QAQC Report for the Automatic Urban and Rural Network, July - September 2017

Report for the Environment Agency
Environment Agency contract number 21316

ED 60071201_2017Q3 | Issue 1 | Date 04/07/2018

Customer:

The Environment Agency

Customer reference:

21316

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Date:

04 July 2018

Ricardo Energy & Environment reference:

Ref: ED60071201_2017Q3- 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 UK Environment Agency, 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.

A total of 158 monitoring stations in the AURN operated during this quarter. There are three co-located and separately named gravimetric particulate analysers at stations with automatic analysers (one at Port Talbot Margam and two (for PM_{10} and $PM_{2.5}$) at London Marylebone Road). Many affiliated stations have additional Environment Agency funded analysers installed on station.

During this quarter, the summer 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.

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 Station Operator (LSO) calibrations, the QA/QC audits and records from Equipment Support Unit (ESU) activity.

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%. Ratified hourly average data capture for the network averaged 91.22% for all pollutants (O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$) during the 3-month reporting period July-September 2017. Average data capture for all pollutants was above 85%. There were 18 stations with average data capture less than 85% for the period (there were 28 stations with average data capture below 90%). Principal reasons for data loss are given here for stations which failed to make the 85% data capture target in this quarter.

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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 EU Directives on Air Quality. However, in addition, the data and information from the AURN is 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 has been appointed as Management Unit (MU) for the AURN monitoring stations that are also part of the London Air Quality Network (LAQN). Ricardo Energy & Environment undertakes the role of Quality Assurance and Control Unit (QA/QC Unit) for 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. 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 (ESUs), under contract to the CMCU or the station owner in the case of affiliated stations.

Dissemination of the data from the AURN via UK-AIR (the UK online Air Information Resource, https://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.

A total of 158 monitoring stations in the AURN operated during this quarter. There are 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.

The main reasons for data loss at the stations are discussed in section 4.

1.2 What This Report Covers

This report covers the three-month period July-September 2017, or "Quarter 3" of the year. This report covers the main QA/QC activities; the relevant CMCU reports should be consulted for more detail on 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:

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

1.4 Changes to the Network during this Quarter

There were no new stations commissioned in the network during the period July - September 2017, and no site closures.

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 Summer 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 stations 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 stations, 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 station 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 station 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 station cylinder concentrations. These tests use a set of Ricardo Energy & Environment certified cylinders that are taken to all the stations. The concentrations of the station 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 Station 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 station in the Network. These cylinders are recently calibrated by the Calibration Laboratory at Ricardo Energy & Environment, and allow us to examine how different station analysers respond when they are supplied with the same gas used at other stations. 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. These individual results are tabulated, and statistical analyses undertaken (e.g. network average result, network standard deviation, deviation of individual stations from the network mean etc.).

These results are then used to pick out problem stations, 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 station 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 stations 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 station cylinder concentrations between intercalibrations. Station cylinders can sometimes become unstable, especially at low pressures. All station 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 and BAM 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 the QA/QC's air quality software 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 Summer Intercalibration, July-September 2017

During the summer 2017 intercalibration, audits were carried out on the 156 monitoring stations in operation at the time. (Two monitoring stations were out of operation).

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

Table 3-1 Summary of audited analyser performance – 156 UK stations

Parameter	Number of outliers	Number tested	% outliers in total
NOx analyser	10	146	6.8%
CO analyser	2	7	28.6%
SO_2 analyser	3	27	11.1%
Ozone analyser	12 (7 more than 10% from standard)	75	16%
FDMS and BAM analysers	17 x k_0, 5 x flows	78 PM_{10} 73 $PM_{2.5}$	14.6%
Gravimetric PM analysers	0	10	-
Cylinders	7	179	3.9%
Total	55 analysers	416 analysers	13.2% of analysers

The number of analyser outliers identified (13.2%) is lower than at the winter 2017 intercalibration, but still comparable with the percentages identified at previous intercalibrations.

3.2 Network Intercalibrations

The evaluated concentration of the audit cylinders was calculated for each station and 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 **Error! Reference source not found.** below.

Table 3-2 Audit Cylinder Results

Parameter	Network Mean	Audit reference concentration	Network Accuracy %	%Std Dev
NO	463	457	+1.2%	3.4
NO_2	456	459	-0.7%	4.1
CO	20.4	20.0	+2.3%	6.2
SO_2	473	468	+1.0%	4.1

- **Oxides of Nitrogen**

  A total of ten outliers were identified during this intercalibration. Of these outliers, five can be attributed to analyser drift, four to changes in station cylinder concentration 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 three outliers were identified at this intercalibration. Two of the outliers were due to a change in the station cylinder concentrations, the other was caused by an apparent difference between audit and LSO calibrations. All m-xylene interference tests were less than 33 ppb, which is a satisfactory result.

- **Ozone**

  A total of 12 outliers were identified during the summer 2017 exercise. Seven of the outliers had a calibration response more than 10% from the reference photometer.

- **Particulate Analysers**

  There were 17 calculated k_0 values outside the required ±2.5% of the stated values. This is worse than the previous exercise where 14 outliers were identified. QA/QC unit continue to investigate the reasons for this step change in performance, but it appears that the filters used to determine k_0 are the cause of the increase in failing k_0 tests. Revised procedures are being implemented for winter 2018, additional tests are planned to identify the root cause and the findings will be reported in the next intercalibration reports.

  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

- **PM analyser zero tests**

  In the zero baseline tests carried out at the summer 2017 audit, a total of 14 analysers gave average responses to particle-free air that were outside ±3 µg m^{-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**

  Seven of the 179 station cylinders used to scale ambient pollution data were found to be outside the ±10% acceptance limit. Four were NO cylinders, three SO_2.

London Stations

The results of the intercalibration for the 17 London stations (including the two co-located Partisols at London Marylebone Road) 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	0	
CO analyser	0	2
SO_2 analyser	0	3
Ozone analyser	0	8
FDMS and BAM analysers	3	17
Gravimetric PM analysers	0	3

English Stations (Excluding London)

The results of the intercalibration for the 107 stations in England outside of London are summarised in **Error! Reference source not found.** below:

Table 3-4 Summary of audited analyser performance – Stations in England (Excluding London)

Parameter	Number of outliers	Number in region
NOx analyser	6	98
NOx converter	7	
CO analyser	0	1
SO_2 analyser	2	16
Ozone analyser	6	53
FDMS and BAM analysers	9	93
Gravimetric PM analysers	0	3

Scottish Stations

The results of the intercalibration for the 21 Scottish stations are summarised in **Error! Reference source not found.** below:

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

Parameter	Number of outliers	Number in region
NOx analyser	3	19
NOx converter	1	
CO analyser	1	1
SO_2 analyser	1	3
Ozone analyser	4	10
FDMS and BAM analysers	3	12
Gravimetric PM analysers	0	4

Welsh Stations

The results of the intercalibration for the 10 Welsh stations are summarised in **Error! Reference source not found.** below:

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

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

Northern Ireland Stations

The results of the intercalibration for the six 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	1	5
NOx converter	0	
CO analyser	0	1
SO_2 analyser	0	3
Ozone analyser	2	4
FDMS and BAM analysers	1	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), BS EN14625:2012 (O_3) and BS EN 12341:2014 (PM10 and 2.5) 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 station after this date needed to be replaced before June 2013. Ricardo Energy & Environment took the necessary steps to ensure the procedures used in the AURN complied with the requirements ahead of the deadlines. The procedures used for 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 stations 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. Values outside of ±15%, or ±25% for particulate monitoring instruments, are shown in red.

Table 3-8 Analyser measurement uncertainties (%)

Station	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
Aberdeen	02-Aug	11.2			11.3	8.8	16.5
Aberdeen Union Street Roadside	03-Aug				12.4		
Aberdeen Wellington Road	02-Aug				12.3		
Armagh Roadside	18-Aug				13.2	8.8	
Aston Hill	21-Aug	11.2			**16.7**		
Auchencorth Moss	26-Jul	11.2				11.5	19.0
Ballymena Antrim Road	17-Aug				12.7		
Ballymena Ballykeel	17-Aug			12.1	12.3	9.8	
Barnsley Gawber	16-Aug	8.3		11.7	9.8		
Barnstaple A39	05-Jul					10.8	16.4
Bath Roadside	03-Jul				12.2		
Belfast Centre	01-Sep	9.0	7.6	10.1	10.8	8.9	16.6
Belfast Stockman's Lane	31-Aug				12.9	10.1	
Billingham	09-Aug				12.3		
Birkenhead Borough Road	06-Jul				12.4		
Birmingham Acocks Green	17-Jul	11.2			12.2		16.4
Birmingham A4540 Roadside	17-Jul	11.2			12.7	9.4	16.4
Blackburn Accrington Road	12-Jul				11.8		
Blackpool Marton	12-Jul	8.3			9.9		16.4
Bournemouth	29-Aug	11.2			12.2		
Bradford Mayo Avenue	04-Jul				11.3		
Brighton Preston Park	25-Jul	11.2			12.4		11.0
Bristol St Paul's	07-Jul	11.2			12.2	9.2	16.4

Station	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
Bristol Temple Way	03-Jul				12.3		
Bury Whitefield Roadside	19-Jul				12.6	10.3	
Bush Estate	26-Jul	11.2			13.0		
Cambridge Roadside	08-Aug				11.8		
Camden Kerbside	17-Aug				12.0	8.8	16.4
Cannock A5190 Roadside	20-Jul				12.2		
Canterbury	25-Aug	11.2			12.3		
Cardiff Centre	02-Aug	11.2		10.0	13.8	9.6	16.6
Carlisle Roadside	11-Jul				11.2	8.7	16.4
Charlton Mackrell	23-Aug	10.6			12.4		
Chatham Centre Roadside	24-Aug				12.3	9.3	12.6
Chepstow A48	22-Aug				12.6	8.7	16.4
Chesterfield Loundsley Green	15-Aug				11.7	8.7	16.4
Chesterfield Roadside	14-Aug				11.2	9.4	16.4
Chilbolton	21-Aug	11.2		**29.5**	14.9	8.7	16.4
Christchurch Barrack Road	29-Aug				12.2		
Coventry Allesley	30-Aug	8.3			9.8		17.2
Coventry Binley Road	30-Aug				12.4	8.9	
Cwmbran	03-Aug	8.3			13.1		
Derby St Alkmunds Way	24-Aug				12.7		
Derry Rosemount	16-Aug	12.4		13.1	13.4	9.2	16.4
Doncaster A630 Cleveland Street	16-Aug				12.2		
Dumbarton Roadside	10-Jul				**15.3**		
Dumfries	10-Jul				12.2		
Ealing Horn Lane	01-Aug					8.9	
Eastbourne	31-Aug				12.3		16.4
Edinburgh St Leonards	27-Jul	11.2	7.9	10.6	12.4	11.9	18.2
Eskdalemuir	10-Jul	11.2			12.3		
Exeter Roadside	06-Jul	7.2			13.2		
Fort William	19-Jul	11.2			12.8		
Glasgow Great Western Road	28-Jul				12.2		
Glasgow High Street	25-Jul				12.3	9.8	18.5
Glasgow Kerbside	25-Jul				10.1		
Glasgow Townhead	25-Jul	8.3			12.2	12.2	17.4
Glazebury	11-Jul	11.2			12.3		

Station	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
Grangemouth	25-Jul			11.1	11.2	8.8	16.5
Grangemouth Moray	25-Jul			13.0	11.2		
Greenock A8 Roadside	20-Jul				13.5		
Hafod-yr-Ynys Roadside	03-Aug				12.2		
Haringey Roadside	17-Aug				11.8		
High Muffles	08-Aug	11.2			12.2		
Honiton	06-Jul				12.4		
Horley	24-Jul				14.8		
Hull Freetown	05-Jul	8.3		11.3	9.8		16.5
Hull Holderness Road	05-Jul				12.2	9.3	
Inverness	01-Aug				12.2	8.0	11.0
Ladybower	14-Aug	11.2		10.5	12.3		
Leamington Spa	31-Aug	10.4			11.8	8.7	17.0
Leamington Spa Rugby Road	31-Aug				12.8	8.7	16.4
Leeds Centre	03-Jul	8.3	8.3	12.3	10.3	**75.4**	**42.6**
Leeds Headingley Kerbside	04-Jul				12.2	8.7	16.4
Leicester A594 Roadside	22-Aug				12.2	8.8	
Leicester University	22-Aug	8.3			12.4		16.4
Leominster	21-Aug	11.7			12.3		
Lerwick	04-Aug	11.2		10.0	12.2		
Lincoln Canwick Road	15-Aug				12.3		
Liverpool Speke	04-Jul	10.4		10.0	11.2	8.7	16.4
London Bexley	09-Aug				12.2		16.4
London Bloomsbury	07-Aug	11.2		10.0	12.3	8.7	16.4
London Eltham	26-Jul	10.4			11.9	8.7	16.7
London Haringey Priory Park South	18-Aug	10.4			12.6		
London Harlington	14-Aug	11.2			12.2		
London Harrow Stanmore	Out of action						
London Hillingdon	08-Aug	8.3			9.8		
London Marylebone Road	27-Jul	11.2	**33.6**	10.0	12.3	8.7	16.4
L. Marylebone Rd Partisol	Not tested						
London N. Kensington	25-Jul	11.2	7.5	10.1	13.0	8.7	16.6
London Teddington Bushy Park	14-Aug					9.9	13.3
London Westminster	01-Aug				11.5		

Station	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
Lough Navar	14-Aug	13.5				8.7	
Lullington Heath	25-Jul	11.2		10.0	12.2		
Luton A505 Roadside	15-Aug				12.4		
Mace Head	15-Aug	8.3					
Manchester Piccadilly	13-Jul	8.3		11.6	9.8		
Manchester Sharston	13-Jul	11.2		10.0	14.0		
Market Harborough	23-Aug	8.3			10.9		
Middlesbrough	08-Aug	11.2		10.5	12.2	8.7	16.4
Narberth	31-Jul			10.0	12.2	8.9	
Newcastle Centre	10-Aug	8.3			9.8	9.0	16.4
Newcastle Cradlewell Roadside	Out of action						
Newport	02-Aug				11.9	9.2	16.4
Northampton Spring Park	29-Aug	7.2			13.3	9.8	
Norwich Lakenfields	10-Aug	8.3			10.4	9.2	16.7
Nottingham Centre	21-Aug	9.7		10.0	12.2	8.7	16.4
Nottingham Western Boulevard	24-Aug				12.6	8.7	
Oldbury Birmingham Road	19-Jul				13.5		
Oxford Centre Roadside	21-Jul				11.6		
Oxford St Ebbes	21-Jul	10.4			**17.0**	8.7	16.4
Peebles	27-Jul	11.2			12.4		
Plymouth Tavistock Road	04-Jul				12.2		
Plymouth Centre	04-Jul	8.3			9.8	8.8	16.4
Port Talbot Margam	01-Aug	8.3	11.5	12.3	9.9	9.5	16.4
Port Talbot PM_{10} Partisol	01-Aug					8.2	
Portsmouth	31-Aug	8.3			13.2	8.7	16.4
Preston	12-Jul	8.3			9.8		16.4
Reading London Road	04-Jul				11.6	22.4	13.1
Reading New Town	04-Jul	8.3			10.9	8.7	16.4
Rochester Stoke	24-Aug	13.4		10.2	12.2	8.7	16.4
Salford Eccles	10-Jul				13.7	8.7	17.5
Saltash Callington Road	05-Jul					11.0	16.4
Sandy Roadside	15-Aug				12.8	8.7	16.5
Scunthorpe Town	04-Jul			10.7	12.8	8.7	
Shaw Crompton Way	19-Jul				12.3	14.9	
Sheffield Barnsley Road	17-Aug				12.3		
Sheffield Devonshire Green	17-Aug	8.3			9.9	8.7	16.6

Station	Date of audit	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
Sheffield Tinsley	17-Aug				11.3		
Sibton	07-Aug	11.2					
Southampton Centre	30-Aug	8.3		10.8	9.8	8.7	16.7
Southampton A33 Roadside	30-Aug				12.2	11.3	
Southend-on-Sea	17-Aug	8.3			10.8		
Southwark A2 Old Kent Road	31-Jul				12.7	8.7	
St Helens Linkway	04-Jul				12.2	8.8	
St Osyth	14-Aug	8.3			9.8		
Stanford-le-Hope Roadside	15-Aug				12.2	9.1	16.6
Stockton on Tees A1035 Roadside	07-Aug				12.5		16.5
Stockton-on-Tees Eaglescliffe	07-Aug				12.2	9.7	12.6
Stoke-on-Trent Centre	18-Jul	8.3			11.7		16.5
Stoke on Trent A50 Roadside	18-Jul				12.6	8.7	
Storrington Roadside	26-Jul				12.4		
Strathvaich	31-Jul	11.2					
Sunderland Silksworth	10-Aug	11.2			11.2		16.4
Sunderland Wessington Way	09-Aug				12.2		
Swansea Roadside	01-Aug				12.2	9.3	12.7
Thurrock	15-Aug	11.2		10.0	12.5	8.7	
Tower Hamlets Roadside	08-Aug				12.2		
Walsall Woodlands	19-Jul	11.2			12.2		
Warrington	03-Jul				12.6	10.2	16.6
Weybourne	10-Aug	8.3					
Wicken Fen	11-Aug	11.2		10.6	12.7		
Widnes Milton Road	05-Jul				12.9		
Wigan Centre	10-Jul	8.3			**15.1**		16.7
Wirral Tranmere	05-Jul	8.3			10.6		16.4
Worthing A27 Roadside	24-Jul				**23.7**		
Wrexham	03-Jul			10.0	12.2	8.0	11.0
Yarner Wood	22-Aug	11.2			12.4		
York Bootham	05-Jul				11.5	8.7	16.4
York Fishergate	09-Aug				**32.1**	9.1	16.6
Total > 15% (gaseous) or > 25% (PM)	**-**	**0**	**1**	**1**	**6**	**1**	**1**

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 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 very high values recorded for the Leeds Centre FDMS analysers are due to excessively high flows (23 and 29 litres per minute, compared to 16.7) recorded at the audit. The ESU attended but the flows had returned to normal. No reason could be determined. The London Marylebone Road CO result is due to poor analyser performance, and some data were deleted as a result. The York Fishergate NO_2 result is due to difficulties in carrying out the linearity test, and again is probably not representative of the actual analyser performance.

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 July-September 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. Note that all particulate analysers (except Fidas and Partisols) will lose typically 2-6 days per year while the six-monthly zero checks are carried out. Occasionally, this will be longer if the filters are left fitted for longer than planned. The network mean was at least 85% for all pollutants.

Table 4-1 Data Capture Summary, July-September 2017

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	All
Number of stations	7	146	75	71	74	27	160 (Inc. Partisols)
Number of stations < 85 %	1	11	4	10	10	2	18
Number of stations < 90%	1	15	6	23	19	4	28
Network mean	85.49	93.88	95.72	87.34	87.74	94.48	91.22

4.1.2 Generic Data Quality Issues

As highlighted in section 3.2, there were 17 calculated k_0 values outside the required ±2.5% of the stated values. This is worse than the previous (winter 2017) exercise where 14 outliers were identified. QA/QC unit continue to investigate the reasons for this step change in performance, but it appears that the filters used to determine k_0 are the cause of the increase in failing k_0 tests. Revised procedures are being implemented for winter 2018, additional tests are planned to identify the root cause and the findings will be reported in the next intercalibration reports.

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

A summary of data capture for England for July-September 2017 is given in Table 4-2:

Table 4-2 Data Capture for England, July-September 2017

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	All
Barnsley Gawber		93.84	98.51			98.32	96.89
Barnstaple A39				0.00	0.00		0.00
Bath Roadside		98.46					98.46
Billingham		98.60					98.60
Birkenhead Borough Road		99.37					99.37
Birmingham A4540 Roadside		98.32	97.01	94.57	95.56		96.37
Birmingham Acocks Green		66.44	99.14		94.93		86.84
Blackburn Accrington Road		93.30					93.30
Blackpool Marton		98.51	98.60		97.24		98.11
Bournemouth		95.97	98.82		98.91		97.90
Bradford Mayo Avenue		95.15					95.15
Brighton Preston Park		96.69	98.10		98.91		97.90
Bristol St Pauls		98.41	91.76	93.39	90.13		93.42
Bristol Temple Way		99.28					99.28
Bury Whitefield Roadside		99.09		87.09			93.09
Cambridge Roadside		93.21					93.21
Cannock A5190 Roadside		70.88					70.88
Canterbury		97.96	98.55				98.26
Carlisle Roadside		95.24		88.41	96.06		93.24
Charlton Mackrell		94.34	98.51				96.42
Chatham Roadside		96.20		89.40	83.06		89.55
Chesterfield Loundsley Green		34.01		97.42	93.89		75.11
Chesterfield Roadside		94.66		94.88	96.33		95.29
Chilbolton Observatory		98.23	98.46	95.88	96.20	93.98	96.55
Christchurch Barrack Road		98.28					98.28
Coventry Allesley		98.64	98.78		93.48		96.97
Coventry Binley Road		98.14		93.34			95.74
Derby St Alkmund's Way		96.60					96.60
Doncaster A630 Cleveland Street		99.05					99.05
Eastbourne		99.59			97.42		98.51
Exeter Roadside		98.55	98.87				98.71
Glazebury		98.60	98.60				98.60
High Muffles		96.97	96.15				96.56
Honiton		94.75					94.75
Horley		99.23					99.23
Hull Freetown		98.41	98.46		96.33	97.78	97.75
Hull Holderness Road		98.41		95.56			96.99
Ladybower		98.55	97.28			89.27	95.03

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	All
Leamington Spa		97.10	99.68	94.43	89.86		95.27
Leamington Spa Rugby Road		98.51		94.29	94.29		95.70
Leeds Centre	94.11	98.32	98.41	94.97	94.75	98.28	96.47
Leeds Headingley Kerbside		98.01		91.98	96.06		95.35
Leicester A594 Roadside		99.05		96.74			97.89
Leicester University		98.69	98.73		96.47		97.96
Leominster		82.84	83.47				83.15
Lincoln Canwick Road		99.37					99.37
Liverpool Speke		97.46	98.51	90.44	91.26	98.55	95.24
Lullington Heath		95.15	95.43			98.82	96.47
Luton A505 Roadside		94.57					94.57
Manchester Piccadilly		98.41	97.78		94.97	98.37	97.38
Manchester Sharston		98.41	98.41				98.41
Market Harborough		94.47	98.69				96.58
Middlesbrough		96.51	97.10	92.75	85.19	96.42	93.60
Newcastle Centre		98.55	98.60	94.61	94.57		96.58
Newcastle Cradlewell Roadside		0.00					0.00
Northampton Spring Park		98.37	98.51		92.48		96.45
Norwich Lakenfields		98.46	98.69	89.95	88.18		93.82
Nottingham Centre		98.60	98.69	94.11	95.79	98.41	97.12
Nottingham Western Boulevard		98.55		93.34			95.95
Oldbury Birmingham Road		85.10					85.10
Oxford Centre Roadside		95.15					95.15
Oxford St Ebbes		93.34		95.92	90.76		93.34
Plymouth Centre		98.64	98.87	93.03	95.15		96.42
Plymouth Tavistock Road		97.28					97.28
Portsmouth		99.64	57.65	76.22	48.41		70.48
Preston		97.69	98.28		91.39		95.79
Reading London Road		92.84		89.90			91.37
Reading New Town		98.46	98.64	96.56	91.26		96.23
Rochester Stoke		96.24	17.89	91.03	88.18	97.15	78.10
Salford Eccles		94.38		89.27	97.19		93.61
Saltash Callington Road				30.39	97.28		63.84
Sandy Roadside		98.91		1.49	1.49		33.97
Scunthorpe Town		98.28		67.80		98.37	88.15
Shaw Crompton Way		99.37					99.37
Sheffield Barnsley Road		96.65					96.65
Sheffield Devonshire Green		98.37	98.78	93.93	94.25		96.33
Sheffield Tinsley		94.25					94.25
Sibton			99.05				99.05
Southampton A33		98.91		88.04			93.48
Southampton Centre		98.55	98.51	83.92	96.65	92.21	93.97
Southend-on-Sea		95.61	98.23		98.05		97.30

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	All
St Helens Linkway		99.46		92.66			96.06
St Osyth		93.93	97.19				95.56
Stanford-le-Hope Roadside		99.37		78.67	81.57		86.53
Stockton-on-Tees A1305 Roadside		98.51			96.38		97.44
Stockton-on-Tees Eaglescliffe		98.28		96.01	96.74		97.01
Stoke-on-Trent A50 Roadside		98.37		97.74			98.05
Stoke-on-Trent Centre		98.64	97.92		85.10		93.89
Storrington Roadside		99.55					99.55
Sunderland Silksworth		81.79	98.96		90.40		90.38
Sunderland Wessington Way		77.63					77.63
Thurrock		93.12	92.03	89.86		90.35	91.34
Walsall Woodlands		99.41	98.78				99.09
Warrington		99.64		97.46	89.40		95.50
Weybourne			99.64				99.64
Wicken Fen		91.08	98.55			91.26	93.63
Widnes Milton Road		99.73					99.73
Wigan Centre		98.91	99.46		89.58		95.98
Wirral Tranmere		98.87	98.82		84.74		94.14
Worthing A27 Roadside		96.92					96.92
Yarner Wood		63.86	72.46				68.16
York Bootham		98.55		95.83	96.97		97.12
York Fishergate		92.48		85.91	74.95		84.45
Number of Stations	**1**	**99**	**49**	**43**	**49**	**15**	**103**
Number of stations < 85 %	**0**	**8**	**4**	**7**	**7**	**0**	**12**
Number of stations < 90%	**0**	**9**	**4**	**16**	**14**	**1**	**17**
Average	**94.11**	**94.19**	**94.82**	**85.80**	**88.13**	**95.84**	**91.52**

Barnstaple A39

During ratification, it was noticed that the sample dewpoints continued to show significant diurnal variation, probably due to inadequate temperature control within the enclosure. This could be seen in the mass data, and all data from both PM analysers have been deleted for the quarter.

Birmingham Acocks Green

The NOx analyser suffered from detector and pump faults during the quarter. Following service on 25th July, the analyser did not respond to calibration gas and further ESU attention was necessary.

Bury Whitefield Roadside

The PM_{10} FDMS suffered two periods of severe instability which were deleted during ratification.

Cannock A5190 Roadside

The analyser suffered a communications fault resulting in the loss of data from 7th to 31st August.

Carlisle Roadside

Following the zero test started on 11th July, a period of unstable PM_{10} data was observed; this was rectified at the service on 21st July.

Chatham Roadside

Some data were lost from both BAM instruments due to tape faults or breakages.

Chesterfield Loundsley Green

It was noticed during ratification that the NOx data had an odd diurnal profile, with highest concentrations at night. Investigation by the ESU found a leak in the NO_2 converter. Data from 1st April to 20th September have been deleted.

Ladybower

A lamp fault resulted in the loss of SO_2 data from 10th to 17th September.

Leamington Spa

A damaged v-seal resulted in the loss of $PM_{2.5}$ data from 28th July to 2nd August.

Leominster

A fire near the station damaged the power supply, and the site temporarily ceased operation on 18 September.

Middlesbrough

The $PM_{2.5}$ data were lost between 16th and 24th August due to a stuck valve motor.

Newcastle Cradlewell Roadside

As detailed in the Q1 and Q2 reports of this year, the analyser has not been operational since January. The analyser was returned to the workshop in February with a view to replacing the motherboard. Further investigation at the workshop identified that a burnt out component was the cause of the fault and as such the motherboard did not require replacement. The analyser was reinstalled in July; however, upon installation another serious fault was identified. The ESU confirmed that the analyser was now beyond economic repair. The Local Authority placed the order for a new analyser in September with a 6 to 8 week lead in time for delivery. An Environment Agency owned API analyser was offered to the station owners in September as a temporary solution, however, due to the already severe impact upon data capture this year and high cost for installation the local authority decided not to progress this option. A new analyser was finally installed on 31st October.

Norwich Lakenfields

The $PM_{2.5}$ FDMS suffered a seized valve motor from 27th to 31st July. A period of spurious and noisy PM_{10} data was deleted from 30th August to 5th September.

Oldbury Birmingham Road

The CMCU alerted the LSO to a change in NOx profile on 2nd August. The LSO attended and performed a calibration, but the data continued to be suspicious. A further visit on 15th August revealed the sample line was not connected to the analyser, and it had been internally sampling during this period. Data for the affected period were deleted.

Portsmouth

As reported in previous reports, the local authority-owned air conditioning was not working properly during the summer. The ozone analyser was turned off to avoid damage on 29th August following an ESU callout. The ESU for the ozone analyser refused to attend to it until the air conditioning was once again operational. The station temperature improved and the analyser was restarted on 6th October.

The temperature problems also caused intermittent loss of both $PM_{2.5}$ and PM_{10} FDMS analysers. However, following the zero tests on 31st August, the LSO was not available to remove the HEPA filters, and the ESU removed the PM_{10} filter on 13th September. Unfortunately, the ESU was unable to access the inlet cage, and so the $PM_{2.5}$ filter was not removed until return of the LSO on 27th September. A mass flow controller fault was found at this point, and the analyser was removed for workshop repair.

Reading London Road

A membrane fault resulted in the loss of PM_{10} data from 12th to 19th September.

Rochester Stoke

The ozone analyser was found to be reading very low at the summer audit. A lamp fault and a leak in the sample system resulted in the loss of ozone data from 10th May to 14th September. A slightly longer than usual zero test resulted in some loss of PM_{10} and $PM_{2.5}$ data.

Saltash Callington Road

The air conditioning system struggled to keep an even station temperature, and the cyclic sample dew points observed resulted in poor quality data which were deleted up to 1 September.

Sandy Roadside

Following failure of the air conditioning at the station on 26th May, the FDMS analysers remained switched off to avoid damage. These were switched back into service on 29th September.

Scunthorpe Town

The PM_{10} data became noisy in September, and was identified as a regional outlier during ratification. PM_{10} data from 5th-30th September have been deleted.

Southampton Centre

The PM_{10} data became noisy in September, and this was not addressed at the autumn service. A new mass transducer was fitted on 13th September, which improved data quality.

Stanford-le-Hope Roadside

Following failure of the air conditioning on 1st August, the FDMS analysers were switched off to avoid any damage. Monitoring was restored on 17th August.

Stoke-on-Trent Centre

Poor quality $PM_{2.5}$ data was observed around the audit in July, and an ESU callout found damaged valve seals. Data improved somewhat, but a further zero test was carried out.

Sunderland Silksworth

The sample inlet tube was not properly replaced following the QA/QC audit on 10th August. The ESU attended and failed to rectify the problem; this was spotted at the service on 22nd August; these data have been deleted between audit and service.

Sunderland Wessington Way

The air conditioning unit failed on 1st July; data have been deleted up to the replacement on 20th July.

Wirral Tranmere

The $PM_{2.5}$ data between the service on 14th July and the ESU callout on 24th July were deleted due to leaks in the sampling system.

Yarner Wood

The ozone analyser suffered a flow fault due to debris in the sample inlet. Data between 14th to 21st August were lost. At the replacement of the analysers on 29th September, damage to the sample inlet was found which exposed the sample tubes, so to avoid water ingress, the sample tubes (O_3 and NO_x) were disconnected from the analysers until repair on 2nd October.

York Fishergate

The air conditioning unit failed on 25th May and station operation was suspended until repair on 5th July. The PM_{10} FDMS lost its firmware whilst switched off and this was rectified on 7th July. Following drier replacement on 25th August, PM_{10} data were of poor quality, and when the ESU attended on 1st September, the part necessary for repair was not available. Correct operation resumed on 5th September.

4.3 Data Capture and Station-Specific Issues - Greater London

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

Table 4-3 Data Capture for Greater London, July-September 2017

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Average
Camden Kerbside		99.23		94.29	94.38		95.97
Ealing Horn Lane				88.18			88.18
Haringey Roadside		99.68					99.68
London Bexley		96.56			97.51		97.03
London Bloomsbury		96.51	96.65	91.85	92.48	71.47	89.79
London Eltham		99.23	99.32		92.44		97.00
London Haringey Priory Park South		99.64	99.73				99.68
London Harlington		99.46	85.96	99.64	99.64		96.17
London Harrow Stanmore					0.00		0.00
London Hillingdon		98.73	98.91				98.82
London Marylebone Road	12.68	98.87	96.47	95.34	96.69	98.96	83.17
London Marylebone Road (Partisol)				96.74	91.30		94.02
London N. Kensington	99.37	99.32	98.37	58.06	93.93	99.23	91.38
London Teddington Bushy Park					74.05		74.05
London Westminster		87.64			97.83		92.73
Southwark A2 Old Kent Road		99.64		92.26			95.95
Tower Hamlets Roadside		99.68					99.68
Number of Stations	**2**	**13**	**7**	**8**	**10**	**3**	**17**
Number of stations < 85 %	**1**	**0**	**0**	**1**	**2**	**1**	**3**
Number of stations < 90%	**1**	**1**	**1**	**2**	**2**	**1**	**6**
Average	**56.02**	**98.01**	**96.49**	**89.54**	**83.24**	**89.89**	**88.02**

The following station-specific issues were identified:

Ealing Horn Lane

The drier was replaced at the service on 6th September; however poor performance resulted in CMCU to request a further replacement on 11th September. Data from this period have been deleted.

London Bloomsbury

The station SO_2 analyser was removed for workshop repair on 27th July, and a hot spare installed on 31st July. This replacement analyser performed very poorly, with several callouts. The poor performance continued into Q4, with a detector failure in November. Data have been deleted from installation up to service on 16th August.

London Harlington

There were a number of lamp faults in the ozone analyser during the quarter.

London Harrow Stanmore

The station remains without mains power during adjacent building work.

London Marylebone Road

The recently replaced CO analyser continued to perform poorly during the quarter. It was removed for warranty repair on 8th August. Obtaining replacement parts took longer than expected, and a hot spare was eventually installed early in October.

London North Kensington

The local authority purchased a new drier, which has been installed on 6th July because of high baselines. A period of spuriously low data followed, and the drier was removed on 8th August when engineer reinstalled the old one. Another new drier was ordered and fitted on 25th September. Data from 6th July to 8th August, and 21st to 15th August (repeat zero check) have been deleted. Data up to 5th September have been rescaled.

London Teddington Bushy Park

The shuttle valve motor failed on 14th August, during the zero test. Following the service on 25th August, data were noisy, and were deleted from this service up to 17th September. A leaking drier was found by the engineer. Problems with the analyser persisted into Q4.

London Westminster

The NOx analyser was serviced on 24th August, but subsequent data were of poor quality and the ESU were issued with a further callout. Data up to 4th September have been deleted.

4.4 Data Capture and Station-Specific Issues – Wales

A summary of data capture for Wales for July-September 2017 is given in Table 4-4.

Table 4-4 Data Capture for Wales, July-September 2017

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Average
Aston Hill		98.55	94.75				96.65
Cardiff Centre	98.51	98.37	98.51	95.06	95.70	98.46	97.43
Chepstow A48		91.26		91.17	92.62		91.68
Cwmbran		88.09	97.46				92.78
Hafod-yr-ynys Roadside		98.41					98.41
Narberth		95.15	97.64	95.65		77.58	91.51
Newport		14.40		30.30	25.91		23.54
Port Talbot Margam (Partisol)				98.91			98.91
Port Talbot Margam	98.19	93.66	98.41	96.69	90.90	98.19	96.01
Swansea Roadside		97.87		88.68	88.22		91.59
Wrexham		97.42		93.48	94.57	94.93	95.10
Number of Stations	**2**	**10**	**5**	**8**	**6**	**4**	**11**
Number of stations < 85 %	**0**	**1**	**0**	**1**	**1**	**1**	**1**
Number of stations < 90%	**0**	**2**	**0**	**2**	**2**	**1**	**1**
Average	**98.35**	**87.32**	**97.36**	**86.24**	**81.32**	**92.29**	**88.51**

Cwmbran

The NOx analyser developed a pump fault on 8th September, which was repaired by the ESU on 18th September.

Narberth

A leaking sample inlet filter resulted in the loss of SO_2 at the start of July. The analyser performed poorly, with bad baseline drift, resulting in the loss of data from 23rd July to 10th August.

Newport

On 17th July CMCU requested the LSO call out their ESU to investigate a clear instrument response issue observed since 14th July. The ESU arrived on 19th July and rebuilt the sample pump. Satisfactory instrument performance was restored and CMCU deleted the data over this period. The pump failed again on 22nd July, and the ESU attended again on 25th July. After a few days satisfactory operation, drift in the analyser response resulted in a further callout on 4th August. The ESU were unable to repair on station, and removed it to the workshop. On arrival at the station to reinstall on 11th August, significant water ingress in the cabin was observed, and all equipment was removed to avoid damage. The problem remained unresolved as of 31st December.

Swansea Roadside

The zero test on the BAM analysers lasted from 1st to 12th August.

4.5 Data Capture and Station-Specific Issues – Scotland

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

Table 4-5 Data Capture for Scotland, July-September 2017

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Average
Aberdeen		96.15	96.83	94.02	94.57		95.39
Aberdeen Union Street Roadside		99.41					99.41
Aberdeen Wellington Road		99.23					99.23
Auchencorth Moss			98.69	96.56	92.80		96.01
Bush Estate		93.43	98.69				96.06
Dumbarton Roadside		27.94					27.94
Dumfries		99.18					99.18
Edinburgh St Leonards	98.28	98.46	98.51	92.21	94.02	98.51	96.66
Eskdalemuir		98.60	98.64				98.62
Fort William		94.16	98.73				96.44
Glasgow Great Western Road		97.78					97.78
Glasgow High Street		99.68		97.19	95.74		97.54
Glasgow Kerbside		98.37					98.37
Glasgow Townhead		97.60	98.69	96.20	96.24		97.18
Grangemouth		97.92		92.84	97.55	96.69	96.25
Grangemouth Moray		66.03					66.03
Greenock A8 Roadside		99.23					99.23
Inverness		89.31		98.91	98.91		95.71
Lerwick			99.59				99.59
Peebles		98.60	98.32				98.46
Strathvaich			87.95				87.95
Number of Stations	**1**	**18**	**10**	**7**	**7**	**2**	**21**
Number of stations < 85 %	**0**	**2**	**0**	**0**	**0**	**0**	**2**
Number of stations < 90%	**0**	**3**	**1**	**0**	**0**	**0**	**3**
Average	**98.28**	**91.73**	**97.46**	**95.42**	**95.69**	**97.60**	**92.34**

Dumbarton Roadside

The station air conditioning failed in July, and the analyser was switched off on 25th July. A replacement was obtained, but on restarting monitoring on 25th September, the LSO was unable to carry out calibrations due to a zero air regulator fault. The next valid calibration was not carried out until 30th November, and so significant data loss in Q4 is anticipated.

Grangemouth Moray

As reported in the previous quarterly report, problems with the air conditioning were observed in Q2 and Q3; the NOx analyser was turned off from 14th August to 8th September.

The analyser was removed for workshop repair following the service on 14th August, when smoke was observed coming from it. The analyser was subsequently deemed beyond economical repair, and a new EA funded analyser was installed on 8th September.

Inverness

Following suspicions regarding the NOx data since the installation of the new analyser on 29th August, CMCU called the LSO out on 7th September to investigate. The LSO reported that the instrument sample inlet was connected to the NOx gas cylinder rather than the sample inlet. The LSO reconnected the external sampling head tubing, performed a calibration check and left the instrument sampling.

Strathvaich

On 25th August, the station experienced power supply failure and on 29th August the LSO established that, despite replacement of a blown fuse, the instrument would not successfully reboot. An ESU call out was issued and on 4th September a station investigation resulted in replacement of the instrument power supply, and analyser satisfactory operation was restored.

4.6 Data Capture and Station-Specific Issues - Northern Ireland

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

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

Name	CO	NO_2	O_3	PM_{10}	PM_{25}	SO_2	Average
Mace Head			99.82				99.82
Armagh Roadside		94.66		94.20			94.43
Ballymena Antrim Road		97.01					97.01
Ballymena Ballykeel		98.82				95.34	97.08
Belfast Centre	97.28	98.23	98.46	87.50	95.02	98.41	95.82
Belfast Stockman's Lane		98.51		93.12			95.81
Derry Rosemount		96.15	98.87	73.51	89.36	85.55	88.69
Lough Navar			98.87	89.54			94.20
Number of Stations	**1**	**6**	**4**	**5**	**2**	**3**	**8**
Number of stations < 85 %	**0**	**0**	**0**	**1**	**0**	**0**	**0**
Number of stations < 90%	**0**	**0**	**0**	**3**	**1**	**1**	**1**
Average	**97.28**	**97.23**	**99.00**	**87.57**	**92.19**	**93.10**	**95.36**

Belfast Centre

Some PM_{10} data were lost 19th to 26th September due to leaks in the pipe connections. The SO_2 data are of poor quality and resulted in data loss in subsequent quarters.

Derry Rosemount

On 12th July CMCU requested the LSO and their affiliate ESU to investigate loss of communication with the FDMS following the installation of a new electricity meter on 11th July. The electrician had failed to reset the PM_{10} trip switch back to the correct position or notify CMCU of works being completed at the station. On 13th July the LSO reset the switch to the correct position and monitoring was restored. Following a callout for noisy data on 31st July, the LSO found the air conditioning was switched off; data from 28th to 31st July have been deleted. Further data were lost 3rd to 16th September due to water ingress casing damage to the shuttle valve.

A period of extremely noisy $PM_{2.5}$ data were deleted between 28th July to 2nd August.

The SO_2 analyser continued to perform poorly during this quarter. The baseline drifted so rapidly that daily processing adjustment resulted in an unusual profile. The data remain provisional pending investigations.

Lough Navar

A suspected power interruption resulted in the loss of data from 7th to 10th July; on restart a fault with the pump resulted in further data loss.

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 QA/QC 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 QA/QC criteria are required to meet the data quality objectives. This may require review and revision of historic calibration data by applying the new criteria.

Details of changes made during July to September 2017, to data previously ratified, are shown in Table 5-1.

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

Monitoring Station	Pollutant(s)	Dates	Nature of Change
Aberdeen Wellington Road	NOx	25th May to beginning of Q3	Reprocessing of NOx zero baseline.
Belfast Centre	PM_{10}, $PM_{2.5}$	9th Mar - 5th May (PM_{10}) and 15th May into Q3 ($PM_{2.5}$).	Reject PM_{10} from 9th Mar to 5th May – volatiles outlier. Baseline correction required for $PM_{2.5}$ of +4.6 µg m^{-3} from 15th May to end of Q2 and into Q3.
Bush Estate	NOx	All Q2, back into Q1.	Reprocess Q2 zero baseline and sensitivity.
Carlisle Roadside	NOx	All Q1 and Q2	Incorrect units on calibration sheet (zero sometimes reported in ppm rather than ppb). The analyser is a Monitor Labs (displays in ppm) and LSO needs to be consistent. To remove and re-enter the

Monitoring Station	Pollutant(s)	Dates	Nature of Change
			calibrations from Q1 2017 for whole year. Reprocess baselines and sensitivity.
Eastbourne	NOx	Q1-Q2	Missing calibrations (LSO has been unavailable for some time). To reprocess if and when we get these (review with Q4).
Edinburgh St Leonards	NOx	Q1-Q2	To check and possibly reprocess Q1 and Q2.
Glasgow Great Western Road	NOx	Q1-Q2	To check and possibly reprocess Q1 and Q2.
Glasgow High Street	NOx	Q1-Q2	To check and possibly reprocess Q1 and Q2. (Done.)
Grangemouth	PM_{10}	1st May to end Q2	Zero baseline adjustment of 4.6 µg m^{-3} or 4.2 µg m^{-3} applied to PM_{10} from 1st May (gap) to 28th Jul.
Greenock A8 Roadside	NOx	Q2	Applied cylinder rescale to NO between 17th May and 20th Jul.
Honiton	NOx	Final few days of Q2	Reprocess.
Ladybower	SO_2	All Q2	Reprocess.
Leeds Centre	PM_{10}	2nd Mar – 13th Jul	Zero baseline adjustment of 3.6 µg m^{-3}.
Leeds Headingley Kerbside	$PM_{2.5}$	1st Apr – 21st Jul	Zero baseline adjustment of 4.2 µg m^{-3}.
Leominster	NOx	Q2	Reprocessing of NOx scaling.
Liverpool Speke	NOx & SO_2	Q2	Adjustment of processing.
Portsmouth	O_3	From spring audit on 30th Mar to end of Q2 (30th Jun).	Ramped rescale between spring audit on 30th Mar and summer audit on 31st Aug.
Reading New Town	NOx & O_3	Q2	Reprocessing of zero baseline in Q2.
Rochester Stoke	O_3	Mid May to end of Q2 and into Q3.	(Outlier at summer 17 audit.) To delete data from mid- May to 14th Sep (ESU call-out).
Sibton	O_3	Q2	Review and reprocess Q2.
Southend	NOx	Q2	Reprocess, having received LSO calibration records that were previously missing.
Thurrock	NOx	Q2	Zero baseline needs slight amendment.
Warrington	NOx	End of June	Amendment to processing at end of Q2.

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:

Table 6-1 Summary of "High" Risk Station Safety Status Incidents, July – September 2017

Station	Risk	Date went to 'High'	Date resolved
Newport	Water ingress through fragile roof.	11/08/2017	Not resolved at time of writing
Leominster	Fire very close by. Power supply off and no access until further notice.	18/09/2017	w/c 13/11/2017

7 Equipment Upgrade Requirements

The SO_2 analysers at Derry Rosemount and Belfast Centre show excessive baseline drift, and consideration should be given to replacement.

8 Station Infrastructure Issues

As reported in section 6, the cabin at Newport requires refurbishment or replacement.

9 Conclusions

1. During Quarter 3 of 2017 there was a total of 158 AURN monitoring stations in operation. Two sites have collocated Partisols treated as separate sites
2. Data ratification for this quarter was completed by the deadline of 31st December 2017.
3. Ratified hourly average data capture for the network averaged 91.22% for all pollutants (O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$) during the 3-month reporting period July-September 2017. Average data capture for all pollutants were above 85%. There were 18 stations with data capture less than 85% for the period (28 below 90%). 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%.
4. During this quarter, the summer 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.
5. The uncertainty of measurement for each analyser has been determined to ensure compliance with the Data Quality Objective. Ten analysers were found to be outside the required uncertainty. The most common cause of this is noisy response as measured during the audit. This usually indicates poor instrument performance; such cases are reviewed at the Quality Circle to assess the impact on reported data, and may be reported to CMCU and ESUs prior to service to ensure the necessary repair procedures are carried out by the engineer reducing the chance of the recurrence in the next quarter.

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