
QA/QC Data Ratification Report for the Automatic Urban and Rural Network, April-June 2014



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Executive summary

Ricardo-AEA carries out the quality assurance and quality 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 89.41% for all pollutants (O_3 , NO_2 , SO_2 , CO , PM_{10} and $PM_{2.5}$) during the 3-month reporting period April-June 2014. Average data capture for all pollutants except PM_{10} were above 85%. There were 30 stations with data capture less than 85% for the period.

A total of 140 monitoring stations in the AURN operated during this quarter. Some of these are co-located and separately named gravimetric particulate analysers at stations with automatic analysers. Many affiliated stations have additional Defra-funded analysers installed on site.

The main reasons for data loss at the stations have been provided and these were predominantly due to instrument or air conditioning faults, response instability or problems associated with the replacement of analysers and infrastructure.

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1 Introduction

This quarterly report covers the Quality Assurance and Quality Control (QA/QC) activities undertaken by Ricardo-AEA to ratify automatic monitoring data from Defra and the Devolved Administrations' Automatic Urban and Rural Network (AURN) for the period 1 April- 30 June 2014. Eleven stations also use non-automatic gravimetric particulate samplers (Partisols); there are 17 of these in the network. Eight of them are co-located with FDMS analysers at Auchencorth Moss, Harwell, London North Kensington and Marylebone Road for both PM₁₀ and PM_{2.5}.

1.1 Overview of Network Performance

Ratified hourly average (daily average for Partisols) data capture for the network averaged 89.41% for all pollutants (O₃, NO₂, SO₂, CO, PM₁₀ and PM_{2.5}) during the 3 month reporting period April-June 2014 (see Table 1.1). 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; 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 stations starting or closing during the period, the data capture is based on the actual date starting or closing. All except PM₁₀ achieved 85% or higher data capture on average. The data capture target for the purposes of monitoring compliance with the EU Air Quality Directive (Directive 2008/50/EC) is 90% excluding planned servicing and maintenance. For practical purposes in the AURN, planned maintenance is assumed to be 5% so a target of 85% data capture is used.

Table 1.1: AURN Ratified Data Capture (%) by Quarter, April-June 2014

	CO	PM ₁₀	PM _{2.5}	NO ₂	O ₃	SO ₂	Mean
Q1 2014	95.35	85.45	83.51	94.31	95.01	90.02	89.72
Q2 2014	99.75	83.40	89.99	91.98	95.43	91.07	89.41

Overall, 332 out of the 393 analysers (85%) achieved data capture levels above the required 85% 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 85%

Total Number Of Analysers	Q1 Jan-Mar 2014 (No. below 85%)	Q2 Jan-Mar 2014 (No. below 85%)
CO	7	0
NO ₂	116	16
O ₃	79	5
PM ₁₀ ¹	70	21
PM _{2.5} ¹	80	14
SO ₂	29	5
Total <90%	80	61

¹ Includes FDMS, BAM and Partisol analysers.

In total, 30 out of the 140 operational network stations in the quarter (21.4%) had an average data capture rate below the required 85% level for the April-June 2014 period.

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:

- Auchencorth Moss PM_{2.5}, rescaled 23 Oct 2013-5 February 2014, K₀ coefficient outlier.
- Portsmouth PM_{2.5}, deleted 3rd to 6th Aug 2013.and 25 February-31 March 2014, low volatile concentrations.
- Storrington Roadside, PM₁₀ deleted 15 November 2013-31 March 2014, regional outlier.

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

The following stations were commissioned during this period:

Station	Pollutants measured	Date started
Blackburn Accrington Road	NO ₂	28 May 14
Coventry Allesley	NO ₂ O ₃ PM _{2.5}	17 June 14
Ealing Horn Lane	PM ₁₀	21 May 14
Glasgow Great Western Road	NO ₂	5 June 14
Shaw Crompton Way	NO ₂	12 June 14

3 Generic Data Quality Issues

3.1 FDMS Performance Issues

Several FDMS analysers continued to give problems during the quarter. Out of 134 operational analysers, 35 had data capture less than 85%. However, *average* data capture for PM_{2.5} only was above 85% for this quarter.

4 Station Specific Issues

In this section, we now discuss in turn specific station issues for 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. Analysers with data capture less than 90% are highlighted in yellow and those with data capture less than 85% are highlighted in orange.

4.1 London

4.1.1 Data Capture

The data capture for stations in London (within the M25) for the period April-June 2014 is given in Table 4.1:

Table 4.1 Data Capture for London, April-June 2014 (%)

Site	CO	PM ₁₀	PM ₂₅	NO ₂	O ₃	SO ₂	Average
Camden Kerbside		61.77	43.91	99.13			68.27
Haringey Roadside		100.00	99.68	62.32			82.88
London Bexley			99.82	98.49		94.32	97.54
London Bloomsbury		99.54	99.86	99.82	99.63	99.36	99.64
London Eltham			88.78	95.65	99.77		94.73
London Haringey Priory Park South				98.76	99.86		99.31
London Harlington		80.04	99.08	93.18	86.58		89.72
London Harrow Stanmore			99.82				99.82
London Hillingdon				99.59	99.77		99.68
London Marylebone Road	99.63	89.51	99.59	99.50	97.85	99.63	97.62
London Marylebone Road		94.51	98.90				96.70
London N. Kensington	99.73	99.82	93.13	99.73	99.73	94.69	97.80
London N. Kensington		100.00	98.90				99.45
London Teddington				96.52	96.66		96.59
London Teddington Bushy Park			61.13				61.13
London Westminster			98.90	99.95			99.91
Southwark A2 Old Kent Road		70.92		94.46			82.69
Tower Hamlets Roadside				99.73			99.73
Ealing Horn Lane		100.00					100.00
Number of Sites	2	10	13	14	8	4	19
Number of sites < 85 %	0	4	2	1	0	0	4
Number of sites < 90%	0	5	3	1	1	0	6
Network mean	99.68	85.95	90.88	95.49	97.48	97.00	90.88

4.1.2 Station Specific Issues

Camden Kerbside

The air conditioning failed during the summer of 2014; the PM_{2.5} FDMS was switched off on 16 May to avoid possible damage; the PM₁₀ FDMS continued to operate but suffered frequent periods of noisy data due to temperature issues.

Haringey Roadside

The NO_x analyser developed a fault at the end of May, but despite several attempts by the ESU to rectify it, normal operation was not restored until July.

London Teddington Bushy Park

Noisy data continued to be a problem, probably as a result of temperature problems. Data from 16-20 May and 31 May-19 June have been deleted during ratification. The station needed to be relocated a short distance to allow for redevelopment work at Teddington; data were lost from 20-30 June

Southwark A2 Old Kent Road

The enclosure was found to have been vandalised on 2 June, and the air conditioning was not operational. This resulted in the PM₁₀ data being deleted up to the end of the month, when the site was switched off completely.

4.2 England (excluding London)

4.2.1 Data Capture

The data capture for stations in England for the period April-June 2014 is given in Table 4.2:

Table 4.2 Data Capture for England, April-June 2014

Site	CO	PM ₁₀	PM ₂₅	NO ₂	O ₃	SO ₂	Average
Barnsley Gawber				99.40	99.73	97.53	98.89
Barnstaple A39		95.28	95.15				95.22
Bath Roadside				99.73			99.73
Billingham				99.45			99.45
Birmingham Acocks Green			99.68	99.27	99.91		99.62
Birmingham Tyburn		57.14	99.40	99.82	99.91	99.86	91.23
Birmingham Tyburn Roadside		92.26	95.88	98.81	98.63		96.39
Blackburn Accrington Road				99.50			99.50
Blackpool Marton			99.68	99.82	99.77		99.76
Bottesford					98.95		98.95
Bournemouth			98.90	99.27	99.91		99.57
Brighton Preston Park			97.80	99.86	99.91		99.84
Bristol St Paul's		97.89	66.07	99.91	99.95		90.96
Cambridge Roadside				99.68			99.68
Canterbury				99.95	99.91		99.93
Carlisle Roadside		78.25	90.38	97.99			88.87
Charlton Mackrell				99.77	99.63		99.70
Chatham Centre Roadside		95.33	92.99	99.73			96.02

Site	CO	PM ₁₀	PM ₂₅	NO ₂	O ₃	SO ₂	Average
Chesterfield		54.44	54.21	54.44			54.37
Chesterfield Roadside		95.10	99.63	92.17			95.63
Coventry Allesley			92.1	15.38	92.31		66.60
Coventry Memorial Park			59.98	76.92	76.88		71.26
Eastbourne		99.73	99.91	99.91			99.85
Exeter Roadside				24.45	24.54		24.50
Glazebury				84.75	99.91		92.33
Great Dun Fell					99.82		99.82
Harwell		99.91	99.04	99.95	99.82	95.79	98.90
Harwell		98.90	89.01				93.96
High Muffles				77.47	95.42		86.45
Honiton				99.91			99.91
Horley				99.31			99.31
Hull Freetown		99.59	99.77	96.89	97.71	99.50	98.69
Ladybower				95.01	95.65	95.19	95.28
Leamington Spa		99.40	100.00	89.93	93.82		95.79
Leamington Spa Rugby Road		3.43	94.32	95.33			64.36
Leeds Centre	99.82	99.36	98.72	99.73	99.91	99.68	99.53
Leeds Headingley Kerbside		59.16	99.95	99.86			86.32
Leicester University			98.63	95.65	99.59		97.95
Leominster				98.90	94.83		96.86
Lincoln Canwick Road				98.58			98.58
Liverpool Queen's Drive Roadside				99.77			99.77
Liverpool Speke		69.18	69.28	69.78	69.73	66.80	68.96
Lullington Heath				48.67	99.54	95.33	81.18
Manchester Piccadilly			99.82	99.27	99.91	100.00	99.75
Manchester South				99.86	99.95		99.91
Market Harborough				95.33	99.54		97.44
Middlesbrough		84.52	92.99	98.99	61.58	69.09	81.44
Newcastle Centre		99.82	99.86	99.77	99.50		99.74
Newcastle Cradlewell Roadside				98.81			98.81
Northampton Kingsthorpe			100.00	99.82	99.68		99.75
Norwich Lakenfields		99.77	92.95	99.86	99.91		98.12
Nottingham Centre		90.89	91.12	99.73	99.22	99.68	96.13
Oxford Centre Roadside				99.73			99.73
Oxford St Ebbes		36.58	36.86	99.77			57.74
Plymouth Centre		100.00	81.04	99.91	99.91		95.22
Portsmouth		99.91	100.00	100.00	99.95		99.97
Preston			88.83	99.31	99.68		95.94
Reading New Town		87.96	99.18	99.86	99.18		96.54
Rochester Stoke		90.61	90.20	99.86	99.95	99.86	96.10
Salford Eccles		93.59	87.27	92.77			91.21

Site	CO	PM ₁₀	PM _{2.5}	NO ₂	O ₃	SO ₂	Average
Saltash Callington Road		92.67	94.18				93.43
Sandy Roadside		57.46	67.17	79.08			67.90
Scunthorpe Town		99.91		99.18		52.52	83.87
Shaw Crompton Way				96.66			98.33
Sheffield Devonshire Green		72.53	90.89	99.77	99.59		90.69
Sheffield Tinsley				95.74			95.74
Sibton					98.49		98.49
Southampton Centre		99.95	100.00	95.56	99.54	95.65	98.14
Southend-on-Sea			98.40	98.12	98.17		98.23
St Osyth				93.91	98.40		96.15
Stanford-le-Hope Roadside		94.18	85.53	99.45			93.06
Stockton-on-Tees Eaglescliffe		99.54	99.91	99.91			99.79
Stoke-on-Trent Centre		93.96	93.96	92.49	93.82		93.56
Storrington Roadside		36.77	98.31	54.40			63.16
Sunderland Silksworth			99.54	0.00	98.44		66.00
Thurrock		86.03		96.38	98.81	71.15	88.10
Walsall Woodlands				99.91	99.86		99.89
Warrington		66.80	67.22	98.31			77.44
Weybourne					99.91		99.91
Wicken Fen				99.86	96.66	95.79	97.44
Wigan Centre			96.84	99.73	100.00		98.86
Wirral Tranmere			57.46	72.76	99.36		76.53
Yarner Wood				92.45	99.91		96.18
York Bootham		99.04	99.27				99.15
York Fishergate		99.63	99.73	91.21			96.86
Number of Sites	1	40	52	76	53	16	85
Number of sites < 85 %	0	12	9	12	4	4	15
Number of sites < 90%	0	14	13	13	4	4	19
Network mean	99.82	84.41	90.37	91.46	95.75	89.59	93.03

4.2.2 Station Specific Issues

Carlisle Roadside

Air conditioning failure resulted in a considerable quantity of noisy data from the FDMS analysers. PM₁₀ data from 11 to 26 June have been deleted, along with shorter periods of PM_{2.5} data

Chesterfield

The site closed on 20 May pending relocation.

Coventry Allesley

This site was commissioned on 17 June, but the NO_x analyser suffered a chiller failure on startup. A hotspare loan analyser was installed on 26 June.

Coventry Memorial Park

The site closed on 10 June pending relocation.

Exeter Roadside

Following the QA/QC audit on 23 April, the instruments were left internally sampling for the rest of the quarter. All data have been deleted.

High Muffles

Some NO_x and ozone data were lost at the end of May into June due to air conditioning failure.

.Leamington Spa Rugby Road

The PM₁₀ data from this site was anomalously low from 4 April. The analyser was removed for workshop repair. On return to site on 9 May, the instrument was damaged, and removed once again for repair. A replacement mass transducer was ordered, and the analyser returned to site at the end of July.

Leeds Headingley Kerbside

The PM₁₀ data were identified as being out of line with regional averages for much of this quarter, and data from 25 May to 30 June have been deleted.

Liverpool Speke

A contractor carrying out groundworks adjacent to the site cut through the power cable on 30 April; repairs were not complete until 27 May.

Lullington Heath

The NO_x analyser had been replaced by a loan instrument in November 2013. However this developed a series of faults resulting in poor quality data during this quarter. NO_x data have been deleted from 19 May until the end of June.

Middlesbrough

The SO₂ and O₃ analysers suffered multiple lockups preventing logging of data throughout the quarter, despite numerous attempts by the LSO and ESU to reset them. Ultimately both analysers were replaced at the end of June and normal operation was restored. In addition, the PM₁₀ FDMS had a leaking valve resulted in the loss of data from 19-30 April.

Oxford St Ebbes

Both PM_{2.5} and PM₁₀ volatile data appeared low up to the drier replacement in May 2014. The air conditioning fault may be a contributory factor in this quarter. PM₁₀ and PM_{2.5} data have been deleted from 25 February to 27 May.

Sandy Roadside

A callout was issued for failed air conditioning on 12 May, but despite attention, a repair was not successfully completed until 2 July. The elevated temperatures resulted in considerable data loss from the FDMS analysers.

Scunthorpe Town

The SO₂ analyser was reinstalled following workshop repair on 1 April; however a logger fault resulted in a loss of data up to 13 May, when a replacement analyser was installed.

Sheffield Devonshire Green

The PM₁₀ data were lost between 5 and 24 June due to failure on the control board and the valve motor.

Storrington Roadside

The NO_x analyser was removed for workshop repair due to a leaking converter and faulty motherboard in early April; however a replacement was not installed until 12 May. In addition,

the PM₁₀ FDMS had a new drier fitted on 22 May; review of data before this has resulted in the deletion of data from 15 November 2013 up to 22 May 2014.

Sunderland Silksworth

There were no full calibrations carried out at this site between 6 March and 20 June; all NO_x data for the quarter have been deleted. This was due to regulator problems, and removal from site of the NO rather than the NO₂ cylinder.

Thurrock

The PM₁₀ data were identified as a regional outlier and have been deleted between 19 and 29 May. The SO₂ analyser required a replacement photomultiplier on 25 April, data from 28 March to the repair have been deleted.

Warrington

The site suffered air conditioning failure resulting in some loss of data from all analysers during the quarter.

.Wirral Tranmere

On 17 May, the air conditioning failed and the resultant noisy data have been deleted.

4.3 Scotland

4.3.1 Data Capture

The data capture for stations in Scotland for the period April-June 2014 is given in Table 4.3.

Table 4.3 Data Capture for Scotland, April-June 2014

Site	CO	PM ₁₀	PM ₂₅	NO ₂	O ₃	SO ₂	Average
Aberdeen		99.04	96.20	98.53	99.63		98.35
Aberdeen Union Street Roadside				82.19			82.19
Auchencorth Moss		98.90	98.90		99.22		99.20
Auchencorth Moss		99.22	84.80				92.01
Bush Estate				99.91	96.25		98.08
Dumbarton Roadside				93.22			93.22
Dumfries				99.50			99.50
Edinburgh St Leonards	99.86	99.91	100.00	99.86	94.55	99.45	98.94
Eskdalemuir				99.95	99.82		99.89
Fort William				98.31	99.40		98.86
Glasgow Great Western Road				99.65			99.65
Glasgow Kerbside		28.89	48.12	99.59			58.87
Glasgow Townhead		95.15	99.95	99.91	99.91		98.73
Grangemouth		96.93	90.48	93.18		97.30	94.47
Grangemouth Moray				95.42			95.42
Inverness		98.90	100.00	99.22			99.24
Lerwick					0.00		0.00
Peebles				99.82	99.91		99.86
Strath Vaich					98.26		98.26
Number of Sites	1	8	8	15	9	2	18
Number of sites < 85 %	0	1	2	2	1	0	3

Site	CO	PM ₁₀	PM ₂₅	NO ₂	O ₃	SO ₂	Average
Number of sites < 90%	0	1	2	2	1	0	3
Network mean	99.86	89.62	89.81	92.44	88.70	98.37	89.72

4.3.2 Station Specific Issues

Aberdeen Union Street Roadside

The site was turned off from 29 April to 13 May for repairs to the air conditioning unit.

Glasgow Kerbside

Continuing problems with the air conditioning unit resulted in the loss of data from both FDMS units.

Lerwick

The station is temporarily closed due to building works at the Observatory.

4.4 Wales

4.4.1 Data Capture

The data capture for stations in Wales for April-June 2014 is given in Table 4.4.

Table 4.4 Data Capture for Wales, April-June 2014

Site	CO	PM ₁₀	PM ₂₅	NO ₂	O ₃	SO ₂	Average
Aston Hill				95.05	99.91		97.48
Cardiff Centre	100.00	100.00	99.95	98.35	99.95	99.36	99.60
Chepstow A48		98.63	93.09	97.76			96.49
Cwmbran				99.73	99.91		99.82
Narberth		98.95		99.86	100.00	99.82	99.66
Newport		59.48	99.77	88.23			82.49
Port Talbot Margam		97.80					97.80
Port Talbot Margam	99.50	99.63	100.00	99.18	99.54	99.45	99.55
Swansea Roadside		97.16	96.52	99.86			97.85
Wrexham		93.41	98.90	99.50		99.91	99.56
Number of Sites	2	8	6	9	5	4	10
Number of sites < 85 %	0	1	0	0	0	0	1
Number of sites < 90%	0	1	0	1	0	0	1
Network mean	99.75	93.13	98.04	97.50	99.86	99.63	97.03

4.4.2 Station Specific Issues

Newport

Much of the PM₁₀, and some PM_{2.5} data, data have been deleted this quarter due to high baselines. Also, a communications fault resulted in the loss of some NO_x data in early June.

4.5 Northern Ireland (including Mace Head)

4.5.1 Data Capture

The data capture for stations in Northern Ireland (including Mace Head in the Republic of Ireland) for the period October to December 2014 is given in Table 4.5.

Table 4.5 Data Capture for Ireland, April-June 2014

Site	CO	PM ₁₀	PM ₂₅	NO ₂	O ₃	SO ₂	Average
Armagh Roadside		86.86		95.88			91.37
Ballymena Ballykeel						100.00	100.00
Belfast Centre	99.73	99.95	99.77	91.58	95.42	90.52	96.16
Derry		93.32	93.41	100.00	99.86	33.65	84.05
Lough Navar		93.54			99.54		96.54
Mace Head					99.27		99.27
Number of Sites	1	4	2	3	4	3	6
Number of sites < 85 %	0	0	0	0	0	1	1
Number of sites < 90%	0	1	0	0	0	1	1
Network mean	99.73	93.42	96.59	95.82	98.52	74.73	94.56

4.5.2 Station Specific Issues

Derry

The SO₂ data for this quarter was very noisy, and much of it has been deleted during ratification. The fault continues into Q3.

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, April-June 2014

	CO	PM ₁₀	PM ₂₅	NO ₂	O ₃	SO ₂	Average
Number of Stations	7	74	82	121	80	29	143
Number of stations < 85 %	0	21	14	16	5	5	30
Number of stations < 90%	0	25	19	18	6	5	35
Network mean	99.75	83.40	89.99	91.98	95.43	91.07	89.41

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 $0 \mu\text{g m}^{-3}$.

With this information, stations 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 $5 \mu\text{g m}^{-3}$.

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

6 LSO Manual and AURN Hub

This manual is available via the AURN Hub at <http://uk-air.defra.gov.uk/reports/empire/lsoman/lsoman.html>. The AURN Hub is a password protected website for the use of AURN contractors including Local Site Operators and Equipment Support units.

Current versions of the LSO calibrations spreadsheet are also available to download from the LSO manual page of the Hub.

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