QA/QC Data Ratification Report for the Automatic Urban and Rural Network, October-December 2016 and Annual Report, 2016

Report for Defra and the Devolved Administrations

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Executive summary

Ricardo Energy & Environment carries out the quality assurance and quality control (QA/QC) activities for the Automatic Urban and Rural Monitoring Network (AURN) on behalf of the UK Department for Environment, Food and Rural Affairs (Defra), the Scottish Government, Welsh Government and Department of Agriculture, Environment and Rural Affairs (DAERA) in Northern Ireland. This report summarises the QAQC activities in the final quarter of 2016 (October to December 2016), and for the calendar year 2016 as a whole.

A total of 156[1] monitoring stations in the AURN operated during the three-month period October – December 2016.

Ratified hourly average data capture for the network averaged 93.02% for all pollutants (O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$) during the three-month reporting period October-December 2016. Average data capture for all pollutants were above 85%. There were 19 monitoring stations with data capture less than 90% for the period, of which 13 had data capture below 85%.

For the whole calendar year 2016, ratified hourly average data capture for the network averaged 90.76% for all pollutants (O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$). The target for annual data capture is 85%, which is based upon the 90% data capture target of the Air Quality Directive, with an allowance of 5% for planned maintenance. There were 50 monitoring stations with data capture less than 90% for the period, of which 31 had data capture below 85%.

The main reasons for data loss were sampling faults, closures for cabin repairs, poor analyser performance and persistent temperature problems.

Ricardo Energy & Environment carried out two Network Intercalibration exercises during calendar year 2016, in winter (January - March) and summer (August - September). The data were ratified quarterly in arrears and made available via Defra's online UK Air Information Resource (UK-AIR). In addition, calibration of all ozone analysers was carried out in April and October.

The routine QA/QC procedures include checking of particulate analyser baselines. The CEN standard method for ambient particulate matter EN16450 states that action must be taken when baseline response is higher than 3 µg m^{-3} but does not state what the action should be. Up to 2016 the only agreed action was to delete the data. However, as part of ongoing improvement activities a protocol was agreed in early 2016 to enable baselines to be corrected where baseline responses exceed 3 µg m^{-3}. From 2015, the dataset has been assessed and baselines adjusted where there is evidence to suggest this is appropriate, for example, a high zero response.

[1] Note: this doesn't count the two Partisol gravimetric samplers which are co-located at sites with FDMS instruments, and treated as separate sites for data processing purposes.

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1 Introduction

1.1 Background

The UK Automatic Urban and Rural Network (AURN) was established to provide information on air quality 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 are required by scientists, policy makers and planners to enable them to make informed decisions on managing and improving air quality for the benefit of health and the natural environment.

A number of organisations are involved in the day-to-day running of the network. Currently, the role of Central Management and Co-ordination Unit (CMCU) for the AURN is contracted to Bureau Veritas, whilst the Environmental Research Group (ERG) of King's College London 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 Quality 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 (UK) Ltd and are provided with an ISO17025 certificate of calibration by Ricardo. The monitoring equipment is serviced and maintained by a number of Equipment Support Units, under contract to the CMCU.

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 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, available on UK-AIR.

A total of 156 monitoring stations in the AURN operated during this quarter. This *doesn't* include the two stations where Partisol gravimetric particulate samplers were co-located with automatic particulate analysers. (The gravimetric data have historically been used in validating the performance of the automatic analysers). For data processing purposes, in these cases the gravimetric sampler is treated as a separate station; and they are shown, and counted, separately in the data capture tables in section 4. Hence, in these tables the total number of sites appears as 158. The main reasons for data loss at the stations are discussed in section 4. 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 October to December 2016, or "Quarter 4" of the year. As it is the final quarterly report of the year, it also includes a summary of significant events and statistics for the full calendar year, a summary of health and safety activities, an inventory of Defra-owned equipment held by the QA/QC Unit in connection with this work, and a section relating to issues of improved technologies. 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 at 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 2016

Table 1.1 shows the new monitoring stations which were commissioned in 2016, and those that closed in 2016.

Table 1.1 Station changes in 2016

New stations	Pollutants	Date started
Southampton A33	NOx, PM_{10}	01/01/2016
Chilbolton Observatory	NOx, O_3, PM_{10}, $PM_{2.5}$, SO_2	11/01/2016
Aberdeen Wellington Road	NOx	09/02/2016
Nottingham Western Boulevard	NOx, PM_{10}	01/03/2016
Reading London Road	NOx, PM_{10}	04/03/2016
Derry Rosemount	NOx, O_3, PM_{10}, $PM_{2.5}$, SO_2	21/03/2016
Greenock A8 Roadside	NO_2	05/05/2016
Sheffield Barnsley Road	NO_2	01/08/2016
Cannock A5190 Roadside	NO_2	10/08/2016
Birkenhead Borough Road	NO_2	18/08/2016
Christchurch Barrack Road	NO_2	01/09/2016
Birmingham A4540 Roadside	NO_2 O_3 $PM_{2.5}$ PM_{10}	09/09/2016
St Helens Linkway	NO_2	27/09/2016
Worthing A27 Roadside	NO_2	01/10/2016
Station Closures	**Pollutants**	**Date closed**
Derry	NOx, O_3, PM_{10}, $PM_{2.5}$, SO_2	29/2/2016
Birmingham Tyburn Roadside	NO_2 O_3 $PM_{2.5}$ PM_{10}	07/09/2016
Great Dun Fell	O3	28/10/2016
Bottesford	O3	28/10/2016
Additional analysers at existing stations	**Pollutants**	**Date started**
Ballymena Ballykeel	NO_2	01/05/2016
Reading London Road	PM_{10}	04/05/2016
York Bootham	NO_2	18/08/2016

In addition, during 2016, the FDMS instruments at London Harlington were replaced with a Fidas 200 analyser. This is an optical light scattering device capable of measuring several different size fractions, including $PM_{2.5}$ and PM_{10}. This analyser is fully MCERTS compliant. Fidas data from 1 January 2016 have been reported from London Harlington.

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 of 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 QA/QC Audits

2.2.1 Purpose of Intercalibration

The QA/QC intercalibration audits 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 (LSOs) in undertaking calibrations. As it is the calibrations by the LSOs that are used to scale pollution datasets, it is important to check that these are undertaken competently.
12. Zero "calibration" of all automatic PM analysers. This test allows the baseline performance of PM analysers to be evaluated, to determine whether any remedial action is required to the analyser or baseline to be corrected during ratification.

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 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 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.

Full audits of all analysers are carried out at six-monthly intervals in the winter (January-February) and summer (July-August). In addition, audits of ozone analysers are also carried out in spring (April) and autumn (October).

2.2.2 Methodology for FDMS & 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}. 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. Up to now 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}. The 2016 dataset have been assessed and baselines adjusted where there is evidence to suggest this is appropriate, for example a high zero response. This has resulted in some previously rejected data being reinstated. This protocol will continue from now onwards.

2.3 Overview of Data Ratification

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

3 Intercalibration Results Summary (2016)

3.1 National Network Overview

A summary of the findings of the 2016 intercalibrations is given in Table 3.1.

Table 3.1 Summary of Network Intercalibrations, 2016

	Winter 2016			Summer 2016		
Parameter	Number of outliers	Number in network	% outliers in total	Number of outliers	Number in network	% outliers in total
NOx analyser	18	137	13%	20	138	14.5%
CO analyser	0	7	0%	1	7	14.3%
SO2 analyser	6	28	21%	6	28	21.4%
Ozone analyser	27	81	33%	17	80	21.3% (4 deviated by more than 10% from the reference standard.)
FDMS and BAM analysers	2x K0, 5x flows 11x zero tests	3 PM_{10} BAM 2 $PM_{2.5}$ BAM 73 PM_{10} FDMS 80 $PM_{2.5}$ FDMS	11%	4x K0, 3x flows 33x zero tests	4 PM_{10} BAM 3 $PM_{2.5}$ BAM 65 PM_{10} FDMS 70 $PM_{2.5}$ FDMS 1 $PM_{2.5}$ Fidas	4.9%
Gravimetric PM analysers	0	17	0%	3	17	17.6%
Cylinders	8	172	5%	8	173	4.6%
Total	69 analysers	428 analysers	16% of analysers	54 analysers	413 analysers	13.1% of analysers

In the spring 2016 ozone intercalibration, there were 16 analysers out by more than 5%. The figure for the autumn exercise was 15.

3.2 Calculations of Measurement Uncertainty

The uncertainty of measurement of each analyser is calculated at each intercalibration. These are presented in the January-March and July-September QA/QC reports.

3.3 Certification

Certificates of calibration for each intercalibration exercise are provided on the AURN Hub (at http://aurnhub.defra.gov.uk/login.php).

4 Data Ratification Results (4th Quarter)

4.1 Data Capture – Network Overview

4.1.1 Overall Data Capture

Ratified hourly average (daily average for Partisols) data capture for the network averaged 93.02% for all pollutants (O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$) during the three-month reporting period October-December 2016. Data capture statistics are calculated using the actual data capture as hourly averages (daily for Partisol) against the total number of hours (or days) in the relevant period; service and maintenance are counted as lost data. It is permissible to discount routine service and calibration from achievable data capture targets, but this is not calculated. For stations starting or closing during the period, the data capture is based on the actual date starting or closing. All pollutants achieved 85% or higher data capture on average. The data capture target for the purposes of monitoring compliance with the EU Air Quality Directive (Directive 2008/50/EC) is 90% excluding planned servicing and maintenance. For practical purposes in the AURN, planned maintenance is assumed to be 5% so a target of 85% data capture is used.

Data capture for each quarter is shown in Table 4.1.

Table 4.1 AURN Ratified Data Capture (%) by Quarter, 2016

Quarter	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Mean
Q1 2016	86.68	91.44	94.27	80.76	84.17	88.79	89.26
Q2 2016	92.70	94.11	95.49	86.59	93.31	91.18	92.74
Q3 2016	90.77	91.17	91.48	84.38	85.13	90.64	89.40
Q4 2016	96.86	93.50	92.84	93.89	93.59	90.58	93.02
2016	**91.76**	**92.17**	**94.21**	**86.56**	**87.81**	**89.37**	**90.76**

The data captures from previous quarters have been recalculated to reflect data changed in subsequent quarters.

Note that the overall data capture value is the average calculated from the data captures at individual stations, these themselves being the average of all pollutants at that station.

4.1.2 Generic Data Quality Issues

The following generic data quality issues have been identified in 2016:

- The use of obsolete mass transducer filters on FDMS analysers, resulting in high analyser noise
- Improperly configured sampling systems which compromise the sampled air, resulting in false readings. This has been a problem in the past, and during 2016 continued to cause significant data loss, for example at Edinburgh St Leonards and London Westminster.

4.1.3 Data Precision

As part of the requirements of the INSPIRE Directive 2007/2/EC and 2011/850/EU Implementing Decision, data are reported to one decimal place (two for CO).

4.2 Data Capture and Station-Specific Issues October-December 2016- England (Excluding Greater London)

Table 4.2 shows percentage data capture for stations in England during Quarter 4 of 2016. The table is followed by details of individual station-specific issues.

Table 4.2 Data Capture – England – Quarter 4 (Oct-Dec) 2016

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Quarter Average
Barnsley Gawber		99.77	99.68			99.77	99.74
Barnstaple A39				90.35	99.55		94.95
Bath Roadside		99.73					99.73
Billingham		98.60					98.60
Birkenhead Borough Road		98.91					98.91
Birmingham A4540 Roadside		99.59	99.09	89.40	42.57		82.67
Birmingham Acocks Green		99.95	99.95		99.82		99.91
Birmingham Tyburn		98.64	98.87	96.65	99.86	98.69	98.54
Blackburn Accrington Road		99.73					99.73
Blackpool Marton		99.86	99.91		99.82		99.86
Bottesford			99.48				99.48
Bournemouth		97.19	98.28		92.39		95.95
Bradford Mayo Avenue		99.23					99.23
Brighton Preston Park		99.73	99.59		100.00		99.77
Bristol St Paul's		99.77	99.91	99.77	99.09		99.64
Bury Whitefield Roadside		99.64		99.41			99.52
Cambridge Roadside		97.15					97.15
Cannock A5190 Roadside		90.63					90.63
Canterbury		99.32	99.68				99.50
Carlisle Roadside		98.14		95.15	88.45		93.92
Charlton Mackrell		99.86	99.91				99.89
Chatham Roadside		98.96		92.21	90.90		94.02
Chesterfield Loundsley Green		99.86		95.06	99.82		98.25
Chesterfield Roadside		99.55		99.68	99.64		99.62
Chilbolton Observatory		99.82	99.73	92.62	99.50	70.24	92.38
Christchurch Barrack Road		99.68					99.68
Coventry Allesley		99.91	99.86		99.59		99.79

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Quarter Average
Doncaster A630 Cleveland Street		98.82					98.82
Eastbourne		99.86		97.69	75.63		91.06
Exeter Roadside		99.64	99.73				99.68
Glazebury		99.95	99.82				99.89
Great Dun Fell			100.00				100.00
High Muffles		98.64	97.83				98.23
Honiton		88.13					88.13
Horley		99.32					99.32
Hull Freetown		99.77	99.68		99.86	99.64	99.74
Hull Holderness Road		99.55		99.91			99.73
Ladybower		98.78	84.33			98.73	93.95
Leamington Spa		99.86	99.77	99.73	99.82		99.80
Leamington Spa Rugby Road		99.91		94.11	99.41		97.81
Leeds Centre	95.15	99.82	99.64	99.77	99.82	99.86	99.01
Leeds Headingley Kerbside		99.68		99.23	99.64		99.52
Leicester A594 Roadside		99.50		99.59			99.55
Leicester University		98.73	99.00		98.60		98.78
Leominster		0.00	0.00				0.00
Lincoln Canwick Road		99.41					99.41
Liverpool Queen's Drive Roadside		87.27					87.27
Liverpool Speke		99.64	99.55	98.01	99.09	99.59	99.18
Lullington Heath		99.82	99.86			95.65	98.45
Luton A505 Roadside		99.64					99.64
Manchester Piccadilly		99.86	99.77		94.43	99.77	98.46
Manchester Sharston		99.73	95.74				97.74
Market Harborough		94.25	98.64				96.44
Middlesbrough		99.37	99.91	99.82	92.57	89.22	96.18
Newcastle Centre		99.64	99.82	99.28	99.86		99.65
Newcastle Cradlewell Roadside		95.15					95.15
Northampton Kingsthorpe		98.69	98.73		98.91		98.78
Norwich Lakenfields		99.86	99.91	99.82	95.15		98.69
Nottingham Centre		99.77	99.68	99.32	99.95	99.77	99.70
Nottingham Western Boulevard		99.68		99.41			99.55

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Quarter Average
Oldbury Birmingham Road		65.99					65.99
Oxford Centre Roadside		99.68					99.68
Oxford St Ebbes		0.00		0.00	0.00		0.00
Plymouth Centre		99.59	99.86	99.82	99.68		99.74
Portsmouth		94.16	99.95	99.68	99.59		98.35
Preston		99.59	99.82		99.82		99.74
Reading London Road		95.38		98.37			96.87
Reading New Town		99.86	99.86	99.18	74.14		93.26
Rochester Stoke		90.94	84.74	89.86	89.31	91.21	89.21
Salford Eccles		99.50		88.41	94.07		93.99
Saltash Callington Road				98.91	99.28		99.09
Sandy Roadside		99.23		89.90	89.72		92.95
Scunthorpe Town		93.21		98.10		96.47	95.92
Shaw Crompton Way		89.81					89.81
Sheffield Barnsley Road		99.28					99.28
Sheffield Devonshire Green		99.09	99.77	98.87	88.99		96.68
Sheffield Tinsley		99.77					99.77
Sibton			99.77				99.77
Southampton A33		99.91		98.19			99.05
Southampton Centre		0.00	0.00	0.00	0.00	0.00	0.00
Southend-on-Sea		98.51	98.41		98.01		98.31
St Helens Linkway		99.80					99.80
St Osyth		98.41	98.46				98.44
Stanford-le-Hope Roadside		99.68		99.68	99.41		99.59
Stockton-on-Tees A1305 Roadside		99.68			99.59		99.64
Stockton-on-Tees Eaglescliffe		99.59		97.83	94.52		97.31
Stoke-on-Trent A50 Roadside		98.23		99.59			98.91
Stoke-on-Trent Centre		99.68	99.82		98.10		99.20
Storrington Roadside		99.73		99.05	88.68		95.82
Sunderland Silksworth		95.52	96.24		100.00		97.25
Sunderland Wessington Way		99.86					99.86
Thurrock		98.87	99.59	99.50		94.16	98.03
Walsall Woodlands		99.86	99.82				99.84

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Quarter Average
Warrington		99.82		96.74	99.95		98.84
Weybourne			99.91				99.91
Wicken Fen		98.73	97.33			91.98	96.01
Widnes Milton Road		98.28					98.28
Wigan Centre		98.19	91.03		87.55		92.26
Wirral Tranmere		98.64	99.82		99.55		99.34
Worthing A27 Roadside		99.14					99.14
Yarner Wood		99.95	85.64				92.80
York Bootham		99.68		99.41	97.74		98.94
York Fishergate		86.82		92.12	92.48		90.47
Number of Sites	**1**	**97**	**52**	**44**	**51**	**16**	**103**
Number of sites < 85 %	**0**	**4**	**4**	**2**	**5**	**2**	**5**
Number of sites < 90%	**0**	**8**	**5**	**6**	**11**	**3**	**9**
Average	**95.15**	**95.02**	**94.52**	**92.71**	**91.25**	**89.05**	**94.33**

Birmingham A4540 Roadside

This station replaced Birmingham Tyburn Roadside on 9th September. Poor FDMS performance was observed, particularly on the $PM_{2.5}$. The mass transducer was replaced on 10th October, but volatile concentrations remained anomalously low. The analyser was removed for workshop repair on 22nd November, where a small leak in the pipework was discovered. Reinstallation took place on 3rd December and data quality appear satisfactory.

Chilbolton

The SO_2 data during this quarter contained many brief periods of spurious, noisy data which were deleted, along with a longer period from 11th-21st December. The analyser was found to have a detector fault and was replaced by a hotspare early in January.

Cambridge Roadside

Due to a telecoms problem, no data were collected from 21st -31st October.

Eastbourne

The $PM_{2.5}$ analyser had been performing poorly in Q3, having received a new tapered element. A new mass transducer was fitted on 21st October which cured the problem. Data have been lost from 27th July to 21st October

Honiton

The analyser developed a fault on 7th November, requiring a new detector, and ultimately removal for workshop repair. Monitoring recommenced 15th November.

Leominster

The station was switched off in August 2016 due to a leaking roof. The equipment was reinstalled in February 2017.

Liverpool Queens Drive Roadside

The station closed on 7th November.

Middlesbrough

The SO_2 analyser suffered from autocal run-on which resulted in the loss of one hour's data each day. In addition, problems with the high voltage power supply resulted in noisy data and ultimately an ESU callout for replacement.

Oldbury Birmingham Road

The power to the station was switched off from 10th September to 28th October due to an electrical fault.

Oxford St Ebbes

All data were deleted due to the encroaching vegetation around the station being noncompliant with the Air Quality Directive.

Reading New Town

The $PM_{2.5}$ data was of poor quality this quarter, and data have been deleted from 10th to 31st December. A number of ESU callouts have failed to fix the problem.

Salford Eccles

The PM_{10} analyser lost its firmware and required workshop repair; data from 30th September to 10th October have been lost.

Sandy Roadside

The PM_{10} analyser suffered cooler status faults from 14th to 19th September, and following a gap in December, high volatiles resulted in the data between 5th and 9th December being deleted during ratification. The $PM_{2.5}$ data were deleted from 30th November (filter change) to an LSO callout on 9th December due to negative volatile concentrations.

Shaw Crompton Way

The NOx analyser suffered some sort of daily IZS malfunction, affecting measured data between midnight and 2 a.m. almost every day. These data have been deleted. It is believed the issue has now been successfully rectified.

Southampton Centre

The station was closed from 9th June 2016 to 24th January 2017 due to cabin replacement works.

Storrington Roadside

The $PM_{2.5}$ analyser was found to have a leak on 19 September. Following repair, some spurious data were observed up to a pump repair on 10th December, some data have been deleted.

Wigan Centre

The cabin at Wigan was replaced in October 2016. Following recommissioning, some air conditioning problems resulted in unstable $PM_{2.5}$ data which were deleted.

Yarner Wood

The ESU were called out to the ozone analyser on 21st December due to a pump fault. The subsequent data looked anomalous, and the LSO was called out on 30th December. The sample line was found to be disconnected.

4.3 Data Capture and Station-Specific Issues October-December 2016- Greater London

Table 4.3 shows percentage data capture for stations in Greater London during Quarter 4 of 2016. The table is followed by details of individual station-specific issues.

Table 4.3 Data Capture – Greater London - Quarter 4 (Oct-Dec) 2016

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Quarter Average
Camden Kerbside		99.77		90.67	99.59		96.68
Ealing Horn Lane				98.64			98.64
Haringey Roadside		99.55					99.55
London Bexley		95.56			98.78		97.17
London Bloomsbury		99.09	99.95	99.68	99.64	34.65	86.60
London Eltham		95.43	93.30		98.28		95.67
London Haringey Priory Park South		95.88	95.88				95.88
London Harlington		88.13	94.88	99.37	99.41		95.45
London Harrow Stanmore					99.77		99.77
London Hillingdon		99.82	99.82				99.82
London Marylebone Road	84.19	99.28	97.06	94.16	94.57	99.64	94.81
London Marylebone Road				100.00	100.00		100.00
London N. Kensington	99.82	99.77	99.55	94.16	97.06	99.55	98.32
London Teddington Bushy Park					84.65		84.65
London Westminster		0.00			92.39		46.20
Southwark A2 Old Kent Road		99.82		98.91			99.37
Tower Hamlets Roadside		98.01					98.01
Number of Sites	**2**	**13**	**7**	**8**	**11**	**3**	**17**
Number of sites < 85 %	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Number of sites < 90%	**1**	**2**	**0**	**0**	**1**	**1**	**3**
Average	**92.01**	**90.01**	**97.20**	**96.95**	**96.74**	**77.94**	**93.33**

London Bloomsbury

The SO_2 data were erratic due to a leak in the IZS valve. Data from 10th October to 8th December have been deleted.

London Marylebone Road

The CO analyser suffered a number of faults including power supply and memory loss. A new analyser was installed early in 2017.

London Teddington Bushy Park

The ESU was called out on 19th December and a valve fault was found, but the engineer was unable to repair it. The analyser was removed for workshop repair. Reinstallation was delayed by electrical maintenance works at the station.

London Westminster

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

4.4 Data Capture and Station-Specific Issues October-December 2016– Wales

Table 4.4 shows percentage data capture for stations in Wales during Quarter 4 of 2016. The table is followed by details of individual station-specific issues.

Table 4.4 Data Capture Wales - Quarter 4 (Oct-Dec) 2016

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Quarter Average
Aston Hill		99.59	91.30				95.45
Cardiff Centre	100.00	97.46	97.37	99.50	96.24	99.95	98.42
Chepstow A48		93.03		98.91	99.23		97.06
Cwmbran		99.73	99.77				99.75
Hafod-yr-ynys Roadside		99.46					99.46
Narberth		48.10	99.86	99.14		98.73	86.46
Newport		94.34		94.52	99.77		96.21
Port Talbot Margam				98.91			98.91
Port Talbot Margam	99.23	95.06	99.73	99.28	98.32	99.28	98.48
Swansea Roadside		99.77		99.59	99.59		99.65
Wrexham		55.25		100.00	93.48	99.82	87.14
Number of Sites	**2**	**10**	**5**	**8**	**6**	**4**	**11**
Number of sites < 85 %	**0**	**2**	**0**	**0**	**0**	**0**	**0**

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Quarter Average
Number of sites < 90%	**0**	**2**	**0**	**0**	**0**	**0**	**2**
Average	**99.62**	**88.18**	**97.61**	**98.73**	**97.77**	**99.45**	**96.09**

Narberth

The NOx data were seen to be noisy. An ESU callout found a detector fault, and the analyser was removed for workshop repair on 14th November. This was reinstalled on 17th November, but all data from 1st October to 17th November have been deleted.

Wrexham

The NOx analyser developed a fault and was removed for workshop repair on 22nd November. A hotspare of a different type was installed on 25th November, but the LSO did not know how to perform calibrations on it, so none were carried out. It has not been possible to correctly scale the data from this analyser so data from 22nd November 2016 to 13th January 2017 have been deleted.

4.5 Data Capture and Station-Specific Issues October-December 2016– Scotland

Table 4.5 shows percentage data capture for stations in Scotland during Quarter 4 of 2016. The table is followed by details of individual station-specific issues.

Table 4.5 Data Capture Scotland - Quarter 4 (Oct-Dec) 2016

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Quarter Average
Aberdeen		99.50	99.59	99.55	99.46		99.52
Aberdeen Union Street Roadside		99.18					99.18
Aberdeen Wellington Road		99.91					99.91
Auchencorth Moss			99.73	77.26	99.00		92.00
Bush Estate		99.82	99.91				99.86
Dumbarton Roadside		89.36					89.36
Dumfries		91.85					91.85
Edinburgh St Leonards	99.82	99.77	99.82	83.38	99.91	99.82	97.09
Eskdalemuir		98.82	98.73				98.78
Fort William		99.68	99.82				99.75
Glasgow Great Western Road		99.91					99.91

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Quarter Average
Glasgow High Street		99.09		96.29	99.59		98.32
Glasgow Kerbside		99.73					99.73
Glasgow Townhead		99.82	99.82	99.77	99.95		99.84
Grangemouth		95.79		98.91	99.91	99.95	98.64
Grangemouth Moray		96.24					96.24
Greenock A8 Roadside		99.59					99.59
Inverness		99.68		91.30	100.00		97.00
Lerwick			99.64				99.64
Peebles		98.87	99.77				99.32
Strathvaich			99.82				99.82
Number of Sites	**1**	**18**	**10**	**7**	**7**	**2**	**21**
Number of sites < 85 %	**0**	**0**	**0**	**2**	**0**	**0**	**0**
Number of sites < 90%	**0**	**1**	**0**	**2**	**0**	**0**	**1**
Average	**99.82**	**98.15**	**99.67**	**92.35**	**99.69**	**99.89**	**97.87**

Dumbarton Roadside

The NOx converter failed on 18 August; a replacement was not installed until 10th October.

4.6 Data Capture and Station-Specific Issues October-December 2016- Northern Ireland

Table 4.6 shows percentage data capture for stations in Northern Ireland (also the Mace Head station in the Republic of Ireland) during Quarter 4 of 2016. The table is followed by details of individual station-specific issues.

Table 4.6 Data Capture Northern Ireland (and Mace Head) - Quarter 4 (Oct-Dec) 2016

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Average
Mace Head			99.95				99.95
Armagh Roadside		95.74		74.09			84.92
Ballymena Ballykeel		99.73				85.64	92.69
Belfast Centre	99.77	95.65	99.86	99.82	99.91	98.28	98.88

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Average
Belfast Stockman's Lane		99.64		99.55			99.59
Derry Rosemount		99.82	93.98	99.00	99.91	96.88	97.92
Lough Navar			92.07	91.35			91.71
Number of Sites	**1**	**5**	**4**	**5**	**2**	**3**	**7**
Number of sites < 85 %	**0**	**0**	**0**	**1**	**0**	**0**	**1**
Number of sites < 90%	**0**	**0**	**0**	**1**	**0**	**1**	**1**
Average	**99.77**	**98.12**	**96.47**	**92.76**	**99.91**	**93.60**	**95.09**

Armagh Roadside

The unstable data noted in Q3 have continued this quarter; data from 1st to 10th October have been deleted. It was noted at the service that the air temperature controller was not working. This analyser is very old, being a conversion from the original TEOM unit.

Ballymena Ballykeel

The SO_2 data was of very poor quality at the beginning of October, with rapid baseline drift which reset at every autocal. Data from 4 to 16 October have been deleted.

4.7 Changes to Previously Ratified Data

The following data from previous quarters have been changed as a result of the ratification process for this quarter (all 2016 unless otherwise stated):

Table 4.7 Changes Affecting Ratified Data in Previous Quarters

Monitoring Station	Pollutant(s)	Dates	Nature of Change
Armagh Roadside	NOx	End of Sep 2016	Amended processing of end of Q3 after addition of first calibration in Oct 2016.
Barnsley Gawber	NOx	3rd Jan - 30th Sep 2016	NO cylinder issue: had been entered as '95' instead of '0095'.
Birmingham Tyburn	PM_{10}	Sep – Dec 2016	Apply zero baseline correction from gap in September to dryer replacement 24th Jan 2017.
Bush	NOx	End of Sep 2016	Reprocessed end of Q3 ignoring a bad LSO calibration.
Cardiff Centre	NOx, CO, SO_2	End of Sep 2016	Reprocessed sensitivity for Q3 due to lack of calibrations at end of Q3.
Glasgow High Street	$PM_{2.5}$	5th Feb 2016 – 16th Jan 2017	Zero baseline correction required.
Glasgow Great Western Road	NOx	Q1-Q3	Slight adjustments made to sensitivity processing.

Leeds Centre	CO	Q3	Analyser baseline drift corrected.
Liverpool Speke	SO_2	Q2-Q4	Reprocessed baseline. Cylinder changed in July.
London Bexley	NOx	Q1-Q3	Blockage or leak in sample line found at winter 2017 audit, and converter efficiency test failed. Reimport calibrations possibly for whole of 2016 and reprocess.
London Marylebone Road	SO_2	Q1-Q3	Reviewed and adjusted as baseline appears elevated through Jun-Sep 2016.
London North Kensington	PM_{10}	18th Jun to end of 2016	Possible zero baseline correction required between summer zero test and end of year.
Mace Head	O3	1st Apr – 31st Dec 2016	Thermo49c and Thermo49i analysers were sampling in parallel from April 2016. Both datasets for April to September 16 compared well with each other. Thermo49i data uploaded from 1 April to 31 December 2016 superseding the previously 49c data for Q2 & Q3 16
Market Harborough	NOx	Sep 2016	Process final few days of Q3 NOx sensitivities.
Narberth	NOx	25th Apr – 15th Nov 2016.	Very noisy NOx continuing from Q3. Suspect faulty PMT. Removed for repair 15th Nov.
Newcastle Centre	NOx	Q3	Reprocessed Q3 NO zero baseline calibrations.
Oxford Centre Roadside	NOx	Q3	Reprocessing required. Converter issue.
Oxford St Ebbes	NOx	Q3	Reprocessing required. Converter issue.
Reading London Road	NOx	Q3	Reprocessing required due to additional calibrations entered
Reading New Town	NOx	Q3	Reprocessing required due to additional calibrations entered
Sandy Roadside	NOx	Sep 2016	Amended sensitivity at the end of Q3.
Sheffield Tinsley	NOx	Q3	Minor adjustment made and Q2 & Q3 locked down after checking.

Stockton-on-Tees A1305	NOx	Q1 and Q2	Changes made to sensitivity around winter 2016 audit.
Stockton-on-Tees A1305	PM_{10}	Q2 and Q3	Additional check for zero baseline correction: extend back to 5th May from dryer change in September.
York Fishergate	NOx	15th Jul – 30th Sep	Amended baseline processing 15th Jul – 30th Sep for consistency with Q2 and Q3.

A list of changes to ratified data is given at http://uk-air.defra.gov.uk/data/changes-to-ratified-data .

4.8 Zero Baseline Correction

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

The following particulate data were rescaled:

- Birmingham Tyburn PM_{10}, September to December 2016.
- Glasgow High Street $PM_{2.5}$, January to December 2016.
- London North Kensington PM_{10}, from 16th June (a gap in data) to 31st December 2016 (and on to audit/start of zero test in early 2017).

(Note: in the above cases, where the period of baseline correction is listed as being to 31 December 2016, it would usually be the case that the correction extends into 2017).

5 Health and Safety Report 2016

The risk status of the following monitoring stations was raised to "High" on the Health & Safety Database during 2016. This list includes all Defra monitoring networks, not just the AURN, as the QAQC contractor acts as health and safety co-ordinator for all monitoring networks. All the problems were satisfactorily resolved. Issues which were erroneously raised as "High" have been discounted.

The abbreviation "SET" stands for Site Electrical Test; the periodic inspection of fixed electrical installations. It is often referred to as the PIR, Periodic Inspection Report.

Table 5.1 Summary of High Risk Occurrences 2016

Station	Issue/Problem	Date went to 'High'	Date resolved
Wigan Centre	Water ingress. Water trapped in roof void entered enclosure.	05/02/2016	23/02/2016
Oxford St Ebbes	Electrical safety concern.	24/03/2016	04/04/2016
London Teddington*	Presence of asbestos	07/04/2016	Closed long-term for refurbishment
Southampton Centre	Leaking roof, electricity turned off	09/06/2016	w/c 16/01/2017
Oxford St Ebbes	Failed site electrical test	28/06/2016	04/07/2016
Reading London Road	Failed site electrical test	29/06/2016	08/07/2016
Leominster	Sagging roof	01/07/2016	w/c 16/01/2017
Aston Hill	Failed SET	06/07/2016	by 08/08/2016
Market Harborough	Failed SET	06/07/2016	by 08/08/2016
London Bloomsbury	Failed SET	12/07/2016	by 08/08/2016
London Hillingdon	Failed SET	12/07/2016	by 25/07/2016
London Westminster	Failed SET	12/07/2016	by 25/07/2016
Reading New Town	Failed SET	12/07/2016	by 25/07/2016
Wrexham	Failed SET	12/07/2016	by 18/07/2016
Yarner Wood	Failed SET	12/07/2016	by 01/08/2016
Norwich Lakenfields	Failed SET	12/07/2016	by 01/08/2016
Southend on Sea	Failed SET	12/07/2016	by 25/07/2016

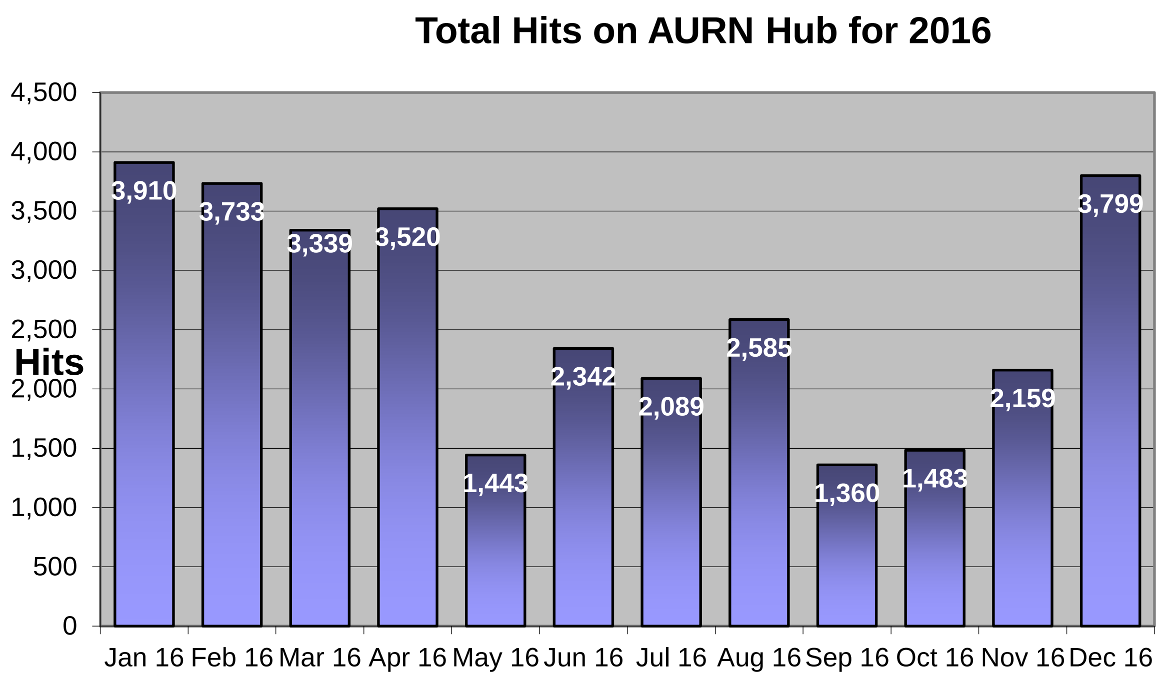
Station	Issue/Problem	Date went to 'High'	Date resolved
Glasgow High Street	Not known	12/07/2016	by 18/07/2016
Saltash Callington Road	Failed SET	14/07/2016	by 25/07/2016
Northampton Kingsthorpe	Failed SET	14/07/2016	by 01/08/2016
Manchester Piccadilly	Water Ingress	28/07/2016	by 01/08/2016
Ladybower	Failed SET	08/08/2016	12/09/2016
Glasgow Great Western	Failed SET	09/08/2016	02/09/2016
Glasgow Kerbside	Failed SET	09/08/2016	12/09/2016
Strathvaich	Failed SET	09/08/2016	05/09/2016
Lullington Heath	Not known	08/09/2016	12/09/2016
Rochester Stoke	Failed SET	21/11/2016	w/c 19/12/2016
Manchester Piccadilly	Failed SET	16/12/2016	w/c 19/12/2016

*The building housing the London Teddington monitoring station was closed for further asbestos removal in 2016. A further closure of at least 12 months is planned, for major refurbishment. The decision was made to mothball the station.

6 AURN Hub

A summary of the usage statistics of the AURN Hub is given in Figure 6.1.

Figure 6.1 Usage Statistics for the AURN Hub



7 Equipment Upgrade Requirements

7.1 Capital Purchases

No equipment upgrades are required at the present time. In early 2017 the Environment Agency made a capital purchase of the following items:

- Five Teledyne T750 ozone photometer/dilution units.
- Five Teledyne T751 zero gas generators.

These replaced several of the ozone photometers used in intercalibrations which had reached the end of their working lives and are not economic to repair.

7.2 Upgrade of Site Gas Regulators

As part of the ongoing maintenance of AURN monitoring stations, the gas regulators are being replaced on a rolling programme. It has been agreed that stations will be provided with selectable flow regulators (Model SI75, described at https://uk-air.defra.gov.uk/assets/documents/reports/empire/lsoman/lsoman.html) This model of regulator offers the following benefits:

- Easily controlled, repeatable flowrate minimising the waste of calibration gas
- Allows removal of critical flow orifices. This allows simplification of the sampling/gas delivery systems at stations, minimising the risk of sampling errors which can result in significant data loss

In order to make the best use of these regulators, all regulators at each station should be of the same type. These regulators have been installed by the QA/QC Unit at intercalibration visits, and training offered to LSOs in their correct operation.

8 Inventory of Defra-Owned Equipment

This section provides an updated list of all Defra-owned equipment used by the QAQC unit. Not all equipment listed is in operational condition.

Table 8.1 Current Asset List as held by Ricardo Energy & Environment

Location	Asset	Serial number	Date in service	Operational	Purpose
Harwell - Ludbridge Mill	API model M401	123	01/04/1999	N	Station ozone calibrations every three months
Glasgow	API model M401	151	01/10/2000	Y	
Harwell - Ludbridge Mill	API model M401	176	01/12/2002	Y	
Glasgow	API model M401	291	01/05/2004	Y	
Harwell - Ludbridge Mill	API model M401	245	unknown	Y	
Harwell - Ludbridge Mill	API model M401	292	01/05/2004	Y	
Harwell - Ludbridge Mill	API model M401	293	01/05/2004	Y	
Glasgow	API model M703	255	01/01/2010	Y	
Glasgow	Sabio 2010 dilution calibrator	03740708	01/02/2005	N	Dilution of high concentration gases to test linearities and converter efficiencies at station calibrations
Harwell - Ludbridge Mill	Sabio 2020 dilution calibrator	02720306B	01/06/2006	N	
Harwell - Ludbridge Mill	Sabio 2020 zero air generator	02710306B	01/06/2006	N	
Harwell - Ludbridge Mill	Sabio 2020 zero air generator	03731208C	01/03/2006	N	

Location	Asset	Serial number	Date in service	Operational	Purpose
Harwell - Ludbridge Mill	Sabio 2030 ozone photometer	7820708	01/03/2008	N	
Harwell - Ludbridge Mill	Sabio 2010 dilution calibrator	02940306A	01/03/2008	Y	
Glasgow	Drycal flow meter	110085	unknown	N	Measurement of sample flowrate of particulate analysers at station calibrations
Harwell - Ludbridge Mill	Drycal flow meter	107881	2006	Y	
Glasgow	Drycal low flow meter	6699	2002	N	
Glasgow	Sabio 2020 zero air source	03620708b	2006	N	Dilution of high concentration gases to test linearities and converter efficiencies at station calibrations
Glasgow	Sabio 2020 zero air source	03711208c	2006	N	
Harwell - Ludbridge Mill	Sabio 2020 zero air source	03701208c	2006	N	
Harwell - Ludbridge Mill	AC31 dual chamber NOx analyser	1672	01/03/2003	Y	For ad-hoc investigations at stations as required
Harwell - Ludbridge Mill	TEI 43C SO_2 analyser	386	01/03/2003	Y	
Harwell - Ludbridge Mill	TEI 48C CO analyser	48C-77631-386	01/03/2003	Y	
Harwell - Ludbridge Mill	M265 chemilumine scent ozone analyser	066	01/03/2003	Y	
Glasgow	API fluorescent S02 Analyser Model 100A	1572	unknown	Y	
Glasgow	Thermo NO-NO2-NOx Analyser Model 42c	42c-56236-307	unknown	Y	
Harwell - Ludbridge Mill	API model M703	278	30/06/2010	Y	

Location	Asset	Serial number	Date in service	Operational	Purpose
Harwell - Ludbridge Mill	API model M703	279	30/06/2010	Y	Station ozone calibrations every three months
Harwell - Ludbridge Mill	Ozone analyser Thermo 49i	713021784	unknown	Y	For calibration of ESU photometers
Harwell - Ludbridge Mill	API model M703	254	06/01/2010	Y	Station ozone calibrations every three months
Harwell - Ludbridge Mill	API model M703	18942	06/01/2010	Y	
Harwell - Ludbridge Mill	BIOS flowmeter	132883	27/8/2013	Y	Measurement of sample flowrate of particulate analysers at station calibrations
Harwell - Ludbridge Mill	BIOS flowmeter	134028	13/12/2013	Y	
Harwell - Ludbridge Mill	BIOS flowmeter	133530	13/12/2013	Y	
Harwell - Ludbridge Mill	Teledyne T750	147	01/04/2017	Y	Combined ozone photometers and dilution kits for station ozone analyser calibration and determination of analyser linearity and converter efficiency. Have associated zero air generators (T751)
Harwell - Ludbridge Mill	Teledyne T750	148	01/04/2017	Y	
Ricardo-Manchester	Teledyne T750	149	01/04/2017	Y	
Ricardo-Glasgow	Teledyne T750	150	01/04/2017	Y	
Ricardo-Glasgow	Teledyne T750	151	01/04/2017	Y	
Harwell - Ludbridge Mill	Teledyne T751	113	01/04/2017	Y	
Harwell - Ludbridge Mill	Teledyne T751	114	01/04/2017	Y	
Ricardo-Manchester	Teledyne T751	115	01/04/2017	Y	
Ricardo-Glasgow	Teledyne T751	116	01/04/2017	Y	
Ricardo-Glasgow	Teledyne T751	117	01/04/2017	Y	
Harwell-Ludbridge Mill	Teledyne T400		01/04/2017	Y	For calibration of ESU photometers

9 Improved Technology

9.1 Improvements Introduced

As mentioned in Section 1.4, the FDMS analysers at London Harlington were replaced by a Fidas 200 unit as of 1st January 2016. This is a light-scattering device capable of measuring many separate size fractions. This instrument is less temperature-sensitive than some other measurement methods and it is hoped that data loss in warm weather will be reduced.

10 Annual Data Capture 2016

10.1 Annual Data Capture 2016

The data capture across the whole network for 2016 is given in Table 10.1.

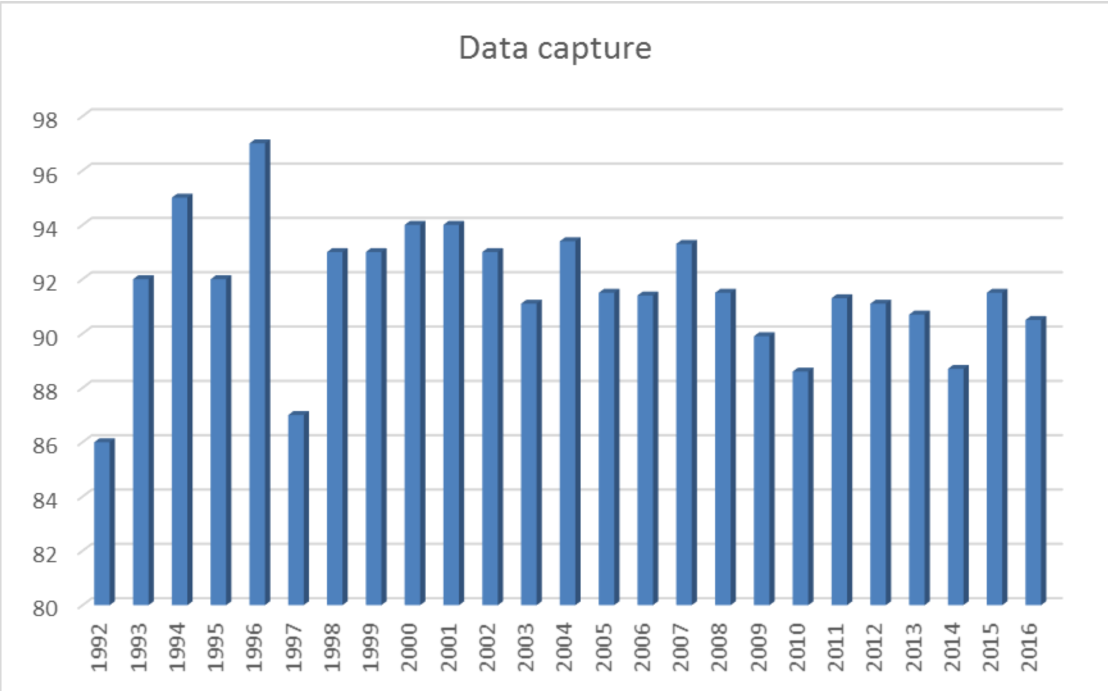
Table 10.1 Annual Data Capture, 2016

Name	CO	NO_2	O_3	PM_{10}	$PM_{2.5}$	SO_2	Annual Average
2016	91.76	92.17	94.21	86.56	87.81	89.37	90.76

The network average data capture was 90.76%, with 31 stations failing to meet the target of 85% and 50 being below 90%. Principal reasons for data loss include station infrastructure upgrades, sampling faults, poor analyser performance and persistent temperature problems.

Figure 10.1 shows average data capture from the AURN from 1992-2016.

Figure 10.1 Data capture (%) 1992-2016



10.2 Stations where Data Capture was below 85%

Table 10.2 shows the stations that failed to meet the requirement for 85% data capture across all the pollutants in 2016. The data capture target for the purposes of monitoring compliance with the EU Air Quality Directive (Directive 2008/50/EC) is 90% excluding planned servicing and maintenance. For practical purposes in the AURN, planned maintenance is assumed to be 5% so a target of 85% data capture is used.

Table 10.2 Stations below 85%, 2016

Station	Annual Data capture 2016 (%)
Oldbury Birmingham Road	84.78
Norwich Lakenfields	84.39
Stockton-on-Tees Eaglescliffe	84.29
Dumbarton Roadside	83.70
Cambridge Roadside	83.39
Southampton A33 Roadside	82.82
Narberth	82.60
Edinburgh St Leonards	82.56
Auchencorth Moss	82.30
Birmingham A4540 Roadside	82.13
Great Dun Fell	81.82
Bottesford	81.73
Reading London Road	80.90
Auchencorth Moss	80.27
Saltash Callington Road	80.08
Ballymena Ballykeel	79.83
Armagh Roadside	79.82
Wigan Centre	79.82
Liverpool Queen's Drive Roadside	77.90
Wicken Fen	77.28
London Westminster	75.41
Worthing A27 Roadside	74.74
London N. Kensington	73.50
York Bootham	72.60
Blackburn Accrington Road	71.68
Carlisle Roadside	66.45
Leominster	61.46
Exeter Roadside	61.06
London Teddington	56.84
Haringey Roadside	53.97
Southampton Centre	29.09
Oxford St Ebbes	19.10

Details of data loss and the causes are given in the previous quarterly reports.

11 Conclusions and Recommendations

Conclusions for Quarter 4 of 2016

1. During Quarter 4 of 2016 a total of 158 AURN monitoring stations operated at some point in the quarter (at 156 physical locations plus two co-located gravimetric analysers treated as separate sites for data processing purposes).
2. Data ratification for the quarter was completed by the deadline of 31st March 2017.
3. The mean data capture for ratified hourly average data was 93.02% (averaged over all pollutants O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$), for the three-month reporting period October – December 2016.
4. Mean data captures for individual pollutants were as follows: CO, 96.86%; NO_2, 93.50%; O_3, 92.84%; SO_2, 90.58%; PM_{10}, 93.89% and $PM_{2.5}$, 93.59%. The data capture target of the Air Quality Directive is 90% excluding periods of planned maintenance e.g. calibrations, audits and servicing). An allowance of 5% is made for this, hence a target of 85%. The mean data captures for all pollutants met this target in Q4 of 2016.

Conclusions for the Whole of 2016

1. During 2016, 14 new AURN monitoring stations were started up, either as part of the current AURN expansion programme or as replacements. Four monitoring stations closed down. There were therefore 156 monitoring stations in operation as of the end of the year (at 154 physical locations).
2. Three monitoring stations had additional analysers installed as part of the AURN expansion.
3. Data ratification for each quarter was completed by the specified deadline.
4. The mean data capture for ratified hourly average data was 90.76% (averaged over all pollutants O_3, NO_2, SO_2, CO, PM_{10} and $PM_{2.5}$), for the full calendar year.
5. Mean data captures for individual pollutants over the whole year were as follows: CO, 91.76%; NO_2, 92.06%; O_3, 94.18%; SO_2, 88.75%; PM_{10}, 86.02% and $PM_{2.5}$, 87.25%. The mean data capture for all pollutants therefore met the EU target of 85% (which allows for planned maintenance).
6. The uncertainty of measurement for each analyser has been determined in the summer and winter intercalibrations, to ensure compliance with the Data Quality Objective. In the winter 2016 intercalibration, 16% of analysers were found to be outside the required uncertainty, and in the summer intercalibration 13% of analysers were found to be outside the required uncertainty.

Recommendations:

1. The gas regulator replacement programme should be continued to include all regulators at each station replaced at the same time. This ensures the sampling system can be configured correctly at installation.

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