QA/QC Data Ratification Report for the Automatic Urban and Rural Network, July-September 2013, and Intercalibration Report, Summer 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 87.69% for all pollutants (O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$) during the 3-month reporting period July-September 2013. Data capture for NO_2, O_3 and CO were above 90%. There were 45 sites with data capture less than 90% for the period.

A total of 135 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.

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SECTION A Data Ratification Report, July-September 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 July-30 September 2013. During this quarter there were a total of 135 operational monitoring sites in the Network of which there were 100 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 63 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 87.7% for all pollutants (O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$) during the 3 month reporting period July-September 2013 (see Table 1.1). The data captures for O_3, NO_2 and CO were above 90% average, whilst $PM_{2.5}$, PM_{10} and SO_2 failed to meet this target. Data capture statistics 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; gaps due to 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-September 2013

	CO	PM_{10}	$PM_{2.5}$	NO_2	O_3	SO_2	Mean
Q1 2013	**95.85**	**91.56**	**93.10**	**91.20**	**94.53**	**92.85**	**92.62**
Q2 2013	**95.23**	**81.43**	**89.29**	**95.77**	**96.51**	**93.61**	**92.89**
Q3 2013	**91.13**	**77.17**	**79.85**	**92.16**	**93.56**	**88.16**	**87.69**

Overall, 270 out of the 379 analysers (71%) 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 2013 Jan-Mar (No. below 90%)	Q2 2013 Apr-June (No. below 90%)	Q3 2013 Jul-Sept (No. below 90%)
CO	7	1	1	1
NO_2	116	15	10	20
O_3	82	10	5	9
PM_{10}[1]	69	15	26	34
$PM_{2.5}$[1]	80	14	14	39
SO_2	29	4	2	6
Total <90%		59	58	109

[1] Includes FDMS, BAM and Partisol analysers.

In total, 45 out of the 135 operational network sites in the quarter (16%) had an average data capture rate below the required 90% level for the July-September 2013 period. Of these, 38 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:

Gases:

Bath Roadside NOx reprocessed from January-June 2013

Camden Kerbside NOx reprocessed from January-June 2013

Charlton Mackrell NOx reprocessed from January-June 2013

Chatham Roadside NOx reprocessed from January-March 2013

Harwell NOx deleted from 15 May to 30 June (and on to 30 September); sampling fault

Narberth NOx NOx reprocessed from January-June 2013

Norwich Lakenfields NOx reprocessed from January-June 2013

Peebles, NOx and O_3 deleted from 4 February to 1 August, sampling faults

Portsmouth O_3, sample leak from 25 April up to 30 June (and on to 8 August)

Yarner Wood NOx reprocessed February 2013

Particulates:

Blackpool Marton $PM_{2.5}$, deleted from 1 January to 30 June, poor quality data

Eastbourne PM_{10}, deleted 14 April- 15 June, regional outlier

Haringey Roadside, PM_{10} deleted from 12 May to 30 June (and on to 26 August) and $PM_{2.5}$, 18-21 June, poor dryer performance.

Leamington Spa Rugby Road PM_{10}, deleted 20 April to 30 June, noisy data

Port Talbot Margam PM_{10}, deleted 29-30 June, PM_{10} volatiles lower than $PM_{2.5}$

Stanford-le-Hope Roadside PM_{10}, deleted 29 to 30 June (and on to 29 August), dryer fault resulting in high volatile concentrations

A list of changes to ratified data is given at http://uk-air.defra.gov.uk/data/changes-to-ratified-data

2 Changes in the Network for Directive Compliance

3 The following sites commenced operation this quarter:

Site	Pollutants	Date commissioned
Leicester University	NOx O_3 $PM_{2.5}$	27 September 2013*
London Teddington Bushy Park	$PM_{2.5}$	29 August 2013

The following sites closed

Site	Date closed
Lerwick	29 August 2013
Sheffield Centre	30 August 2013
Leicester Centre	23 September 2013

3 Generic Data Quality Issues

3.1 FDMS Performance Issues

Ongoing and intensive investigation into the performance of FDMS analysers has highlighted an apparent baseline offset, often related to dryer faults. 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

There were significant data losses from two sites noted this quarter; both affect data from previous quarters. These were at Harwell (NOx) and Peebles (NOx and O_3).

In the case of Harwell, the ESU installed individual sample lines in May following failure of the manifold fan. The sample inlet is particularly high at this site, and the tubes were installed below the top of the inlet in error, causing the analyser to sample air from inside the monitoring cabin. The NOx was clearly affected, and the SO_2 and O_3 will be reviewed next quarter.

Figure 1 Peebles NOx and O3, 2013

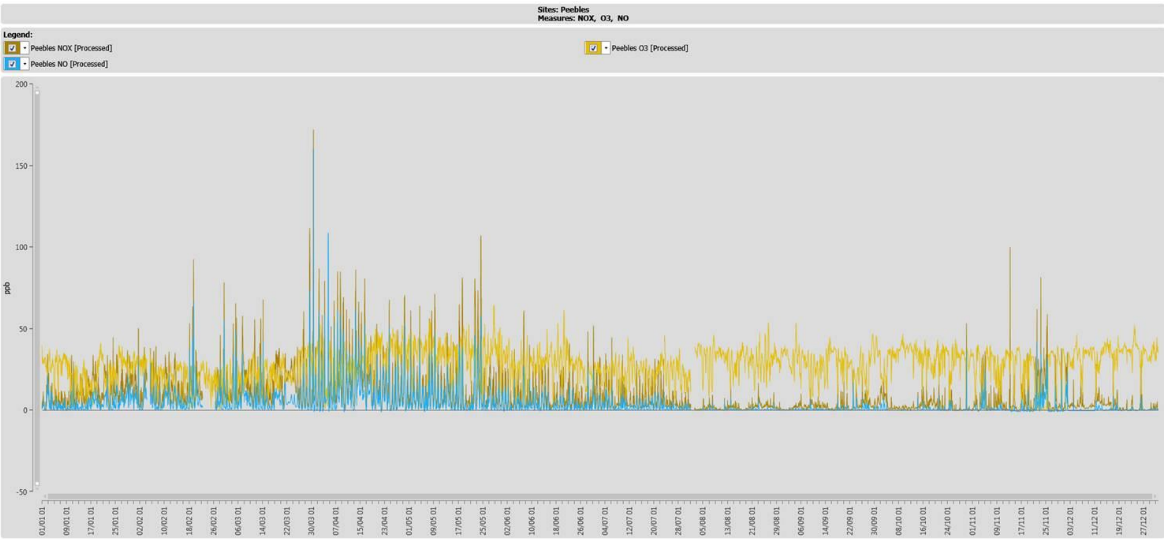

Figure *1* shows a clear step change in both pollutants (NOx and O_3) at the summer service. The engineer noted a leaking ozone sample filter, but it is believed that the NOx (and possibly O_3) sample inlets were disturbed during the service. The NOx profiles then much more closely resemble 2012 patterns. Both the NOx and O_3 datasets have been deleted between the winter and summer services.

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 at http://aurnhub.defra.gov.uk/cmcu-reports.php.

Sites/pollutants that have less than 90% data capture are shaded in yellow and those which have less than 85% data capture are shaded in orange.

4.1 London

4.1.1.Data Capture

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

Table 4.1 Data Capture for London, July-September 2013

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Camden Kerbside		95.38	96.01	99.82			97.07
Haringey Roadside		28.85	96.42	99.73			75.00
London Bexley			96.51	99.77		99.18	98.49
London Bloomsbury		77.85	88.68	96.29	96.38	57.11	83.26
London Eltham			98.60	99.68	99.82		99.37
London Haringey Priory Park South				99.64	99.91		99.77
London Harlington		96.15	96.69	96.29	97.28		96.60
London Harrow Stanmore			62.59				62.59
London Hillingdon				98.82	98.73		98.78
London Marylebone Road	97.69	96.51	97.15	97.55	99.73	97.64	97.71
London Marylebone Road		97.83	100.00				98.91
London N. Kensington	99.68	29.71	95.52	99.68	98.60	99.68	87.15
London N. Kensington		98.91	100.00				99.46
London Teddington			100.00	97.51	97.46		97.62
London Westminster			93.48	98.51	97.78		98.05

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Southwark A2 Old Kent Road		92.48		97.55			95.02
Tower Hamlets Roadside				99.73			99.73
Number of Sites	**2**	**9**	**13**	**14**	**9**	**4**	**17**
Number of Sites <85%	**0**	**3**	**1**	**0**	**0**	**1**	**3**
Number of Sites <90%	**0**	**3**	**2**	**0**	**0**	**1**	**4**
Mean	**98.69**	**79.30**	**93.97**	**98.61**	**98.41**	**88.41**	**93.21**

4.1.2 Site Specific Issues

Haringey Roadside

Both the $PM_{2.5}$ and PM_{10} volatile concentrations were seen to be low in comparison with other sites. Replacement dryers were requested. PM_{10} data have been deleted from 12 May to 26 August, and $PM_{2.5}$ data from 18 to 21 June.

London Bloomsbury

The SO_2 analyser had a lamp fault resulting in the loss of data from 18-23 July. The gas sample manifold was found to be full of water at the audit on 31 July; the analysers were turned off to prevent further damage. The SO_2 pump was found to be faulty at the service on 20 August; data between these events have been deleted.

The FDMS analysers, particularly the PM_{10}, suffered some data loss in July due to elevated site temperatures. A further problem with the main valve resulted in the loss of PM_{10} data from 28-30 August.

London Harrow Stanmore

Following the FDMS zero check on 7 August, the Hepa filter was not removed until 13 August. However, the sharp cut cyclone was not replaced when the filter was removed, and this was only detected on 10 September so data from 7 August to 10 September have been lost

London North Kensington

Following a dryer replacement in August, the PM_{10} concentrations were unstable and inconsistent with other local sites; all PM_{10} data up to 4 September have been deleted.

4.2 England (excluding London)

4.2.1Data Capture

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

Table 4.2 Data Capture for England, July-September 2013

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Barnsley Gawber				97.92	97.96	96.38	97.42
Bath Roadside				99.32			99.32
Billingham				98.60			98.60
Birmingham Acocks Green			95.20	98.37	98.64		97.40

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Birmingham Tyburn		96.29	80.53	99.14	99.82	82.43	91.64
Birmingham Tyburn Roadside		58.11	48.82	86.96	90.40		71.07
Blackburn Darwen Roadside				84.74			84.74
Blackpool Marton			0.00	94.52	98.64		64.39
Bottesford					96.20		96.20
Bournemouth			95.65	98.19	88.95		93.61
Brighton Preston Park			97.83	98.46	98.51		98.47
Bristol St Paul's		89.67	90.63	97.24	98.19		93.93
Cambridge Roadside				98.32			98.32
Canterbury				97.19	93.70		95.45
Carlisle Roadside		95.83	85.01	99.73			93.52
Charlton Mackrell				97.33	98.41		97.87
Chatham Centre Roadside		99.59	88.77	99.59			95.98
Chesterfield		84.19	91.89	98.69			91.59
Chesterfield Roadside		96.24	85.73	94.66			92.21
Coventry Memorial Park			77.26	94.20	98.14		89.87
Eastbourne		38.90	96.20	96.11			77.07
Exeter Roadside				97.92	98.78		98.35
Glazebury				98.37	96.24		97.31
Great Dun Fell					70.20		70.20
Harwell		7.88	19.11	0.00	97.60	93.52	43.62
Harwell		97.83	66.30				82.07
High Muffles				98.78	98.82		98.80
Honiton				98.46			98.46
Horley				98.28			98.28
Hull Freetown		84.19	94.61	92.48	95.97	97.06	92.86
Ladybower				98.10	98.41	42.30	79.60
Leamington Spa		88.50	88.32	95.43	99.64		92.97
Leamington Spa Rugby Road		0.00	95.24	98.01			64.42
Leeds Centre	97.06	94.57	78.85	97.01	91.12	96.88	92.58
Leeds Headingley Kerbside		96.74	68.70	98.91			88.12
Leicester Centre		92.96	91.17	93.30	97.27		93.68
Leominster				95.24	98.41		96.83
Lincoln Canwick Road				98.60			98.60
Liverpool Queen's Drive Roadside				59.65			59.65
Liverpool Speke		97.55	97.64	97.46	96.60	93.39	96.53
Lullington Heath				83.65	96.65	93.48	91.26
Manchester Piccadilly			89.86	77.31	97.10	97.01	90.32
Manchester South				67.07	97.74		82.40
Market Harborough				95.65	95.79		95.72
Middlesbrough		97.74	3.62	97.64	98.46	98.28	79.15
Newcastle Centre		94.07	93.89	93.30	97.46		94.68
Newcastle Cradlewell Roadside				95.38			95.38

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Northampton Kingsthorpe			97.83	98.10	97.15		97.63
Norwich Lakenfields		81.25	90.81	89.90	93.66		88.90
Nottingham Centre		97.69	97.55	89.99	89.67	86.19	92.22
Oxford Centre Roadside				99.14			99.14
Oxford St Ebbes		89.72	90.08	98.01			92.60
Plymouth Centre		83.47	80.80	97.51	97.60		89.84
Portsmouth		90.17	81.70	99.55	45.15		79.14
Preston			47.24	80.21	92.71		73.38
Reading New Town		72.10	76.90	98.23	98.51		86.44
Rochester Stoke		99.23	86.68	84.78	97.42	72.96	88.22
Salford Eccles		94.57	94.52	98.14	96.24		95.87
Saltash Callington Road		92.93	90.94				91.94
Sandy Roadside		62.27	87.27	99.50			83.02
Scunthorpe Town		47.24		98.55		98.96	81.58
Sheffield Centre		53.54	89.86	96.18	95.97		83.89
Sheffield Tinsley				64.40			64.40
Sibton					99.32		99.32
Southampton Centre		93.98	94.02	96.60	96.47	93.07	94.83
Southend-on-Sea			98.78	98.51	98.51		98.60
St Osyth				96.56	98.28		97.42
Stanford-le-Hope Roadside		35.05	66.80	89.95			63.93
Stockton-on-Tees Eaglescliffe		92.21	90.90	94.16			92.42
Stoke-on-Trent Centre		98.55	98.55	78.35	99.18		93.66
Storrington Roadside		49.46	76.59	99.14			75.06
Sunderland Silksworth			77.22	89.99	83.74		83.65
Thurrock		96.83		97.69	98.28	92.48	96.32
Walsall Woodlands				98.82	99.82		99.32
Warrington		99.55	92.16	99.28			97.00
Weybourne					99.05		99.05
Wicken Fen				98.23	98.28	0.00	65.50
Wigan Centre			95.15	98.55	98.87		97.52
Wirral Tranmere			87.45	90.13	96.69		91.43
Yarner Wood				87.73	98.60		93.16
York Bootham		95.06	95.24				95.15
York Fishergate		94.88	80.80	99.09			91.59
Number of Sites	**1**	**40**	**50**	**75**	**53**	**16**	**82**
Number of sites < 85 %	0	14	17	10	3	4	22
Number of sites < 90%	0	17	26	16	5	5	28
Network mean	**97.06**	**80.77**	**81.73**	**92.80**	**95.26**	**83.40**	**89.07**

4.2.2.Site Specific Issues

Birmingham Tyburn Roadside

The PM_{10} FDMS had a motor/seal fault resulting in the loss of data from 2 to 31 July; following the repair, the data were unstable up to 8 August and these data have been deleted. The $PM_{2.5}$ FDMS also had a motor failure on 8 August and was removed for workshop repair. Data has been lost from 1 July to 13 August. Both instruments were unstable for short periods later in the quarter resulting in further data loss.

Blackburn Darwen Roadside

A logger fault following the summer service resulted in no data being recorded up to 25 July, when the internal logger was configured and connected to the modem.

Blackpool Marton

The poor quality $PM_{2.5}$ data continued this quarter, following concerns in previous periods. The volatile concentrations are persistently negative, despite considerable ESU efforts to correct it. All $PM_{2.5}$ data have been deleted from 1 January to 30 September.

Coventry Memorial Park

The $PM_{2.5}$ data was of poor quality during the quarter, following problems with seals and the cooler.

Eastbourne

The volatile $PM_{2.5}$ concentrations were observed to be noisy and low in comparison with other sites; data have been deleted from 13 July to 30 August.

Great Dun Fell

An intermittent lamp fault was responsible for the loss of data between 19 July and 12 August.

Harwell

The sample inlet system was replaced by the ESU following failure of the manifold fan on 15 May. However, the NOx sample tube (and possibly the others) was not pushed fully through the conduit, and this resulted in partial sampling of internal cabin air. The sample inlet was replaced by the QA/QC unit on 30 October, where a step change in concentrations was observed. The NOx data have been deleted between these dates, and the SO_2 and ozone will be reviewed in the fourth quarter.

It was noted that both FDMS analysers over-read compared to the collocated Partisol data. Zero checks carried out on the FDMS analysers showed the baselines were above the acceptable limits, and new dryers were requested. The $PM_{2.5}$ data has been deleted up to the dryer change on 11 September, but the PM_{10} analyser remained noisy following the dryer change, and data have been deleted from 1 July to the ESU callout on 23 September.

Ladybower

The SO_2 analyser had a photomultiplier fault resulting in the deletion of data from 25 July to 13 September.

Leamington Spa Rugby Road

The PM_{10} data was noted as unacceptably noisy from 20 April to the end of this quarter.

Leeds Headingley Roadside

The $PM_{2.5}$ FDMS showed an unacceptably high zero during the zero check carried out 16-19 July. Data have been deleted from 2 to 31 July.

Liverpool Queens Drive Roadside

A fault with the air conditioning resulted in the analyser being switched off from 13 July to 5 August. Following this, the data looked anomalously high and have been deleted up to 14 August.

Manchester South

The NOx analyser was found to have a photomultiplier fault at the service on 28 August. This was finally resolved by workshop repair; data collection restarted on 26 September

Middlesbrough

The $PM_{2.5}$ analyser suffered from serious problems resulting in lengthy workshop repairs; all data from 4 July to 30 September have been deleted, and problems continue into the next quarter.

Norwich Lakenfields

Some PM_{10} data have been deleted due to zero checks and a pump fault found at the service on 31 July.

Plymouth

Following the FDMS zero checks on 3 July, the LSO did not reinstall the sharp cut cyclone on the $PM_{2.5}$ FDMS analyser. This was replaced at the scheduled service on 18 July. The PM_{10} FDMS was identified as a regional outlier and data from 6 to 18 July have been deleted.

Portsmouth

The ozone sample line was found to be loose at the back of the analyser at the summer QA/QC audit. On inspection of the data, the concentrations appear unexpectedly low and the data have been deleted from 25 April to 6 August.

The $PM_{2.5}$ FDMS had a number of ESU callouts for pump faults and leaks. Data have been deleted from 6 to 18 September.

Preston

Both the $PM_{2.5}$ FDMS and the NOx analysers suffered serious faults which required workshop repair. NOx data was lost from 22 August to 4 September, and $PM_{2.5}$ data from 4 to 8 July, and from 11 July to 22 August.

Reading New Town

Problems with the air conditioning at the site resulted in poor quality $PM_{2.5}$ And PM_{10} data throughout the quarter.

Rochester Stoke

The NOx analyser was found to be internally sampling from the service resulting in data loss from 9-17 July. A broken pump resulted in some lost $PM_{2.5}$ data during August. An unspecified fault with the SO_2 analyser resulted in data from 27 July to 6 August being deleted.

Sandy Roadside

The problem with unstable measurements of $PM_{2.5}$ and PM_{10} continued this quarter, with substantial data loss due to temperature and dryer faults despite numerous callouts and attention to the air conditioning.

Scunthorpe

The PM_{10} volatile concentrations were seen to be anomalously high (and rising) throughout the quarter, leading ultimately to dryer replacement on 17 October. Data from 20 August to the dryer replacement have been deleted.

Sheffield Centre

The performance of the PM_{10} FDMS was becoming increasingly poor during the quarter, and data from 8 August up to the site closure on 2 September have been deleted.

Sheffield Tinsley

The NOx analyser suffered from a flow sensor, photomultiplier and autozero faults, which resulted in some poor quality data which have been deleted.

Stanford-le-Hope Roadside

The sample manifold fan was switched off from 3 to 10 September; NOx data have been deleted.

A leak was found in the $PM_{2.5}$ FDMS on 25 July; data from 8 to 25 July have been deleted.

The PM_{10} dryer was found to require replacement on 22 August. Data have been deleted from 29 June to 29 August. Data improved noticeably following replacement of the dryer.

Storrington Roadside

Substantial losses of $PM_{2.5}$ and PM_{10} data occurred during the quarter resulting from air conditioning faults.

Sunderland Silkworth

The NOx sample pump failed on 23 July. Further problems with the pump and delays in organising repairs caused further data loss in September. The service on the $PM_{2.5}$ FDMS introduced some instability; data from 17 July to 6 August have been deleted. Ozone data from 17 September have been lost due to various failed components.

Wicken Fen

Ongoing problems with noisy SO_2 data continued throughout this quarter and beyond. All SO_2 data have been deleted for this quarter.

4.3 Scotland

4.3.1Data Capture

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

Table 4.3 Data Capture for Scotland, July-September 2013

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Aberdeen		57.47	39.76	0.00	53.53		37.69
Aberdeen Union Street Roadside				99.05			99.05
Auchencorth Moss		67.39	98.91		99.77		98.49
Auchencorth Moss (FDMS)		0.00	0.00				0.00
Bush Estate				98.87	98.91		98.89

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Dumbarton Roadside				98.60			98.60
Dumfries				98.41			98.41
Edinburgh St Leonards	58.11	94.88	95.97	99.46	99.64	97.96	91.00
Eskdalemuir				98.55	98.73		98.64
Fort William				95.34	99.00		97.17
Glasgow Kerbside		71.38	80.03	93.70			81.70
Grangemouth		87.45	35.24	97.96		98.46	79.78
Grangemouth Moray				99.46			99.46
Inverness		93.48	98.91	98.91			98.70
Lerwick					64.27		64.27
Peebles				64.67	64.67		64.67
Strath Vaich					99.91		99.91
Number of Sites	**1**	**7**	**7**	**13**	**9**	**2**	**17**
Number of Sites<85%	**1**	**4**	**4**	**2**	**3**	**0**	**6**
Number of Sites<90%	**1**	**5**	**4**	**2**	**3**	**0**	**6**
Mean	**58.11**	**67.44**	**64.12**	**87.92**	**86.49**	**98.21**	**82.73**

4.3,2 Site Specific Issues

Aberdeen

The NOx analyser was reported with autozero faults in July, and this persisted throughout the quarter. All data for Q3 have been deleted. The ozone analyser was suspected to be internal sampling, as the sample line was found to be loose at the summer QA/QC audit. The data have been deleted from 9 July to 20 August. Both FDMS analysers were affected by fluctuating dew points during July and August, resulting in significant data loss. In addition, the sharp cut cyclone was not replaced following zero checks; $PM_{2.5}$ data from 12 to 20 August have been lost.

Auchencorth Moss

The sites had ongoing air conditioning faults during the quarter. In addition, the PM_{10} analyser had a chiller fault in July, and a replacement part could not be sourced due to the age of the instrument. All data from both FDMS instruments have been deleted for this quarter.

Glasgow Kerbside

The concentrations of volatiles of both $PM_{2.5}$ and PM_{10} have been observed to peak every evening between 21:00 and 24:00, possibly due to an air conditioning issue. The data for this period each day have been deleted.

Grangemouth

The $PM_{2.5}$ data were identified as a regional outlier (volatile concentration too high) from 15 July to 5 September; the data have been deleted.

Lerwick

The site ceased operation on 29 August pending redevelopment of the Lewick observatory.

Peebles

There was a fault with the sampling inlet-see Section 3.2.

4.4 Wales

4.4.1Data Capture

The data capture for sites in Wales for July-September 2013 is given in Table 4.4.

Table 4.4 Data Capture for Wales, July-September 2013

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Aston Hill				98.64	95.20		96.92
Cardiff Centre	97.60	81.02	78.58	97.55	97.55	96.33	91.44
Chepstow A48		95.52	89.36	98.69			94.52
Cwmbran				98.87	99.23		99.05
Mold				100.00	93.07		96.54
Narberth		93.84		97.87	98.64	98.37	97.18
Newport		67.26	60.96	66.12			64.78
Port Talbot Margam		93.48					93.48
Port Talbot Margam	98.46	82.43	20.38	98.55	98.46	98.46	82.79
Swansea Roadside		94.61	94.61	98.73			95.98
Wrexham		88.04	96.74	98.10		100.00	98.78
Number of Sites	**2**	**8**	**6**	**10**	**6**	**4**	**11**
Number of Sites<85%	**0**	**3**	**3**	**1**	**0**	**0**	**2**
Number of Sites<90%	**0**	**4**	**4**	**1**	**0**	**0**	**2**
Mean	**98.03**	**87.02**	**73.44**	**95.31**	**97.03**	**98.29**	**91.95**

Shaded boxes are for data capture < 90%

4.4.2 Site Specific Issues

Newport

The logger used for recording NOx and PM_{10} concentrations locked up on 14th August. No data from these instruments was recorded until 11 September, when the NOx analyser was reconfigured to store these data.

In addition, the $PM_{2.5}$ FDMS sharp cut cyclone was not replaced following the zero check on 12 July. This was replaced on 29 July, and data between these dates have been deleted. Further data loss from this instrument occurred between 11 and 25 September due to failed v-seals.

Port Talbot Margam

The volatile $PM_{2.5}$ concentration was observed to be significantly higher than the PM_{10} volatile concentration for much of the quarter. PM_{10} data have been deleted during ratification from 29 June to 15 July, and $PM_{2.5}$ from 11 July to 29 September.

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 July-September 2013 is given in Table 4.5.

Table 4.5 Data Capture for Ireland, July-September 2013

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Armagh Roadside		33.70		99.68			66.69
Ballymena Ballykeel						94.29	94.29
Belfast Centre	90.58	39.67	39.58	97.24	96.97	97.51	76.92
Derry		89.72	95.24	92.07	99.86	94.79	94.34
Lough Navar		49.14			94.70		71.92
Mace Head					98.69		98.69
Number of Sites	**1**	**4**	**2**	**3**	**4**	**3**	**6**
Number of sites < 85 %	**0**	**3**	**1**	**0**	**0**	**0**	**3**
Number of sites < 90%	**0**	**4**	**1**	**0**	**0**	**0**	**3**
Network mean	**90.58**	**53.06**	**67.41**	**96.33**	**97.18**	**95.53**	**80.83**

4.5.2Site Specific Issues

Armagh Roadside

The volatile PM_{10} concentrations became increasingly low then negative during the quarter, and were not in line with other regional sites; data from 1 August to 30 September have been deleted. The ESU replaced the v seals on 7 October.

Belfast Centre

The $PM_{2.5}$ and PM_{10} volatiles were identified as being above other regional sites from the previous quarter; data from 1-20 July have been deleted.

Lough Navar

The site suffered from temperature problems during the summer, which resulted in the loss of some data this quarter. The air conditioning unit was deemed to be inadequate, and was replaced on 2 September.

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, July-September 2013

	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Site Total
Number of Sites	7	69	80	116	82	29	135
Number of sites < 85 %	1	24	27	13	6	5	38
Number of sites < 90%	1	33	37	19	8	6	45
Network mean	91.13	77.17	79.85	92.16	93.56	88.16	87.69

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 two 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 2014.

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, Summer 2013

7 Introduction

During July to September 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 is some ongoing restructuring of the network since the winter 12/13 intercalibration-see Section 2.

The intercalibration requires the coordination and close cooperation of QA/QC unit, Management Units, ESUs and LSOs 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 MUs and ESUs 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.
12. For the first time, a coordinated zero "calibration" of all automatic PM analysers was undertaken during the summer 2013 intercalibration. This test allows the baseline performance of PM analysers to be evaluated, to determine whether any remedial action is required.

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 k_0 value for FDMS analysers,
- ±10% for particulate analyser flow rates,
- Particulate analyser average zero response within ±3.0 µg/m^3.
- ±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	36	117	31%
CO analyser	0	9	0%
SO_2 analyser	8	30	27%
Ozone analyser	14	82	17%
FDMS and BAM analysers	0 k_0, 4 flow, (33 zero)	58 FDMS PM_{10} 2 BAM PM_{10} 69 FDMS $PM_{2.5}$ 2 BAM $PM_{2.5}$	3%
Gravimetric PM analysers	0 flow	9 PM_{10} 9 $PM_{2.5}$	0%
Total	62	387	16.0%

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.

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 Winter 2013 intercalibration 14.0% 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	463 ppb	459 ppb	1.6	4.0
NO_2	443 ppb	460 ppb	-3.6	4.8
CO	21.2 ppm	21.0 ppm	0.8	3.5
SO_2	456 ppb	456 ppb	-0.1	4.4

- Oxides of Nitrogen.

  A total of 36 outliers (31%) were identified during this intercalibration. This is significantly worse than the previous exercise - 22% of the analysers were identified as outliers in the summer exercise. Of these outliers, 21 can be attributed to analyser drift, 13 to changes in site cylinder concentration and 2 to issues experienced during the audit which compromised the results.

  There was a single converter which fell outside the ±5% acceptance limits. There were 4 further converters identified where the initial result was outside the ±2% trigger for NO_2 rescaling. Additional analysis showed that a total of three outlier converters required rescaling or data deletion to be undertaken.

- Carbon Monoxide

  There were no outliers identified at this intercalibration. No outliers were identified at the previous exercise.

- Sulphur Dioxide

  A total of 8 outliers (27%) were identified at this intercalibration. This is slightly worse than the winter exercise, when 6 analysers were found to be outside the acceptance limits. All m-xylene interference tests were less than 18ppb, compared to 16ppb in winter 2013.

- Ozone

  A total of 14 outliers (17%) were identified during the summer exercise. This is better the previous intercalibration, where 17 analysers were found to be outside the ±5%

acceptance criterion.

- Particulate Analysers

  There were no calculated k_0 determination outside the required ±2.5% of the stated values. A single outlier was identified at the previous exercise.

  One FDMS main flow was found to be outside the ±10% acceptance limits. Three BAM total flows were found to be outside this limit. This total is identical to the previous exercise; four analyser flow outliers were identified in the winter.

  All Partisol analyser total flows were within the acceptance limits.

- PM analyser zero tests

  For the first time, a coordinated programme to assess zero performance of automatic PM analysers was conducted at the summer intercalibration. Of the 131 PM analysers in the network, 33 (25%) gave average responses to particle-free air that were higher than ±3µg/m^3. These results will be fed into the ratification process to determine appropriate action.

- Site Cylinder Concentrations

  12 of the 273 site cylinders (4.3%) used to scale ambient pollution data were found to be outside the ±10% acceptance limit, a little worse than the 3.3% identified in the winter.

9.2 London Sites

The results of the intercomparison for the 16 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	3	13
NOx converter	0	
CO analyser	0	3
SO_2 analyser	1	4
Ozone analyser	3	9
FDMS and BAM analysers	0 k_0, 0 flow (2 zero)	6 FDMS PM_{10} 10 FDMS $PM_{2.5}$
Gravimetric PM analysers	0	2 PM_{10} 3 $PM_{2.5}$
Cylinders	2	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	4	14
NOx converter	1	
CO analyser	0	2
SO_2 analyser	0	3
Ozone analyser	1	10
FDMS and BAM analysers	0 k_0, 0 flow (4 zero)	6 FDMS PM_{10} 6 FDMS $PM_{2.5}$
Gravimetric PM analysers	0	4 PM_{10} 4 $PM_{2.5}$
Cylinders	2	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	4	10
NOx converter	0	
CO analyser	0	2
SO_2 analyser	2	4
Ozone analyser	1	6
FDMS and BAM analysers	0 k_0, 2 flow (1 zero)	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	1	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	2	3
Ozone analyser	0	4
FDMS and BAM analysers	0 k_0, 0 flow (3 zero)	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 86 English sites are summarised below:

Table 9.7 - Summary of audited analyser performance – English Sites

Parameter	Number of outliers	Number in region
NOx analyser	24	76
NOx converter	3	
CO analyser	0	1
SO_2 analyser	3	16
Ozone analyser	9	53
FDMS and BAM analysers	0 k_0, 3 flow (23 zero)	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	7	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 12 of the 273 cylinders (4.3%) used to scale analyser data into concentrations (NO, CO and SO_2) were outside the ±10% acceptance criterion. This is worse than the winter exercise, where 3.3% (9) of the scaling cylinders were outside the acceptance limits. There were 12 NO cylinders identified as outliers.

In addition, the concentrations of 25 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 37 of the 273 cylinders (13.5%) were outside the acceptance limits. This is better than the previous intercalibration, when 16.2% of cylinders were found to be outside the 10% acceptance.

One of the 12 NO cylinders, three appear to have been contaminated (Dumbarton Roadside, London Bexley and Wirral Tranmere); significant oxidation of the NO into NO_2 has occurred since the last intercalibration. The cylinders have been replaced and the performance of the new cylinders will be closely monitored at subsequent audits.

Six cylinders showed significant drift and have been replaced.

The remaining three 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 needed 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 ann	NO_2 hour	PM_{10}	$PM_{2.5}$
08-Jul	Barnsley Gawber	10.7		13.4	10	10		
04-Jul	Bath Roadside				13.5	14		
16-Jul	Billingham				13.5	14		
09-Jul	Birmingham Acocks Green	12.4			13.5	14		16.4
08-Jul	Birmingham Tyburn	8.7		12.3	11.8	11.8	9.57	16.4
08-Jul	Birmingham Tyburn Roadside	12.4			13.5	14	No test	16.4
03-Jul	Blackburn Darwen Roadside				10.5	10.5		
03-Jul	Blackpool Marton	10.7			10	10		16.4
24-Jun	Bottesford	10.7						

Date	Site	O_3	CO	SO_2	NO_2 ann	NO_2 hour	PM_{10}	$PM_{2.5}$
07-Aug	Bournemouth	12.4			13.5	14		11
16-Jul	Brighton Preston Park	12.4			13.5	14		11
01-Jul	Bristol St Paul's	12.4			13.5	14	8.7	16.4
24-Jul	Cambridge Roadside				10.5	10.5		
07-Aug	Camden Kerbside				10.5	10.5	8.7	16.4
31-Jul	Canterbury	12.4			13.5	14		
02-Jul	Carlisle Roadside				10.5	10.5	8.7	16.4
03-Jul	Charlton Mackrell	11.8			13.5	14		
27-Jun	Chatham Centre Roadside				13.5	14	8.7	16.4
09-Jul	Chesterfield				10.5	10.5	8.7	16.4
09-Jul	Chesterfield Roadside				10.5	10.5	8.7	16.4
30-Jul	Coventry Memorial Park	10.7			10	10		16.4
16-Jul	Eastbourne				13.5	14	8.7	16.4
02-Jul	Exeter Roadside	8.7			11.8	11.8		
16-Aug	Glazebury	12.4			13.5	14		
02-Jul	Great Dun Fell	12.4						
06-Aug	Haringey Roadside				10.5	10.5	9.84	16.4
12-Aug	Harwell	12.4		13.4	13.5	14	8.7	16.4
12-Aug	Harwell PARTISOL						8	11
17-Jul	High Muffles	12.4			13.5	14		
02-Jul	Honiton				13.5	14		
15-Jul	Horley				10.5	10.5		
17-Jul	Hull Freetown	10.7		13.4	10	10	8.7	18.56
10-Jul	Ladybower	12.4		13.4	13.5	14		
02-Jul	Leamington Spa	11.8		No test	10.5	10.5	9.31	16.4
01-Jul	Leamington Spa Rugby Road				13.5	14	8.7	16.4
16-Jul	Leeds Centre	10.7	9.5	13.4	10	10	8.7	16.4
16-Jul	Leeds Headingley Kerbside				13.5	14	8.7	16.4
31-Jul	Leicester Centre	10.7			10	10	8.7	16.4
25-Jul	Leominster	12.4			13.5	14		
28-Jun	Lincoln Canwick Road				13.5	14		
20-Jun	Liverpool Queen's Drive Roadside				13.5	14		
20-Jun	Liverpool Speke	10.7		13.4	10	10	10.02	16.4
30-Jul	London Bexley			13.4	13.5	14		16.4

Date	Site	O_3	CO	SO_2	NO_2 ann	NO_2 hour	PM_{10}	$PM_{2.5}$
31-Jul	London Bloomsbury	12.4		13.4	13.5	14	8.7	16.4
18-Jul	London Eltham	11.8			10.5	10.5	8.7	16.4
05-Aug	London Haringey Priory Park South	11.8			13.5	14		
25-Jul	London Harlington	12.4			13.5	14	8.7	16.4
07-Aug	London Harrow Stanmore							16.4
25-Jul	London Hillingdon	10.7			10	10		
15-Jul	London Marylebone Road	12.4	9.5	13.4	13.5	14	8.7	16.4
15-Jul	London Marylebone Road PARTISOL						8	11
16-Jul	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-Aug	London Teddington	12.4			13.5	14		
08-Aug	London Teddington Bushy Park							11
24-Jul	London Westminster	Not compliant			13.5	14		11
04-Jul	Lullington Heath	12.4		13.4	13.5	14		
15-Aug	Manchester Piccadilly	10.7		13.4	10	10		16.4
15-Aug	Manchester South	12.4			13.5	14		
09-Aug	Market Harborough	10.7			10	10		
16-Jul	Middlesbrough	12.4		13.4	13.5	14	8.7	No test
15-Jul	Newcastle Centre	10.7			10	10	8.7	16.4
15-Jul	Newcastle Cradlewell Roadside				10.5	10.5		
01-Aug	Northampton Kingsthorpe	8.7			11.8	11.8		11
23-Jul	Norwich Lakenfields	10.7			10	10	8.7	16.4
24-Jun	Nottingham Centre	10.7		13.4	10	10	8.7	16.4
14-Aug	Oxford Centre Roadside				10.5	10.5		
14-Aug	Oxford St Ebbes				10.5	10.5	8.7	16.4
03-Jul	Plymouth Centre	10.7			10	10	8.7	16.4
06-Aug	Portsmouth	10.7			11.8	11.8	8.7	16.4
03-Jul	Preston	10.7			10	10		16.4
13-Aug	Reading New Town	10.7			10	10	10.92	16.4
25-Jun	Rochester Stoke	Not compliant		13.4	13.5	14	8.7	16.4

Date	Site	O_3	CO	SO_2	NO_2 ann	NO_2 hour	PM_{10}	$PM_{2.5}$
14-Aug	Salford Eccles	11.8			10.5	10.5	8.7	16.4
03-Jul	Saltash Callington Road						8.7	16.4
25-Jul	Sandy Roadside				13.5	14	15.36	16.4
17-Jul	Scunthorpe Town			11	10.5	10.5	8.8	
08-Jul	Sheffield Centre	10.7			10.43	10.43	8.7	16.4
09-Jul	Sheffield Tinsley				13.5	14		
22-Jul	Sibton	12.4						
05-Aug	Southampton Centre	10.7		13.4	10	10	9.78	16.4
27-Jun	Southend-on-Sea	10.7			10	10		16.4
22-Jul	Southwark A2 Old Kent Road				13.5	14	8.7	
03-Jul	St Osyth	10.7			10	10		
04-Jul	Stanford-le-Hope Roadside				13.5	14	8.7	16.4
16-Jul	Stockton-on-Tees Eaglescliffe				13.5	14	17.68	12.6
21-Jun	Stoke-on-Trent Centre	10.7			10	10	8.75	16.4
17-Jul	Storrington Roadside				10	10	8.7	16.4
17-Jul	Sunderland Silksworth	12.4			10.5	10.5		16.4
27-Jun	Thurrock	12.4			13.5	14	8.7	
01-Aug	Tower Hamlets Roadside				10.5	10.5		
10-Jul	Walsall Woodlands	12.4			13.5	14		
19-Jun	Warrington				10.5	10.5	8.7	16.4
23-Jul	Weybourne	10.7						
23-Jul	Wicken Fen	12.4		13.4	13.5	14		
14-Aug	Wigan Centre	10.7			10	10		16.4
18-Jun	Wirral Tranmere	10.7			10	10		16.4
02-Jul	Yarner Wood	12.4			13.5	14		
18-Jul	York Bootham						13.62	16.4
18-Jul	York Fishergate				10.5	10.5	8.7	16.4
13-Aug	Mace Head	Not approved						
20-Aug	Armagh Roadside				10.5	10.5	8.7	
15-Aug	Ballymena Ballykeel			11				
20-Aug	Belfast Centre	No test	9.5	13.5	10	10	8.7	16.4
16-Aug	Derry	12.4		13.4	13.54	14.02	8.7	16.4
12-Aug	Lough Navar	12.4					11.07	

Date	Site	O_3	CO	SO_2	NO_2 ann	NO_2 hour	PM_{10}	$PM_{2.5}$
05-Aug	Aberdeen	12.4			13.5	14	8.7	16.4
06-Aug	Aberdeen Union Street Roadside				13.5	14		
24-Jul	Auchencorth Moss	12.4					No test	No test
24-Jul	Auchencorth Moss PM_{10} PM_{25} (FDMS)						8.7	16.4
24-Jul	Bush Estate	12.4			13.5	14		
22-Jul	Dumbarton Roadside				10.5	10.5		
01-Jul	Dumfries				13.5	14		
23-Jul	Edinburgh St Leonards	12.4	9.5	13.4	13.5	14	8.7	16.4
01-Jul	Eskdalemuir	12.4			13.6	14		
24-Jul	Fort William	12.4			13.5	14		
22-Jul	Glasgow Kerbside				10	10	8.7	16.4
22-Jul	Grangemouth			11	10.5	10.5	8.7	16.4
22-Jul	Grangemouth Moray				11.0	11.1		
08-Aug	Inverness				13.5	14	8	11
07-Aug	Lerwick	12.4						
23-Jul	Peebles	12.4			13.5	14		
08-Aug	Strath Vaich	12.4						
01-Jul	Aston Hill	12.4			13.5	14		
12-Jul	Cardiff Centre	12.4	9.5	13.4	13.5	14	8.7	No test
11-Jul	Chepstow A48				10.5	10.5	8.7	16.4
12-Jul	Cwmbran	10.7			11.8	11.8		
17-Jun	Mold	12.4			13.5	14		
09-Jul	Narberth	12.4		13.8	13.5	14	8.7	
10-Jul	Newport				10.5	10.5	8.7	16.4
11-Jul	Port Talbot Margam	10.7	9.5	13.4	13.5	14	No test	No test
11-Jul	Port Talbot Margam PM_{10} $PM_{2.5}$ PM_{10} Partisol)						No test	
11-Jul	Swansea Roadside				13.5	14	19.1	**34.3**
18-Jun	Wrexham			13.4	13.5	14	11.7	11

This table is updated and extended after every intercalibration to include upgraded sites and replacement analysers.

The poor measurement uncertainty reported for the PM analysers at Swansea arose as a result of the very low measured flow rates at the audit. The significance of this will be examined fully during ratification.

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

13 Certification

The Network Certificate of Calibration is presented in Appendix 3. 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 April to September 2013.

Appendices

Appendix 1

Partisol Data: July-September 2013

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

Site	PM_{10}	PM_{25}	Reason
Auchencorth Moss	67%		Failed seal
Harwell		66%	Leak
Wrexham	89%		Flow sensor fault

Appendix 2

Site Details

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

Appendix 3

Certificate of Calibration

CERTIFICATE OF CALIBRATION

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

Telephone 01235 753212

Authorised Signatories: S Eaton

B Stacey

Signed:

Date of Issue: 21 May 2014

Customer Name and Address: Daniel Waterman

Atmosphere and Noise
Resource, Atmosphere and Sustainability
Department for Environment, Food and Rural Affairs
Area 2C Nobel House, 17 Smith Square, London, SW1P 3JR

Date of Calibration: July to September 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.

1. Carbon Monoxide

Date Year = 2013	Site	Analyser number	[1]Zero output	Uncertainty (ppm)	[2]Calibration Factor	Uncertainty (%)	*Maximum Residual (%)
English sites							
16-Jul	Leeds Centre	458	-0.4	0.2	0.990	2.2	3.4
London Sites							
15-Jul	London Marylebone Road	651	0.1	0.2	1.032	2.2	2.7
16-Jul	London N. Kensington	2313	0.1	0.2	1.027	2.1	1.0
Northern Irish Sites							
20-Aug	Belfast Centre	462	0	0.2	0.990	3.1	5.6
Scottish Sites							
23-Jul	Edinburgh St Leonards	159	0.7	0.2	0.933	2.1	0.9
Welsh Sites							
12-Jul	Cardiff Centre	12599	0.7	0.2	0.959	2.1	1.0
11-Jul	Port Talbot Margam	605214618	0.1	0.2	1.039	2.1	1.8

2. Sulphur Dioxide

Date Year =2013	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max Residual (%)	*m-xylene interference (ppb)
English sites								
08-Jul	Barnsley Gawber	08050082	4.4	2.5	1.055	3.2	3	2.1
08-Jul	Birmingham Tyburn	EH937000	1.8	2.5	0.983	3.1	3.9	9.5
12-Aug	Harwell	83	-3.9	2.5	1.048	3.0	1.8	22.7
17-Jul	Hull Freetown	342	2	2.6	1.116	3.1	0.8	
10-Jul	Ladybower	1178	0	2.5	1.031	3.3	2.2	1.0
16-Jul	Leeds Centre	CM050084	3	2.5	0.963	3.1	1.3	4.6
20-Jun	Liverpool Speke	17509	1.9	2.5	1.035	3.2	1.9	5.7
04-Jul	Lullington Heath	12181	-1	2.5	0.981	3.2	1.9	7.5
15-Aug	Manchester Piccadilly	19216	1	2.5	0.950	3.5	5.1	15.7
16-Jul	Middlesbrough	1660	0.6	2.5	0.975	3.3	6.0	15.5
24-Jun	Nottingham Centre	1629	-1.2	2.5	1.022	3.1	2.1	14.0
25-Jun	Rochester Stoke	19446	0	2.5	0.832	3.6	2.0	20.0
17-Jul	Scunthorpe Town	110870	42	2.5	0.694	3.7	3.8	12.5
05-Aug	Southampton Centre	14895	10.2	2.6	1.063	3.1	1.4	14.1
23-Jul	Wicken Fen	14349	3.9	2.5	1.024	3.3	1.4	8.3
London Sites								
30-Jul	London Bexley	318	0.1	2.6	1.158	3.4	2.9	0.0
31-Jul	London Bloomsbury	74	-0.8	2.52	0.995	3.3	2.3	7.6
15-Jul	London Marylebone Road	2644	0.9	2.57	1.131	3.1	1.7	3.1
16-Jul	London N.	2576	7.7	2.51	0.980	3.2	3.6	7.8

Date Year =2013	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max Residual (%)	*m-xylene interference (ppb)
	Kensington							
Northern Irish Sites								
15-Aug	Ballymena Ballykeel	4901234	0	2.4	0.710	3.8	2.4	17.8
20-Aug	Belfast Centre	1766	6.9	2.5	1.035	5.3	4.2	4.5
16-Aug	Derry	1697	0.7	2.54	1.055	4.1	2.9	15.4
Scottish Sites								
23-Jul	Edinburgh St Leonards	84	-5.1	2.51	0.972	3.3	1.9	12.2
22-Jul	Grangemouth	1211322	0	2.5	0.951	2.9	1.1	21.9
Welsh Site								
12-Jul	Cardiff Centre	14319	6.6	2.52	1.006	3.0	0.3	11.1
09-Jul	Narberth	14896	1.5	2.48	0.895	5.9	5.6	18.4
11-Jul	Port Talbot Margam	1	0.9	2.53	1.023	3.0	1.9	2.3
18-Jun	Wrexham	1181	3.9	2.5	0.860	3.8	2.8	2.6

3. Ozone

Date Year =2013	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max Residual (%)
English sites							
08-Jul	Barnsley Gawber	cm08060030	0.3	3	0.958	3.1	2.4
09-Jul	Birmingham Acocks Green	19224	-3.2	3	1.028	3.3	1.3
08-Jul	Birmingham Tyburn	WB6AG7TF	1.2	3	0.949	3.1	1.2
08-Jul	Birmingham Tyburn Roadside	19188	0.6	3	1.060	3.3	0.9
03-Jul	Blackpool Marton	cm08060037	0.1	3	0.974	3.1	0.7
24-Jun	Bottesford	CM08060022	0.1	3	0.945	3.2	1.0
07-Aug	Bournemouth	17503	-1.2	3	1.004	3.1	0.0
16-Jul	Brighton Preston Park	12461	-1.8	3	0.959	3.1	1.7
01-Jul	Bristol St Paul's	14358	0.2	3	1.016	3.3	0.2
03-Jul	Charlton Mackrell	1111957	-1	3	1.005	3.4	1.2
30-Jul	Coventry Memorial Park	CM08060044	-0.2	3	1.023	3.1	0.9
02-Jul	Exeter Roadside	F0100E0S	-0.7	3	1.013	3.3	1.2
16-Aug	Glazebury	19751	0.5	3	1.013	3.2	1.9
12-Aug	Harwell	1648	-1.1	3	1.034	3.1	0.5
17-Jul	High Muffles	1641	0.1	3	1.029	3.1	0.9
17-Jul	Hull Freetown	08060045	0	3	0.993	3.1	0.3
10-Jul	Ladybower	1651	0	3	0.993	3.1	2.5
02-Jul	Leamington Spa	411370	4.5	3	0.954	3.3	0.7
16-Jul	Leeds Centre	M)8060036	0.4	3	1.097	3.1	1.4
31-Jul	Leicester Centre	CM08060020	-2.2	3	1.058	3.2	1.3
25-Jul	Leominster	14470	0.3	3	1.009	3.6	0.5

Date Year =2013	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	[*]Max Residual (%)
20-Jun	Liverpool Speke	CM08060041	0.7	3	1.033	3.3	0.5
04-Jul	Lullington Heath	17494	-0.5	3	1.012	3.1	0.7
15-Aug	Manchester Piccadilly		-0.5	3	1.083	3.1	2.0
15-Aug	Manchester South	16954	-0.9	3	1.057	3.1	0.8
09-Aug	Market Harborough	CM08060031	-3.9	3	1.061	3.2	2.3
16-Jul	Middlesbrough	944	-0.6	3	1.043	3.1	1.9
15-Jul	Newcastle Centre	cm08060033	-0.9	3	0.955	3.2	1.3
01-Aug	Northampton Kingsthorpe	47R76STR	1.6	3	1.055	3.1	0.9
23-Jul	Norwich Lakenfields	aea10	0.2	3	1.056	3.1	0.7
24-Jun	Nottingham Centre	CM08060032	0.8	3	0.959	3.3	0.8
03-Jul	Plymouth Centre	CM08060027	-0.5	3	1.073	3.3	0.1
06-Aug	Portsmouth	80600203	2.2	3	1.103	3.1	0.3
03-Jul	Preston	cm08060042	0.3	3	0.998	3.1	0.3
13-Aug	Reading New Town	CM08060025	0.1	3	1.016	3.3	0.3
25-Jun	Rochester Stoke	378	2	3	0.978	3.1	1.6
14-Aug	Salford Eccles	411771	3.3	3	0.884	3.3	1.3
08-Jul	Sheffield Centre	cm08060024	0	3	0.982	3.1	1.2
22-Jul	Sibton	146	-0.8	3	1.014	3.1	1.0
05-Aug	Southampton Centre	CM08060021	-0.5	3	1.046	3.2	2.1
27-Jun	Southend-on-Sea	60017	0.4	3	1.033	3.1	0.3
03-Jul	St Osyth	60035	-3.0	3	0.998	3.1	1.6
21-Jun	Stoke-on-Trent Centre	CM08060026	0.5	3	1.085	3.3	2.1
17-Jul	Sunderland Silksworth	436	1.0	3	0.942	3.1	2.4
27-Jun	Thurrock	20094	0.5	3	1.010	3.1	1.6
10-Jul	Walsall Woodlands	19222	2.3	3	0.972	3.4	1.1
23-Jul	Weybourne	80038	-0.7	3	1.021	3.1	0.5
23-Jul	Wicken Fen	14345	-1.2	3	1.057	3.2	0.6
14-Aug	Wigan Centre	cm08060018	-1.8	3	1.020	3.1	0.4
18-Jun	Wirral Tranmere	CM08060040	-0.5	3	1.212	3.4	0.5
02-Jul	Yarner Wood	2437	-1.7	3	1.016	3.1	0.3
London Sites							
31-Jul	London Bloomsbury	435	-0.6	3	1.073	3.4	0.9
18-Jul	London Eltham	1111958	0	3	1.030	3.4	0.4
25-Jul	London Harlington	107	-1.0	3	1.064	3.3	1.3
25-Jul	London Hillingdon	8060034	-0.1	3	1.040	3.5	1.0
15-Jul	London Marylebone Road	2432	6.2	3	1.025	3.3	1.1
16-Jul	London N. Kensington	2372	2.3	3	1.061	3.3	0.5
08-Aug	London Teddington	2447	1.1	3	1.058	3.3	1.2
24-Jul	London Westminster	879	1.5	3	1.415	3.3	1.7
Northern Ireland Sites (plus Mace Head)							
20-Aug	Belfast Centre	1586	Not	tested	photometer	fault at	audit

Date Year =2013	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max Residual (%)
16-Aug	Derry	1586	-1.8	3	1.036	3.1	0.6
12-Aug	Lough Navar	1640	3.2	3	1.059	3.4	2.3
13-Aug	Mace Head	77086-385	0.6	3	1.000	3.2	0.3
Scottish Sites							
05-Aug	Aberdeen	800	-0.2	3	0.991	3.1	1.1
24-Jul	Auchencorth Moss	1646	-0.3	3	1.036	3.1	0.1
24-Jul	Bush Estate	1645	0.0	3	1.006	3.1	1.1
23-Jul	Edinburgh St Leonards	136	2.4	3	1.006	3.1	1.5
01-Jul	Eskdalemuir	158	1.8	3	1.060	3.1	0.9
24-Jul	Fort William	1023	0.9	3	1.014	3.1	1.5
07-Aug	Lerwick	2433	-1	3	0.993	3.1	0.6
23-Jul	Peebles	2449	3.2	3	1.285	3.1	1.9
08-Aug	Strath Vaich	176	-0.2	3	0.999	3.1	0.1
Welsh Sites							
01-Jul	Aston Hill	144	1.0	3	1.005	3.1	1.3
12-Jul	Cardiff Centre	14348	-2.6	3	1.011	3.2	1.6
12-Jul	Cwmbran	60043	0.1	3	0.972	3.1	0.4
17-Jun	Mold	17499	0.4	3	1.004	3.3	0.6
09-Jul	Narberth	10290	0.5	3	1.029	3.1	0.8
11-Jul	Port Talbot Margam	3	0.4	3	0.945	3.1	0.5

4. Oxides of Nitrogen

Date Year =2013	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max residual (%)	*Converter efficiency (%)
08-Jul	Barnsley	NO	08050057	1	2.5	0.960	3.9	3.3	99.3
	Gawber	NOx		0.6	2.5	0.956	3.7	2.7	
04-Jul	Bath Roadside	NO	12758	1.1	2.6	1.088	3.5	1.9	99.6
		NOx		0.7	2.6	1.082	3.5	2.0	
16-Jul	Billingham	NO	574	1.4	2.6	1.152	3.5	0.4	99.6
		NOx		2.6	2.6	1.173	3.5	1.6	
09-Jul	Birmingham	NO	19212	0.2	2.6	1.215	3.5	1.6	99.2
	Acocks Green	NOx		3	2.6	1.221	3.5	1.2	
08-Jul	Birmingham	NO	Y78CC7MC	1.1	2.6	1.163	3.5	1.3	99.8
	Tyburn	NOx		3.9	2.5	1.039	3.5	1.2	
08-Jul	Birmingham	NO	14324	-2.5	2.8	1.473	3.5	1.9	99.4
	Tyburn Roadside	NOx		-2.3	3.0	1.487	3.5	1.5	
03-Jul	Blackburn Darwen	NO	1011851	0	2.5	0.998	3.5	3.5	99.6
	Roadside	NOx		3	2.5	1.009	4.5	4.5	
03-Jul	Blackpool	NO	08050075	0.6	2.5	0.967	3.5	0.5	101.5
	Marton	NOx		0.9	2.5	0.926	3.5	0.7	
07-Aug	Bournemouth	NO	17507	0.3	2.6	1.192	3.68	2.5	97.9
		NOx		0.7	2.6	1.163	3.5	1.5	

Date Year =2013	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max residual (%)	*Converter efficiency (%)
16-Jul	Brighton Preston	NO	13068	0.3	2.6	1.162	3.5	0.7	98.1
	Park	NOx		0.8	2.6	1.173	3.5	0.5	
01-Jul	Bristol St Paul's	NO	14353	0	2.6	1.099	3.5	1.4	97.9
		NOx		2.5	2.6	1.111	3.5	1.2	
24-Jul	Cambridge	NO	1011843	1	2.7	1.332	3.5	1.4	98.1
	Roadside	NOx		2	2.7	1.338	3.5	1.8	
31-Jul	Canterbury	NO	11666	0	2.6	1.177	3.5	0.6	98.7
		NOx		0	2.6	1.171	3.5	1.1	
02-Jul	Carlisle	NO	1011849	0	2.6	1.219	3.5	0.8	98.7
	Roadside	NOx		1	2.6	1.232	3.5	0.4	
03-Jul	Charlton	NO	2120	1.1	2.5	0.895	3.5	0.5	101.3
	Mackrell	NOx		0.8	2.5	0.874	3.5	0.2	
27-Jun	Chatham Centre	NO	19206	1	2.6	1.072	3.5	1.2	98.5
	Roadside	NOx		3	2.6	1.059	3.5	0.3	
09-Jul	Chesterfield	NO	1011837	-1	2.6	1.110	3.65	1.8	101.6
		NOx		2	2.6	1.113	3.74	1.3	
09-Jul	Chesterfield	NO	1011835	0	2.8	1.521	4.25	2.2	99.6
	Roadside	NOx		1	2.8	1.530	4.27	2.2	
30-Jul	Coventry	NO	08030109	0.5	2.6	1.246	3.5	0.8	99.5
	Memorial Park	NOx		0.5	2.6	1.250	3.5	0.6	
16-Jul	Eastbourne	NO	19209	1.4	2.6	1.152	3.5	0.7	99.6
		NOx		0.4	2.6	1.167	3.5	1.1	
02-Jul	Exeter Roadside	NO	G0000D1S	0	2.7	0.879	3.5	1.0	98.7
		NOx		1.4	2.7	0.876	3.5	1.0	
16-Aug	Glazebury	NO	14354	1.2	2.6	1.129	3.5	0.1	99.1
		NOx		1.5	2.6	1.143	3.5	0.5	
12-Aug	Harwell	NO	79	1.9	2.6	1.161	3.5	1.6	99.7
		NOx		6.5	2.6	1.180	3.5	1.5	
17-Jul	High Muffles	NO	1783	-0.6	2.6	1.211	3.5	1.0	99.6
		NOx		-0.5	2.6	1.234	3.5	1.1	
02-Jul	Honiton	NO	19214	0.1	2.7	1.288	3.5	0.5	99.6
		NOx		0.7	2.6	1.283	3.5	0.8	
15-Jul	Horley	NO	1401954	-1	3.1	1.169	3.5	0.5	100.4
		NOx		2	2.8	1.180	3.5	0.4	
17-Jul	Hull Freetown	NO	08050056	0	2.6	1.104	3.55	0.2	99.5
		NOx		-6	2.6	1.104	3.54	0.3	
10-Jul	Ladybower	NO	72	0	2.6	1.089	3.95	2.4	99.2
		NOx		-1	2.5	1.066	4.25	3.3	
02-Jul	Leamington Spa	NO	1011842	0	2.6	1.230	3.5	1.1	100.5
		NOx		7	2.8	1.269	3.5	1.2	
01-Jul	Leamington Spa	NO	19211	2.6	2.6	1.092	3.51	2.2	100.5
	Rugby Road	NOx		-22.6	2.6	1.078	3.74	1.6	

Date Year =2013	Site		Analyser number	1Zero output	Uncertainty (ppb)	2Calibration Factor	Uncertainty (%)	*Max residual (%)	*Converter efficiency (%)
16-Jul	Leeds Centre	NO	CM08050066	0.8	2.6	1.161	3.59	0.5	99.6
		NOx		0.3	2.6	1.155	3.54	0.5	
16-Jul	Leeds Headingley	NO	342	0.3	2.6	1.177	3.58	0.5	98.1
	Kerbside	NOx		2.6	2.6	1.188	3.61	0.9	
31-Jul	Leicester Centre	NO	08050021	0.5	2.6	1.055	3.5	0.5	98.7
		NOx		0.5	2.6	1.093	3.5	0.6	
25-Jul	Leominster	NO	14863	-0.6	2.5	0.963	3.5	0.7	99.6
		NOx		-0.5	2.5	0.979	3.5	0.2	

28-Jun	Lincoln Canwick	NO	19203	3	2.6	1.100	3.5	0.5	98.6
	Road	NOx		1.6	2.6	1.098	3.5	0.8	
20-Jun	Liverpool Queen's	NO	16927	-1.2	2.6	1.231	3.5	2.0	98.1
	Drive Roadside	NOx		1.6	2.6	1.242	3.5	1.6	
20-Jun	Liverpool Speke	NO	08050069	0.2	2.5	0.959	3.7	1.7	100.3
		NOx		0.6	2.5	0.95	3.5	1.6	
04-Jul	Lullington Heath	NO	14313	0.6	2.6	1.072	3.5	0.3	95.9
		NOx		0.9	2.6	1.063	3.5	0.3	
15-Aug	Manchester	NO	08050065	3.9	2.5	0.937	3.5	1.6	99.3
	Piccadilly	NOx		3.5	2.5	0.982	3.5	1.7	
15-Aug	Manchester	NO	17311	4.6	3.2	2.137	3.5	0.4	101.7
	South	NOx		4.8	3.2	2.160	3.5	0.7	
09-Aug	Market	NO	08050068	0	2.4	0.642	3.5	0.5	99.7
	Harborough	NOx		-0.1	2.4	0.689	3.5	0.7	
16-Jul	Middlesbrough	NO	2287	1.7	2.6	1.146	3.5	1.4	100.4
		NOx		1.7	2.6	1.148	3.5	1.6	
15-Jul	Newcastle	NO	08050063	0.7	2.5	0.999	3.5	1.2	99.3
	Centre	NOx		0.8	2.5	1.031	3.5	1.2	
15-Jul	Newcastle Cradlewell	NO	1011853	1	3.5	0.960	3.5	0.8	98.2
	Roadside	NOx		6	2.7	0.975	3.5	1.9	
01-Aug	Northampton	NO	8ATJ6APR	-0.5	2.5	0.937	3.5	0.1	98.8
	Kingsthorpe	NOx		1.1	2.5	0.943	3.5	0.3	
23-Jul	Norwich	NO	aea13	0.3	2.5	1.024	3.5	1.2	98.1
	Lakenfields	NOx		0.8	2.5	1.021	3.5	1.2	
24-Jun	Nottingham	NO	08050072	1.3	2.5	0.832	3.5	4.3	98.6
	Centre	NOx		1.1	2.5	0.820	3.5	3.9	
14-Aug	Oxford Centre	NO	1011844	0.1	2.7	1.321	3.5	0.9	98.3
	Roadside	NOx		0.2	2.7	1.331	3.5	1.4	
14-Aug	Oxford St Ebbes	NO	1011830	0	2.5	1.083	3.5	1.7	101.7
		NOx		2	2.8	1.098	3.5	2.0	
03-Jul	Plymouth Centre	NO	08050062	0.2	2.5	0.947	3.5	0.4	99.3
		NOx		0.7	2.5	0.952	3.5	0.4	
06-Aug	Portsmouth	NO	A24819	-0.9	2.5	0.951	3.5	0.2	99.6

Date Year =2013	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max residual (%)	*Converter efficiency (%)
		NOx		0.7	2.5	0.951	3.5	0.6	
03-Jul	Preston	NO	08050664	1	2.5	1.044	3.5	0.8	107.1
		NOx		1	2.5	1.050	3.5	0.6	
13-Aug	Reading New	NO	08050059	0.5	2.5	0.868	3.5	0.9	98.9
	Town	NOx		-0.4	2.5	0.919	3.5	0.9	
25-Jun	Rochester Stoke	NO	18593	0	2.6	1.105	3.5	0.6	98.2
		NOx		-1	2.6	1.088	3.5	0.9	
14-Aug	Salford Eccles	NO	1011881	0	2.5	1.005	3.5	1.2	97.6
		NOx		4	2.6	1.023	3.5	0.8	
25-Jul	Sandy Roadside	NO	2585	-2.4	2.8	1.553	3.5	2.0	100.6
		NOx		-8.2	2.8	1.593	3.5	1.2	
17-Jul	Scunthorpe	NO	1011847	50	3.4	2.472	4.3	1.6	101.1
	Town	NOx		53	3.4	2.494	4.0	1.5	
08-Jul	Sheffield Centre	NO	08050055	0.5	2.5	1.031	5.8	5.3	100.4
		NOx		1.0	2.5	1.039	5.8	5.2	
09-Jul	Sheffield Tinsley	NO	847	7.8	2.5	0.855	3.6	2.2	100.0
		NOx		10.5	2.5	0.900	3.7	2.8	
05-Aug	Southampton	NO	08030106	0	2.7	0.957	3.5	1.8	100.8
	Centre	NOx		0.8	2.5	0.965	3.5	1.1	
27-Jun	Southend-on-	NO	50071	0.1	2.5	1.054	3.5	1.2	99.6
	Sea	NOx		0.3	2.5	1.059	3.5	0.7	
03-Jul	St Osyth	NO	50073	0	2.5	0.925	3.5	0.9	99.3
		NOx		-3	2.5	0.906	3.5	1.2	
04-Jul	Stanford-le-	NO	20093	1	2.5	1.069	3.5	0.8	98.7
	Hope Roadside	NOx		2	2.6	1.082	3.5	0.9	
16-Jul	Stockton-on-Tees	NO	332	1.2	2.7	1.353	4.3	3.1	98.8
	Eaglescliffe	NOx		1.5	2.7	1.358	4.2	3.2	
21-Jun	Stoke-on-Trent	NO	08050070	1	2.5	0.971	3.6	0.6	99.3
	Centre	NOx		0.5	2.6	1.010	3.5	0.2	
17-Jul	Storrington	NO	40022	0.3	2.8	1.550	3.5	1.0	100.5
	Roadside	NOx		-0.3	2.8	1.546	3.5	0.7	
17-Jul	Sunderland	NO	1011854	0	2.6	1.181	4.4	5.1	98.0
	Silksworth	NOx		4	2.6	1.194	3.8	3.3	
27-Jun	Thurrock	NO	20092	0.3	2.7	1.358	3.5	0.3	97.4
		NOx		0.4	2.7	1.361	3.5	0.3	
10-Jul	Walsall	NO	192123	0.6	2.6	1.121	3.5	0.5	99.9
	Woodlands	NOx		4.2	3.7	1.127	3.5	0.2	
19-Jun	Warrington	NO	1011826	-0.1	2.5	0.965	3.8	2.1	98.3
		NOx		5	2.7	0.993	3.5	1.5	
23-Jul	Wicken Fen	NO	13069	0.9	2.4	0.729	3.5	0.4	98.6
		NOx		1.6	2.4	0.730	3.5	2.3	

Date Year =2013	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	[*]Max residual (%)	[*]Converter efficiency (%)
14-Aug	Wigan Centre	NO	1011832	0	2.5	1.044	4.9	4.6	100.8
		NOx		2	2.5	1.054	4.8	4.4	
18-Jun	Wirral Tranmere	NO	08050060	0	2.8	1.546	3.5	0.1	98.8
		NOx		0.3	2.8	1.638	3.5	0.4	
02-Jul	Yarner Wood	NO	1784	0.4	2.6	1.084	3.5	1.5	99.9
		NOx		0.3	2.6	1.070	3.5	0.7	
18-Jul	York Fishergate	NO	1011848	-1	2.5	0.931	3.5	0.3	101.2
		NOx		3	2.5	0.937	3.6	0.7	
London Sites									
07-Aug	Camden	NO	1011846	0	2.7	1.208	3.5	0.6	98.9
	Kerbside	NOx		2	2.8	1.217	3.5	0.1	
06-Aug	Haringey	NO	1011827	0	2.8	1.161	3.5	0.6	101.6
	Roadside	NOx		4	3.3	1.172	3.5	0.4	
30-Jul	London Bexley	NO	327	0.9	2.6	1.131	3.5	0.9	98.4
		NOx		1.1	2.6	1.181	3.5	1.6	
31-Jul	London	NO	74	1	3.4	1.374	3.6	3.0	100.0
	Bloomsbury	NOx		0.9	2.8	1.357	3.8	4.3	
18-Jul	London Eltham	NO	1101834	0	2.8	1.034	3.5	0.8	98.6
		NOx		6	2.6	1.043	3.5	1.0	
05-Aug	London	NO	1084	2.2	2.6	1.244	3.5	0.3	98.4
	Haringey	NOx		1.6	3.0	1.244	3.5	0.4	
25-Jul	London	NO	1090	1.2	2.7	1.269	3.5	1.5	100.7
	Harlington	NOx		1.7	2.8	1.273	3.5	1.1	
25-Jul	London	NO	8050017	0.6	2.5	0.929	3.5	0.4	99.1
	Hillingdon	NOx		0.8	2.5	0.926	3.5	0.3	
15-Jul	London	NO	3366	0.6	2.6	1.202	3.5	1.5	99.6
	Marylebone Road	NOx		3.2	2.6	1.240	3.5	1.6	
16-Jul	London N.	NO	3273	1.5	2.6	1.132	3.5	0.6	98.3
	Kensington	NOx		3	2.6	1.132	3.5	0.3	
08-Aug	London	NO	3406	2	2.6	1.258	3.5	1.6	99.1
	Teddington	NOx		-0.3	2.8	1.258	3.5	1.4	
24-Jul	London	NO	573	0	2.6	1.109	3.5	2.8	98.7
	Westminster	NOx		1.8	4.4	1.128	3.5	1.4	
22-Jul	Southwark A2	NO	1954	-9.8	2.8	1.214	3.6	2.4	98.3
	Old Kent Road	NOx		-5.9	4.6	1.268	3.9	2.4	
01-Aug	Tower Hamlets	NO	1011838	0	2.8	1.071	3.5	0.5	98.3
	Roadside	NOx		7	3	1.105	3.5	0.3	
Northern Irish Sites									
20-Aug	Armagh	NO	1011845	0	2.7	1.403	3.6	1.3	99.5
	Roadside	NOx		3	2.7	1.410	4.0	2.9	
20-Aug	Belfast Centre	NO	08050074	-0.2	2.7	1.431	3.6	1.6	99.5
		NOx		-1.1	2.7	1.429	3.6	1.4	

Date Year =2013	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	[*]Max residual (%)	[*]Converter efficiency (%)
16-Aug	Derry	NO	2130	1.7	2.6	1.1354	4.3	5.23	100
		NOx		5.3	2.6	1.1374	4.7	5.46	
Scottish Sites									
05-Aug	Aberdeen	NO	519	0.9	2.6	1.210	4.9	3.9	94.7
		NOx		1.2	2.6	1.221	4.9	4.0	
06-Aug	Aberdeen Union Street Roadside	NO	299	0.8	2.6	1.125	4.2	2.6	100.4
		NOx		0.9	2.6	1.138	3.9	1.9	
24-Jul	Bush Estate	NO	2244	1	2.5	0.984	3.5	1.3	101.8
		NOx		3.2	2.5	0.997	3.5	1.5	
22-Jul	Dumbarton Roadside	NO	10118	1	2.6	1.192	4.0	3.4	99.1
		NOx		2	2.6	1.195	4.1	3.9	
01-Jul	Dumfries	NO	1494	1	2.5	1.023	3.5	1.2	98.5
		NOx		1.4	2.5	1.039	3.5	0.6	
23-Jul	Edinburgh St Leonards	NO	73	0.5	2.7	1.295	3.5	0.9	101.0
		NOx		0.9	2.7	1.297	3.5	0.8	
01-Jul	Eskdalemuir	NO	347	1.5	2.5	0.945	6.9	6.0	98.1
		NOx		2	2.5	0.957	5.1	3.5	
24-Jul	Fort William	NO	344	0	2.5	0.981	3.9	1.9	100.4
		NOx		0.1	2.5	0.955	3.8	3.1	
22-Jul	Glasgow Kerbside	NO	06010041	0	2.6	1.214	3.7	3.0	99.6
		NOx		0	2.6	1.217	4.0	3.2	
22-Jul	Grangemouth	NO	1011836	-1	2.6	0.983	3.5	0.1	99.3
		NOx		0	2.6	0.998	3.5	0.8	
22-Jul	Grangemouth Moray	NO	1011852	0	2.7	1.011	5.9	5.3	99.1
		NOx		2	3.1	1.048	6.0	5.5	
08-Aug	Inverness	NO	1489	0.5	2.6	1.208	3.6	0.8	99.5
		NOx		0.4	2.6	1.218	3.5	0.3	
23-Jul	Peebles	NO	2213	0.7	2.6	1.076	3.5	1.4	101.4
		NOx		2.7	2.6	1.098	3.5	0.8	
Welsh Sites									
01-Jul	Aston Hill	NO	2302	0.2	2.6	1.085	3.5	0.7	98.9
		NOx		1.4	3.2	1.085	3.5	1.5	
12-Jul	Cardiff Centre	NO	14325	0.4	2.7	1.383	3.5	1.3	100.0
		NOx		2.2	2.7	1.414	3.5	1.2	
11-Jul	Chepstow A48	NO	6595058	0	2.7	1.424	3.5	0.9	99.4
		NOx		6	2.7	1.428	3.5	0.9	
12-Jul	Cwmbran	NO	1	0.6	2.5	1.018	3.5	0.7	98.9
		NOx		1.2	2.5	0.998	3.5	0.7	
17-Jun	Mold	NO	345	1.6	2.6	1.039	3.5	0.9	98.1
		NOx		2.2	2.5	1.055	3.5	1.0	
09-Jul	Narberth	NO	14311	0	2.5	0.967	3.5	0.6	98.2
		NOx		0.5	2.5	0.957	3.5	0.3	

Date Year =2013	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*Max residual (%)	*Converter efficiency (%)
10-Jul	Newport	NO	829	0	2.6	1.173	3.5	0.7	101.3
		NOx		6	2.8	1.189	3.5	0.8	
11-Jul	Port Talbot	NO	12811	7.1	2.5	1.002	3.5	0.7	99.1
	Margam	NOx		6.6	2.5	0.998	3.5	2.4	
11-Jul	Swansea	NO	16695	1.3	2.6	1.214	3.6	1.5	98.6
	Roadside	NOx		1.6	2.6	1.204	3.5	0.2	
18-Jun	Wrexham	NO	1490	2.2	2.6	1.079	3.5	1.4	98.1
		NOx		3.8	2.6	1.101	3.5	1.5	

5. Particulate Analysers

Date Year =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 (%)
English sites										
09-Jul	Birmingham Acocks Green	PM2.5	192900702	15926	1	1.15	3.01	2.2	15.70	2.2
08-Jul	Birmingham	PM10	200390809	14921	1	-0.13	2.83	2.2	15.40	2.2
	Tyburn	PM2.5	200860809	14726	1	0.29	2.87	2.2	15.58	2.2
08-Jul	Birmingham	PM10		Analyser	not	present				
	Tyburn Roadside	PM2.5	190220606	14208	1	-1.56	2.95	2.2	15.79	2.2
03-Jul	Blackpool Marton	PM2.5	244240302	13036	1	1.10	2.96	2.2	17.41	2.2
07-Aug	Bournemouth	PM2.5	218630603						15.47	2.2
16-Jul	Brighton Preston Park	PM2.5	218650603						16.47	2.2
01-Jul	Bristol St Paul's	PM10	244260302	13232	1	0.41	2.97	2.2	15.64	2.2
		PM2.5	264950701	13647	1	-1.97	3.00	2.2	15.49	2.2
02-Jul	Carlisle	PM10	272570809	14378	1	-0.77	3.00	2.2	16.37	2.2
	Roadside	PM2.5	273410810	15084	1	-0.57	2.98	2.2	16.12	2.2
27-Jun	Chatham Centre	PM10	27108	14514	1	-0.06	3.07	2.2	15.92	2.2
	Roadside	PM2.5	27343	16007	1	0.04	2.93	2.2	15.45	2.2
09-Jul	Chesterfield	PM10	27316	16126	1	-1.20	2.99	2.2	16.63	2.2
		PM2.5	27341	12334	1	-0.81	3.11	2.2	16.79	2.2
09-Jul	Chesterfield	PM10	22299	11334	1	-0.10	3.07	2.2	16.55	2.2
	Roadside	PM2.5	27339	10914	1	-1.55	3.06	2.2	16.58	2.2
30-Jul	Coventry Memorial Park	PM2.5	192890702	14831	1	-0.92	**3.07**	2.2	**17.07**	2.2
16-Jul	Eastbourne	PM10	272380809	14337	1	-1.15	3.13	2.2	17.07	2.2
		PM2.5	272440809	14839	1	0.04	3.00	2.2	16.22	2.2
12-Aug	Harwell	PM10	201670811	14771	1	-1.13	2.87	2.2	15.90	2.2
		PM2.5	167570401	12434	1	0.34	2.92	2.2	16.12	2.2
12-Aug	Harwell Partisol	PM10	21859						16.13	2.2
		PM2.5	21257						15.98	2.2
17-Jul	Hull Freetown	PM10	220209803	14100	1	-0.07	3.00	2.2	16.40	2.2
		PM2.5	264980701	13912	1	-1.98	3.01	2.2	13.88	2.2

Date Year =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 (%)
02-Jul	Leamington	PM10	27295	15073	1	0.52	2.94	2.2	15.46	2.2
	Spa	PM2.5	27248	14218	1	0.26	2.93	2.2	15.35	2.2
01-Jul	Leamington Spa	PM10	26566	13826	1	-0.75	2.89	2.2	15.87	2.2
	Rugby Road	PM2.5	27205	15905	1	-0.81	2.90	2.2	15.61	2.2
16-Jul	Leeds Centre	PM10	24451	13279	1	-0.87	2.97	2.2	16.02	2.2
		PM2.5	27254	16821	1	-1.29	2.90	2.2	15.68	2.2
16-Jul	Leeds Headingley	PM10	27287	17550	1	-0.20	2.82	2.2	15.71	2.2
	Kerbside	PM2.5	27249	14542	1	-1.09	2.93	2.2	15.31	2.2
31-Jul	Leicester	PM10	134079605	14214	1	-1.68	2.97	2.2	17.04	2.2
	Centre	PM2.5	192490701	14791	1	-1.16	3.05	2.2	16.24	2.2
20-Jun	Liverpool	PM10	172220302	15839	1	0.17	2.98	2.2	15.31	2.2
	Speke	PM2.5	192860702	14760	1	-0.99	3.10	2.2	15.90	2.2
15-Aug	Manchester Piccadilly	PM2.5	26038	13869	1	-1.12	3.01	2.2	16.75	2.2
16-Jul	Middlesbrough	PM10	167250309	13951	1	-1.29	2.84	2.2	16.61	2.2
		PM2.5		Analyser	fault	not	tested			
15-Jul	Newcastle	PM10	172140302	13885	1	0.45	3.00	2.2	16.65	2.2
	Centre	PM2.5	171990301	14926	1	0.60	2.99	2.2	16.44	2.2
01-Aug	Northampton Kingsthorpe	PM2.5	21013						16.21	2.2
23-Jul	Norwich	PM10	21495	15628	1	-0.51	3.02	2.2	16.23	2.2
	Lakenfields	PM2.5	27328	15732	1	0.83	2.95	2.2	15.55	2.2
24-Jun	Nottingham	PM10	273690811	15378	1	-1.30	3.37	2.2	17.30	2.2
	Centre	PM2.5	250250401	12147	1	-0.30	3.04	2.2	16.43	2.2
14-Aug	Oxford St	PM10	200870809	14818	1	0.01	3.03	2.2	16.18	2.2
	Ebbes	PM2.5	200160808	17123	1	-0.27	2.97	2.2	16.46	2.2
03-Jul	Plymouth	PM10	201750811	12259	1	-0.15	2.97	2.2	15.77	2.2
	Centre	PM2.5	203960911	14300	1	-0.28	2.95	2.2	15.70	2.2
06-Aug	Portsmouth	PM10	1121	16736	1	-1.47	2.93	2.2	15.77	2.2
		PM2.5	22823	18358	1	-0.99	2.95	2.2	14.85	2.2
03-Jul	Preston	PM2.5	228810001	12974	1	0.15	3.06	2.2	16.81	2.2
13-Aug	Reading New	PM10	21314	13231	1	0.24	2.93	2.2	15.13	2.2
	Town	PM2.5	26575	13941	1	-1.38	2.98	2.2	15.73	2.2
25-Jun	Rochester	PM10	27224	14820	1	-0.62	3.05	2.2	16.36	2.2
	Stoke	PM2.5	27258	15942	1	-0.02	3.06	2.2	16.27	2.2
14-Aug	Salford Eccles	PM10	2000	13721	1	0.22	2.91	2.2	15.96	2.2
		PM2.5	27272	14602	1	-0.24	2.91	2.2	15.92	2.2
03-Jul	Saltash	PM10	168160208	14084	1	-0.40	2.91	2.2	15.61	2.2
	Callington Road	PM2.5	201690811	12286	1	-0.65	2.97	2.2	15.96	2.2
25-Jul	Sandy	PM10	27278	11337	1	0.40	2.99	2.2	14.30	2.2
	Roadside	PM2.5	27632	15969	1	-0.69	2.87	2.2	15.36	2.2
17-Jul	Scunthorpe Town	PM10	273200810	14894	1	-0.70	2.88	2.2	15.58	2.2
08-Jul	Sheffield	PM10	25024	11978	1	-2.22	3.04	2.2	16.47	2.2

Date Year =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 (%)
	Centre	PM2.5	27253	15443	1	-1.25	3.03	2.2	16.33	2.2
05-Aug	Southampton	PM10	172560302	13934	1	0.43	2.92	2.2	15.36	2.2
	Centre	PM2.5	200330808	16617	1	0.57	3.09	2.2	16.43	2.2
27-Jun	Southend-on-Sea	PM2.5	22927	12388	1	-0.38	2.57	2.2	15.53	2.2
04-Jul	Stanford-le-	PM10	21800	12715	1	0.38	**3.08**	**2.2**	**16.63**	**2.2**
	Hope Roadside	PM2.5	22048	13205	1	1.24	**2.97**	**2.2**	**16.41**	**2.2**
16-Jul	Stockton-on-Tees	PM10	H4554						13.90	2.2
	Eaglescliffe	PM2.5	H4553						15.82	2.2
21-Jun	Stoke-on-Trent	PM10	177470401	12424	1	-0.62	2.86	2.2	15.58	2.2
	Centre	PM2.5	200570809	13467	1	-0.26	2.84	2.2	15.79	2.2
17-Jul	Storrington	PM10	200280808	15761	1	0.52	2.93	2.2	16.04	2.2
	Roadside	PM2.5	201760811	12875	1	1.01	2.99	2.2	16.25	2.2
17-Jul	Sunderland Silksworth	PM2.5	200310808	15687	1	-0.72	2.98	2.2	14.47	2.2
27-Jun	Thurrock	PM10	27329	13953	1	-0.68	2.97	2.2	16.08	2.2
19-Jun	Warrington	PM10	175980309	11921	1	-0.68	3.06	2.2	15.63	2.2
		PM2.5	100060808	16269	1	-0.54	3.09	2.2	15.74	2.2
14-Aug	Wigan Centre	PM2.5	27291	14803	1	-0.41	2.90	2.2	15.75	2.2
18-Jun	Wirral Tranmere	PM2.5	15366001	13240	1	-0.40	2.93	2.2	15.74	2.2
18-Jul	York Bootham	PM10	218779212	14522	1	-1.46	2.88	2.2	14.62	2.2
		PM2.5	272090807	16008	1	-1.68	2.96	2.2	15.57	2.2
18-Jul	York Fishergate	PM10	273480810	15572	1	-0.80	2.98	2.2	15.60	2.2
		PM2.5	272320808	17944	1	-1.63	2.97	2.2	15.92	2.2
London Sites										
07-Aug	Camden	PM10	21152	12121	1	1.10	3.00	2.2	16.18	2.2
	Kerbside	PM2.5	23248	13021	1	2.08	3.14	2.2	16.49	2.2
06-Aug	Haringey	PM10	27338	15349	1	0.56	2.98	2.2	15.35	2.2
	Roadside	PM2.5	27260	13747	1	-0.38	3.02	2.2	17.77	2.2
30-Jul	London Bexley	PM2.5	25007	11625	1	0.27	3.04	2.2	15.76	2.2
31-Jul	London	PM10	24446	13820	1	0.58	3.06	2.2	16.40	2.2
	Bloomsbury	PM2.5	27240	14738	1	-0.16	3.09	2.2	15.93	2.2
18-Jul	London Eltham	PM10	27012	14112	1	2.14	2.94	2.2	15.96	2.2
		PM2.5	27012	14084	1	1.93	2.90	2.2	15.64	2.2
25-Jul	London	PM10	24902	12071	1	-1.75	3.06	2.2	16.55	2.2
	Harlington	PM2.5	23959	12637	1	-1.31	3.11	2.2	16.58	2.2
07-Aug	London Harrow Stanmore	PM2.5	27274	16232	1	-0.08	3.06	2.2	16.08	2.2
15-Jul	London	PM10	27230	16695	1	-1.45	3.00	2.2	15.95	2.2
	Marylebone Road	PM2.5	24192	12963	1	1.18	3.07	2.2	16.32	2.2
15-Jul	Marylebone Road	PM10	21221						16.61	2.2
	Partisol	PM2.5	20943						16.47	2.2
16-Jul	London N.	PM10	27391	12717	1	0.35	3.01	2.2	16.35	2.2

Date Year =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 (%)
	Kensington	PM2.5	27189	15902	1	0.74	3.06	2.2	16.08	2.2
16-Jul	N. Kensington	PM10	21019						16.55	2.2
	Partisol	PM2.5	21015						16.33	2.2
08-Aug	London Teddington	PM2.5	27265	15335	1	-0.21	3.14	2.2	15.97	2.2
24-Jul	London Westminster	PM2.5	20939						16.45	2.2
22-Jul	Southwark A2 Old Kent Road	PM10	26480	15048	1	-0.50	3.06	2.2	16.71	2.2
Northern Irish Sites										
20-Aug	Armagh Roadside	PM10	166530201	13677	1	0.77	3.01	2.2	16.97	2.2
20-Aug	Belfast Centre	PM10	172110302	14208	1	0.10	**3.03**	**2.2**	**16.41**	**2.2**
		PM2.5	929880702	15693	1	-0.23	**3.04**	**2.2**	**16.77**	**2.2**
16-Aug	Derry	PM10	202830902	16041	1	1.48	3.12	2.2	16.72	2.2
		PM2.5	134949608	10956	1	0.61	3.05	2.2	16.57	2.2
12-Aug	Lough Navar	PM10	133999604	13044	1	1.76	not	measured	18.24	2.2
Scottish Sites										
05-Aug	Aberdeen	PM10	24427	11499	1	-0.61	2.97	2.2	16.22	2.2
		PM2.5	27368	11995	1	-1.84	3.03	2.2	16.28	2.2
24-Jul	Auchencorth	PM10		dryer	fault	not	Tested			
	Moss	PM2.5		analyser	switched	Off				
24-Jul	Auchencorth	PM10	215500112						analyser	fault
	Moss Partisol	PM2.5	215480112						16.67	2.2
23-Jul	Edinburgh St	PM10	199970808	13696	1	0.03	3.09	2.2	16.27	2.2
	Leonards	PM2.5	201190808	17045	1	0.20	3.11	2.2	16.26	2.2
22-Jul	Glasgow	PM10	27344	14287	1	-2.02	**3.19**	**2.2**	**17.38**	**2.2**
	Kerbside	PM2.5	27337	14855	1	-1.75	**3.19**	**2.2**	**17.44**	**2.2**
22-Jul	Grangemouth	PM10	201210810	16013	1	0.60	3.07	2.2	16.78	2.2
		PM2.5	100110808	13764	1	0.02	3.04	2.2	16.36	2.2
08-Aug	Inverness	PM10	21555						16.91	2.2
		PM2.5	21861						16.79	2.2
Welsh Sites										
12-Jul	Cardiff Centre	PM10	25499	13633	1	-1.77	2.87	2.2	15.88	2.2
		PM2.5		dryer	fault	not	tested	2.2		
11-Jul	Chepstow A48	PM10	27242	14153	1	-0.22	2.97	2.2	16.03	2.2
		PM2.5	27223	15955	1	-0.25	2.94	2.2	16.59	2.2
09-Jul	Narberth	PM10	26563	13799	1	-0.53	2.93	2.2	16.12	2.2
10-Jul	Newport	PM10	21029	13794	1	-1.38	**3.22**	2.2	**18.18**	2.2
		PM2.5	26566	16452	1	-1.02	2.94	2.2	15.88	2.2
11-Jul	Port Talbot	PM10								
	Margam	PM2.5		analysers	not	tested	episode	in	progress	
11-Jul	PT Margam Partisol	PM10		analyser	not	tested	episode	in	progress	

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11-Jul	Swansea	PM10	20072						13.65	2.2
	Roadside	PM2.5	20071						11.08	2.2
18-Jun	Wrexham	PM10	21224						18.39	2.2
		PM2.5	21011						16.62	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.

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