QAQC Report for the Automatic Urban and Rural Network, January-March 2018

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Contact:

Alison Loader
Ricardo Energy & Environment
Gemini Building, Harwell, Didcot, OX11 0QR,
United Kingdom

t: +44 (0) 1235 75 3632
e: alison.loader@ricardo.com

Ricardo Energy & Environment Ltd is certificated to ISO9001 and ISO14001

Author:

Stewart Eaton

Approved By:

Alison Loader

Date:

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Executive summary

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

This quarterly report summarises the QAQC activities carried out over the period 1st January 2018 to 31st March 2018. It presents the key data capture and data quality statistics, and highlights any issues that have been identified relating to the monitoring stations and their apparatus. The number of AURN monitoring stations in operation during part or all of this period was 168.

During this quarter, the winter 2018 intercalibration exercise was carried out, involving comprehensive performance tests on every analyser in the network. This allows the accuracy of the measured results to be determined, and a measurement uncertainty for each analyser to be calculated, as required by the Data Quality Objectives of the European Union's Air Quality Directive (2008/50/EC).

The data from each analyser in the network have been ratified by the QA/QC Unit using documented and validated methods. This process takes into account input from Local Site Operator (LSO) calibrations, the QA/QC audits and records from Equipment Support Unit (ESU) activity.

The routine QA/QC procedures have included checking of particulate analyser baselines for some time now. The CEN standard method for ambient particulate matter EN16450 states that action must be taken when baseline response is higher than 3 µg m^{-3} but does not state what the action should be. Up to the 2015 dataset the only agreed action was to delete the data. However, as part of ongoing improvement activities a protocol has been agreed to enable baselines to be corrected where baseline responses exceed ±3 µg m^{-3}. Accordingly, baseline correction – where it is deemed appropriate – has now been incorporated into the data ratification protocols.

Data ratification for the quarter was completed by the deadline of 30th June 2018. The mean data capture for ratified hourly average data was 94.32% (averaged over all pollutants O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$), for the three-month reporting period January to March 2018.

The data capture target of the Air Quality Directive is 90% excluding periods of planned maintenance e.g. calibrations, audits and servicing). An allowance of 5% is made for this, hence a target of 85%. Mean data captures for individual pollutants were as follows: CO 97.12%, NO_2 96,59%, O_3 97.01%, SO_2 87.38%, PM_{10} 91.13%, and $PM_{2.5}$ 89.46%. Hence, the mean data captures for all pollutants met this target in Quarter 1 (Q1) of 2018. Principal reasons for data loss are given here for stations which fail to make the 85% data capture target for the quarter.

The uncertainty of measurement for each analyser has been determined to ensure compliance with the Data Quality Objective. Two analysers out of the total of 415 tested were found to be outside the uncertainty limits.

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1 Introduction

1.1 Background

The UK Automatic Urban and Rural Network (AURN) has been established to provide information on air quality concentrations throughout the UK for a range of pollutants. The primary function of the AURN is to provide data in compliance with the Air Quality Directive 2008/50/EC[1]. In addition, the data and information from the AURN are required by scientists, policy makers and planners to enable them to make informed decisions on managing and improving air quality for the benefit of health and the natural environment.

A number of organisations are involved in the day-to-day running of the network. Currently, the role of Central Management and Co-ordination Unit (CMCU) for the AURN is contracted to Bureau Veritas, whilst the Environmental Research Group (ERG) of King's College London (KCL) has been appointed as Management Unit (MU) for the AURN monitoring stations that are also part of the London Air Quality Network (LAQN), together with a small number of others in the south of England. Ricardo Energy & Environment undertakes the role of Quality Assurance and Control Unit (QA/QC Unit) for all stations within the AURN. The responsibility for operating individual monitoring stations is assigned to local organisations with relevant experience in the field under the direct management (and contract to) CMCU. The people within these organisations who carry out the operation of the monitoring stations are referred to as Local Site Operators (LSOs). Calibration gases for the network are supplied by Air Liquide Ltd and are provided with an ISO17025 certificate of calibration by Ricardo Energy & Environment. The monitoring equipment is serviced and maintained by a number of Equipment Support Units, under contract to the CMCU or the station owner in the case of Local Authority-owned affiliated stations.

Dissemination of the data from the AURN via UK-AIR (the UK online Air Information Resource, http://uk-air.defra.gov.uk) and other media such as social media and freephone services, is undertaken by the Data Dissemination Unit (DDU). A summary report of the data is also published annually in the "*Air Pollution in the UK*" series of reports, which can be found at https://uk-air.defra.gov.uk/library/annualreport/index .

A total of 168 monitoring stations at 166 locations in the AURN operated during this quarter. The total of 168 includes two stations where Partisol gravimetric particulate samplers are co-located with automatic particulate analysers. For data processing purposes the gravimetric sampler is treated as a separate station; and they are shown, and counted, separately in the data capture tables in section 4.

1.2 What this Report Covers

This report covers the three-month period January-March 2018, or "Quarter 1" (Q1) of the year. This report covers the main QA/QC activities and a summary of the significant station operational issues.

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

1.3 Where to Find More Information

Further information on the AURN can be found in the following:

- UK-AIR, www.uk-air.defra.gov which contains information on individual stations along with real-time hourly data, graphs and statistics.
- The AURN Hub. This online resource for AURN stakeholders contains network-specific information relating to the AURN, including the LSO Manual, QA/QC audit and ESU service schedules and supporting information.

[1] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2008:152:0001:0044:EN:PDF

1.4 Changes to the Network during this Quarter

Table 1-1 shows the changes that were made to the network during the period January – March 2018:

Table 1-1 Network Changes Jan - Mar 2018

Station	Pollutants	Date Added
Monitoring Stations Started Up:		
Dewsbury Ashworth Grove	NO_2	01/04/18
Burton-on-Trent Horninglow	NO_2	01/02/18
Swindon Walcot	NO_2	01/01/18

No monitoring stations closed down.

The following additional instruments were introduced at existing sites:

- Introduction of the PM_{10} particulate analyser at the affiliated site Newcastle Cradlewell: this went live to the network on 26th February 2018. This instrument is an Environment Agency gifted analyser and supported by Newcastle City Council.
- Introduction of the $PM_{2.5}$ particulate fully funded analyser at the affiliated site Worthing A27 Roadside. This went live to the network on 20th March 2018.
- The Partisol $PM_{2.5}$ at London Westminster was removed from site in February and replaced with a $PM_{2.5}$ beta attenuation monitor (BAM).

2 Methodology

2.1 Overview of QA/QC Activities

The QA/QC activities consist of the following key parts:

- QA/QC audits of all analysers in the network every six months (three months for ozone).
- Ratification of the data on a three-monthly basis, and delivery of ratified data to the Data Dissemination Unit for dissemination via UK-AIR and other routes.
- Assessment of new station locations in conjunction with the CMCU, and assessment of compliance with the siting criteria in the Directive.
- Investigation of instances of suspected poor-quality data.

2.2 Winter 2018 QA/QC Audits

The intercalibration requires the coordination and close cooperation of QA/QC Unit, Management Units, Equipment Support 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 MU's and ESU's for approval. ESU ozone photometers are calibrated at Ricardo Energy & Environment and all QA/QC equipment and cylinders are tested, calibrated and verified before use.

QA/QC visits are always undertaken before any ESU service 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 service 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.

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; i.e. that a 200ppb NO_2 pollution episode in (for example) 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 Energy & Environment 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 LSOs that are used to scale pollution datasets, it is important to check that these are undertaken competently.
12. Zero "calibration" of all automatic PM analysers. This test allows the baseline performance of PM analysers to be evaluated, to determine whether any remedial action is required.

2.3 Network Intercalibration

Once all data have been collected, a "Network Intercalibration" 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 Energy & Environment and allows QA/QC Unit 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 intercalibration 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 disseminated via UK-AIR and other routes.
- 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 cylinders 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.

2.4 Methodology for FDMS Baseline Checks

As part of the QA/QC remit for continuous improvement, an ad hoc study of particulate matter (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 µg m^{-3}. A mean zero average concentration of 3 µg m^{-3} provides a trigger for further investigation, and possible drier replacement if deemed necessary. The test is equally valid for BAM instruments, and thus the tests are also carried out on these.

The routine QA/QC procedures have included checking of particulate analyser baselines for some time now. The CEN standard method for ambient particulate matter EN16450 states that action must be taken when baseline response is higher than 3 µg m^{-3} but does not state what the action should be. Until 2016 the only agreed action was to delete the data. However, as part of ongoing improvement activities a protocol has been agreed to enable baselines to be corrected where baseline responses exceed 3 µg m^{-3}.

Fidas instruments are also subject to zero checks, but by their nature of operation, this can be completed during the normal site audit activity, and so no LSO visit is required to remove the filter. Data losses are therefore minimised.

2.5 Overview of Data Ratification

Data for each station are supplied monthly by the CMCUs. Once initial monthly data files have been received, checked and loaded into the QA/QC Unit's data processing system, the process of data ratification begins. This process is required to refine data scaling based on all the calibration and audit data available, and to identify, withdraw or flag anomalous data due to instrument or sampling faults or where data fall outside the Uncertainties or Limits of Detection defined by the Data Quality Objectives (DQOs) of Directive 2008/50/EC (the Air Quality Directive) and the European Union's Implementing Provisions for Reporting.

3 Intercalibration Results

3.1 Winter Intercalibration, January-February 2018

During the winter 2018 intercalibration, audits were carried out on 167 monitoring stations out of 168 in operation at the time.

The results of the intercalibration are summarised in Table 3-1 below:

Table 3-1 Summary of audited analyser performance – 168 UK stations

Parameter	Number of outliers	Number in network	% outliers in total
NOx analyser	13	151	8.6%
CO analyser	2	7	28.6%
SO_2 analyser	4	27	14.8%
Ozone analyser	13 (4 more than 10% from standard)	75	17.3%
FDMS and BAM analysers	6 x k_0, 2 x flows (16 x zero tests)	76 PM_{10} 71 $PM_{2.5}$	5.4%
Gravimetric PM analysers	2	10	20%
Cylinders	7	185	3.8%
Total	42 analysers	417 analysers	10.1% of analysers

The number of analyser outliers identified (10.1%) is lower than at the summer 2017 intercalibration (13.2%).

3.2 Network Intercalibrations

The concentration of the audit cylinders was calculated averaged across all monitoring stations 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 3-2 below.

Table 3-2 Audit Cylinder Results

Parameter	Network Mean, ppb (ppm for CO)	Audit reference concentration ppb (ppm for CO)	Network Accuracy %	%Std Dev
NO	453	461	-1.7%	**3.7%**
NO_2	431	446	-3.3%	**4.0%**
CO	19.9	20.0	-0.6%	**1.8%**
SO_2	462	467	-1.0%	**4.1%**

- **Oxides of Nitrogen**

  A total of 13 outliers were identified during this intercalibration. Of these outliers, seven were attributed to analyser drift, two to changes in site cylinder concentration, three to differences between the CMCU and QAQC Unit cylinder databases and one to issues experienced during the audit which compromised the results.

  There were five converters which fell outside the ±5% acceptance limits. There were three converter tests between 95% and 98%. There were a further five converters identified where the initial result was outside the ±2% trigger for NO_2 rescaling.

- **Carbon Monoxide**

  There were two CO outliers identified at this intercalibration, both caused by an apparent difference between audit and LSO calibrations.

- **Sulphur Dioxide**

  A total of four outliers were identified at this intercalibration. Three of the outliers can be attributed to drift, the other was caused by an apparent difference between audit and LSO calibrations. All m-xylene interference tests were less than 27 ppb.

- **Ozone**

  A total of 13 outliers were identified at this intercalibration. Four of the outliers had a calibration response more than 10% from the reference photometer.

- **Particulate Analysers**

  There were six calculated k_0 values outside the required ±2.5% of the stated values. This is much better than the previous exercise where 17 outliers were identified. All except one of the outlier results were within 2.5 to 3.0% of the stated values, a dramatic improvement over more recent intercomparisons. One outlier was a result of the control unit being incorrectly configured.

  No FDMS main flows were found to be outside the ±10% acceptance limits. One BAM and one FDMS total flows were found to be outside this limit. Two Partisol total flows were found to be outside the ±10% acceptance limits.

London Sites

The results of the intercalibration for the 16 London sites (including the co-located Partisols) in operation at the time of the intercalibration are summarised in **Error! Reference source not found.** below:

Table 3-3 Summary of audited analyser performance – London Sites

Parameter	Number of outliers	Number in region
NOx analyser	0	13
NOx converter	1	
CO analyser	0	2
SO_2 analyser	1	3
Ozone analyser	1	8
FDMS, Fidas and BAM analysers	0	17

Gravimetric PM analysers	0	3

English Sites (Excluding London)

The results of the intercalibration for the 110 sites in England outside of London are summarised in **Error! Reference source not found.** below:

Table 3-4 Summary of audited analyser performance – Sites in England

Parameter	Number of outliers	Number in region
NOx analyser	12	103
NOx converter	3	
CO analyser	0	1
SO_2 analyser	1	16
Ozone analyser	6	53
FDMS and BAM analysers	6 k_0, 2 flow	93
Gravimetric PM analysers	0	3

Scottish Sites

The results of the intercalibration for the 23 Scottish sites are summarised in **Error! Reference source not found.** below:

Table 3-5 Summary of audited analyser performance – Scottish Sites

Parameter	Number of outliers	Number in region
NOx analyser	1	20
NOx converter	1	
CO analyser	1	1
SO_2 analyser	1	3
Ozone analyser	2	10
FDMS, Fidas and BAM analysers	0	12
Gravimetric PM analysers	1	4

Welsh Sites

The results of the intercalibration for the 11 Welsh sites are summarised in **Error! Reference source not found.** below:

Table 3-6 Summary of audited analyser performance – Welsh Sites

Parameter	Number of outliers	Number in region
NOx analyser	0	10
NOx converter	0	
CO analyser	0	2
SO_2 analyser	1	4
Ozone analyser	2	5
FDMS and BAM analysers	0	11
Gravimetric PM analysers	1	3

Northern Ireland Sites

The results of the intercalibration for the eight sites in Northern Ireland, plus Mace Head in the Republic of Ireland, are summarised in **Error! Reference source not found.** below:

Table 3-7 Summary of audited analyser performance – Northern Ireland Sites plus Mace Head

Parameter	Number of outliers	Number in region
NOx analyser	0	5
NOx converter	0	
CO analyser	1	1
SO_2 analyser	0	3
Ozone analyser	1	4
FDMS and BAM analysers	0	9
Gravimetric PM Analysers	0	0

3.3 Certification

The Network Certificate of Calibration is available on the AURN Hub (login page at https://aurnhub.defra.gov.uk/login.php). This certificate presents the results of the individual analyser scaling factors on the day of the audit, as calculated by Ricardo Energy & Environment using the audit cylinder standards, in accordance with our ISO17025 accreditation.

3.4 Calculation of Measurement of Uncertainty

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 EN14211:2012 (NOx), BS EN14212:2012 (SO_2), BS EN14626:2012 (CO) and BS EN14625:2012 (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 were compliant. Older, non-compliant equipment still on site after this date needed to be replaced before June 2013. Ricardo Energy & Environment 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 intercalibrations 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 PM analysers, the required measurement uncertainty is less than ±25%. For sites that have CEN-compliant instrumentation, it is possible to calculate the overall uncertainty of measuring air quality. This information is station and analyser specific and presented in **Error! Reference source not found.** below:

Table 3-8 Analyser measurement uncertainties (%)

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
Aberdeen	19-Feb	11.2			11.1	8.7	16.4
Aberdeen Union Street Roadside	20-Feb				12.2		
Aberdeen Wellington Road	20-Feb				12.3		
Armagh Roadside	08-Feb				12.8	9.7	
Aston Hill	19-Feb	11.2			12.2		
Auchencorth Moss	10-Jan	11.2				10.1	16.8
Ballymena Antrim Road	09-Feb				13.4		
Ballymena Ballykeel	09-Feb				13.5		
Barnsley Gawber	01-Feb	8.3		11.7	9.8		
Barnstaple A39	10-Jan					8.7	16.9
Bath Roadside	04-Jan				12.3		
Belfast Centre	13-Feb	8.4	7.6	11.1	11.7	9.7	17.0
Belfast Stockman's Lane	13-Feb				13.9	9.3	
Billingham	27-Feb				12.2		
Birkenhead Borough Road	18-Jan				12.3		
Birmingham Acocks Green	08-Jan	11.2			13.0		17.1
Birmingham A4540 Roadside	09-Jan	11.2			12.6	8.8	16.4
Birmingham Tyburn							
Blackburn Accrington Road	11-Jan				11.9		
Blackpool Marton	11-Jan	8.3			10.1		16.6
Borehamwood Meadow Park	15-Mar				9.8		
Bournemouth	12-Feb	11.2			12.2		12.6
Bradford Mayo Avenue	31-Jan				11.1		

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
Brighton Preston Park	16-Jan	11.2			12.2		11.0
Bristol St Paul's	03-Jan	11.2			12.4	8.7	16.8
Bristol Temple Way	04-Jan				12.2	10.1	
Burton-on-Trent Horninglow	05-Mar				12.2		
Bury Whitefield Roadside	10-Jan				12.3	8.7	
Bush Estate	08-Mar				12.2		
Cambridge Roadside	13-Feb				11.8		
Camden Kerbside	22-Jan				12.1	9.1	16.5
Cannock A5190 Roadside	11-Jan				12.3		
Canterbury	08-Mar	11.6			12.6		
Cardiff Centre	08-Feb	11.2		9.9	13.5	8.7	16.4
Cardiff Newport Road							
Carlisle Roadside	10-Jan				12.2	8.7	16.4
Charlton Mackrell	20-Feb	11.0			12.3		
Chatham Centre Roadside	08-Mar				12.6		
Chepstow A48	31-Jan				14.1	11.8	16.4
Chesterfield Loundsley Green	16-Jan				11.4	8.7	16.4
Chesterfield Roadside	09-Mar				12.2	10.1	16.7
Chilbolton	05-Jan	11.2		10.7	13.4	8.7	16.4
Christchurch Barrack Road	12-Feb				12.6		12.8
Coventry Allesley	06-Feb	8.3			9.8	9.6	
Coventry Binley Road	06-Feb				12.2	8.7	
Cwmbran	29-Jan	8.3			13.1		
Derby St Alkmunds Way	08-Mar				12.2		
Derry Rosemount	07-Feb	11.2		11.3	13.8	8.7	16.4
Dewsbury Ashworth Grove	04-May				12.2		
Doncaster A630 Cleveland Street	23-Jan				12.3		
Dundee Mains Loan	12-Feb				9.8		
Dumbarton Roadside	03-Jan				11.1		
Dumfries	09-Jan				12.3		
Ealing Horn Lane	20-Feb					8.7	
Eastbourne	17-Jan				12.2		17.0
Edinburgh Nicolson Street	14-Dec				12.2		
Edinburgh St Leonards	11-Jan	11.5	7.6	10.2	13.8	8.7	16.5

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
Eskdalemuir	09-Jan	11.2			12.4		
Exeter Roadside	11-Jan	7.2			13.2		
Fort William	03-Jan	11.2			12.2		
Glasgow Great Western Road	30-Jan				12.7		
Glasgow High Street	29-Jan				13.5	8.7	16.4
Glasgow Kerbside	29-Jan				10.9		
Glasgow Townhead	29-Jan	9.0			13.4	8.7	16.4
Glazebury	10-Jan	11.2			12.2		
Grangemouth	17-Jan			9.9	13.1	8.7	17.4
Grangemouth Moray	16-Jan			13.2	11.3		
Greenock A8 Roadside	04-Jan				9.8		
Hafod-yr-ynys Roadside	31-Jan				12.2		
Haringey Roadside	25-Jan				13.0		
Hartlepool St Abbs Walk	27-Feb				12.3		
High Muffles	25-Jan	11.2			13.3		
Honiton	09-Jan				12.2		
Horley	15-Jan				12.4		
Hull Freetown	24-Jan	8.3		10.0	9.8		16.5
Hull Holderness Road	22-Jan				12.3	9.3	
Immingham Woodlands Avenue	24-Jan				12.3		
Inverness	27-Feb				12.2	9.6	15.4
Ladybower	31-Jan	11.2		10.0	12.2		
Leamington Spa	07-Feb	10.5			11.1	8.7	**101.3**
Leamington Spa Rugby Road	07-Feb				12.2	9.5	16.4
Leeds Centre	30-Jan	8.3	8.8	11.6	10.4	8.7	16.4
Leeds Headingley Kerbside	31-Jan				13.1	8.7	16.4
Leicester A594 Roadside	07-Mar				12.4	8.7	
Leicester University	07-Mar	8.3			9.8		16.8
Leominster	19-Feb	11.5			12.2		
Lerwick	21-Feb	11.2		10.0	12.2		
Lincoln Canwick Road	15-Jan				12.6		
Liverpool Speke	15-Jan	8.3		10.0	11.7	8.7	16.4
London Bexley	24-Jan				12.2		16.6
London Bloomsbury	22-Jan	11.2		10.0	12.3	8.7	16.4
London Eltham	17-Jan	10.4			12.3		16.4

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
London Haringey Priory Park South	25-Jan	10.5			12.3		
London Harlington	21-Feb	11.2			12.7		
London Hillingdon	26-Jan	8.3			12.2		
London Marylebone Road	16-Jan	11.2	7.5	11.4	12.4	9.2	16.4
London N. Kensington	15-Jan	11.2	7.5	10.1	12.9	8.7	16.4
London Teddington Bushy Park	19-Feb					8.9	16.5
London Westminster	20-Feb				11.3		11.3
Lough Navar	07-Feb	11.2				8.7	
Lullington Heath	17-Jan	11.2		10.8	12.2		
Luton A505 Roadside	24-Jan				12.2		
Mace Head	06-Feb	8.3					
Manchester Piccadilly	22-Jan	8.3		11.6	9.8		16.5
Manchester Sharston	11-Jan	11.2		10.0	12.2		
Market Harborough	08-Feb	8.3			10.4		
Middlesbrough	27-Feb	11.2		10.0	12.2	8.7	17.1
Narberth	05-Feb	11.2		10.0	12.2	8.7	
Newcastle Centre	19-Feb	8.3			9.8	8.7	16.4
Newcastle Cradlewell Roadside	19-Feb				13.0	9.5	
Newport	Not tested						
Northampton Spring Park	05-Feb	7.3			13.2		12.6
Norwich Lakenfields	14-Feb	8.3			9.8	13.4	16.4
Nottingham Centre	06-Mar	8.3		10.0	9.8	9.1	16.4
Nottingham Western Boulevard	08-Mar				12.2	8.7	
Oldbury Birmingham Road	10-Jan				13.5		
Oxford Centre Roadside	05-Jan				11.7		
Oxford St Ebbes	05-Jan	10.7			12.1	9.1	16.4
Peebles	12-Jan	11.2			13.6		
Plymouth Tavistock Road	08-Jan				12.2		
Plymouth Centre	09-Jan	8.3			9.8	8.7	16.4
Port Talbot Margam	07-Feb	8.3	11.6	11.6	9.8	8.7	16.4
Portsmouth	15-Feb	8.3			13.2	10.6	16.4
Portsmouth Anglesea Road	29-Dec				12.2		
Preston	11-Jan	8.3			9.8		16.4
Reading London Road	04-Jan				11.3	9.9	

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
Reading New Town	04-Jan	8.3			9.8	8.7	16.4
Rochester Stoke	07-Mar	11.2		10.0	13.4	8.7	16.4
Salford Eccles	08-Jan				13.2	8.7	16.4
Saltash Callington Road	08-Jan					9.8	16.4
Sandy Roadside	24-Jan				12.3	8.7	16.4
Scunthorpe Town	23-Jan			10.0	11.1	8.7	
Shaw Crompton Way	10-Jan				12.2	12.6	
Sheffield Barnsley Road	17-Jan				12.8		12.7
Sheffield Devonshire Green	16-Jan	8.3			9.8	8.7	16.4
Sheffield Tinsley	17-Jan				12.9		
Sibton	12-Feb	11.3					
Southampton Centre	13-Feb	8.3		10.0	10.9	8.7	16.6
Southampton A33 Roadside	13-Feb				12.2	8.7	
Southend-on-Sea	15-Mar	8.3			9.8		
Southwark A2 Old Kent Road	21-Feb				12.3	8.7	
St Helens Linkway	23-Jan				12.2	8.7	
St Osyth	14-Mar	8.3			9.8		
Stanford-le-Hope Roadside	23-Feb				12.5	8.7	16.4
Stockton on Tees A1035 Roadside	26-Feb				12.2		16.9
Stockton-on-Tees Eaglescliffe	26-Feb				12.4	10.0	12.6
Stoke-on-Trent Centre	09-Jan	8.3			9.8		16.5
Stoke on Trent A50 Roadside	09-Jan				12.2	8.8	
Storrington Roadside	16-Jan				9.8		
Strath Vaich	26-Feb	11.2					
Sunderland Silksworth	20-Feb	11.2			11.2		16.4
Sunderland Wessington Way	20-Feb				12.2		
Swansea Roadside	06-Feb				12.2	11.2	15.8
Swindon Walcot	01-Feb				12.2		
Telford Hollinswood	05-Mar				12.3		
Thurrock	22-Feb	11.3		10.3	12.5	8.7	
Tower Hamlets Roadside	25-Jan				13.3		
Walsall Woodlands	10-Jan	11.2			13.7		
Warrington	16-Jan				12.0	8.7	16.4
Weybourne	13-Feb	8.3					

Site	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
Wicken Fen	12-Feb	11.2		10.2	**15.5**		
Widnes Milton Road	17-Jan				12.2		
Wigan Centre	23-Jan	8.3			13.3		16.4
Wirral Tranmere	17-Jan	8.3			9.8		16.4
Worthing A27 Roadside	09-Mar						13.6
Wrexham	16-Jan			9.8	12.2	22.5	11.0
Yarner Wood	20-Feb	11.2			12.3		
York Bootham	24-Jan				12.3	8.7	16.4
York Fishergate	24-Jan				12.2	8.7	16.4
Total > 15 (gaseous) or > 25 (PM)	**-**	**0**	**0**	**0**	**1**	**0**	**1**

There were a small number of analysers where the calculated uncertainty was higher than the Directive compliance limit. The most common cause of this is noisy response as measured during the audit. This is generally an indication of poor instrument performance, and these are reviewed at the Quality Circle to assess the impact on reported data. High noise levels on particulate analysers are reported to CMCU and ESUs prior to each service to ensure the necessary repair procedures are carried out by the engineer.

The spurious high result for Leamington Spa $PM_{2.5}$ was due to a flow fault discovered at the audit. Some data around this period were deleted during ratification. The Wicken Fen NOx analyser also had a fault at the time of audit.

It should be noted that these uncertainties are applicable only on the day of test, and do not necessarily infer that these values apply to the entire year's dataset. In particular, a high uncertainty measured at audit may be as a result of a fault, and this results in an ESU visit to affect a repair. The QA/QC Unit then decides whether to report the data or delete them as appropriate.

4 Data Ratification Results

4.1 Data Capture – Network Overview

4.1.1 Overall Data Capture

The overall data capture for the period January-March 2018 is given in Table 4-1. The data capture target of the Air Quality Directive is 90% excluding periods of planned maintenance (e.g. calibrations, audits and servicing). An allowance of 5% is made for this, hence the target of 85% also shown in the table. Note that data capture figures are correct at time of writing and are subject to change.

Table 4-1 Data Capture Summary, January-March 2018 (Quarter 1)

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	All
Number of Stations	7	155	75	75	78	27	168
Number of stations < 85 %	0	3	2	5	14	5	10
Number of stations < 90%	0	4	3	15	21	6	18
Average	**97.12**	**96.59**	**97.01**	**91.13**	**89.46**	**87.38**	**94.32**

Average data capture was at least 85% for all pollutants – CO, NO_2, O_3 and SO_2. However, it is important to note that most PM analysers in the Network underwent a zero test during quarter 1 (Q1) of 2018, which inevitably results in the loss of a few days' data. In some cases, the filter was left on for excessive periods, resulting in unnecessary data loss.

4.1.2 Generic Data Quality Issues

The QA/QC audits continued to identify high particle analyser baselines and some data were deleted as a result. These zero tests, along with regional volatile comparisons, continue to provide evidence for poor FDMS drier performance. However, as explained above, the results of zero baseline tests are now being used to apply correction to data where high baselines have been identified.

In some cases, the ESU may choose to avoid significant data loss by removing an instrument for workshop repair, and install a temporary loan instrument in station. This is termed a "hotspare" analyser. This may not be of the same type of analyser, which has implications for LSO calibration procedures, and also for the reporting of instrument types in the annual data submission.

4.2 Data Capture and Station-Specific Issues - England (Excluding Greater London)

A summary of data capture for England for January-March 2018 is given in Table 4-2:

Table 4-2 Data Capture for England, January-March 2018

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	All
Barnsley Gawber		98.43	98.38			97.82	98.21
Barnstaple A39				92.87	92.82		92.85
Bath Roadside		98.33					98.33
Billingham		97.18					97.18

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	All
Birkenhead Borough Road		99.12					99.12
Birmingham A4540 Roadside		97.55	89.95	92.08	94.95		93.63
Birmingham Acocks Green		98.66	98.75		95.37		97.59
Blackburn Accrington Road		98.10					98.10
Blackpool Marton		94.49	98.61		93.70		95.60
Borehamwood Meadow Park		98.61					98.61
Bournemouth		94.26	94.21		92.13		93.53
Bradford Mayo Avenue		90.88					90.88
Brighton Preston Park		98.56	98.38		98.89		98.61
Bristol St Paul's		98.33	96.34	92.18	92.36		94.80
Bristol Temple Way		98.75		89.26			94.00
Burton-on-Trent Horninglow		99.65					99.65
Bury Whitefield Roadside		99.35		92.45			95.90
Cambridge Roadside		97.18					97.18
Cannock A5190 Roadside		99.44					99.44
Canterbury		94.72	98.56				96.64
Carlisle Roadside		95.14		90.14	91.25		92.18
Charlton Mackrell		99.12	98.70				98.91
Chatham Roadside		99.35		95.09	94.49		96.31
Chesterfield Loundsley Green		84.35		95.23	96.48		92.02
Chesterfield Roadside		92.31		93.89	93.52		93.24
Chilbolton Observatory		98.52	98.29	88.56	91.34	94.12	94.17
Christchurch Barrack Road		92.78			93.80		93.29
Coventry Allesley		94.58	98.84		93.84		95.76
Coventry Binley Road		98.43		95.28			96.85

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	All
Derby St Alkmund's Way		99.58					99.58
Doncaster A630 Cleveland Street		98.89					98.89
Eastbourne		96.02			99.35		97.69
Exeter Roadside		98.89	99.68				99.28
Glazebury		97.64	98.61				98.12
Hartlepool St Abbs Walk		98.43					98.43
High Muffles		98.66	97.87				98.26
Honiton		98.70					98.70
Horley		98.84					98.84
Hull Freetown		98.33	98.61		95.51	0.00	73.11
Hull Holderness Road		98.06		95.74			96.90
Immingham Woodlands Avenue		99.03					99.03
Ladybower		98.52	91.20			98.33	96.02
Leamington Spa		94.40	99.40	84.77	81.20		89.94
Leamington Spa Rugby Road		99.40		94.03	94.12		95.85
Leeds Centre	95.74	95.56	93.80	92.50	80.37	95.65	91.57
Leeds Headingley Kerbside		98.56		92.55	92.18		94.43
Leicester A594 Roadside		98.61		95.74			97.18
Leicester University		98.75	98.80		96.34		97.96
Leominster		98.56	98.84				98.70
Lincoln Canwick Road		99.26					99.26
Liverpool Speke		98.43	98.56	95.14	93.61	97.96	96.74
Lullington Heath		98.61	98.80			98.66	98.69
Luton A505 Roadside		99.44					99.44
Manchester Piccadilly		98.33	97.78		91.25	98.33	96.42
Manchester Sharston		98.47	98.56				98.52
Market Harborough		93.94	98.24				96.09
Middlesbrough		97.18	91.85	94.03	93.52	97.04	94.72

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	All
Newcastle Centre		98.33	98.47	95.65	95.32		96.94
Newcastle Cradlewell Roadside		98.52		88.92			93.72
Northampton Spring Park		99.58	99.86		96.57		98.67
Norwich Lakenfields		98.75	98.84	85.46	92.87		93.98
Nottingham Centre		98.38	98.70	91.71	96.11	97.04	96.39
Nottingham Western Boulevard		98.61		93.15			95.88
Oldbury Birmingham Road		96.02					96.02
Oxford Centre Roadside		95.05					95.05
Oxford St Ebbes		95.00		95.88	91.11		94.00
Plymouth Centre		98.43	98.66	96.34	96.02		97.36
Plymouth Tavistock Road		94.35					94.35
Portsmouth		98.47	96.44	93.66	70.14		89.68
Portsmouth Anglesea Road		94.86		97.08			95.97
Preston		98.19	98.33		93.75		96.76
Reading London Road		94.72		91.85			93.29
Reading New Town		98.52	98.70	83.80	82.55		90.89
Rochester Stoke		99.77	99.86	93.75	92.73	99.63	97.15
Salford Eccles		96.81		95.51	83.94		92.08
Saltash Callington Road				95.23	96.30		95.76
Sandy Roadside		99.72		88.52	76.85		88.36
Scunthorpe Town		97.73		96.67		97.69	97.36
Shaw Crompton Way		97.36					97.36
Sheffield Barnsley Road		98.52			88.75		93.63
Sheffield Devonshire Green		98.29	98.38	95.28	95.42		96.84
Sheffield Tinsley		98.33					98.33
Sibton			98.98				98.98

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	All
Southampton A33		97.50		92.50			95.00
Southampton Centre		97.96	97.82	93.80	75.97	91.48	91.41
Southend-on-Sea		99.26	99.58		68.01		88.95
St Helens Linkway		99.63		91.67			95.65
St Osyth		97.50	97.69				97.59
Stanford-le-Hope Roadside		98.43		88.06	95.46		93.98
Stockton-on-Tees A1305 Roadside		98.38			93.80		96.09
Stockton-on-Tees Eaglescliffe		98.24		88.94	93.98		93.72
Stoke-on-Trent A50 Roadside		95.51		95.05			95.28
Stoke-on-Trent Centre		98.43	98.70		85.79		94.31
Storrington Roadside		98.06					98.06
Sunderland Silksworth		93.06	97.08		93.33		94.49
Sunderland Wessington Way		98.38					98.38
Swindon Walcot		97.74					97.74
Telford Hollinswood		96.57					96.57
Thurrock		96.71	97.87	93.98		97.82	96.60
Walsall Woodlands		99.44	98.98				99.21
Warrington		95.42		24.81	95.97		72.07
Weybourne			99.91				99.91
Wicken Fen		96.39	98.98			87.96	94.44
Widnes Milton Road		69.86					69.86
Wigan Centre		99.17	97.59		88.43		95.06
Wirral Tranmere		98.56	78.33		96.06		90.99
Worthing A27 Roadside		99.54			80.24		89.89
Yarner Wood		95.65	92.55				94.10
York Bootham		99.44		94.12	93.33		95.63
York Fishergate		89.58		86.99	88.06		88.21
Number of Stations	**1**	**106**	**49**	**46**	**52**	**15**	**110**

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	All
Number of stations < 85 %	**0**	**2**	**1**	**3**	**9**	**1**	**3**
Number of stations < 90%	**0**	**3**	**2**	**11**	**13**	**2**	**9**
Average	**95.74**	**97.17**	**97.35**	**91.08**	**90.95**	**89.97**	**95.17**

The following station-specific issues were identified:

Birmingham A4540 Roadside

A lamp failure resulted in the loss of ozone data from 14th-20th March.

Bristol Temple Way

The PM_{10} zero test was carried out from 4th-9th January. Further data were lost 1st - 5th February due a tape breakage.

Chesterfield Loundsley Green

Problems with the internal zero/span continued from last quarter, resulting in the loss of some data every day. In order to fix this, the reaction cell was replaced on 21st March, and several days data were lost while the analyser settled down following this work.

Chilbolton Observatory

The PM_{10} FDMS had a valve motor failure on 6th February. A period of unstable data from 16th-19th February was deleted during ratification.

Hull Freetown

The SO_2 data was found to be of very poor quality, with excessive baseline drift. Data have been deleted from 20th November 2017 to the end of March.

Leamington Spa

The $PM_{2.5}$ FDMS suffered a flow fault resulting in the loss of data from 27th January-6th February. The PM_{10} FDMS suffered a valve motor fault resulted in the loss of data from 3rd -10th January. Other small amounts of both $PM_{2.5}$ and PM_{10} were lost during ratification due to being below the negative detection limit, or where $PM_{2.5}$ was higher than PM_{10}.

Leeds Centre

The zero test on the FDMS analysers was carried out from 30th January-2nd February; however, the sharp cut cyclone was not replaced on the inlet. $PM_{2.5}$ data were therefore lost up to the service on 14th February. A communications fault resulted in the loss of all data from the station from 26th February-1st March.

Newcastle Cradlewell Roadside

The PM_{10} BAM was installed on 12th February, but shortly afterwards spurious negative readings were observed. The ESU found a water leak in the roof; data were lost 19th -22nd February.

Norwich Lakenfields

The PM_{10} FDMS lost its firmware causing the loss of data from 3rd -7th February. A further communications fault occurred on 30th March.

Portsmouth

Poor quality $PM_{2.5}$ data were observed from 20th January-5th February, caused by a leaking valve. A leak on a main flow tube resulted in a loss of $PM_{2.5}$ data from 7th -13th March.

Reading New Town

The zero tests carried out between 4th and 10th January were inconclusive and were repeated 8th -14th March. Although the $PM_{2.5}$ tests gave high results, this could not be seen in the data.

Salford Eccles

The $PM_{2.5}$ data failed to return to normal following the zero test; data have been deleted from 8th-22nd January.

Sandy Roadside

Following the zero test 24th -30th January, it is suspected that the sharp cut cyclone was not replaced before the service on 12th February; these data have been deleted. The PM_{10} data loss was due to the zero test.

Sheffield Barnsley Road

A number of ESU callouts were issued due to the BAM failing the leak check at LSO calibration visits.

Southampton Centre

The $PM_{2.5}$ data were seen to be a regional outlier from 16th February-6th March, data between these dates have been deleted during ratification.

Southend-on-Sea

The $PM_{2.5}$ FDMS control unit was damaged during power supply problems in 2017, and had been removed for workshop repair. The control unit was found to be unrepairable, and a replacement had to be sourced and installed. Monitoring recommenced 29th January.

Stanford-le-Hope Roadside

The PM_{10} FDMS was found to be sampling inside the cabinet by the ESU at the service on 5th March. It is assumed that this started at the audit on 23rd February; data between these dates have been deleted.

Stoke-on-Trent Centre

Some noisy $PM_{2.5}$ data between 5th -20th February were deleted during ratification.

Warrington

The PM_{10} FDMS suffered from several firmware losses in late 2017 and into 2018. When the reinstallation took place on 10th November, the k0 value entered into the control unit was mistyped, being 42% out. Rescaling of data during ratification did not produce realistic results, and as a result data were deleted from 1st January to a further firmware reload on 9th March. CMCU also report repeated communications issues with this analyser during this period.

Wicken Fen

The SO_2 analyser at this station has a history of producing cyclic, spiking data. A period of particularly bad data was deleted from 24th February -5th March.

Widnes Milton Road

Repeated memory faults with the NOx analyser resulted in lost data from 1st -9th January, 2nd -6th February, and 9th -21st February.

Wirral Tranmere

The ozone analyser was found to underread by 44% at the winter audit. A subsequent ESU callout found the scrubber to have failed. Data have been deleted from 1st – 19th January, continuing the deletion from 23rd November.

Worthing A27

The $PM_{2.5}$ BAM was commissioned on 1st March; however, a damaged seal in the sampling system resulted in loss of data from 9th – 16th March.

4.3 Data Capture and Station-Specific Issues - Greater London

A summary of data capture for Greater London for January-March 2018 is given in Table 4-3:

Table 4-3 Data Capture for Greater London, January-March 2018

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Average
Camden Kerbside		91.85		97.87	98.01		95.91
Ealing Horn Lane				98.56			98.56
Haringey Roadside		99.72					99.72
London Bexley		99.07			99.63		99.35
London Bloomsbury		98.38	98.43	88.66	90.60	79.44	91.10
London Eltham		95.09	99.54		39.40		78.01
London Haringey Priory Park South		99.21	99.40				99.31
London Harlington		95.56	99.86	99.77	99.77		97.71
London Hillingdon		98.61	98.80				98.70
London Marylebone Road	97.82	97.96	98.19	96.02	92.69	98.01	96.78
London Marylebone Road Partisol				98.89	98.89		98.89
London N. Kensington	96.02	98.19	95.51	99.95	99.95	98.01	96.93
London Teddington Bushy Park					94.91		94.91
London Westminster		93.52			64.44		78.98
Southwark A2 Old Kent Road		98.52		97.36			97.94
Tower Hamlets Roadside		98.89					98.89
Number of Stations	**2**	**13**	**7**	**8**	**10**	**3**	**16**
Number of stations < 85 %	**0**	**0**	**0**	**0**	**2**	**1**	**2**
Number of stations < 90%	**0**	**0**	**0**	**1**	**2**	**1**	**2**
Average	**96.92**	**97.28**	**98.53**	**97.14**	**87.83**	**91.82**	**95.11**

The following station-specific issues were identified:

London Bloomsbury

The SO_2 analyser was replaced by a hot-spare in December; however, the performance of this analyser was also poor and was eventually replaced again on 4th January. The performance of the analyser at this station has been the subject of scrutiny by both CMCU and QA/QC Unit.

A longer than normal zero test resulted in the loss of $PM_{2.5}$ and PM_{10} data from 22nd -29th January.

London Eltham

The $PM_{2.5}$ FDMS suffered very poor performance during the quarter, with cooler, drier and pump faults. Data have been deleted from 17th January-10th March.

London Westminster

The $PM_{2.5}$ Partisol was replaced by a BAM on 27th February; however, on 26th March it was discovered that it had been installed as PM_{10}, so data from 27th February to 1st April have been deleted.

4.4 Data Capture and Station-Specific Issues - Wales

A summary of data capture for Wales for January-March 2018 is given in Table 4-4.

Table 4-4 Data Capture for Wales, January-March 2018

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Average
Aston Hill		98.70	91.11				94.91
Cardiff Centre	98.47	98.56	98.56	92.50	92.96	98.38	96.57
Chepstow A48		95.19		93.80	94.03		94.34
Cwmbran		98.10	98.10				98.10
Hafod-yr-Ynys Roadside		96.90					96.90
Narberth		98.43	98.80	94.26		45.32	84.20
Newport		0.00		0.00	0.00		0.00
Port Talbot Margam Partisol				84.44			84.44
Port Talbot Margam	98.29	98.24	95.93	94.21	92.08	98.33	96.18
Swansea Roadside		98.19		94.77	94.72		95.90
Wrexham		98.84		90.00	83.33	71.90	86.02
Number of Stations	**2**	**10**	**5**	**8**	**6**	**4**	**11**
Number of stations < 85 %	**0**	**1**	**0**	**2**	**2**	**2**	**3**
Number of stations < 90%	**0**	**1**	**0**	**2**	**2**	**2**	**4**
Average	**98.38**	**88.12**	**96.50**	**80.50**	**76.19**	**78.48**	**84.32**

The following station-specific issues were identified:

Narberth

The SO_2 analyser suffered significant baseline drift during the quarter; an ESU callout on 5th April found a blockage in the sample line. Data from 11th February up to the callout have been deleted.

Newport

The station was non-operational for this quarter while awaiting commissioning of a new enclosure.

Port Talbot Margam Partisol

The Partisol sampler stopped sampling from 23rd -26th February. A pump fault caused further data loss from 18th – 26th March.

Wrexham

Both Partisols suffered problems during this quarter. The $PM_{2.5}$ sampler had filter exchange faults from 22nd February-4th March, and again 18th-20th March. The PM_{10} sampler was found to have a high flowrate at the winter audit on 16th January, and data from audit to service on 24th January have been deleted.

4.5 Data Capture and Station-Specific Issues - Scotland

A summary of data capture for Scotland for January-March 2018 is given in Table 4-5:

Table 4-5 Data Capture for Scotland, January-March 2018

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Average
Aberdeen		98.56	98.38	95.42	95.56		96.98
Aberdeen Union Street Roadside		99.17					99.17
Aberdeen Wellington Road		98.66					98.66
Auchencorth Moss			98.89	93.75	93.47		98.89
Bush Estate		98.66	98.61				98.63
Dumbarton Roadside		95.00					95.00
Dumfries		99.40					99.40
Dundee Mains Loan		98.43					98.43
Edinburgh Nicolson Street		99.81					99.81
Edinburgh St Leonards	94.81	97.82	97.82	91.34	85.46	96.53	93.97
Eskdalemuir		94.54	98.70				96.62
Fort William		98.84	98.84				98.84
Glasgow Great Western Road		97.92					97.92
Glasgow High Street		94.58		95.32	95.09		95.00
Glasgow Kerbside		99.68					99.68
Glasgow Townhead		97.87	98.61	95.42	91.90		95.95
Grangemouth		93.33		88.89	88.33	93.38	90.98
Grangemouth Moray		98.33					98.33

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Average
Greenock A8 Roadside		99.26		99.72	99.72		99.57
Inverness		98.94		91.11	78.89		89.65
Lerwick			50.14				50.14
Peebles		98.56	98.61				98.59
Strathvaich			99.63				99.63
Number of Stations	**1**	**20**	**10**	**8**	**8**	**2**	**23**
Number of stations < 85 %	**0**	**0**	**1**	**0**	**1**	**0**	**1**
Number of stations < 90%	**0**	**0**	**1**	**1**	**3**	**0**	**2**
Average	**94.81**	**97.87**	**93.82**	**93.87**	**91.05**	**94.95**	**95.21**

The following station-specific issues were identified:

Edinburgh St Leonards

Some $PM_{2.5}$ data (and PM_{10} to a lesser extent) were lost at the end of January, probably due to station temperature issues.

Grangemouth

The zero tests were carried out on both FDMS from 14th to 22nd January. There were two periods (27th-29th January and 11th-12th February) where no data for any pollutants were received from CMCU.

Inverness

The $PM_{2.5}$ Partisol had a pump fault from 27th February-12th March.

Lerwick

The data from Lerwick were spuriously high compared to other sites between 20th December and 14th February, when an ESU callout found a blockage in the analyser. These data have been deleted.

4.6 Data Capture and Station-Specific Issues - Northern Ireland & Mace Head

A summary of data capture for Northern Ireland, and Mace Head in the Republic of Ireland, for January-March 2018, is given in Table 4-6:

Table 4-6 Data Capture for Northern Ireland (plus Mace Head), January-March 2018

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	**Average**
Mace Head			99.81				99.81
Armagh Roadside		94.77		94.54			94.65
Ballymena Antrim Road		94.35					94.35
Ballymena Ballykeel		91.94				33.52	62.73
Belfast Centre	98.66	93.98	98.33	95.79	95.97	98.06	96.80
Belfast Stockman's Lane		98.38		92.96			95.67
Derry Rosemount		95.14	98.75	92.96	88.80	98.75	94.88
Lough Navar			98.80	96.81			97.80
Number of Stations	**1**	**6**	**4**	**5**	**2**	**3**	**8**
Number of stations < 85 %	**0**	**0**	**0**	**0**	**0**	**1**	**1**
Number of stations < 90%	**0**	**0**	**0**	**0**	**1**	**1**	**1**
Average	**98.66**	**94.76**	**98.92**	**94.61**	**92.38**	**76.77**	**92.09**

Ballymena Ballykeel

As reported in the Q4 2017 report, during this period, the SO_2 analyser developed a lamp driver board fault. As this is a LA owned instrument and the part was not covered by the service contract, a lengthy delay ensued while the repair was carried out. The analyser was finally repaired and reinstalled on 20th February 2018. Further data were lost 10th -15th March due to a communications fault.

Derry Rosemount

Following the zero test carried out 7th -9th February, the $PM_{2.5}$ FDMS did not recover immediately, and data to 14th February have been deleted.

4.7 Zero Baseline Correction

Until 2016, the only agreed action that could be taken in the event of a zero baseline response outside the range ±3 µg m^{-3} was to reject data. However, as part of ongoing improvement activities a protocol has been agreed to enable PM baselines to be corrected where baseline responses exceed 3 µg m^{-3}. Baseline correction has been incorporated into the data ratification protocols as of 2016 data onwards.

It is possible that the zero tests carried out at the summer 2018 audits will reveal additional cases where zero baseline correction would be advisable. If this happens, any changes to previously ratified data will be dealt with according to the agreed protocols.

4.8 Ongoing Investigations

As reported in previous QA/QC reports, QA/QC unit has confirmed that testing the k_0 with the current batches of 92 mg filters is the root cause of the increase in outliers identified at previous intercomparisons. It appears that these suspect filters, which are widely used throughout the network, may also be causing the analysers to overestimate measured concentrations, by up to 4%. The supplier of the filters has been contacted for a response to this evidence and we still await their reply.

5 Changes to Previously Ratified Data

Occasionally there are circumstances where it is necessary to make changes to data which have previously been flagged as "Ratified". This may be for example where:

- A QAQC audit or other investigation has detected a problem which affects data back into an earlier ratification period.
- Long-term analysis has detected an anomaly between expected and measured trends which requires further investigation and possible data correction.
- Further research comes to light which indicates that new or tighter QAQC criteria are required to meet the data quality objectives. This may require review and revision of historic calibration data by applying the new criteria.

During ratification of the 2018 Q1 data, some changes were also made to data from 2017 that had previously been flagged as ratified. These changes, and the reasons, are shown in Table 5-1.

Table 5-1 Changes to 2017 Data Previously Marked as Ratified

Monitoring Station	Pollutant(s)	Dates	Nature of Change
Aston Hill	NOx	All of 2017	NOx: Floating NO baseline throughout 2017. Need to reprocess 2017/2018, although change will be minor (less than 0.5 ppb).
Chepstow A48	PM_{10}	Q4 of 2017	Zero baseline correction adjusted from 4.1 µg m^{-3} to 3.3 µg m^{-3} from 1st Oct to end of 2017.
Glazebury	NOx	From 1st Nov 2017 – 10th Jan 2018.	Anomalous calibration on 20th Dec: reprocess, ignoring this calibration.
Hafod-yr-Ynys Roadside	NOx	NOx 15th Dec 2017 – 3rd Jan 2018 and NO 20th – 30th Sep 2017.	Sensitivity adjustments.
High Muffles	NOx	1st Jul – 31st Dec 2017	Data rejection 1st Jul – 14th Sep and reprocessing to end of year and into 2018.
London Bloomsbury	$PM_{2.5}$	Q4 of 2017	Zero baseline correction of 4.5 µg m^{-3} from 2nd Oct 2017 – 6th Mar 2018.
Yarner Wood	NOx	Q1, Q3 & Q4 2017	Removed suspect calibration on 15th Feb (entered after ratification). Reprocessed sensitivity between callouts on 29th Sep & 19th Oct 2017.

6 Health and Safety Report

A summary of instances when an AURN station went to 'HIGH' risk status during the quarter is given in Table 6-1: both of these issues have now been resolved.

Table 6-1 Summary of Cases When an AURN Station Went to "High" Risk Status, Jan – Mar 2018

Station	Risk	Date went to 'High'	Date resolved	Action taken
Newport	Water ingress through fragile roof.	11/08/2017	01/05/18	Enclosure replaced

7 Equipment Upgrade Requirements

A programme of upgrades of FDMS to BAM and Fidas instruments is underway during 2018.

8 Station Infrastructure Issues

No station infrastructure issues have been identified by the QA/QC Unit this quarter.

9 Conclusions and Recommendations

1. During Quarter 1 of a total of 168 monitoring stations at 166 locations were in operation. The total of 168 includes two stations where Partisol gravimetric particulate samplers are co-located with automatic particulate analysers..
2. During this quarter, the winter 2018 intercalibration exercise was carried out, involving comprehensive performance tests on every analyser in the network. This allows the accuracy of the measured results to be determined, and a measurement uncertainty for each analyser to be determined, as required by the Data Quality Objective.
3. Data ratification for the quarter was completed by the deadline of 30th June 2018.
4. The mean data capture for ratified hourly average data was 94.32% (averaged over all pollutants O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$), for the three-month reporting period January to March 2018. Mean data captures for individual pollutants were as follows: CO 97.12%, NO_2 96.59%, O_3 97.01%, SO_2 87.38%, PM_{10} 91.13%, and $PM_{2.5}$ 89.46%. The data capture target of the Air Quality Directive is 90% excluding periods of planned maintenance e.g. calibrations, audits and servicing). An allowance of 5% is made for this, hence a target of 85%. The mean data captures for all pollutants met this target in Quarter 1 of 2018.
5. The uncertainty of measurement for each analyser has been determined to ensure compliance with the Data Quality Objective. Two analysers were found to be outside the required uncertainty.

The Gemini Building
Fermi Avenue
Harwell
Didcot
Oxfordshire
OX11 0QR
United Kingdom

t: +44 (0)1235 753000
e: enquiry@ricardo.com

ee.ricardo.com