QAQC Report for the Automatic Urban and Rural Network, Jan-Mar 2015

Report for Defra and the Devolved Administrations
Defra contract number 21316

ED 60071201_2015Q1 | Issue 1 | Date 25/09/2015

Customer:

Defra and the Devolved Administrations

Customer reference:

21316

Confidentiality, copyright & reproduction:

This report is the Copyright of Defra and the Devolved Administrations. It has been prepared by Ricardo Energy & Environment, a trading name of Ricardo-AEA Ltd, under contract to Defra and the Devolved Administrations dated 01/04/2015. The contents of this report may not be reproduced in whole or in part, nor passed to any organisation or person without the specific prior written permission of Defra and the Devolved Administrations. Ricardo Energy & Environment accepts no liability whatsoever to any third party for any loss or damage arising from any interpretation or use of the information contained in this report, or reliance on any views expressed therein.

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-AEA Ltd is certificated to ISO9001 and ISO14001

Author:

Stewart Eaton

Approved By:

Alison Loader

Date:

25 September 2015

Ricardo Energy & Environment reference:

Ref: ED60071201_2015Q1- Issue 1

Executive summary

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

Ratified hourly average data capture for the network averaged 91.43% for all pollutants (O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$) during the 3-month reporting period January-March 2015. Average data capture for all pollutants were above 85%. There were 19 stations with data capture less than 85% for the period (33 below 90%).

A total of 147 monitoring stations in the AURN operated during this quarter, of which 74 were Local Authority owned stations affiliated to the national network. Some are co-located and separately named gravimetric particulate analysers at stations with automatic analysers. Many affiliated stations have additional Defra-funded analysers installed on site.

During this quarter, the winter 2015 intercalibration exercise has been carried out, involving carrying out comprehensive performance tests and accredited calibrations of every station 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 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.

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 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 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, 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, http://uk-air.defra.gov.uk/) and other media such as teletext 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 147 monitoring stations in the AURN operated during this quarter. Some of these are co-located and separately-named gravimetric particulate analysers at stations with automatic analysers. Many affiliated stations have additional Defra-funded analysers installed on station.

The main reasons for 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.

1.2 What this report covers

This report covers the three-month period January to March 2015, or "Quarter 1" 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.

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 LSO Manual, QA/QC audit and ESU service schedules, CMCU reports and supporting information.
- UK-AIR, www.uk-air.defra.gov which contains information on individual stations along with real-time hourly data, graphs and statistics.

1.4 Changes to the Network during this Quarter

The following changes were made to the network during the period January-March 2015:

Table 1.1 New Stations Commissioned January-March 2015

Station	Pollutants	Date commissioned
Stockton on Tees A1305 Roadside	NO_2	1 January 2015
Hull Holderness Road	NO_2	15 January 2015
Sunderland Wessington Way	NO_2	15 January 2015
Glasgow High Street	NO_2 $PM_{2.5}$ PM_{10}	5 February 2015
Widnes Milton Road (affiliate)	NO_2	10 March 2015
Luton A505 Roadside	NO_2	1 March 2015
Bury Whitefield Roadside (affiliate)	NO_2 PM_{10}	1 March 2015
Chesterfield Loundsley Green	NO_2 $PM_{2.5}$ PM_{10}	1 March 2015

The PM_{10} analysers at Hull Freetown and Stoke-on-Trent Centre were removed for installation at the new Hull and Stoke stations respectively. In addition, the $PM_{2.5}$ and PM_{10} analysers from Glasgow Kerbside were relocated to the new Glasgow High Street station. The data for Widnes Milton Road will be held over and ratified with the April-June data.

2 Methodology

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.

2.1 Winter Intercalibration, Jan-Mar 2015

2.1.1 Overview of Winter Intercalibration

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

2.1.2 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}. The test is equally valid for BAM instruments, and thus the tests are also carried out on these.

2.2 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, (Ricardo Energy & Environment's air quality data management system) the process of data ratification begins. This process is required to refine data scaling based on all the calibration and audit data available, and to identify, withdraw or flag anomalous data due to instrument or sampling faults or where data fall outside the Uncertainties or Limits of Detection defined by the Data Quality Objectives (**DQOs**) of Directive 2008/50/EC (the Air Quality Directive) and the European Union's Implementing Provisions for Reporting.

3 Intercalibration Results

3.1 National Network Overview

During January to March 2015, Ricardo Energy & Environment undertook an intercalibration of 142 monitoring stations in operation in the Defra and the Devolved Administrations Automatic Urban and Rural Monitoring Network. The intercalibration exercise is a vital step in the process of data ratification. The audits are used to undertake a number of analyser and infrastructure performance checks that cannot be performed by Local Station Operators, with a view to ensuring confidence in the accuracy, consistency and traceability of air pollution measurements made at all the monitoring stations.

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 service 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.

Once all data have been collected, a "Network Intercomparison" 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 intercomparison results is broadly as follows:

- The analyser responses to audit gas are converted into concentrations, using provisional calibration factors obtained from the Management Units on the day of the intercalibration. These factors are also used for the provisional data supplied to the web/interactive TV services.
- These individual results are tabulated, and statistical analyses undertaken (e.g. network average result, network standard deviation, deviation of individual 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 ko 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.

The results of the intercalibration are summarised in Table 3.1 below:

Table 3.1 Summary of Intercomparison, Winter 2015

Parameter	Number of outliers	Number in network	% outliers in total
NOx analyser	29	126	23 (20)%
CO analyser	0	7	0%
SO_2 analyser	6	30	20 (20)%
Ozone analyser	13	83	16 (26)%
FDMS and BAM analysers	1 k_0, 6 flow, (12 zero)	62 FDMS PM_{10} 3 BAM PM_{10} 69 FDMS $PM_{2.5}$ 2 BAM $PM_{2.5}$	5 (8)%
Gravimetric PM analysers	1 flow	8 PM_{10} 9 $PM_{2.5}$	6%
Total	56	399	14.0%

Two stations were not in operation at the time of the intercalibration. A replacement location is currently being prepared for the Chesterfield station. The station at Southwark A2 Old Kent Road is currently suspended pending repair of the air conditioning unit.

There are currently no gravimetric measurements of PM_{10} or $PM_{2.5}$ at either of the Glasgow monitoring stations.

The number of analyser outliers identified is better than the previous exercise. At the summer 2014 intercalibration 16.3% of the analysers in use were identified as outliers.

The procedures used to determine network performance are documented in Ricardo Energy & Environment Work Instructions. These methods are regularly updated and improved and are evaluated by the United Kingdom Accreditation Service (UKAS). Ricardo Energy & Environment holds ISO17025 accreditation for the on-station calibration of all the analyser types (NOx, CO, SO_2, O_3) and for the determination of the FDMS k_0 factor and particulate analyser flow rates used in the network. An ISO17025 certificate of calibration (Calibration Laboratory number 0401) for the analysers in the AURN presented on the AURN Hub.

3.2 Network Intercomparisons

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	Audit reference concentration	Network Accuracy %	%Std Dev
NO	487 ppb	488 ppb	-0.2	4.2
NO_2	483 ppb	495 ppb	-2.5	4.5
CO	21.1 ppm	20.7 ppm	2.0	5.5
SO_2	459 ppb	452 ppb	1.6	4.9

- Oxides of Nitrogen.

  A total of 29 outliers (23%) were identified during this intercalibration. This is worse than the previous exercise - 20% of the analysers were identified as outliers in the summer exercise. Of these outliers, 17 can be attributed to analyser drift, five to changes in station cylinder concentration, four due to scaling factors and zeros received from the management units and two to issues experienced during the audit which compromised the results. There is a number of different of logger types in use at one station (Scunthorpe Town) which meant that the audit and previous LSO calibrations were recorded using different systems. All of the above outliers can be corrected with no data loss or impact on data quality.

  There were no converters which fell outside the ±5% acceptance limits. There were four converters identified where the initial result was outside the ±2% trigger for NO_2 rescaling. Additional analysis showed that a total of three of these outlier converters required rescaling to be undertaken.

- Carbon Monoxide

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

- Sulphur Dioxide

  A total of six outliers (20%) were identified at this intercalibration. This is the same as the summer exercise. All m-xylene interference tests were less than 24 ppb, compared to 21 ppb in summer 2014.

- Ozone

  A total of 13 outliers (16%) were identified during the winter exercise. This is better than the previous intercalibration, where 21 analysers were found to be outside the ± 5% acceptance criterion.

- Particulate Analysers

  There was a single calculated k_0 determination outside the required ± 2.5% of the stated values. This is the same as the previous exercise.

Four FDMS main flows were found to be outside the ±10% acceptance limits. Two BAM total flows were found to be outside this limit. This total is better than the previous exercise; a total of ten analyser flow outliers were identified in the summer.

A single Partisol analyser total flow was outside the acceptance limits. This is the same as the previous exercise.

- PM analyser zero tests

  A total of 12 analysers gave average responses to particle-free air that were higher than ± 3 µg/m^3. This is better than the previous exercise, where 17 responses were higher than 3 µg/m^3. These results will be fed into the ratification process to determine appropriate action.

- Station Cylinder Concentrations

  Five of the 163 station cylinders (3.1%) used to scale ambient pollution data were found to be outside the ±10% acceptance limit.

3.2.1 English Stations

The results of the intercalibration for the 86 English stations are summarised in Table 3.3 below:

Table 3.3 Summary of audited analyser performance – English Stations

Parameter	Number of outliers	Number in region
NOx analyser	23	76
NOx converter	2	
CO analyser	0	1
SO_2 analyser	5	16
Ozone analyser	8	53
FDMS and BAM analysers	0 k_0, 2 flow (11 zero)	37 FDMS PM_{10} 1 BAM PM_{10} 46 FDMS $PM_{2.5}$ 1 BAM $PM_{2.5}$
Gravimetric PM analysers	1	1 PM_{10} 4 $PM_{2.5}$
Cylinders	9	191

As noted earlier, the results from the intercalibration exercises are used to inform the entire data ratification process. Any actions required as a result of the intercalibration findings are discussed in the ratification section of this report.

3.2.2 London Stations

The results of the intercomparison for the 15 London stations in operation at the time of the intercalibration are summarised below:

Table 3.4 Summary of audited analyser performance – London Stations

Parameter	Number of outliers	Number in region
NOx analyser	4	12
NOx converter	2	
CO analyser	0	3
SO_2 analyser	0	4
Ozone analyser	2	9
FDMS and BAM analysers	1 k_0, 0 flow (2 zero)	5 FDMS PM_{10} 10 FDMS $PM_{2.5}$
Gravimetric PM analysers	0	2 PM_{10} 3 $PM_{2.5}$
Cylinders	0	35

3.2.3 Scottish Stations

The results of the intercomparison for the 18 Scottish stations are summarised below:

Table 3.5 Summary of audited analyser performance – Scottish Stations

Parameter	Number of outliers	Number in region
NOx analyser	1	14
NOx converter	0	
CO analyser	0	2
SO_2 analyser	0	3
Ozone analyser	1	10
FDMS and BAM analysers	0 k_0, 2 flow (3 zero)	6 FDMS PM_{10} 6 FDMS $PM_{2.5}$
Gravimetric PM analysers	0	4 PM_{10} 4 $PM_{2.5}$
Cylinders	2	33

3.2.4 Welsh Stations

The results of the intercomparison for the 10 Welsh stations are summarised below:

Table 3.6 Summary of audited analyser performance – Welsh Stations

Parameter	Number of outliers	Number in region
NOx analyser	1	10
NOx converter	0	
CO analyser	0	2
SO_2 analyser	1	4
Ozone analyser	0	6
FDMS and BAM analysers	0 k_0, 2 flow (1 zero)	5 FDMS PM_{10} 1 BAM PM_{10} 3 FDMS $PM_{2.5}$ 1 BAM $PM_{2.5}$
Gravimetric PM analysers	1	2 PM_{10} 1 $PM_{2.5}$
Cylinders	1	26

3.2.5 Northern Ireland Stations (plus Mace Head)

The results of the intercomparison for the five Northern Irish stations and Mace Head (in the Republic of Ireland) are summarised in Table 3.7 below:

Table 3.7 Summary of audited analyser performance – Northern Irish Stations

Parameter	Number of outliers	Number in region
NOx analyser	0	3
NOx converter	0	
CO analyser	0	1
SO_2 analyser	0	3
Ozone analyser	2	4
FDMS and BAM analysers	0 k_0, 0 flow (0 zero)	4 FDMS PM_{10} 1 FDMS $PM_{2.5}$
Gravimetric PM analysers	0	0 PM_{10} 0 $PM_{2.5}$
Cylinders	0	9

3.2 Results of Station Cylinder Concentration Tests

During the intercalibration, the concentrations of the on-station cylinders were evaluated using the audit cylinder standards. The calculated results showed that five of the 163 (3.1%) cylinders (6.1%) used to scale analyser data into concentrations (NO, CO and SO_2) were outside the ±10% acceptance criterion. This is worse than the winter exercise, where 6.1% (14) of the scaling cylinders were outside the acceptance limits. There were two NO, two SO_2 and one CO cylinders identified as outliers.

One SO_2 cylinder (Leeds Centre) has been replaced, the remaining SO_2 and NO cylinders will be examined at the next audit to determine whether replacement is required. Data will be rescaled during ratification as appropriate.

The result for the CO cylinder (Edinburgh) is thought to have arisen as a result of instrument pressurisation and no remedial action has been taken. The performance of the cylinder and calibration system will be investigated at the next audit.

3.3 Calculations of Measurement 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 are compliant. Older, non-compliant equipment still on station 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 intercomparisons have been fully compliant with the CEN protocols since January 2006.

To comply with the Directive, the uncertainty for gaseous analyser measurements must be less than ± 15%. For 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 Table 3.8 below:

Table 3.8 Analyser measurement uncertainties

Date	Station	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
12-Feb	Barnsley Gawber	8.3		11.8	9.8		
16-Jan	Barnstaple A39					8.7	16.4
12-Jan	Bath Roadside				13.0		
20-Jan	Billingham				10.9		
19-Jan	Birmingham Acocks Green	11.2			12.2		16.4
20-Jan	Birmingham Tyburn	7.3		13.9	13.1	8.7	16.4
20-Jan	Birmingham Tyburn Roadside	11.2			12.6	8.7	16.4
15-Jan	Blackburn Accrington Road				11.3		
15-Jan	Blackpool Marton	9.4			9.8		
25-Feb	Bottesford	8.3					
25-Feb	Bournemouth	11.2			12.6		
28-Jan	Brighton Preston Park	4.0			11.2		
13-Jan	Bristol St Paul's	11.2			12.4	8.7	16.4
25-Feb	Bury Whitefield Roadside				13.7	8.7	16.4
04-Feb	Cambridge Roadside				11.4		
03-Dec	Cannock Watling Street				12.3		
12-Feb	Canterbury	11.2			13.5		
27-Feb	Carlisle Roadside				11.9	8.7	16.4
17-Feb	Charlton Mackrell	10.4			11.1		
12-Feb	Chatham Centre Roadside				12.6	8.7	16.4
-	Chesterfield	Station not operational					
11-Feb	Chesterfield Roadside				11.5	8.7	16.4

Date	Station	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
17-Feb	Coventry Allesley	8.3			9.9		16.4
27-Jan	Eastbourne				12.7	8.7	
15-Jan	Exeter Roadside	7.3			13.3		
14-Jan	Great Dun Fell	11.2					
15-Jan	Glazebury	11.2			12.2		
29-Jan	Harwell	11.2		10.0	10.9	8.7	16.4
12-Feb	High Muffles	11.2			10.9		
15-Jan	Honiton				13.0		
26-Jan	Horley				12.7		
14-Jan	Hull Freetown	10.0		12.1	11.7		16.4
15-Jan	Hull Holderness Road				12.2	8.7	
10-Feb	Ladybower	11.2		9.0	11.1		
26-Feb	Leamington Spa	10.6			12.9	8.7	16.4
26-Feb	Leamington Spa Rugby Road				12.2	8.7	16.4
12-Jan	Leeds Centre	8.4	7.5	11.8	9.8	8.7	16.4
12-Jan	Leeds Headingley Kerbside				12.2	8.7	16.4
18-Feb	Leicester University	8.3			10.8		16.4
09-Feb	Leominster	11.2			12.2		
24-Feb	Lincoln Canwick Road				12.3		
07-Jan	Liverpool Queen's Drive Roadside				12.2		
06-Jan	Liverpool Speke	8.3		11.8	9.8	8.7	16.4
27-Jan	Lullington Heath	11.2		10.6	11.4		
13-Jan	Manchester Piccadilly	8.3		10.0	12.2	9.3	16.4
13-Jan	Manchester South	11.3		10.0	12.2		
19-Feb	Market Harborough	8.3			9.8		
21-Jan	Middlesbrough	11.2		10.4	10.9	8.7	16.4
19-Jan	Newcastle Centre	8.3			10.2		
19-Jan	Newcastle Cradlewell Roadside				11.9		

Date	Station	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
16-Feb	Northampton Kingsthorpe	7.2			13.2		
03-Feb	Norwich Lakenfields	8.3			11.1	8.7	16.4
25-Feb	Nottingham Centre	8.3		10.5	11.6	8.7	16.4
21-Jan	Oldbury Birmingham Road				13.4		
23-Feb	Oxford Centre Roadside				14.3		
23-Feb	Oxford St Ebbes	10.8			13.9	8.7	16.4
14-Jan	Plymouth Centre	8.3			10.8	11.2	16.4
24-Feb	Portsmouth	8.3			13.3	8.7	16.4
16-Jan	Preston	8.3			10.7		
16-Feb	Reading New Town	8.3			10.4	8.7	16.4
19-Feb	Rochester Stoke			11.1	12.2	8.7	16.4
12-Jan	Salford Eccles	10.6			13.2	8.7	16.4
14-Jan	Saltash Callington Road					8.7	16.4
02-Feb	Sandy Roadside				13.3	8.7	16.4
14-Jan	Scunthorpe Town			3.9	11.1	8.7	
14-Jan	Shaw Crompton Way				13.1	9.3	
11-Feb	Sheffield Devonshire Green	8.3			9.8	8.7	16.4
11-Feb	Sheffield Tinsley				10.9		
04-Feb	Sibton	11.2					
23-Feb	Southampton Centre	8.3		10.1	15.5	8.7	16.4
10-Feb	Southend-on-Sea	8.3			11.9		16.4
-	Southwark A2 Old Kent Road	Station not operational					
09-Feb	St Osyth	8.3			9.8		
11-Feb	Stanford-le-Hope Roadside				12.3	8.7	16.4
21-Jan	Stockton-on-Tees A1305				12.2		
20-Jan	Stockton-on-Tees Eaglescliffe				12.2	9.3	12.6

Date	Station	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
22-Jan	Stoke-on-Trent Centre	8.3			11.6	8.7	16.4
28-Jan	Storrington Roadside				11.2	8.7	16.4
20-Jan	Sunderland Silksworth	11.2			11.6		16.4
19-Jan	Sunderland Wessington Way				12.2		
11-Feb	Thurrock	11.2		10.2	12.2	38.4	
21-Jan	Walsall Woodlands	11.2			12.8		
07-Jan	Warrington			6.5	16.0	8.7	16.4
03-Feb	Weybourne	8.3					
22-Dec	Wicken Fen	11.2		10.5	11.2		
08-Jan	Wigan Centre	8.3			16.5		16.4
06-Jan	Wirral Tranmere	8.3			9.8		16.4
18-Feb	Yarner Wood	11.2			11.0		
13-Jan	York Bootham					10.3	16.4
13-Jan	York Fishergate				11.6	8.7	16.4
20-Feb	Armagh Roadside				11.2	8.7	
17-Feb	Ballymena Ballykeel			6.2		8.7	
24-Feb	Belfast Centre	8.3	7.5	10.2	11.5	8.7	16.4
23-Feb	Belfast Stockman's Lane				11.1	9.3	
18-Feb	Derry	11.6		10.0	12.3	11.2	16.4
19-Feb	Lough Navar	12.3				8.7	
26-Feb	Mace Head						
18-Feb	Camden Kerbside				15.0	8.7	16.4
09-Feb	Ealing Horn Lane					8.7	
17-Feb	Haringey Roadside				15.1		16.4
10-Feb	London Bexley			10.0	12.2		16.4
05-Feb	London Bloomsbury	11.2		11.4	12.3	8.7	16.4
13-Feb	London Eltham	10.4			12.8		
17-Feb	London Haringey Priory Park South	12.0			14.0		
30-Jan	London Harlington	11.2			14.8	8.7	16.4

Date	Station	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
26-Feb	London Harrow Stanmore						16.4
30-Jan	London Hillingdon	8.3			9.9		
26-Jan	London Marylebone Road	11.2		10.4	15.1	8.7	16.4
27-Jan	London N. Kensington	11.3	7.5	12.0	13.5	8.7	16.4
19-Feb	London Teddington Bushy Park					9.1	16.4
19-Feb	London Teddington	11.2			12.4		
03-Feb	London Westminster	11.2			11.1		
09-Feb	Tower Hamlets Roadside				22.0		
21-Jan	Aberdeen	4.9			11.3	8.7	16.4
22-Jan	Aberdeen Union Street Roadside				12.3		
28-Jan	Auchencorth Moss	11.2				14.2	16.4
28-Jan	Bush Estate	11.2			12.2		
03-Feb	Dumbarton Roadside				11.1		
27-Feb	Dumfries				10.9		
27-Jan	Edinburgh St Leonards	11.7	8.7	10.2	12.2	8.8	16.4
13-Jan	Eskdalemuir	11.2			12.6		
04-Feb	Fort William				12.2		
03-Feb	Glasgow Great Western Road				12.2		
20-Jan	Glasgow High Street				12.2	8.7	16.4
05-Feb	Glasgow Kerbside				9.8		
19-Dec	Glasgow Kerbside					8.7	16.4
05-Feb	Glasgow Townhead	8.3			11.0	8.7	16.4
26-Jan	Grangemouth Moray				11.1		
26-Jan	Grangemouth			5.4	11.3	8.7	16.4
23-Jan	Inverness				12.3		
29-Jan	Peebles	11.2			12.2		
09-Feb	Aston Hill	11.2			12.2		

Date	Station	O_3	CO	SO_2	NO_2	PM_{10}	$PM_{2.5}$
23-Jan	Chepstow A48				12.5	8.7	16.4
22-Jan	Cwmbran	8.4			16.7		
21-Jan	Hafod-yr-ynys Roadside				12.2		
19-Jan	Narberth			10.7	11.0	8.7	
22-Jan	Newport				29.6	8.7	16.4
20-Jan	Port Talbot Margam	8.3	13.5	11.6	10.0	8.7	16.4
20-Jan	Swansea Roadside				17.9	9.3	99.1
05-Jan	Wrexham			8.7	11.0		

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

The poor measurement uncertainty reported for the NOx analysers at Cwmbran, Newport, Southampton, Swansea, Tower Hamlets, Warrington and Wigan were all due to significant instrument noise recorded during the audit

The poor measurement uncertainties for Thurrock PM_{10} and Swansea Roadside $PM_{2.5}$ arose as a result of the very low measured instrument flow rates at the audit. The significance of this will be examined fully during ratification.

The ozone analyser at Mace Head is not a CEN compliant model and therefore no performance data have been calculated.

3.4 Certification

The Network Certificate of Calibration is available on the AURN Hub. 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.

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 2015 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 2015

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Number of stations	7	72	79	125	79	28	145
Number of stations < 85 %	1	17	13	12	3	4	19
Number of stations < 90%	1	27	23	16	5	4	33
Network mean	**91.27**	**85.06**	**88.44**	**93.22**	**96.57**	**94.56**	**91.43**

4.1.2 Generic Data Quality Issues

During the ratification of this quarter's data, it was noticed that for two stations, Cambridge Roadside and Exeter Roadside, that the stated times of audits and calibrations did not exactly match the gaps in the data received from CMCU. On investigation, both stations were found to have external data loggers rather than on-board logging of data, and the clock time for the logger was incorrect, around one hour for Cambridge and 2½ hours for Exeter. The QA/QC unit have corrected the time stamps on these datasets, and the data reported as ratified (following some delay). It is noted that at Horiba-equipped stations (such as Exeter Roadside), the QA/QC unit is not able to see the logger clock (there is no display) and it is strongly recommended that the CMCU provide evidence to the QA/QC unit that these stations are within the maximum expected 15-minute error.

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

A summary of data capture for England for January-March 2015 is given in Table 4.2:

Table 4.2 Data Capture for England, January-March 2015

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Barnsley Gawber				97.92	98.33	97.92	98.06
Barnstaple A39		86.34	94.54				90.44
Bath Roadside				98.15			98.15
Billingham				85.46			85.46
Birmingham Acocks Green			95.79	96.57	98.52		96.96
Birmingham Tyburn		96.06	88.24	99.49	99.77	81.57	93.03

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Birmingham Tyburn Roadside		93.06	94.58	93.84	98.29		94.94
Blackburn Accrington Road				97.36			97.36
Blackpool Marton			60.93	98.52	98.70		86.05
Bottesford					99.54		99.54
Bournemouth			98.89	98.47	98.66		98.57
Brighton Preston Park			90.00	98.10	98.19		97.98
Bristol St Paul's		90.79	90.93	98.19	98.52		94.61
Bury Whitefield Roadside		60.65		0.00			23.98
Cambridge Roadside				93.94			93.94
Canterbury				98.43	99.21		98.82
Carlisle Roadside		87.59	87.41	79.72			84.91
Charlton Mackrell				97.69	99.68		98.68
Chatham Centre Roadside		91.94	92.92	86.06			90.31
Chesterfield Loundsley Green		0.00	0.00	0.00			0.00
Chesterfield Roadside		96.25	95.51	97.41			96.39
Coventry Allesley			95.05	98.19	93.98		95.74
Eastbourne		72.78	11.16	98.24			60.73
Exeter Roadside				99.40	93.56		96.48
Glazebury				97.82	96.99		97.41
Great Dun Fell					99.63		99.63
Harwell		85.46	92.18	96.76	97.45	97.13	93.80
Harwell (Partisol)		98.89	97.78				98.33
High Muffles				95.60	96.30		95.95
Honiton				98.52			98.52
Horley				99.40			99.40
Hull Freetown			82.45	96.06	97.27	96.30	91.77
Hull Holderness Road		84.44		95.42			89.93
Ladybower				98.61	98.52	98.61	98.58
Leamington Spa		93.61	93.70	95.00	99.49		95.45

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Leamington Spa Rugby Road		94.35	91.76	98.47			94.86
Leeds Centre	97.04	93.89	93.94	96.99	96.34	97.13	95.89
Leeds Headingley Kerbside		95.05	78.33	98.66			90.68
Leicester University			95.23	98.43	98.56		97.41
Leominster				97.82	97.82		97.82
Lincoln Canwick Road				99.49			99.49
Liverpool Queen's Drive Roadside				97.64			97.64
Liverpool Speke		86.44	90.51	97.08	97.31	97.45	93.76
Lullington Heath				95.79	98.75	98.66	97.73
Manchester Piccadilly			92.36	96.90	97.55	82.36	92.29
Manchester South				98.33	98.61		98.47
Market Harborough				94.07	98.38		96.23
Middlesbrough		91.85	91.25	96.99	97.50	75.19	90.56
Newcastle Centre		93.66	92.69	96.90	96.94		95.05
Newcastle Cradlewell Roadside				27.22			27.22
Northampton Kingsthorpe			97.78	97.87	99.44		98.64
Norwich Lakenfields		95.19	57.64	40.60	98.56		73.00
Nottingham Centre		77.27	93.89	99.58	99.49	98.98	93.84
Oldbury Birmingham Road				98.29			98.29
Oxford Centre Roadside				98.80			98.80
Oxford St Ebbes		96.30	96.30	97.78			96.79
Plymouth Centre		95.46	88.43	98.24	97.45		94.90
Portsmouth		71.85	94.40	78.56	98.75		85.89
Preston			92.45	98.33	98.56		96.45
Reading New Town		95.05	94.49	98.33	98.47		96.59
Rochester Stoke		86.53	89.72	98.47	97.04	98.56	94.06
Salford Eccles		96.06	95.93	98.19			96.73
Saltash Callington Road		96.85	97.04				96.94
Sandy Roadside		73.15	96.30	99.72			89.72

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Scunthorpe Town		75.19		97.82		97.87	90.29
Shaw Crompton Way		99.68		98.24			98.96
Sheffield Devonshire Green		66.06	55.46	71.34	96.57		72.36
Sheffield Tinsley				98.29			98.29
Sibton					99.58		99.58
Southampton Centre		72.45	72.41	92.96	97.04	97.13	86.40
Southend-on-Sea			95.32	99.17	99.17		97.89
St Osyth				93.15	91.99		92.57
Stanford-le-Hope Roadside		97.13	93.33	99.17			96.54
Stockton on Tees A1035 Roadside				98.98			98.98
Stockton-on-Tees Eaglescliffe		92.96	93.15	96.20			94.10
Stoke-on-Trent Centre		55.42	88.75	98.66	99.81		85.66
Storrington Roadside		89.44	89.35	57.50			78.77
Sunderland Silksworth			96.02	94.35	99.49		96.62
Sunderland Wessington Way				83.01			83.01
Thurrock		97.22		99.49	99.58	94.03	97.58
Walsall Woodlands				85.37	91.94		88.66
Warrington		94.07	78.61	98.89			90.52
Weybourne					99.81		99.81
Wicken Fen				98.66	98.56	98.43	98.55
Wigan Centre			75.23	99.63	96.44		90.43
Wirral Tranmere			89.86	98.38	98.47		95.57
Yarner Wood				98.06	95.83		96.94
York Bootham		95.79	95.97				96.87
York Fishergate		90.19	95.93	85.65			90.59
Number of stations	**1**	**44**	**51**	**82**	**52**	**16**	**90**
Number of stations < 85 %	**0**	**13**	**10**	**10**	**0**	**3**	**12**
Number of stations < 90%	**0**	**19**	**17**	**14**	**0**	**3**	**20**

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Network mean	**97.04**	**82.15**	**86.31**	**90.50**	**97.89**	**94.21**	**89.80**

Billingham

The analyser had been fitted with an incorrectly sized sample filter on 3 November 2014 up to 12 January 2015; data between these dates have been deleted due to the resultant sample leak.

Blackpool Marton

The $PM_{2.5}$ FDMS analyser produced intermittent poor-quality data during the quarter, and the volatile fraction was occasionally a regional outlier. Several short periods of data have been deleted.

Bury Whitefield Roadside

The Bury Whitefield Roadside station has been operation for several months, but several problems with the station infrastructure and NOx analyser failure have delayed commissioning of the station from the expected start date of 1 January. Data went live for NO_2 and PM_{10} following the reinstallation of the station NOx analyser on 11 March, but there were no LSO calibrations carried out until July; all NOx data have been deleted for this quarter, and will likely also be for Q2. PM_{10} data are available from 1 March.

Carlisle Roadside

The NOx analyser was removed for workshop attention during the service on 5 March as the analyser apparently had parts missing. It was reinstalled on 13 March, but immediately developed a flow fault, resulting in loss of data to 18 March. Both FDMS analysers showed occasional periods of noisy data and some short periods at both $PM_{2.5}$ and PM_{10} have been deleted.

Eastbourne

The $PM_{2.5}$ FDMS analyser became unresponsive on 13 January. Despite several attempts at repair, data quality did not improve, and data up to 31 March have been deleted; this will continue into Q2. The PM_{10} volatile concentrations became a regional outlier in early March; data from 11 March to 31 March have been deleted.

Newcastle Cradlewell Roadside

The station had been without an ESU contractor from autumn 2014. There were several periods of spurious data which have been deleted. A chafed cable caused the power to trip on 4 February, this was rectified by the new ESU on 27 February. An internal leak was found at the service on 6 March; all data have been lost from 29 December to 6 March.

Norwich Lakenfields

The NOx analyser developed a fault, and a spare instrument was installed on 30 January. Unfortunately, the data from this were very noisy up to the service on 13 March, and these data have been deleted. In addition, the $PM_{2.5}$ cyclone was not replaced following the zero baseline check on 6 February. This was replaced on 13 March, data between these dates have been deleted.

Portsmouth

The NOx analyser appears to have been sampling internally between the service on 10 March up to what appears to be undocumented station activity on 25 March; data have been deleted. The PM_{10} FDMS was found to have the drier tubes fitted incorrectly in April, possibly following drier replacement in November 2014. Although the data look acceptable, some periods of high noise have been deleted during ratification.

Sheffield Devonshire Green

The station was out of operation from 9 March, when the sample inlets were damaged through vandalism. Repairs were completed in early June.

Storrington Roadside

This station has had a 'hot spare' NOx analyser installed since May 2014. Communications were lost on 23 January 2015. On the February the ESU installed original Thermo instrument, however the data have not been collected from spare analyser between those dates. All the PM data were collected on 24 February and communicating with the original Thermo. Unfortunately ESU put the original NOx analyser back in with hourly logging instead of 15 min, which has been rectified on 24 February.

4.3 Data Capture and Station-Specific Issues - Greater London

A summary of data capture for England for January-March 2015 is given in Table 4.3:

Table 4.3 Data Capture for London, January-March 2015

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Camden Kerbside		88.52	96.16	99.58			94.75
Ealing Horn Lane		84.07					84.07
Haringey Roadside			87.55	97.31			92.43
London Bexley			94.95	96.76		0.00	63.90
London Bloomsbury		92.50	93.10	97.36	97.45	97.36	95.56
London Eltham			22.64	95.05	99.68		72.45
London Haringey Priory Park South				75.56	98.98		87.27
London Harlington		91.44	91.67	91.99	99.81		93.73
London Harrow Stanmore			91.90				91.90
London Hillingdon				98.33	98.38		98.36
London Marylebone Road	98.75	96.34	96.57	98.10	98.38	98.66	97.80
London Marylebone Road		98.89	98.89				98.89
London N. Kensington	98.24	95.74	91.67	98.10	97.69	98.19	96.60
London N. Kensington		98.89	98.89				98.89
London Teddington				83.84	89.72		86.78
London Teddington Bushy Park			92.87				92.87
London Westminster			100.00	98.33			98.40
Southwark A2 Old Kent Road		0.00		0.00			0.00
Tower Hamlets Roadside				98.61			98.61
Number of Stations	**2**	**9**	**13**	**14**	**8**	**4**	**19**
Number of stations <85 %	**0**	**2**	**1**	**3**	**0**	**1**	**4**

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Number of stations < 90%	**0**	**3**	**2**	**3**	**1**	**1**	**6**
Network mean	**98.50**	**82.93**	**88.99**	**87.78**	**97.51**	**73.55**	**86.49**

Ealing Horn Lane

The data from the FDMS analyser became noisy after the service on 16 February. An engineer was called out on 20 February and again on 24 February. These data have been deleted.

London Bexley

The SO_2 analyser was noisy and erratic for the entire quarter, and the data have been deleted. The analyser was deaffiliated at the end of the quarter. The closure date for this pollutant has been set to 31 December 2014.

London Eltham

The $PM_{2.5}$ FDMS suffered switching valve failure and was removed for workshop repair on 6 March, and reinstalled on 11 March.

London Haringey Priory Park South

The NOx analyser had a long-standing fault which had not been attended to by the outgoing ESU. The new ESU removed it from station and installed a 'hot spare' analyser on 7 January. Unfortunately, there are insufficient calibrations to reliably ratify the data from the spare instrument, and these have been deleted up to 20 January.

London Teddington

The NOx inlet was left disconnected following service on 4 March, seven days data have been lost. In addition, the station was switched off from 13-19 March for the removal of asbestos in the building.

Southwark A2 Roadside

The station continued to be offline whilst the enclosure and air conditioning were repaired.

4.4 Data Capture and Station-Specific Issues – Wales

A summary of data capture for England for January-March 2015 is given in Table 4.4

Table 4.4 Data Capture for Wales, January-March 2015

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Aston Hill				94.12	98.47		96.30
Cardiff Centre	62.04	58.98	56.20	59.26	62.69	61.90	60.18
Chepstow A48		57.22	92.50	99.12			82.95
Cwmbran				99.44	98.70		99.07
Hafod-yr-ynys Roadside				98.24			98.24
Narberth		93.84		97.64	97.69	97.50	96.67
Newport		85.60	92.27	91.25			89.71
Port Talbot Margam (Partisol)		96.67					96.67
Port Talbot Margam	98.24	96.44	95.51	98.24	98.66	98.33	97.57

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Swansea Roadside		95.69	95.42	98.29			96.47
Wrexham		100.00	100.00	98.33		97.87	98.18
Number of stations	**2**	**8**	**6**	**10**	**5**	**4**	**11**
Number of stations < 85 %	**1**	**2**	**1**	**1**	**1**	**1**	**2**
Number of stations < 90%	**1**	**3**	**1**	**1**	**1**	**1**	**3**
Network mean	**80.14**	**85.56**	**88.65**	**93.39**	**91.24**	**88.90**	**92.00**

Cardiff Centre

The station was closed for replacement of the station enclosure from 15 January to 17 February. Following this, the $PM_{2.5}$ FDMS developed a cooler fault which could not be rectified on site, and was removed for workshop repair; data from 24-28 February were lost. Furthermore, periods of spurious high data were deleted from 6-9 March, possibly due to a sampling issue.

Chepstow A48

The PM_{10} FDMS was seen to give a flat output following the QA/QC audit on 19 January; subsequent ESU investigations found the magnets had fallen off the mass transducer. A replacement transducer was ordered and fitted on 26 February.

4.5 Data Capture and Station-Specific Issues – Scotland

A summary of data capture for England for January-March 2015 is given in Table 4.5:

Table 4.5 Data Capture for Scotland, January-March 2015

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Aberdeen		96.71	91.44	98.84	59.12		86.53
Aberdeen Union St Roadside				99.63			99.63
Auchencorth Moss (Partisol)		93.33	85.56		97.64		97.01
Auchencorth Moss (FDMS)		95.23	94.03				94.63
Bush Estate				98.61	98.70		98.66
Dumbarton Roadside				95.60			95.60
Dumfries				93.89			93.89
Edinburgh St Leonards	91.48	95.93	84.03	98.61	98.61	98.43	94.51
Eskdalemuir				99.77	99.86		99.81
Fort William				98.61	98.47		98.54
Glasgow Great Western Rd				98.38			98.38
Glasgow High Street		89.07	87.55	90.37			89.00
Glasgow Kerbside				98.24			98.24

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Glasgow Townhead		22.27	77.45	92.96	96.99		72.42
Grangemouth		95.83	95.14	94.17		98.29	95.86
Grangemouth Moray				99.07			99.07
Inverness		93.33	95.56	83.84			84.66
Lerwick					76.99		76.99
Peebles				92.82	98.70		95.76
Strath Vaich					96.02		96.02
Number of stations	**1**	**8**	**8**	**16**	**10**	**2**	**20**
Number of stations < 85 %	**0**	**1**	**2**	**1**	**2**	**0**	**3**
Number of stations < 90%	**0**	**2**	**4**	**1**	**2**	**0**	**5**
Network mean	**91.48**	**85.21**	**88.84**	**95.84**	**92.11**	**98.36**	**93.26**

Aberdeen

The ozone analyser developed an intermittent response during January, due to a faulty power supply. The analyser was eventually removed for workshop repair. The spare instrument installed also developed a fault, and data were lost between 3 February and 12 March.

Glasgow High Street

This station narrowly failed to make 90% data capture, although was only commissioned on 5 January.

Glasgow Townhead

The PM_{10} FDMS produced persistently poor quality data, ultimately leading to the replacement of the mass transducer on 16 February. Data continued to be poor, resulting in considerable data loss. The $PM_{2.5}$ data also appeared to be low at times in comparison to other stations, and some data have been deleted.

Inverness

The NOx analyser is suspected of sampling internal cabin air following the LSO calibration on 17 March and this was not rectified at the subsequent service. It is likely data in Q2 will also be deleted.

4.6 Data Capture and Station-Specific Issues - Northern Ireland

A summary of data capture for England for January-March 2015 is given in Table 4.6:

Table 4.6 Data Capture for Northern Ireland (including Mace Head), January-March 2015

Name	CO	PM_{10}	PM_{25}	NO_2	O_3	SO_2	Average
Armagh Roadside		29.35		95.69			62.52
Ballymena Ballykeel						99.68	99.68
Belfast Centre	93.10	93.89	93.98	92.92	85.74	97.08	92.79
Belfast Stockman's Lane		96.48		98.33			97.41
Derry		86.57	91.71	96.53	97.82	97.18	93.96
Lough Navar		90.97			97.59		94.28
Mace Head					99.95		
Number of stations	**1**	**5**	**2**	**4**	**4**	**3**	**6**
Number of stations < 85 %	**0**	**1**	**0**	**0**	**0**	**0**	**1**
Number of stations < 90%	**0**	**2**	**0**	**0**	**1**	**0**	**1**
Network mean	**93.10**	**79.45**	**92.85**	**95.87**	**95.28**	**97.98**	**90.11**

Armagh Roadside

The FDMS analyser performed very poorly during this quarter, partly due to the cooler fault which remained unattended to until May. No filter changes were carried out which contributed to the data loss. More data will probably be lost in Q2.

4.7 Changes to Previously Ratified Data

The following data reported as ratified in previous periods have been amended for the reasons given:

- Auchencorth Moss PM_{10} (FDMS), rescaled from 20/8/14 to 31/12/14, main flow outlier
- Glasgow Kerbside NOx for Q4 2014 rescaled in the light of Q1 2015 ratification actions
- London Marylebone Road $PM_{2.5}$, rescaled from 27/8/14-31/12 14, K_0 outlier.

5 Health and Safety Report

A summary of instances when an AURN station went to 'HIGH' risk status during the quarter is given in Table 5.1:

Table 5.1 Summary of "High" Risk Station Safety Status Incidents, January-March 2015

Station	Risk	Date went to 'High'	Date resolved	Action taken
None	-	-	-	-

An incident occurred at Chepstow A48 Roadside during the QA/QC audit on 23 January. Whilst the NOx analyser was being calibrated using the station cylinder and regulator, the gas pressure in the calibration system suddenly rose to full cylinder pressure. Minor damage was done to the analyser, and the audit was aborted. The regulator was sent to the gas supplier for investigation, though no feedback had been received as at August 2015. (Because the regulator was removed from the station and did not result in an ongoing safety issue at the station, it was not relevant or appropriate to enter this as a risk in the Health and Safety Database – the purpose of the Database being to highlight current risks to those visiting monitoring stations.)

6 Equipment Upgrade Requirements

6.1 Equipment

No specific network equipment has been identified as requiring replacement this quarter.

6.2 Station Infrastructures

No specific station infrastructure issues have been identified this quarter.

7 Conclusions and Recommendations

During Quarter 1 of 2015 there were a total of 146 AURN monitoring stations in operation.

The winter 2015 Intercalibration exercise was carried out during the quarter. These audits were used to undertake a number of analyser and infrastructure performance checks that cannot be performed by Local Station Operators, with a view to ensuring confidence in the accuracy, consistency and traceability of air pollution measurements made at all the monitoring stations.

Data ratification for this quarter was completed by the deadline of 30 June 2015.

Ratified hourly average data capture for the network averaged 91.43% for all pollutants (O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$) during the 3-month reporting period January-March 2015. Average data capture for all pollutants were above 85%. There were 19 stations with data capture less than 85% for the period (33 below 90%).

The uncertainty of measurement for each analyser has been determined to ensure compliance with the Data Quality Objective. Nine analysers were found to be outside the required uncertainty.

Recommendations:

For two stations with external data loggers, the logger clock was found to be set to the incorrect time, resulting in data having to be reprocessed. At Horiba-equipped stations there is no display of the logger time; for these stations, CMCU have been asked to provide evidence to the QA/QC unit that the logger clocks are correct to within the required margin of ±15 minutes.

Ricardo
Energy & Environment

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

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

ee.ricardo.com