023	15297	1	-0.5	3.15	2.2	16.65	2.2
28-Jan	London Westminster	PM25	20939						16.53	2.2
29-Jan	Southwark A2 Old Kent Road	PM10	2000	14932	1	-1.3	0.98	2.2	16.23	2.2

5. English Sites

Carbon Monoxide

2013	Site	Analyser number	[1]Zero output	Uncertainty (ppm)	[2]Calibration Factor	Uncertainty (%)	[*]Maximum Residual (%)
17-Jan	Leeds Centre	1501	2	0.2	1.111	2.2	1.3

Sulphur Dioxide

Date Year =2013	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max Residual (%)	*m-xylene interference (ppb)	Analyser number
09-Jan	Barnsley Gawber	08050082	-3	2.7	0.798	3.1	1.9	4.6
17-Jan	Birmingham Tyburn	EH937000	2	2.4	0.648	3.1	0.1	0.4
08-Jan	Harwell	14350	11	2.5	1.020	3.2	1.1	6.4
18-Jan	Hull Freetown	342	2	2.6	1.082	3.6	7.9	9.7
30-Jan	Ladybower	1178	-22	3.3	1.266	3.2	1.4	11.8
17-Jan	Leeds Centre	08050084	-2	3.3	1.152	3.1	2.7	3.5
23-Jan	Liverpool Speke	1765	9	2.8	0.963	3.1	0.9	16.1
17-Jan	Lullington Heath	12181	2	2.5	1.037	3.2	4.4	11.4
31-Jan	Manchester Piccadilly	19216	0	2.6	0.932	3.2	3.3	12.1
22-Jan	Middlesbrough	1660	7	2.5	1.048	4.1	3.2	0.9
18-Feb	Nottingham Centre	1629	0	2.6	0.621	4.0	2.8	3.8
18-Feb	Rochester Stoke	2800	9	4.0	1.129	4.5	4.0	14.7
18-Jan	Scunthorpe Town	1108-70	55	4.1	1.004	3.4	5.7	0.0
13-Feb	Southampton Centre	343	1	2.6	1.139	18.3	21.6	7.7
19-Feb	Thurrock	20092	2	2.6	0.846	3.1	1.9	3.8
06-Feb	Wicken Fen	11689	-2	2.6	0.984	3.3	2.8	9.5

Ozone

2013	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max Residual (%)
09-Jan	Barnsley Gawber	cm08060030	0	3	1.051	3.1	0.4
16-Jan	Birmingham Acocks Green	2435	-3	3	1.017	3.1	0.6
17-Jan	Birmingham Tyburn	WB6AG7TM	0	3	1.032	3.1	1.2
17-Jan	Birmingham Tyburn Roadside	2434	0	3	1.045	3.2	0.8
07-Jan	Blackpool Marton	080060037	0	3	0.977	3.1	1.9
18-Feb	Bottesford	CM08060022	1	3	0.959	3.3	0.9
05-Feb	Bournemouth	17503	-1	3	0.993	3.2	0.6
26-Feb	Brighton Preston Park	12461	-2	3	0.953	3.1	0.6
15-Feb	Bristol St Paul's	14358	-2	3	1.042	3.1	0.5
21-Feb	Canterbury	19194	6	3	0.912	3.1	0.1
15-Jan	Charlton Mackrell	1111957	0	3	1.065	3.1	1.6
15-Jan	Coventry Memorial Park	CM08060044	0	3	1.014	3.1	1.2
13-Feb	Exeter Roadside	2	3	3	0.915	3.1	0.9
30-Jan	Glazebury	19751	1	3	1.006	3.1	0.2
08-Jan	Harwell	17497	-1	3	1.010	3.1	0.5
29-Jan	High Muffles	1641	1	3	1.046	3.1	2.5
18-Jan	Hull Freetown	cm08060045	0	3	1.043	3.1	0.6
30-Jan	Ladybower	1651	-1	3	0.969	3.1	0.3
15-Jan	Leamington Spa	411790	0	3	1.015	3.5	2.1
17-Jan	Leeds Centre	cm08060036	0	3	1.076	3.1	0.8
16-Jan	Leicester Centre	CM08060020	1	3	1.062	3.1	1.8

RICARDO-AEA

2013	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max Residual (%)
14-Jan	Leominster	#014470	0	3	0.993	3.1	0.1
23-Jan	Liverpool Speke	CM08060041	1	3	0.990	3.2	0.4
17-Jan	Lullington Heath	17494	0	3	1.035	3.1	0.3
31-Jan	Manchester Piccadilly	cm08060039	0	3	0.998	3.1	0.4
30-Jan	Manchester South	16954	-1	3	1.024	3.1	0.5
17-Jan	Market Harborough	CM08060031	-1	3	1.059	3.1	0.8
22-Jan	Middlesbrough	944	-2	3	1.013	3.1	2.3
21-Jan	Newcastle Centre	cm08060033	-1	3	0.968	3.1	1.1
14-Jan	Northampton Kingsthorpe	47R76STR	0	3	1.032	3.1	0.4
05-Feb	Norwich Lakenfields	CM08060028	0	3	1.036	3.1	0.2
18-Feb	Nottingham Centre	60032	0	3	1.095	3.1	0.9
14-Feb	Plymouth Centre	2	0	3	1.085	3.1	0.6
28-Feb	Portsmouth	CM08060023	-1	3	1.038	3.2	0.9
07-Jan	Preston	cm8060042	1	3	1.006	3.1	0.6
07-Jan	Reading New Town	CM08060025	0	3	1.014	3.1	0.7
18-Feb	Rochester Stoke	378	2	3	1.007	3.2	0.7
29-Jan	Salford Eccles	1111956	0	3	0.853	3.1	1.1
07-Jan	Sheffield Centre	cm08060024	0	3	1.055	3.2	1.0
04-Feb	Sibton	14339	-1	3	1.007	3.1	0.2
13-Feb	Southampton Centre	cm08060021	0	3	1.088	3.4	1.2
07-Mar	Southend-on-Sea	CM08060017	0	3	1.166	3.2	0.7
20-Feb	St Osyth	cm08050073	0	3	0.994	3.1	0.9
29-Jan	Stoke-on-Trent Centre	CM08060026	0	3	1.042	3.1	0.8
23-Jan	Sunderland Silksworth	436	1	3	1.352	4.9	1.4
19-Feb	Thurrock	20094	0	3	1.037	3.2	3.1
23-Jan	Walsall Woodlands	19222	0	3	1.179	3.1	0.7
05-Feb	Weybourne	AEA0030	-3	3	1.038	3.2	0.4
06-Feb	Wicken Fen	14345	-2	3	1.055	5.4	0.7
28-Jan	Wigan Centre	cm08060018	-2	3	1.011	3.3	1.3
22-Jan	Wirral Tranmere	CM08060040	-1	3	1.014	3.1	0.9
07-Feb	Yarner Wood	19192	-2	3	1.049	3.3	1.9

Oxides of Nitrogen

2013	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max residual (%)	*Converter efficiency (%)
09-Jan	Barnsley	NO	08050057	1	2.6	1.217	3.5	1.7	
	Gawber	NOx		1	2.6	1.209	3.5	1.7	100.9
15-Feb	Bath Roadside	NO	12758	1	2.6	1.116	3.5	1.8	
		NOx		1	2.6	1.102	3.5	1.4	95.8
22-Jan	Billingham	NO	574	1	2.7	1.300	3.5	0.4	
		NOx		1	2.7	1.289	3.5	0.1	99.5

2013	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max residual (%)	*Converter efficiency (%)
16-Jan	Birmingham	NO	3364	0	2.6	1.131	3.5	0.6	
	Acocks Green	NOx		2	2.8	1.126	3.5	0.7	100.2
17-Jan	Birmingham	NO	Y7ACC7MC	0	2.5	0.958	3.5	0.6	
	Tyburn	NOx		0	2.5	0.951	3.5	0.5	99.5
17-Jan	Birmingham	NO	68	1	3.0	1.869	7.2	4.8	
	Tyburn Roadside	NOx		1	3.1	1.879	6.9	4.6	99.1
08-Jan	Blackburn	NO	1011851	-1	2.5	0.962	3.5	1.3	
	Darwen Roadside	NOx		6	3.0	0.972	3.5	1.4	98.7
07-Jan	Blackpool	NO	08050075	0	2.5	0.925	4.9	3.6	
	Marton	NOx		0	2.5	0.877	3.5	1.4	100.0
05-Feb	Bournemouth	NO	17507	3	2.6	1.154	3.5	0.4	
		NOx		1	2.6	1.095	3.5	1.1	96.0
26-Feb	Brighton Preston	NO	13068	3	2.6	1.194	3.5	0.2	
	Park	NOx		2	2.6	1.184	3.5	0.1	98.8
15-Feb	Bristol St Paul's	NO	14353	0	2.6	1.244	3.5	0.3	
		NOx		2	2.7	1.252	3.5	0.2	98.6
07-Feb	Cambridge	NO	1011843	-1	2.7	1.327	3.5	1.1	
	Roadside	NOx		2	2.7	1.327	3.5	0.3	101.0
21-Feb	Canterbury	NO	11666	1	3.5	1.312	3.5	1.8	
		NOx		0	3.8	1.243	3.5	0.6	99.0
08-Jan	Carlisle	NO	1011849	26	2.6	1.293	3.5	1.4	
	Roadside	NOx		29	2.7	1.304	3.5	0.9	99.5
15-Jan	Charlton	NO	12895	1	2.6	1.201	3.5	2.9	
	Mackrell	NOx		1	2.6	1.198	3.5	2.7	101.1
18-Feb	Chatham Centre	NO	3393	1	2.6	1.198	3.5	1.3	
	Roadside	NOx		0	3.0	1.165	3.5	0.6	99.6
08-Jan	Chesterfield	NO	1011837	0	2.5	0.996	3.5	1.8	
		NOx		2	2.5	1.013	3.5	1.2	100.9
08-Jan	Chesterfield	NO	1011835	0	2.8	1.202	3.5	3.7	
	Roadside	NOx		3	3.3	1.210	3.5	3.4	101.0
15-Jan	Coventry	NO	08030109	0	2.5	0.896	3.5	0.8	
	Memorial Park	NOx		-1	2.5	0.895	3.5	0.9	100.0
27-Feb	Eastbourne	NO	19209	8	2.6	1.128	3.5	0.9	
		NOx		9	2.9	1.122	3.5	0.9	99.0
13-Feb	Exeter Roadside	NO	1	-1	2.6	1.150	3.5	1.6	
		NOx		-2	2.6	1.133	3.5	1.8	98.7
30-Jan	Glazebury	NO	14354	2	2.6	1.124	3.5	0.2	
		NOx		6	2.6	1.142	3.5	1.2	99.5
08-Jan	Harwell	NO	14355	2	2.6	1.281	3.5	0.4	
		NOx		0	2.7	1.267	3.5	0.2	98.7
29-Jan	High Muffles	NO	1783	1	2.6	1.169	3.5	1.0	
		NOx		0	3.0	1.184	3.5	1.1	99.6

2013	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	[*]Max residual (%)	[*]Converter efficiency (%)
14-Feb	Honiton	NO	19214	0	2.6	1.175	3.5	1.1	
		NOx		10	9.8	1.189	3.7	0.8	101.0
25-Feb	Horley	NO	1401954	0	2.5	1.056	3.5	1.8	
		NOx		11	6.7	1.089	3.5	1.8	99.5
18-Jan	Hull Freetown	NO	08050056	0	2.5	0.895	4.6	8.8	
		NOx		0	2.5	0.933	4.6	8.8	98.9
30-Jan	Ladybower	NO	*072	0	2.6	1.136	3.5	2.2	
		NOx		-1	2.8	1.154	3.5	1.9	99.6
15-Jan	Leamington Spa	NO	1011842	0	2.5	1.012	3.6	2.7	
		NOx		2	2.5	1.023	3.7	3.2	99.5
14-Jan	Leamington Spa	NO	19211	2	2.7	1.165	3.5	0.7	
	Rugby Road	NOx		4	2.7	1.173	3.5	0.3	98.4
17-Jan	Leeds Centre	NO	08050066	0	4.1	1.474	3.6	3.6	
		NOx		0	6.0	1.475	3.7	3.8	100.0
17-Jan	Leeds Headingley	NO	342	0	2.6	1.162	3.5	0.7	
	Kerbside	NOx		2	2.6	1.180	3.5	0.1	98.2
16-Jan	Leicester Centre	NO	08050021	-1	2.5	0.916	3.5	0.8	
		NOx		0	2.5	0.913	3.5	0.5	96.9
14-Jan	Leominster	NO	#014863	0	3.6	2.695	4.4	3.5	
		NOx		1	3.6	2.729	4.5	3.6	103.2
19-Feb	Lincoln Canwick	NO	19203	1	2.6	1.182	3.5	0.4	
	Road	NOx		0	3.8	1.173	3.5	0.9	98.9
24-Jan	Liverpool Queen's	NO	1734	-1	2.5	1.024	3.5	0.5	
	Drive Roadside	NOx		0	2.5	1.009	3.5	0.9	100.7
23-Jan	Liverpool Speke	NO	356	0	2.6	1.119	3.5	1.3	
		NOx		-9	2.6	1.087	3.5	2.4	98.6
17-Jan	Lullington Heath	NO	14313	1	2.5	0.994	3.5	1.9	
		NOx		1	2.5	0.965	3.5	2.1	98.7
31-Jan	Manchester	NO	08050065	2	2.5	0.950	3.5	0.1	
	Piccadilly	NOx		2	2.5	0.995	3.5	0.5	97.7
30-Jan	Manchester	NO	17311	2	2.6	1.089	3.5	0.9	
	South	NOx		2	2.6	1.060	3.5	1.2	99.8
17-Jan	Market	NO	08050068	0	2.4	0.760	3.5	1.2	
	Harborough	NOx		1	2.4	0.776	3.5	1.3	101.3
22-Jan	Middlesbrough	NO	2287	2	2.6	1.273	3.5	0.3	
		NOx		12	2.6	1.254	3.5	2.0	101.0
21-Jan	Newcastle	NO	08050063	1	2.5	0.849	3.5	1.2	
	Centre	NOx		1	2.5	0.877	3.5	1.2	99.7
21-Jan	Newcastle	NO	1011853	0	2.7	1.117	3.5	1.1	
	Cradlewell Road	NOx		2	3.2	1.125	3.5	0.8	100.5
14-Jan	Northampton	NO	8ATJ6APR	0	2.5	0.988	3.5	1.1	

2013	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	[*]Max residual (%)	[*]Converter efficiency (%)
	Kingsthorpe	NOx		0	2.6	0.963	3.5	1.1	98.2
05-Feb	Norwich	NO	08050067	-1	2.5	0.989	3.5	1.2	
	Lakenfields	NOx		-1	2.5	0.978	3.5	1.3	101.1
18-Feb	Nottingham	NO	50072	1	2.6	1.202	3.5	0.4	
	Centre	NOx		0	2.6	1.207	3.5	0.6	100.8
09-Jan	Oxford Centre	NO	11844	1	2.6	1.091	3.5	1.6	
	Roadside	NOx		2	2.6	1.089	3.5	1.7	98.6
09-Jan	Oxford St Ebbes	NO	1011830	-1	2.6	0.973	3.5	2.0	
		NOx		1	3.0	0.978	3.5	1.7	100.8
14-Feb	Plymouth Centre	NO	1	1	2.4	0.721	3.5	0.1	
		NOx		1	2.4	0.724	3.5	0.5	99.7
28-Feb	Portsmouth	NO	p0t7cya5	-1	2.5	0.961	3.5	0.5	
		NOx		2	2.5	0.953	3.5	0.8	101.0
07-Jan	Preston	NO	cm0860064	0	2.5	0.966	3.5	1.0	
		NOx		0	2.5	0.950	3.5	1.0	98.9
07-Jan	Reading New	NO	08050059	0	2.5	0.913	3.5	1.0	
	Town	NOx		0	2.5	0.938	3.5	1.2	100.4
18-Feb	Rochester Stoke	NO	3095	1	2.9	1.209	3.5	2.2	
		NOx		1	2.8	1.226	3.5	1.7	99.1
29-Jan	Salford Eccles	NO	1011831	0	2.5	1.010	3.5	0.5	
		NOx		1	2.5	1.016	3.5	0.3	100.4
06-Feb	Sandy Roadside	NO	18006	1	2.6	1.172	3.5	1.8	
		NOx		2	2.6	1.167	3.5	1.3	100.2
18-Jan	Scunthorpe	NO	1011847	51	3.2	2.194	3.5	3.4	
	Town	NOx		52	3.2	2.198	3.5	3.4	98.2
07-Jan	Sheffield Centre	NO	08050055	0	2.5	0.911	3.5	1.8	
		NOx		-1	2.5	0.904	3.5	1.6	128.1
08-Jan	Sheffield Tinsley	NO	847	1	2.7	1.341	3.5	3.2	
		NOx		2	2.7	1.374	3.5	2.8	101.7
13-Feb	Southampton	NO	08030106	1	2.5	0.967	21.8	25.4	
	Centre	NOx		0	2.5	0.969	22.3	25.7	99.6
07-Mar	Southend-on-	NO	08050071	1	2.5	0.946	3.5	0.5	
	Sea	NOx		1	2.5	0.946	3.5	0.3	99.6
20-Feb	St Osyth	NO	08060035	-1	2.6	1.008	3.5	0.9	
		NOx		-2	2.7	0.993	3.5	1.6	100.4
19-Feb	Stanford-le-	NO	20093	1	2.6	1.220	3.5	0.1	
	Hope Roadside	NOx		2	2.6	1.223	3.5	0.3	100.7
23-Jan	Stockton-on-Tees	NO	335	1	2.6	1.138	3.5	0.8	
	Eaglescliffe	NOx		1	2.6	1.125	3.5	0.9	100.5
29-Jan	Stoke-on-Trent	NO	08050070	1	2.5	0.950	4.2	3.7	
	Centre	NOx		0	2.5	0.948	4.2	3.7	99.2
26-Feb	Storrington	NO	09040022	0	3.0	1.971	3.5	1.2	

2013	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	[*]Max residual (%)	[*]Converter efficiency (%)
	Roadside	NOx		0	3.0	1.962	3.5	1.5	100.0
23-Jan	Sunderland	NO	1011854	0	2.4	0.656	3.8	5.1	
	Silksworth	NOx		1	2.5	0.650	3.6	3.3	97.5
19-Feb	Thurrock	NO	20090	1	2.7	1.370	3.5	0.6	
		NOx		1	2.8	1.392	3.5	1.2	100.6
23-Jan	Walsall	NO	19213	1	2.6	1.116	3.5	1.3	
	Woodlands	NOx		5	2.6	1.132	3.5	1.7	99.7
24-Jan	Warrington	NO	1011826	-1	2.6	0.944	3.5	1.0	
		NOx		1	2.6	0.952	3.5	1.0	98.4
06-Feb	Wicken Fen	NO	13069	2	2.5	1.010	3.5	0.8	
		NOx		0	3.1	0.982	3.5	1.6	98.5
28-Jan	Wigan Centre	NO	1011832	1	2.5	0.986	3.5	2.6	
		NOx		2	2.5	0.986	3.5	0.9	95.0
22-Jan	Wirral Tranmere	NO	08050060	-1	2.5	0.908	3.5	0.5	
		NOx		-1	2.5	0.927	3.5	0.8	100.6
07-Feb	Yarner Wood	NO	14406	1	2.6	1.031	3.5	0.4	
		NOx		0	2.5	1.009	3.5	1.2	100.0
08-Jan	York Fishergate	NO	1011848	-1	2.7	0.992	3.5	0.9	
		NOx		2	3.0	1.000	3.5	1.0	99.4

Particulate Analysers

2013	Site		Analyser number	Calculated Spring Constant k_0	Uncertainty (%)	[4]k_0 accuracy (%)	[3]Measured Main Flow (l/min	Uncertainty (%)	[3]Measured Total Flow (l/min)	Uncertainty (%)
16-Jan	Birmingham Acocks Green	PM25	27304	15350	1	-1.6	2.90	2.2	15.53	2.2
17-Jan	Birmingham Tyburn	PM10	27255	14854	1	-0.6	2.86	2.2	15.49	2.2
17-Jan	Birmingham Tyburn	PM25	21372	14612	1	-0.5	3.05	2.2	15.95	2.2
17-Jan	Birmingham Tyburn Roadside	PM10	26034	12092	1	-2.3	2.55	2.2	15.09	2.2
17-Jan	Birmingham Tyburn Roadside	PM25	2000	14173	1	-1.8	2.94	2.2	15.77	2.2
07-Jan	Blackpool Marton	PM25	24424	12893	1	0.0	**2.99**	**2.2**	**16.55**	**2.2**
05-Feb	Bournemouth	PM25	21863						16.34	2.2
26-Feb	Brighton Preston Park	PM25	21865						16.70	2.2
15-Feb	Bristol St Paul's	PM10	24426	13297	1	0.9	**3.01**	**2.2**	**16.88**	**2.2**
15-Feb	Bristol St Paul's	PM25	2000-004	13682	1	-1.7	**2.95**	**2.2**	**16.30**	**2.2**
08-Jan	Carlisle Roadside	PM10	27257	14765	1	1.9	3.00	2.2	16.57	2.2
08-Jan	Carlisle Roadside	PM25	27320	14892	1	-1.8	2.99	2.2	16.16	2.2
18-Feb	Chatham Centre Roadside	PM10	27108	14450	1	-0.5	2.95	2.2	15.90	2.2
18-Feb	Chatham Centre Roadside	PM25	27343	15957	1	-0.3	2.86	2.2	15.19	2.2
08-Jan	Chesterfield	PM10	27316	16290	1	-0.2	2.87	2.2	15.64	2.2

2013	Site		Analyser number	Calculated Spring Constant k_0	Uncertainty (%)	[4]k_0 accuracy (%)	[3]Measured Main Flow (l/min	Uncertainty (%)	[3]Measured Total Flow (l/min)	Uncertainty (%)
08-Jan	Chesterfield	PM25	27314	12505	1	0.6	2.95	2.2	16.15	2.2
08-Jan	Chesterfield Roadside	PM10	22299	11472	1	1.1	3.01	2.2	16.08	2.2
08-Jan	Chesterfield Roadside	PM25	27339	17866	1	-2.4	2.96	2.2	16.14	2.2
15-Jan	Coventry Memorial Park	PM25	26445	14783	1	-1.2	**2.80**	**2.2**	**15.75**	**2.2**
27-Feb	Eastbourne	PM10	2000	14358	1	-1.0	3.07	2.2	16.19	2.2
27-Feb	Eastbourne	PM25	27244	14873	1	0.3	2.98	2.2	15.94	2.2
08-Jan	Harwell	PM10	27333	14783	1	-1.1	2.64	2.2	15.20	2.2
08-Jan	Harwell	PM25	21366	12418	1	0.2	3.01	2.2	15.69	2.2
08-Jan	Harwell Partisol	PM10	21257						16.22	2.2
08-Jan	Harwell Partisol	PM25	21859						15.91	2.2
18-Jan	Hull Freetown	PM10	24445	14116	1	0.1	2.92	2.2	15.73	2.2
18-Jan	Hull Freetown	PM25	26498	13973	1	-1.6	3.02	2.2	16.38	2.2
15-Jan	Leamington Spa	PM10	27295	15001	1	0.0	2.83	2.2	15.02	2.2
15-Jan	Leamington Spa	PM25	27248	14217	1	0.3	2.87	2.2	15.32	2.2
14-Jan	Leamington Spa Rugby Road	PM10	27205	13909	1	-0.2	**3.06**	**2.2**	**16.80**	**2.2**
14-Jan	Leamington Spa Rugby Road	PM25	26566	15854	1	-1.1	**3.05**	**2.2**	**17.08**	**2.2**
17-Jan	Leeds Centre	PM10	24451	13293	1	-0.8	3.14	2.2	15.93	2.2
17-Jan	Leeds Centre	PM25	27254	16929	1	-0.7	3.17	2.2	15.96	2.2
17-Jan	Leeds Headingley Kerbside	PM10	27287	17521	1	-0.4	2.95	2.2	15.88	2.2
17-Jan	Leeds Headingley Kerbside	PM25	27249	14607	1	-0.6	2.83	2.2	15.19	2.2
16-Jan	Leicester Centre	PM10	24442	14247	1	-1.5	2.9	2.2	15.34	2.2
16-Jan	Leicester Centre	PM25		analyser	not	present				
23-Jan	Liverpool Speke	PM10	24450	15765	1	-0.3	3.01	2.2	15.30	2.2
23-Jan	Liverpool Speke	PM25	28607	14733	1	-1.2	2.96	2.2	15.31	2.2
31-Jan	Manchester Piccadilly	PM25	26038	13770	1	-1.8	2.97	2.2	15.60	2.2
22-Jan	Middlesbrough	PM10	24325	13816	1	-2.2	**2.95**	**2.2**	**17.29**	**2.2**
22-Jan	Middlesbrough	PM25	27195	15813	1	-1.2	**2.96**	**2.2**	**17.61**	**2.2**
21-Jan	Newcastle Centre	PM10	24448	13868	1	0.3	**3.11**	**2.2**	**17.11**	**2.2**
21-Jan	Newcastle Centre	PM25	24447	14866	1	0.2	**3.05**	**2.2**	**17.32**	**2.2**
14-Jan	Northampton Kingsthorpe	PM25	21013						16.13	2.2
05-Feb	Norwich Lakenfields	PM10	21495	15549	1	-1.0	2.89	2.2	15.86	2.2
05-Feb	Norwich Lakenfields	PM25	27328	15732	1	0.8	2.86	2.2	15.26	2.2
18-Feb	Nottingham Centre	PM10	27369	15495	1	-0.6	2.93	2.2	15.51	2.2
18-Feb	Nottingham Centre	PM25	25025	12207	1	0.2	2.88	2.2	15.87	2.2
09-Jan	Oxford St Ebbes	PM10	27296	14819	1	0.0	3.01	2.2	16.36	2.2
09-Jan	Oxford St Ebbes	PM25	27235	17121	1	-0.3	2.87	2.2	15.85	2.2

2013	Site		Analyser number	Calculated Spring Constant k_0	Uncertainty (%)	[4]k_0 accuracy (%)	[3]Measured Main Flow (l/min	Uncertainty (%)	[3]Measured Total Flow (l/min)	Uncertainty (%)
14-Feb	Plymouth Centre	PM10	24428	12308	1	0.2	2.88	2.2	15.61	2.2
14-Feb	Plymouth Centre	PM25	27221	14306	1	-0.2	3.02	2.2	15.71	2.2
28-Feb	Portsmouth	PM10	7628	16814	1	-1.0	3.01	2.2	16.14	2.2
28-Feb	Portsmouth	PM25	21358	18405	1	-0.7	2.88	2.2	15.26	2.2
07-Jan	Preston	PM25	228810001	12784	1	-1.3	**3.03**	**2.2**	**16.61**	**2.2**
07-Jan	Reading New Town	PM10	21315	13212	1	0.1	2.93	2.2	15.77	2.2
07-Jan	Reading New Town	PM25	25090	14022	1	-0.8	2.97	2.2	15.63	2.2
18-Feb	Rochester Stoke	PM10	27241	14788	1	-0.8	2.97	2.2	15.58	2.2
18-Feb	Rochester Stoke	PM25	27258	15982	1	0.2	2.89	2.2	15.42	2.2
29-Jan	Salford Eccles	PM10	2000	13650	1	-0.3	2.95	2.2	16.11	2.2
29-Jan	Salford Eccles	PM25	27272	14487	1	-1.0	2.89	2.2	15.20	2.2
06-Feb	Sandy Roadside	PM10	22018	11170	1	-1.1	2.90	2.2	15.87	2.2
06-Feb	Sandy Roadside	PM25	27632	15928	1	-0.9	2.90	2.2	15.72	2.2
18-Jan	Scunthorpe Town	PM10	27366	14987	1	-0.1	2.84	2.2	15.39	2.2
07-Jan	Sheffield Centre	PM10	25024	12148	1	-3.6	2.91	2.2	16.05	2.2
07-Jan	Sheffield Centre	PM25	27253	15795	1	1.0	2.96	2.2	15.54	2.2
13-Feb	Southampton Centre	PM10	24448	13952	1	0.6	2.92	2.2	15.83	2.2
13-Feb	Southampton Centre	PM25	27258	16558	1	0.2	3.05	2.2	16.24	2.2
07-Mar	Southend-on-Sea	PM25	22927	12503	1	0.6	**2.95**	**2.2**	**16.63**	**2.2**
19-Feb	Stanford-le-Hope Roadside	PM10	12667	12628	1	-0.3	3.05	2.2	15.83	2.2
19-Feb	Stanford-le-Hope Roadside	PM25	13043	13205	1	1.2	3.19	2.2	16.36	2.2
23-Jan	Stockton-on-Tees Eaglescliffe	PM10	h4554						14.57	2.2
23-Jan	Stockton-on-Tees Eaglescliffe	PM25	h4553						15.51	2.2
29-Jan	Stoke-on-Trent Centre	PM10	25028	12533	1	0.2	2.88	2.2	15.92	2.2
29-Jan	Stoke-on-Trent Centre	PM25	27262	13602	1	0.7	2.90	2.2	16.03	2.2
26-Feb	Storrington Roadside	PM10	15679	15721	1	0.3	3.01	2.2	15.75	2.2
26-Feb	Storrington Roadside	PM25	27229	12838	1	0.7	2.97	2.2	15.56	2.2
23-Jan	Sunderland Silksworth	PM25	27247	15612	1	-1.2	2.98	2.2	15.81	2.2
19-Feb	Thurrock	PM10	27329	13934	1	-0.8	2.90	2.2	14.45	2.2
24-Jan	Warrington	PM10	27183	11884	1	-1.0	2.91	2.2	15.03	2.2
24-Jan	Warrington	PM25	27269	16234	1	-0.8	2.93	2.2	15.16	2.2
28-Jan	Wigan Centre	PM25	27291	14711	1	-1.0	2.83	2.2	14.71	2.2
22-Jan	Wirral Tranmere	PM25	22883	13249	1	-0.3	3.02	2.2	16.08	2.2
08-Jan	York Bootham	PM10	21877	14585	1	-1.0	2.95	2.2	15.14	2.2

2013	Site		Analyser number	Calculated Spring Constant k_0	Uncertainty (%)	[4] k_0 accuracy (%)	[3] Measured Main Flow (l/min	Uncertainty (%)	[3] Measured Total Flow (l/min)	Uncertainty (%)
08-Jan	York Bootham	PM25	27209	15999	1	-1.7	2.91	2.2	15.25	2.2
08-Jan	York Fishergate	PM10	27232	15600	1	-0.6	2.91	2.2	15.70	2.2
08-Jan	York Fishergate	PM25	27330	18062	1	-1.0	2.86	2.2	15.50	2.2

The above factors have been calculated using certified standards. The analysers listed above have been tested for zero response, calibration factor, linearity, converter efficiency (NOx analysers), m-xylene interference (SO_2 analysers), k_0 / main flow rate (for TEOM analysers) and total flow rate (for particulate analysers), by documented methods. Note that the test results are valid on the day of test only, as analyser drift over time cannot be quantified.

The calibration results for NOx, NO, CO, SO_2, O_3 and Particulates are those that fall within our scope of accreditation. Results marked with an asterisk (*) on this certificate fall outside our accreditation, but have been included for completeness.

1 The zero response is the zero reading on the logging system of the analyser when audit zero gas was introduced to the analysers under test.

2 The calibration factor is the multiplying factor required to scale the reading on the data logging system into concentration units (ppb for NO, NOx and SO_2, ppm for CO – 1ppm = 1000 ppb). It should be used in conjunction with the analyser output and the zero response, according to the following equation:

Concentration = (output – zero response) x Calibration factor

The scaling factor for gaseous analysers is calculated using mole fraction concentrations.

3 The measured main flow rate (where this is applicable) is the flow rate through the sensor unit of a TEOM analyser. The measured aux flow rate (where this is applicable) is the flow rate through the bypass tubing of the TEOM particulate analyser under test. The measured total flow rate is the total flow rate through the particulate analyser under test. Units of flow are $l.min^{-1}$. Measurements shown in **bold** are not made at the normal sample inlet and may not therefore accurately represent the actual flow through the inlet.

4 The k_0 accuracy value (specifically for TEOM analysers) indicates the closeness of the calculated result (in g/s^2 units) to the manufacturer's specified value of k_0.

* The maximum residual is the percentage maximum deviation of the worst linearity point from the line of best fit

* Converter is the measured efficiency of the NO_2 to NO converter in the Nitrogen Oxides analyser

* meta-xylene interference is the response of the SO_2 analyser when supplied with approx 1ppm meta-xylene.

This certificate is an electronic representation of a certificate signed by **Stewart Eaton** and held by Ricardo AEA at the above address. Hard copies are available on request.

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