QAQC Report for the Automatic Urban and Rural Network, January-March 2017

Report for the Environment Agency
Environment Agency contract number 21316

ED 60071201_2017Q1 | Issue 1 | Date 23/11/2017

Customer:

The Environment Agency

Customer reference:

21316

Confidentiality, copyright & reproduction:

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:

23 November 2017

Ricardo Energy & Environment reference:

Ref: ED60071201_2017Q1- Issue 1

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 2017 to 31st March 2017. 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 at some point during this period was 157.

During this quarter, the winter 2017 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. Principal reasons for data loss are given here for stations which fail to make the 85% data capture target for the quarter.

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 been incorporated into the data ratification protocols as of 2016.

Data ratification for the quarter was completed by the deadline of 30th June 2017. The mean data capture for ratified hourly average data was 93.39% (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 2017.

Mean data captures for individual pollutants were as follows: CO 90.98%, NO_2 95.33%, O_3 96.72%, SO_2 94.13%, PM_{10} 89.11%, and $PM_{2.5}$ 90.39%. 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 (Q1) of 2017.

The uncertainty of measurement for each analyser has been determined to ensure compliance with the Data Quality Objective. Thirteen analysers out of the total of 401 tested were found to be outside the uncertainty limits.

Table of contents

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 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 159 monitoring stations at 157 locations in the AURN operated during this quarter. The total of 159 includes two stations where Partisol gravimetric particulate samplers are co-located with automatic particulate analysers. (The gravimetric data are used in validating the performance of the automatic 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 2017, 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.

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

- 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.

1.4 Changes to the Network during this Quarter

Table 1-1 shows the changes that were made to the network during the period January – March 2017:

Table 1-1 Network Changes Jan - Mar 2017

Station	Pollutants	Date
Monitoring Stations Started Up:		
Plymouth Tavistock Road	NO_2	01/01/2017
Derby St Alkmund's Way	NO_2	20/01/2017
Northampton Spring Park	NO_2 O_3 $PM_{2.5}$	27/03/2017
Stations closed:		
Northampton Kingsthorpe	NO_2 O_3 $PM_{2.5}$	27/03/2017

In addition, the PM_{10} analyser at Eastbourne was removed on 1st January, and both $PM_{2.5}$ and PM_{10} analysers removed from Storrington Roadside on 27th January for redeployment elsewhere in the AURN network as they were no longer required for compliance purposes.

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 upload ratified data to the Data Dissemination Unit.
- 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 2017 QA/QC Audits

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

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 LSO's 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 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 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 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 NO_x, 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.

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}.

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 MODUS, 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 2017

During the winter 2017 intercalibration, audits were carried out on 156 monitoring stations out of 157 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 – 156 UK stations

Parameter	Number of outliers	Number in network	% outliers in total
NOx analyser	14	144	9.7
CO analyser	2	7	28.6
SO_2 analyser	9	27	33.3
Ozone analyser	10	75	13.3 (2 more than 10%)
FDMS and BAM analysers	14 x K_0, 2 x flows (14 x zero tests)	79 PM_{10} 71 $PM_{2.5}$ FDMS	
Gravimetric PM analysers	0	14	0
Cylinders	9	178	5.1
Total	60 analysers	417 analysers	14.4% of analysers

The number of analyser outliers identified (14.4%) is higher than at the summer 2016 intercalibration (13.1%), but lower than the winter 2016 intercalibration (when 16% of analysers in use were identified as outliers). Please note the figures above do not include Northampton Spring Park which only came online at the end of the quarter (27/03/2017) so was not part of the exercise but do include Northampton Kingsthorpe, Derby St Alkmunds Way and Plymouth Tavistock Road.

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. Certified cylinder concentrations are normalised for this purpose as several cylinders are used.

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	463	460	+0.6	3.6
NO_2	440	457	-3.8	4.5
CO	21.3	21.0	+1.6	1.8
SO_2	464	478	-2.9	5.0

Oxides of Nitrogen

A total of 14 outliers were identified during this intercalibration. This is similar to the previous exercise in which 20 of the analysers were identified as outliers. Of these outliers, seven can be attributed to analyser drift, five to changes in station cylinder concentration and two to issues experienced during the audit which compromised the results.

There was a single converter which fell outside the ±5% acceptance limits. There were a further eight 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. One was caused by an apparent change in the cylinder concentration (or possibly a sampling fault), the other by a suspect bad LSO calibration. There was a single outlier identified at the previous intercalibration.

Sulphur Dioxide

A total of nine outliers were identified at this intercalibration. This is worse than the previous exercise, when six outliers were identified. Two of the outliers were due to a change in the station cylinder concentration, four are caused by suspicious LSO calibrations, and the remaining three by drift between calibrations. All m-xylene interference tests were less than 28 ppb.

Ozone

A total of 10 outliers were identified during this exercise. This is better than the previous (summer 2016) intercalibration, where 17 analysers were found to be outside the ±5% acceptance criterion. Just two of the outliers had a calibration response more than 10% from the reference photometer.

Particulate Analysers

There were 14 calculated K_0 values outside the required ±2.5% of the stated values. This is significantly worse than the previous exercise where four outliers were identified. QA/QC unit are investigating the reasons for this step change in performance and will report the findings in the next intercalibration report.

One FDMS main flow was found to be outside the ±10% acceptance limits. One BAM total flows were found to be outside this limit. No Partisol total flows were found to be outside the ±10% acceptance limits. This total is better than the previous exercise, when a total of six analyser flow outliers were identified.

PM analyser zero tests

In the zero baseline tests carried out at the winter 2017 audit, a total of 14 analysers gave average responses to particle-free air that were outside ±3 μgm^{-3}, compared to 33 at the previous exercise. The QA/QC Unit routinely use these results to undertake zero baseline correction where appropriate.

Station Cylinder Concentrations

Nine of the 178 station cylinders (5.1%) used to scale ambient pollution data were found to be outside the ±10% acceptance limit. Two were NO cylinders, six SO_2 and one CO.

London Stations

The results of the intercalibration for the 17 London stations (including the two co-located Partisols) in operation at the time of the intercalibration are summarised in Table 3-3 below:

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

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

English Stations (Excluding London)

The results of the intercalibration for the 103 stations in England outside of London are summarised in Table 3-4 below:

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

Parameter	Number of outliers	Number in region
NOx analyser	9	97
NOx converter	0	
CO analyser	0	1
SO_2 analyser	7	16
Ozone analyser	7	53
FDMS and BAM analysers	10	93
Gravimetric PM analysers	0	3

Scottish Stations

The results of the intercalibration for the 21 Scottish stations are summarised in Table 3-5 below:

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

Parameter	Number of outliers	Number in region
NOx analyser	2	19
NOx converter	0	
CO analyser	1	1
SO_2 analyser	0	3
Ozone analyser	2	10
FDMS and BAM analysers	0	12
Gravimetric PM analysers	0	2

Welsh Stations

The results of the intercalibration for the 11 Welsh stations are summarised in Table 3-6 below:

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

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

Northern Ireland Stations

The results of the intercalibration for the 7 stations in Northern Ireland, plus Mace Head in the Republic of Ireland, are summarised in Table 3-7 below:

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

Parameter	Number of outliers	Number in region
NOx analyser	0	5
NOx converter	0	
CO analyser	1	1
SO_2 analyser	2	3
Ozone analyser	0	4
FDMS and BAM analysers	2	9
Gravimetric PM Analysers	n/a	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 Table 3-8 below:

Table 3-8 Analyser measurement uncertainties (%)

Station	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
Aberdeen	27-Jan	11.2			11.1	8.7	16.4
Aberdeen Union Street Roadside	27-Jan				12.2		
Aberdeen Wellington Road	27-Jan				13.2		
Armagh Roadside	09-Feb				11.7	8.7	
Aston Hill	14-Feb	11.2			12.3		
Auchencorth Moss	08-Feb	11.7				12.1	16.4
Ballymena Ballykeel	06-Feb			9.9	12.4	17.5	
Barnsley Gawber	18-Jan	8.3		11.6	9.8		
Barnstaple A39	06-Jan					8.7	16.4
Bath Roadside	04-Jan				12.2		
Belfast Centre	14-Feb	8.3	8.4	10.5	9.9	8.7	16.4
Belfast Stockman's Lane	14-Feb				12.3	9.5	
Billingham	01-Feb				12.2		
Birkenhead Borough Road	18-Jan				12.2		
Birmingham Acocks Green	16-Jan	11.2			12.8		16.4
Birmingham A4540 Roadside	17-Jan	11.2			12.3	8.7	16.4
Birmingham Tyburn	17-Jan	7.2		12.7	13.3	8.7	16.4
Blackburn Accrington Road	12-Jan				11.4		
Blackpool Marton	12-Jan	8.3			9.8		16.4
Bournemouth	02-Mar				12.3		
Bradford Mayo Avenue	11-Jan				11.5		
Brighton Preston Park	23-Jan	11.2			12.5		11.0
Bristol St Paul's	04-Jan	11.2			12.2	8.7	16.4
Bury Whitefield Roadside	09-Jan				12.2	8.7	
Bush Estate	08-Feb	11.2			12.2		
Cambridge Roadside	06-Feb				12.3		

Station	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
Camden Kerbside	14-Feb				13.3	8.7	16.4
Cannock A5190 Roadside	20-Jan				12.2		
Canterbury	09-Feb	11.2			12.2		
Cardiff Centre	11-Jan	11.2		10.0	13.5	8.7	16.4
Carlisle Roadside	11-Jan				11.2	8.7	16.4
Charlton Mackrell	16-Feb	10.4			12.2		
Chatham Centre Roadside	09-Feb				13.5	9.3	12.6
Chepstow A48	13-Jan				14.4	8.7	16.4
Chesterfield Loundsley Green	16-Jan				11.1	8.7	16.4
Chesterfield Roadside	16-Jan				11.6	8.7	16.4
Chilbolton Observatory	24-Jan	11.2		**33.2**	12.2	8.7	16.4
Christchurch Barrack Road	21-Feb				12.2		
Coventry Allesley	13-Feb	8.3			11.7		16.4
Cwmbran	12-Jan	8.3			13.1		
Derby St Alkmunds Way	22-Feb				12.2		
Derry Rosemount	07-Feb	11.3		10.1	12.4	8.7	16.4
Doncaster A630 Cleveland Street	19-Jan				12.2		
Dumbarton Roadside	19-Jan				11.2		
Dumfries	10-Jan				9.8		
Ealing Horn Lane	01-Feb					8.7	
Eastbourne	24-Jan				12.2		16.4
Edinburgh St Leonards	07-Feb	11.2	7.5	10.0	12.3	8.7	16.4
Eskdalemuir	10-Jan	11.2			12.2		
Exeter Roadside	03-Jan	7.3			13.7		
Fort William	04-Jan	12.1			12.2		
Glasgow Great Western Road	17-Jan				12.2		
Glasgow High Street	16-Jan				12.2	8.7	16.4
Glasgow Kerbside	16-Jan				9.8		

Station	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
Glasgow Townhead	16-Jan	8.4			12.3	8.7	16.4
Glazebury	11-Jan	11.2			12.2		
Grangemouth	31-Jan			10.4	11.7	8.7	16.4
Grangemouth Moray	31-Jan				11.2		
Greenock A8 Roadside	03-Mar				10.5		
Hafod-yr-ynys Roadside	12-Jan				12.3		
Haringey Roadside	16-Feb				**15.7**		
High Muffles	19-Jan	11.2			12.2		
Honiton	03-Jan				14.6		
Horley	23-Jan				**20.1**		
Hull Freetown	13-Jan	8.3		10.8	9.8		16.4
Hull Holderness Road	12-Jan				12.2	8.7	
Inverness	23-Jan				12.3	8.0	11.0
Ladybower	17-Jan	11.3		10.1	12.2		
Leamington Spa	21-Feb	10.5			11.3	8.7	16.4
Leamington Spa Rugby Road	21-Feb				12.5	8.7	16.4
Leeds Centre	10-Jan	8.3	8.1	11.6	9.8	8.7	16.4
Leeds Headingley Kerbside	11-Jan				12.2	8.7	16.4
Leicester A594 Roadside	14-Feb				12.5	8.7	
Leicester University	14-Feb	8.3			9.8		16.4
Leominster	13-Feb	11.2			12.2		
Lerwick	25-Jan	11.2					
Lincoln Canwick Road	23-Feb				12.4		
Liverpool Queen's Drive Roadside							
Liverpool Speke	17-Jan	8.3		10.0	9.8	8.7	16.4
London Bexley	08-Feb				12.9		16.4
London Bloomsbury	06-Feb	11.2		**15.4**	14.0	8.7	16.4
London Eltham	26-Jan	10.6			13.7		16.4

Station	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
London Haringey Priory Park South	16-Feb	10.4			**17.8**		
London Harlington	31-Jan	11.2			13.7		
London Harrow Stanmore	13-Feb						16.4
London Hillingdon	27-Jan	8.3			9.8		
London Marylebone Road	02-Feb	11.3		10.0	12.9	8.7	16.4
London Marylebone Road Partisol	02-Feb					8.0	11.0
London N. Kensington	30-Jan	11.2	7.6	10.0	**15.4**	8.7	16.4
London Teddington Bushy Park	13-Feb					8.7	16.4
London Westminster	01-Feb				12.2	8.0	11.0
Lough Navar	09-Feb	11.2				8.7	
Lullington Heath	26-Jan	11.2		10.0	12.3		
Luton A505 Roadside	01-Feb				12.7		
Mace Head	08-Feb	8.3					
Manchester Piccadilly	11-Jan	8.3		11.6	9.8	8.7	12.6
Manchester Sharston	11-Jan	11.2		10.0	12.2		
Market Harborough	15-Feb	8.3			9.8		
Middlesbrough	01-Feb	12.1		10.4	12.4	8.7	16.4
Narberth	09-Jan			11.5	12.9	8.7	
Newcastle Centre	02-Feb	9.0			10.0	8.7	16.4
Newcastle Cradlewell Roadside	02-Feb				11.3		
Newport	11-Jan				**18.3**	8.7	16.4
Northampton Kingsthorpe	13-Feb	7.3			13.2		11.0
Norwich Lakenfields	30-Jan	8.3			9.8	8.7	16.4
Nottingham Centre	20-Feb	8.3		10.0	10.3	8.7	16.4
Nottingham Western Boulevard	22-Feb				12.2	8.7	
Oldbury Birmingham Road	19-Jan				13.2		

Station	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
Oxford Centre Roadside	09-Feb				12.9		
Oxford St Ebbes	09-Feb	10.4			12.1	8.7	16.4
Peebles	07-Feb	11.5			12.2		
Plymouth Tavistock Road	06-Jan				12.3		
Plymouth Centre	04-Jan	8.3			9.8	8.7	16.4
Port Talbot Margam	10-Jan	8.3	11.5	11.7	9.8	8.7	16.4
Port Talbot Margam Partisol	10-Jan					8.0	
Portsmouth	22-Feb	8.3			13.1	8.7	16.4
Preston	12-Jan	8.3			9.8		16.4
Reading London Road	06-Jan				**35.4**	**42.3**	12.6
Reading New Town	06-Jan	8.3			11.3	8.7	16.4
Rochester Stoke	16-Feb			10.0	**18.4**	8.7	16.4
Salford Eccles	10-Jan				12.2	8.7	16.4
Saltash Callington Road	05-Jan					8.7	16.4
Sandy Roadside	09-Feb				12.2	8.7	16.4
Scunthorpe Town	12-Jan			10.0	11.7	8.7	
Shaw Crompton Way	10-Jan				12.2	9.3	
Sheffield Barnsley Road	18-Jan				**20.0**		
Sheffield Devonshire Green	17-Jan	8.3			9.8	8.7	16.4
Sheffield Tinsley	17-Jan				11.1		
Sibton	06-Feb	11.2					
Southampton Centre	26-Jan	8.3		11.4	9.9	8.7	
Southampton A33 Roadside	20-Feb				12.2	8.7	
Southend-on-Sea	06-Feb	8.3			9.9		16.4
Southwark A2 Old Kent Road	25-Jan				12.6	8.7	
St Helens Linkway	02-Mar					8.7	
St Osyth	06-Feb	8.3			9.8		

Station	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
Stanford-le-Hope Roadside	08-Feb				12.5	8.7	16.4
Stockton on Tees A1035 Roadside	31-Jan				12.2		16.4
Stockton-on-Tees Eaglescliffe	31-Jan				12.5	9.3	12.6
Stoke-on-Trent Centre	18-Jan	8.3			10.0		16.4
Stoke on Trent A50 Roadside	18-Jan				12.2	8.7	
Storrington Roadside	24-Jan				9.8	8.7	16.4
Strathvaich	24-Jan	11.2					
Sunderland Silksworth	02-Feb	11.3			11.7		16.4
Sunderland Wessington Way	01-Feb				12.5		
Swansea Roadside	10-Jan				**19.2**	9.3	12.6
Thurrock	08-Feb	11.2		10.0	12.3	8.7	
Tower Hamlets Roadside	08-Feb				13.6		
Walsall Woodlands	19-Jan	11.2			12.2		
Warrington	16-Jan				13.2	8.7	16.4
Weybourne	31-Jan	8.3					
Wicken Fen	02-Feb	11.2		10.1	12.2		
Widnes Milton Road	17-Jan				12.2	11.4	
Wigan Centre	12-Jan	8.3			**16.0**		16.4
Wirral Tranmere	18-Jan	8.3			9.9		16.4
Worthing A27 Roadside	27-Jan				12.3		
Wrexham	19-Jan			10.0	12.2	8.0	11.0
Yarner Wood	15-Feb	11.2			12.2		
York Bootham	06-Jan				11.1	8.7	16.4
York Fishergate	06-Jan				11.3	8.7	16.4
Total > 15% (gaseous) or > 25% (PM)	**-**	**0**	**0**	**2**	**10**	**1**	**0**

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

There are a number of analysers where the calculated uncertainty is 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 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.

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 2017 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.

Table 4-1 Data Capture Summary, January-March 2017 (Quarter 1)

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	All
Number of Stations	7	143	75	72	77	27	159
Number of stations < 85 %	1	10	3	14	12	3	15
Number of stations < 90%	2	14	5	18	22	5	25
Average	90.98	95.33	96.72	89.11	90.39	94.13	93.39

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 2017, 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.

Please note, whilst Northampton Spring Park is in the tables for data capture because it was not operational for long enough in the quarter it has not been included in the average data capture figures presented above.

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 2017 is given in Table 4-2:

Table 4-2 Data Capture for England, January-March 2017

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	All
Barnsley Gawber		98.52	98.56			98.52	98.53
Barnstaple A39				89.49	94.95		92.22
Bath Roadside		98.33					98.33
Billingham		99.63					99.63
Birkenhead Borough Road		99.44					99.44
Birmingham A4540 Roadside		98.52	98.56	83.06	96.34		94.12
Birmingham Acocks Green		98.43	98.75		95.65		97.61
Birmingham Tyburn				91.67	90.28		90.97
Blackburn Accrington Road		99.31					99.31
Blackpool Marton		98.33	98.61		93.61		96.85
Bournemouth		98.89	99.03		98.89		98.94
Bradford Mayo Avenue		99.26					99.26
Brighton Preston Park		96.34	92.27		98.89		95.83
Bristol St Paul's		98.33	98.47	89.03	71.71		89.39
Bury Whitefield Roadside		98.75		77.92			88.33
Cambridge Roadside		98.19					98.19
Cannock A5190 Roadside		97.69					97.69
Canterbury		98.15	98.61				98.38
Carlisle Roadside		89.49		93.15	95.60		92.75
Charlton Mackrell		98.52	98.33				98.43
Chatham Roadside		97.55		95.28	98.56		97.13
Chesterfield Loundsley Green		95.14		93.70	95.23		94.69
Chesterfield Roadside		99.12		95.05	95.00		96.39

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	All
Chilbolton Observatory		98.38	97.31	95.51	95.32	69.91	91.29
Christchurch Barrack Road		98.24					98.24
Coventry Allesley		98.52	98.70		95.32		97.52
Derby St Alkmund's Way		78.10					78.10
Doncaster A630 Cleveland Street		99.31					99.31
Eastbourne		99.31			89.35		94.33
Exeter Roadside		83.52	83.84				83.68
Glazebury		68.94	98.66				83.80
High Muffles		98.56	98.66				98.61
Honiton		98.70					98.70
Horley		99.03					99.03
Hull Freetown		98.19	98.43		91.39	97.92	96.48
Hull Holderness Road		98.15		79.49			88.82
Ladybower		97.55	97.92			93.80	96.42
Leamington Spa		99.44	99.58	95.51	96.16		97.67
Leamington Spa Rugby Road		99.44		96.25	96.48		97.39
Leeds Centre	98.10	98.01	97.92	93.43	96.02	98.15	96.94
Leeds Headingley Kerbside		98.66		92.13	92.36		94.38
Leicester A594 Roadside		99.12		98.75			98.94
Leicester University		96.20	96.06		97.69		96.65
Leominster		58.06	58.24				58.15
Lincoln Canwick Road		98.80					98.80
Liverpool Speke		98.33	93.61	93.01	96.16	98.33	95.89
Lullington Heath		98.52	91.06			85.14	91.57
Luton A505 Roadside		96.44					96.44
Manchester Piccadilly		90.69	98.47		87.78	98.52	93.87
Manchester Sharston		98.56	98.56				98.56
Market Harborough		89.07	93.01				91.04

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	All
Middlesbrough		96.99	97.41	91.99	90.00	96.90	94.66
Newcastle Centre		98.52	98.66	95.00	95.32		96.87
Newcastle Cradlewell Roadside		24.91					24.91
Northampton Kingsthorpe		98.46	98.56		95.24		97.42
Northampton Spring Park		0.00	0.00		0.00		0.00
Norwich Lakenfields		98.38	98.70	91.85	95.42		96.09
Nottingham Centre		98.47	98.61	94.31	96.02	98.06	97.09
Nottingham Western Boulevard		98.33		97.73			98.03
Oldbury Birmingham Road		99.35					99.35
Oxford Centre Roadside		97.22					97.22
Oxford St Ebbes		97.31		75.60	75.42		82.78
Plymouth Centre		98.84	98.94	92.13	86.76		94.17
Plymouth Tavistock Road		99.04					99.04
Portsmouth		98.43	99.72	65.74	93.98		89.47
Preston		96.99	94.81		86.39		92.73
Reading London Road		99.40		97.41			98.40
Reading New Town		98.61	98.75	90.79	85.28		93.36
Rochester Stoke		90.05	88.47	84.12	77.41	90.28	86.06
Salford Eccles		99.35		96.02	83.89		93.09
Saltash Callington Road				55.19	95.05		75.12
Sandy Roadside		99.72		84.54	69.72		84.66
Scunthorpe Town		98.33		95.05		84.21	92.53
Shaw Crompton Way		98.10					98.10
Sheffield Barnsley Road		99.17					99.17
Sheffield Devonshire Green		98.33	98.38	92.78	86.34		93.96
Sheffield Tinsley		97.73					97.73

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	All
Sibton			87.13				87.13
Southampton A33		98.98		90.60			94.79
Southampton Centre		72.13	71.81	72.50	59.81	72.31	69.71
Southend-on-Sea		98.33	98.47		95.37		97.39
St Helens Linkway		96.57		52.18			74.37
St Osyth		97.96	98.33				98.15
Stanford-le-Hope Roadside		98.01		94.03	96.44		96.16
Stockton-on-Tees A1305 Roadside		99.03			96.11		97.57
Stockton-on-Tees Eaglescliffe		98.29		93.75	95.14		95.73
Stoke-on-Trent A50 Roadside		98.47		90.74			94.61
Stoke-on-Trent Centre		98.47	98.61		92.64		96.57
Storrington Roadside		99.31		25.46	25.65		50.14
Sunderland Silksworth		98.29	98.24		93.70		96.74
Sunderland Wessington Way		98.84					98.84
Thurrock		98.33	93.15	91.94		98.01	95.36
Walsall Woodlands		99.40	99.49				99.44
Warrington		99.58		91.30	96.11		95.66
Weybourne			99.91				99.91
Wicken Fen		98.43	98.56			98.48	98.49
Widnes Milton Road		99.77					99.77
Wigan Centre		98.47	97.69		78.66		91.60
Wirral Tranmere		98.19	98.56		95.60		97.45
Worthing A27 Roadside		99.26					99.26
Yarner Wood		97.59	98.15				97.87
York Bootham		98.24		94.21	79.49		90.65
York Fishergate		98.80		94.68	88.38		93.95
Number of Stations	1	98	50	44	52	15	103
Number of stations < 85 %	0	7	4	11	10	3	11

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	All
Number of stations < 90%	0	9	6	13	17	4	18
Average	98.10	94.99	93.81	87.36	87.77	91.90	92.26

The following station-specific issues were identified:

Barnstaple A39

The PM_{10} FDMS analyser was frequently noisy. Data from the period 6 to 10 January were deleted, along with many anomalous spikes during the rest of January.

Birmingham A4540 Roadside

Several periods of unstable PM_{10} data from the hotspare analyser were deleted during ratification. Data improved following the reinstallation of the repaired station FDMS analyser on 10 March.

Bristol St Pauls

The PM_{10} FDMS suffered from several cooler and flow faults during the quarter. The $PM_{2.5}$ data from 9 to 25 January were identified as a regional outlier and were noisy; this period was deleted.

Bury Whitefield Roadside

The PM_{10} zero filter installed following the audit on 9 January was not removed until 25 January.

Carlisle Roadside

The NOx analyser suffered from two flow faults, and also excessive autocal run-on resulting in the loss of data

Chilbolton Observatory

The SO_2 analyser failed the linearity test at the winter 2017 audit, possibly due to a detector fault. A hotspare was installed, which produced noisy data.

Derby St Alkmund's Way

Data collection for this station did not start until 20 January.

Eastbourne

The $PM_{2.5}$ zero filter installed at the audit on 24 January was not removed until 1 February.

Exeter Roadside

A logger fault resulted in the loss of all data from 10 to 23 January.

Glazebury

The ESU were called out on 13 March to investigate a NOx fault. The engineer found the analyser had powered down automatically due to high internal hut temperature; the aircon was inoperative. The engineer was unable to find the control to restart the aircon, and left the analyser switched off. The aircon and analyser were restarted on 11 April.

Hull Holderness Road

The PM_{10} FDMS analyser was replaced with a BAM at the service on 26 January. Following this, the BAM analyser suffered from persistent tape breaks. This persisted until the analyser was removed for workshop repair in May.

Leominster

The station was recommissioned on 7 February following repairs to the enclosure.

Lullington Heath

The SO_2 analyser suffered a lamp fault; data from 25 to 31 March have been lost. This will continue into Q2.

Manchester Piccadilly
Noisy $PM_{2.5}$ data were deleted from 28 to 31 January.

Market Harborough
The sample lines were found disconnected from the sample inlet at the service on 28 February; however data look real up to 23 February, so it is assumed that the tubes became loose through vibration rather than station activity.

Newcastle Cradlewell Roadside
The station developed an unspecified logger fault on 30 January; repairs were not competed until May. All data for this period have been lost.

Northampton Spring Park
The station started on 27 March; data will be reported with Q2 data in accordance with normal procedure for new sites that start up near the end of a quarter.

Oxford St Ebbes
No $PM_{2.5}$ or PM_{10} data are available prior to 13 January due to the site having overhanging vegetation meaning the data could not be used as it didn't meet the directive criteria. This was subsequently addressed. Two zero tests were carried out this quarter-13 to 17 January and 9 to 13 February.

Plymouth Centre
The $PM_{2.5}$ mass transducer developed a fault during the audit zero test around 5 January. A new transducer was installed on 16 January.

Portsmouth
The volatile PM_{10} concentrations were identified as regional outliers between on 3 to 15 January and 22 to 30 January. These periods have been deleted.

Preston
The $PM_{2.5}$ zero filter installed at the audit on 12 January was not removed until 23 January.

Reading New Town
The $PM_{2.5}$ data were lost up to 13 January due to an unspecified fault, possibly weather related.

Rochester Stoke
The failure of the logger in December resulted in the loss of all data up to 3 January. Some SO_2 data were lost due to autocal run-on during the quarter. In addition, the $PM_{2.5}$ data from 21 to 27 February were identified as regional outliers, and were deleted during ratification.

Salford Eccles
The ESU was called out to the $PM_{2.5}$ FDMS analyser on 2 March for a flow fault. The flow controller was found to be faulty, and was replaced on 8 March.

Saltash Callington Road
The volatile PM_{10} concentration was found to be a regional outlier between 15 February and 22 March; these data have been deleted.

Sandy Roadside
Following completion of the zero test carried out from 9 to 16 February, it appears the sharp cut cyclone was not replaced; it was found in the enclosure by the LSO on 8 March. These data have been deleted.

Scunthorpe Town
The SO_2 analyser pump failed in late December, Although it was attended to, it appears that contamination from the permeation tube could be seen in the ambient data up to a callout in January. Data from 1 to 14 January have been deleted.

Sheffield Devonshire Green

Persistent noisy $PM_{2.5}$ data was observed during the first part of the quarter. Various short periods have been deleted during ratification.

Sibton
Data were deleted 23 January to 2 February due to a cracked sample filter glass

Southampton Centre
The station was recommissioned on 24 January following replacement of the enclosure.

St Helens Linkway
The collection of PM_{10} data started on 7 February following installation of the FDMS.

Storrington Roadside
The $PM_{2.5}$ and PM_{10} FDMS analysers were removed from the station on 27 January for deployment elsewhere in the network.

Wigan Centre
Occasional noisy $PM_{2.5}$ data was observed during the first part of the quarter. Various short periods have been deleted during ratification. An ESU callout for a pump fault on 15 March found damage to the transducer seal.

York Bootham
The $PM_{2.5}$ data was of poor quality during the quarter, probably due to leaks inside the instrument. A hotspare FDMS being installed on 7 February, though poor data was still observed intermittently. Data were deleted from 24 January to 4 February.

York Fishergate
Following the zero check on 6 to 10 January, a period of poor quality $PM_{2.5}$ data was observed, which was deleted. Most of the data were therefore lost between 6 and 18 January.

4.3 Data Capture and Station-Specific Issues - Greater London

A summary of data capture for Greater London for January-March 2017 is given in Table 4-3:

Table 4-3 Data Capture for Greater London, January-March 2017

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Average
Camden Kerbside		97.45		93.10	95.42		95.32
Ealing Horn Lane				95.09			95.09
Haringey Roadside		99.44					99.44
London Bexley		85.88			93.61		89.75
London Bloomsbury		98.33	98.47	95.51	88.80	98.19	95.86
London Eltham		95.09	99.40		90.56		95.02
London Haringey Priory Park South		99.63	99.54				99.58
London Harlington		99.63	99.86	99.77	99.77		99.76
London Harrow Stanmore					84.72		84.72
London Hillingdon		98.80	97.92				98.36
London Marylebone Road	86.62	99.07	97.73	97.73	97.96	99.17	96.38

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Average
London Marylebone Road				98.89	95.56		97.22
London N. Kensington	99.63	99.63	99.68	90.28	69.44	98.98	92.94
London Teddington Bushy Park					68.70		68.70
London Westminster		48.47			96.67		72.57
Southwark A2 Old Kent Road		98.43		94.21			96.32
Tower Hamlets Roadside		99.31					99.31
Number of Stations	**2**	**13**	**7**	**8**	**11**	**3**	**17**
Number of stations < 85 %	**0**	**1**	**0**	**0**	**3**	**0**	**3**
Number of stations < 90%	**1**	**2**	**0**	**0**	**4**	**0**	**4**
Average	**93.12**	**93.78**	**98.94**	**95.57**	**89.20**	**98.78**	**92.73**

The following station-specific issues were identified:

London Bexley

The NOx main valve jammed on 10 February, and the ESU failed to repair it effectively. A hotspare was installed on 8 March.

London Bloomsbury

Following an LSO visit on 3 January when the FDMS filters were changed, the $PM_{2.5}$ FDMS analyser became unstable. This was corrected by the ESU on 10 January; data between the visits have been deleted.

London Harrow Stanmore

Data were deleted from 5 to 12 January due to noisy data, eventually cured by the LSO reseating the filter. The zero test took place from 12 to 16 February and so no ambient data were collected.

London Marylebone Road

A replacement CO analyser was installed on 28 February; unfortunately the logger setup resulted in the truncation of logged data up to the callout on 9 March. Data for this period have been deleted.

London North Kensington

The $PM_{2.5}$ FDMS data was very noisy between the service on 24 February to a callout on 14 March; data have been deleted. Data following the LSO visit on 25 January up to the audit on 30 January were also deleted.

London Teddington Bushy Park

Following an instrument fault on 18 December, a hotspare FDMS analyser was installed on 9 January. The data from this were of poor quality and a regional outlier up to 22 January. The analyser was removed and the original reinstalled on 24 January.

London Westminster

At the winter 2017 audit on 1 February, it was found that the obsolete NO_2 cylinder tube was connected to the analyser instead of the sample line. There had been numerous ESU visits during the latter half of 2016, so it is not possible to determine with certainty when the error was made. However, the other faults also resulted in data loss from 26 August 2016 to 1 February 2017.

4.4 Data Capture and Station-Specific Issues - Wales

A summary of data capture for Wales for January-March 2017 is given in Table 4-4.

Table 4-4 Data Capture for Wales, January-March 2017

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Average
Aston Hill		91.90	97.04				94.47
Cardiff Centre	98.75	98.61	98.75	78.66	88.75	95.93	93.24
Chepstow A48		76.39		94.72	92.96		88.02
Cwmbran		99.58	99.63				99.61
Hafod-yr-ynys Roadside		97.82					97.82
Narberth		98.84	98.94	90.23		98.66	96.67
Newport		98.29		82.96	93.75		91.67
Port Talbot Margam (Partisol)				98.89			98.89
Port Talbot Margam	97.59	97.69	98.52	92.55	95.60	97.69	96.60
Swansea Roadside		97.87		94.44	94.40		95.57
Wrexham		84.81		98.89	98.89	98.24	95.21
Number of Stations	**2**	**10**	**5**	**8**	**6**	**4**	**11**
Number of stations < 85 %	**0**	**2**	**0**	**2**	**0**	**0**	**0**
Number of stations < 90%	**0**	**2**	**0**	**2**	**1**	**0**	**1**
Average	**98.17**	**94.18**	**98.57**	**91.42**	**94.06**	**97.63**	**95.25**

The following station-specific issues were identified:

Cardiff Centre

The zero tests were carried out between 11 to 16 January; however, following this, the data was of poor quality and cast doubt over the validity of the tests. These were then repeated on 2 to 6 March. Data from the PM_{10} FDMS were deleted from 16 to 24 January.

Chepstow A48

The NOx analyser repeatedly switched itself off and on again during the quarter, and was ultimately removed for workshop investigation on 28 March.

Newport

At the service on 23 January, it was found that there was a significant leak in the PM_{10} FDMS analyser. The purge filter holder was found to be cross-threaded. Data from 11 to 23 January have been deleted.

Wrexham

Following failure of the station NOx analyser in November 2016, a hotspare analyser of different manufacture was installed. The LSO was not trained in calibration procedures, and so no calibrations were performed. Data up to 13 January have been deleted.

4.5 Data Capture and Station-Specific Issues - Scotland

A summary of data capture for Scotland for January-March 2017 is given in Table 4-5:

Table 4-5 Data Capture for Scotland, January-March 2017

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Average
Aberdeen		91.57	98.43	95.23	92.27		94.37
Aberdeen Union Street Roadside		93.56					93.56
Aberdeen Wellington Road		88.43					88.43
Auchencorth Moss			99.03	92.92	96.85		96.27
Bush Estate		98.29	98.80				98.54
Dumbarton Roadside		99.63					99.63
Dumfries		98.66					98.66
Edinburgh St Leonards	59.68	91.20	92.27	55.88	87.31	85.23	78.60
Eskdalemuir		98.56	98.66				98.61
Fort William		97.82	98.15				97.99
Glasgow Great Western Road		98.47					98.47
Glasgow High Street		93.52		85.51	95.23		91.42
Glasgow Kerbside		98.43					98.43
Glasgow Townhead		98.56	98.10	95.23	96.20		97.03
Grangemouth		93.94		95.46	96.16	96.94	95.62
Grangemouth Moray		98.75					98.75
Greenock A8 Roadside		31.44					31.44
Inverness		98.66		87.78	98.89		95.11
Lerwick			99.54				99.54
Peebles		98.56	99.63				99.10
Strathvaich			98.70				98.70
Number of Stations	**1**	**18**	**10**	**7**	**7**	**2**	**21**
Number of stations < 85 %	**1**	**1**	**0**	**1**	**0**	**0**	**2**
Number of stations < 90%	**1**	**2**	**0**	**3**	**1**	**1**	**3**
Average	**59.68**	**92.67**	**98.13**	**86.86**	**94.70**	**91.09**	**92.77**

The following station-specific issues were identified:

Aberdeen Wellington Road

The NOx analyser developed a fault during the service on 7 February, and the ESU uplifted it for workshop repair. A hotspare was installed a few days later but this suffered an ozonator failure the following day. The original repaired analyser was reinstalled on 17 February.

Edinburgh St Leonards

The CO analyser continued to perform poorly this quarter. A valve faults caused very erratic data which were deleted between 1 and 10 January. Continuing instability resulted in the installation of a hotspare on 1 March. The data continued to be poor, despite further ESU attention.

The PM_{10} FDMS gave high volatile concentrations up to the audit zero test, and low afterwards. Following a number of callouts, poor data persisted. Data have been deleted 1 to 17 January, 6 to 16 February and 20 February to 3 March. Some periods of noisy and/or negative $PM_{2.5}$ data were deleted during ratification.

During February, there was a fault with the main electrical circuit breaker in the station, which resulted in the loss of several periods of data from all analysers.

The SO_2 analyser would not restart following service on 8 March, and was removed for workshop repair, and was reinstalled on 13 March.

Glasgow High Street

The PM_{10} FDMS analyser suffered a pump fault from 7 to 13 February, a valve motor fault 26 to 28 February and noisy data on 19 March, which were deleted.

Greenock A8 Roadside

A lack of calibrations between 25 November and the service on 7 March, and problems with the calibration system and the station regulator resulted in the deletion of data from 1 January to 3 March. The calibration system caused several NO cylinders to become oxidised, which had not been fully resolved by the time this report was prepared (end of Q2 2017).

Inverness

The PM_{10} Partisol suffered filter exchange failures from 4 to 10 and 11 to 12 January, and a jammed filter on 21 February.

4.6 Data Capture and Station-Specific Issues - Northern Ireland

A summary of data capture for Northern Ireland and Mace Head for January-March 2017 is given in Table 4-6:

Table 4-6 Data Capture for Northern Ireland (plus Mace Head), January-March 2017

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Average
Mace Head			99.68				99.68
Armagh Roadside		99.77		93.80			96.78
Ballymena Ballykeel		99.54				98.06	98.80
Belfast Centre	96.48	97.82	98.66	92.04	91.90	98.15	95.84
Belfast Stockman's Lane		99.07		97.55			98.31
Derry Rosemount		98.98	99.31	94.21	95.42	97.78	97.14
Lough Navar			99.54	90.28			94.91
Number of Stations	**1**	**5**	**4**	**5**	**2**	**3**	**7**

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Average
Number of stations < 85 %	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Number of stations < 90%	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Average	**96.48**	**99.04**	**99.29**	**93.57**	**93.66**	**97.99**	**97.35**

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.

Table 4-7 FDMS Data Rescales carried out During Q1 2017 Ratification

Monitoring Station	Pollutant(s)	Dates (2016 unless stated)
Belfast Centre	PM_{10}	1 Jan-31 Mar
Birmingham Tyburn	PM_{10}	1 Jan-19 Feb
Cardiff Centre	PM_{10}	5 Jan-15 Mar
Derry Rosemount	PM_{10}	5 Sep 16 -7 Feb
Leeds Headingley Kerbside	$PM_{2.5}$	1 Jan- 18 Feb
London N Kensington	PM_{10}	1 Jan-31 Mar

It is possible that the zero tests carried out at the summer 2017 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 Deletion of More Than One Month's Data

The following stations have had more than one month's data deleted during ratification:

Monitoring Station	Pollutant(s)	Dates	Reason
Greenock A8 Roadside	NOx	1 Jan – 3 Mar 2017	Lack of calibrations.
Lullington Heath	SO2	25 Feb – 31 Mar and on into Q2.	Unstable data. Suspect lamp voltage fault.
Saltash Callington Road	PM10	15 Feb – 22 Mar	Volatile (V10) high over this period.

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 2017 Q1 data, some changes were also made to data from 2016 that had previously been flagged as ratified. These changes, and the reasons, are shown in Table 5-1.

Table 5-1 Changes to 2015 Data Previously Marked as Ratified

Monitoring Station	Pollutant(s)	Dates	Nature of Change
Bristol St Pauls	O_3	26 Oct 2016 – 4 Jan 2017.	A re-scale was amended.
Hafod-yr-Ynys Roadside	NOx	Q4 2016	Re-process of analyser sensitivity: small change to Q4 data.
Ladybower	SO_2	1 Oct 2016 – 31 Dec 2016.	Analyser sensitivity reprocessed.
Oldbury Birmingham Road	NOx	1 Sep 2016 (audit) - 31 Dec 2016.	Converter efficiency rescale (below 98% at audit)
Portsmouth	NOx	20 Jul 2016 (audit) - 31 Dec 2016.	Converter efficiency rescale (below 98% at audit)
Reading New Town	NOx	10 Feb 2016-31 March 2016	Calibration corrected due to typographical error in spreadsheet

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 2017

Station	Risk	Date went to 'High'	Date resolved	Action taken
Sandy Roadside	Engineer threatened by employee of local business	13 Feb 17	20 Feb 17	LA spoke to business concerned.
Marylebone Road	Failed site electrical test	7 March 17	w/c 7 March 17	Repaired

7 Equipment Upgrade Requirements

The continued poor performance of the CO analyser at Edinburgh St Leonards has been discussed; this analyser could benefit from replacement.

8 Station Infrastructure Issues

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

9 Conclusions and Recommendations

Conclusions

1. During Quarter 1 of 2017 a total of 157 (plus two co-located Partisol stations) AURN monitoring stations were in operation.
2. During this quarter, the winter 2017 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 2017.
4. The mean data capture for ratified hourly average data was 93.39% (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 2017.
5. Mean data captures for individual pollutants were as follows: CO 90.98%; NO_2 95.33%; O_3 96.72%; SO_2, 94.13%; PM_{10}, 89.11% and $PM_{2.5}$, 90.39%. 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 Q1 of 2017.
6. The uncertainty of measurement for each analyser has been determined to ensure compliance with the Data Quality Objective. Thirteen 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