AEAT/R/ENV/BSrepsum01

Intercalibration Report for the Automatic Urban Network, September 2001

Brian Stacey

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Executive Summary

In July to September 2001, NETCEN conducted an intercalibration audit of 81 sites in the Automatic Urban Network. The tests were undertaken to cross-reference the individual data sets to common traceable calibration standards. This enabled the consistency of measurements throughout the network to be determined.

The results of the intercalibration are summarised in the table below:

Parameter	Number of outliers	Number in network	% outliers in total
Ozone analyser	15	47	32%
NOx analyser	20	77	26%
CO analyser	1	60	2%
SO_2 analyser	6	62	10%
TEOM analyser	5	55	9%
Partisol analyser		6	
Total	47	307	15%

An outlier is defined as an analyser that shows a deviation from the network mean of greater than 10% for NOx, CO and SO_2, 5% for O_3 and a k_0 deviation of more than 2.5% for TEOM.

In addition, 26 of the 274 site cylinders (9%) appeared to have drifted by more than 10% from their certificated values. Four NOx converters were found to be outside the 95% acceptance limit.

The number of analyser outliers identified has decreased significantly at this audit, compared to previous exercises. At the winter intercalibration, 25% of the analysers in use were identified as outliers.

The performance of the network analysers is graded in terms of how their performance could impact on data quality. This process has again highlighted that the majority of outliers are very minor in nature and should have minimal consequences for data capture or data quality.

The performance of 32 of the 65 Local Site Operators was also assessed during this exercise. All the LSO's that were assessed remain keen, and continue to perform their tasks to high standards.

Appended to this report is the UKAS Certificate of Calibration. The certificate presents the results of the individual analyser calibration factors on the day of the audit visit, as calculated by NETCEN using the audit transfer standards, in accordance with our UKAS accreditation to ISO 17025.

In summary, the network continues to operate at a high standard, providing data that are accurate, consistent and traceable to national metrology standards. This report presents the findings from the intercalibration exercise, listing outliers and identifying causes for any poor performance.

Contents

1 Introduction

AEA Technology's National Environmental Technology Centre (NETCEN) has undertaken an intercalibration of air quality monitoring sites in the Automatic Urban Network (AUN) in July to September 2001. These intercalibrations are used to complete a wide range of tests to evaluate the performance of each monitoring station. The following major checks are made:

1. **Analyser accuracy and precision**, as a basic check to ensure reliable datasets from the analysers.
2. **Instrument linearity**, to check that doubling a concentration of gas to the analyser results in a doubling of the analyser signal response. If an analyser is not linear, data cannot be reliably scaled into concentrations.
3. **Instrument signal noise**, to check for a stable analyser response to calibration gases.
4. **Analyser response time**, to check that the analyser responds quickly to a change in gas concentrations.
5. **Leak and flow checks**, to ensure that ambient air reaches the analysers, without being compromised in any way.
6. **NOx analyser converter efficiency**, to ensure reliable operation. This is the device that allows the publication of NO_2 datasets, so it must work acceptably.
7. **TEOM k_0 evaluation**. The analyser uses this factor to calculate mass concentrations, so the value is calculated to determine its accuracy.
8. **SO_2 analyser hydrocarbon interference**, as certain hydrocarbons are known to interfere with the SO_2 detector.
9. **Evaluation of site cylinder concentrations**, using a set of NPL certified cylinders that NETCEN take to all the sites. The concentrations of the site cylinders are used to scale pollution datasets, so it is important to ensure that the concentration of gas in the cylinder does not change.
10. **Competence of Local Site Operators** (LSO) in undertaking calibrations. Similarly, 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.

In addition to the above tests, a "Network Intercomparison" is conducted. This exercise relies upon the fact that NETCEN carry a set of cylinders (called "audit cylinders") to all the sites in the AUN. These cylinders have been recently calibrated by NPL, and allow us to examine how different site analysers respond when they are supplied with the same gas used at other sites.

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 on the day of the intercalibration. This factor is also used for sending out provisional data to the web/teletext/Met Office.
- These individual results are tabulated, and statistical analyses undertaken (e.g. network average result, network standard deviation, deviation of individual sites from the network mean etc.)

These results are then used to pick out problem sites, or "outliers", which are investigated further to determine reasons and investigate possible remedies for the outliers. The definition of an outlier is a site 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 TEOM analysers,
- ±10% for particulate analyser flow rates.

As stated, any outliers that are identified are rigorously checked to determine the cause, and corrective action taken, if necessary. Further details of the typical causes can be found in Section 2.

The procedures used to determine network performance are documented in AEA Technology Work Instructions. These methods are regularly updated and improved and have been evaluated by the United Kingdom Accreditation Service (UKAS). NETCEN holds UKAS accreditation for the on-site calibration of all the analyser types (NOx, CO, SO_2, O_3 and PM_{10}) used in the AUN. A UKAS Certificate of Calibration (Calibration Laboratory number 0401) for the urban sites in the AUN is appended to the report.

A total of 81 sites were audited in this exercise; direct funded sites at Dumfries, London Westminster and Inverness, and affiliated sites at Grangemouth, Cwmbrân, Bournemouth, Canterbury, Stockton-on-Tees Yarm, Wigan Leigh, Portsmouth and Northampton commenced operation during the previous six months. The 82nd site at Wrexham was vandalised immediately after installation, and is currently awaiting improved security measures before recommissioning.

This report presents the results for each pollutant, identifies analysers that did not meet performance standards, investigates the possible causes of these results and recommends any remedial action required to modify the datasets.

2 Analyser Performance

As with the winter 2001 intercalibration report, individual analyser performance has been graded, to provide an indication of how data quality may be affected by the intercalibration results.

The performance grades are as follows:

1. **A** This grade is indicative of an analyser performing very well. All of the tests undertaken were within the required limits, and the quality of the ratified dataset produced by this instrument should be of a high standard. No data should be lost.
2. **B** This grade is indicative of an analyser performing well. The results of the tests have highlighted a minor outlier (for example as a result of minor drift in calibration factor, or a result slightly outside acceptance criteria). This type of outlier is not likely to be

easily detected by the Local Site Operator or the CMCU. The quality of the ratified dataset produced by this analyser should be of a high standard. No data should be lost.

3. **C** This grade indicates an analyser performing acceptably. The results of the tests have highlighted a significant outlier (for example as a result of severe drift in calibration factor, or a result significantly outside acceptance criteria). Close examination of the performance history of the analyser may show that data could be retained, but may require substantial adjustments to the dataset to be performed. It is possible that this type of outlier could be detected by the LSO or CMCU during the scheduled calibrations, but it is likely that the fault will remain undetected until the network intercalibration visit. The LSO should compare the current results with those from previous visits, and carefully examine the progress of the current analyser calibration, to ensure "expected normal" behaviour. Any deviations from these patterns should be reported to CMCU immediately. The quality of the ratified dataset produced by this analyser should be of an acceptable standard. It is possible that some data could be rejected during the ratification process.

4. **D** This grade indicates a poorly performing analyser. The results of the tests have highlighted a serious fault or outlier (for example, a poor NOx converter result, or significant losses of calibration gas to the sampling system), which will have serious implications for the quality of the instrument dataset. Again, the LSO and CMCU might be able to detect this type of poorly performing analyser during the scheduled calibration visits, but it is possible that the fault remains undetected until the network intercalibration visit. The LSO should report any "abnormal" behaviour to the CMCU immediately, who will then decide whether any remedial action is required. Depending upon the cause of the outlier, it is possible that much of the dataset will be salvageable during ratification, but it is likely that significant portions of data will be rejected as a result.

5. **E** This grade indicates either a very poorly performing analyser, or that the analyser was not available for testing. The results of the tests have highlighted a very serious fault, or the analyser has completely malfunctioned during the course of the tests, preventing any meaningful results being obtained. Data from this type of analyser will be seriously compromised, and it will be clear to both the LSO and CMCU that there is a fault with the equipment. Depending upon the exact nature of the fault, it may be possible to save data from the analyser, but it is most likely that large portions of the dataset will need to be rejected.

To further aid the readability of the report, the grades are colour coded: GREEN for grade A and B analysers, YELLOW for grade C and D analysers, and RED for grade E analysers. The Table below presents a summary of the network intercalibration:

Date visited	Site	NOx	CO	SO_2	O_3	PM_{10}
Sites in Scotland						
	Aberdeen	**D**	**A**	**A**	-	**A**
	Dumfries	**A**	-	-	-	-
	Edinburgh Centre	**A**	**A**	**A**	**A**	**A**
	Glasgow Centre	**D**	**A**	**A**	**A**	**A**
	Glasgow City Chambers	**A**	**A**	-	-	-
	Glasgow Kerbside	**A**	**A**	-	-	**A**
	Grangemouth	**A**	-	**A**	-	**A**
	Inverness	**A**	**A**	-	-	-
Sites in Wales						
	Cardiff Centre	**A**	**A**	**A**	**A**	**A**
	Cwmbrân	**B**	-	**A**	-	**A**
	Port Talbot	**A**	-	**A**	**A**	**A**
	Swansea	**A**	**A**	**A**	**A**	**A**
	Wrexham	-	-	-	-	-
Sites in Northern Ireland						
	Belfast Centre	**A**	**A**	**A**	**B**	**B**
	Belfast Clara St	-	-	-	-	**A**
	Belfast East	-	-	**A**	-	-
	Derry	**C**	**A**	**B**	**A**	**A**
Sites in England						
	Barnsley 12	-	-	**A**	-	-
	Barnsley Gawber	**D**	-	**A**	**B**	-
	Bath Roadside	**A**	**A**	-	-	-
	Billingham	**A**	-	-	-	-
	Birmingham Centre	**A**	**A**	**A**	**A**	**A**
	Birmingham East	**A**	**A**	**A**	**A**	**A**
	Blackpool	**A**	**A**	**A**	**A**	**A**
	Bolton	**A**	**A**	**A**	**A**	**A**
	Bournemouth	**A**	-	**A**	-	-
	Bradford Centre	**A**	**B**	**A**	**A**	**A**
	Brighton Roadside	**A**	**A**	-	-	-
	Bristol Centre	**B**	**A**	**A**	**B**	**C**
	Bristol Old Market	**B**	**A**	-	-	-
	Bury Roadside	**A**	**A**	**A**	**A**	**A**
	Cambridge Roadside	**A**	-	-	-	-
	Canterbury	**A**	-	-	-	**A**
	Coventry Memorial Park	**A**	**A**	**A**	**A**	**B**
	Exeter Roadside	**A**	**A**	**A**	**B**	-
	Hove Roadside	**A**	**A**	**A**	-	-
	Hull Centre	**A**	**A**	**A**	**A**	**A**
	Leamington Spa	**B**	**A**	**A**	**A**	**A**
	Leeds Centre	**B**	**A**	**A**	**A**	**A**
	Leicester Centre	**A**	**A**	**A**	**A**	**A**
	Liverpool Centre	**A**	**A**	**B**	-	**A**

Date visited	Site	NOx	CO	SO_2	O_3	PM_{10}
	London A3 Roadside	A	A	-	-	A
	London Bexley	B	A	B	A	A
	London Bloomsbury	E	A	B	B	C
	London Brent	A	A	A	A	A
	London Cromwell Road 2	A	A	A	-	-
	London Hillingdon	A	A	A	A	A
	London Westminster	B	A	A	A	A
	Manchester Piccadilly	A	A	A	A	A
	Manchester South	A	-	A	A	-
	Manchester Town Hall	A	A	-	-	-
	Middlesbrough	A	A	A	A	A
	Newcastle Centre	B	A	A	A	A
	Northampton	A	-	A	-	B
	Norwich Centre	A	A	A	A	A
	Norwich Roadside	D	-	-	-	-
	Nottingham Centre	A	A	A	B	A
	Oxford Centre	A	-	A	-	-
	Plymouth Centre	B	A	A	A	A
	Portsmouth	A	-	A	-	B
	Preston	A	A	A	B	B
	Reading	B	A	B	B	A
	Redcar	B	A	A	B	A
	Rotherham Centre	A	-	A	B	-
	Salford Eccles	B	A	A	B	A
	Sandwell West Bromwich	A	A	A	A	-
	S'thorpe	-	-	A	-	A
	Sheffield Centre	A	A	A	B	A
	Sheffield Tinsley	A	A	-	-	-
	Southampton Centre	A	A	A	B	A
	Southend-on-Sea	A	A	A	A	A
	Stockport	A	A	A	-	A
	Stockton-on-Tees Yarm	A	-	-	-	A
	Stoke-on-Trent Centre	A	A	A	A	A
	Sunderland	-	-	A	-	-
	Thurrock	A	D	A	A	-
	Walsall Alumwell	A	-	-	-	-
	Walsall Willenhall	B	-	-	-	-
	West London	A	A	-	-	-
	Wigan Leigh	A	-	C	-	-
	Wirral Tranmere	B	A	A	A	A
	Wolverhampton Centre	A	A	A	C	A

Note: The Wrexham site was not audited due to vandalism.

Grade	A	B	C	D	E	Not tested
No of instruments	245	38	5	5	1	11

From the above table, it is clear that the vast majority of analysers (283 of the 305 analysers, 93%) in the network are functioning well. This compares well with the winter exercise, where 92% of the analysers were grade A or B. Of the remaining analysers, it is possible that data from the majority can be retained, but some investigation into the causes of the outliers needs to be undertaken. The following sections consider each pollutant in turn.

3 Ozone

The calibration of the ozone analysers was performed using NETCEN photometers certified against the Standard Reference Photometer (SRP), held at the National Physical Laboratory (NPL).

The results from 15 of the 47 analysers (32%) were found to be greater than 5% from the NETCEN standard at this intercalibration. The overall result is much better than the previous exercise, when 54% of the analysers were identified as outliers. Of the 15 outliers, 14 were minor grade B; the Wolverhampton analyser was grade C. This was attributed to a large drift in the instrument response, which should be correctable during ratification.

Subsequent investigations revealed instrument response drift as the main reason for all of the other outlying analysers. Ratification of the data from these sites should be relatively straightforward.

The analyser at Liverpool was not tested due to a fault with the NETCEN photometer during the test.

Despite the fact that a large number of outliers were identified, all were relatively minor in nature. The ratification process should produce reliably scaled datasets, with only minimal consequences for data capture.

4 Nitrogen Oxides

Twenty of the 77 analysers tested (26%) were identified as outliers, giving calculated values that were more than 10% from the network mean response. This result is much better than the previous intercalibration, when 43% of the analysers were found to be outliers.

Close investigation of the results showed that 14 of these outliers were of minor grade B, 1 of grade C 4 of grade D and 1 of grade E.

The grade B outliers were all seen as a result of minor drifts or step changes in analyser response between scheduled LSO calibrations, which will be easily corrected during ratification, without any loss of data.

The analyser at Derry seen to exhibit considerable differences in response when gas was introduced through the sample inlet, as opposed to the dedicated cylinder inlet. This may well have significant consequences for ambient data, as the results from the scheduled calibrations do not appear to accurately represent what the analyser samples from ambient air.

The analyser scaling factors at London Bexley appear to be incorrect, as supplied by CMCU. This is easily correctable, and will not affect data capture for the site.

The analyser at London Bloomsbury broke down during the audit visit; thus its performance could not be evaluated. It is unlikely that data will need to be rejected as a result of this finding.

Comparison of the network average results against the actual cylinder concentrations showed that the network overestimates NO concentrations by approximately 2% of actual concentrations, with a percentage standard deviation around this value of 3.9%. This is a very good result, which demonstrates that measurements are accurate, consistent and traceable to metrology standards.

The result of the network NO_2 intercomparison shows that the network appears to underestimate concentrations by an average of 2.8%, with a percentage standard deviation around this value of 4.1%. This is also a good result, which demonstrates that measurements of NO_2 are accurate, consistent and traceable to metrology standards.

The NOx converters at four sites (5%) were found to have fallen below the 95% acceptance limit:

1. Aberdeen 92%
2. Barnsley Gawber 86%
3. Glasgow Centre 91%
4. Norwich Roadside 85%

The performance of the analysers at these sites will be closely scrutinised during ratification, and it is possible that some data will need to be rejected as a result. The ESUs should continue to undertake three monthly converter tests to ensure optimal performance.

Recommendation: ESU to undertake three monthly converter tests at the above sites

5 Carbon Monoxide

Just one of the 60 analysers (2%) was identified as an outlier. This is much better than the previous exercise, when 14% of the analysers were found to be outside the acceptance limits.

The analyser at Oxford Centre was away for repair at the time of the audit visit; the analyser at Dumfries had not been commissioned prior to the audit.

The analyser at Thurrock was suffering from a truncated zero response at the time of the audit, resulting in an apparent underread. All available data will be used to review this result, but it is likely that significant portions of data will need to be rejected as a result of this finding.

Comparison of the network average results against the actual cylinder concentrations showed that, overall, the network continues to measure concentrations of CO to within 1% of actual values, with a percentage standard deviation of 3.4%. This is an excellent result, demonstrating that measurements are accurate, consistent and traceable to metrology standards.

6 Sulphur Dioxide

The analysers at six of the 62 sites (10%) were identified as outliers, giving calculated values that were more than 10% from the network mean response. Of these outliers, 5 were grade B, 1 was grade C. This result is similar to the previous intercalibration, when seven analysers were found to be outliers.

The outliers at Derry, Liverpool Centre, London Bloomsbury and Reading were all seen as a result of minor drifts or step changes in analyser response between scheduled LSO calibrations, which will be easily corrected during ratification, without any loss of data.

The analyser scaling factor at London Bexley appears to be incorrect, as supplied by CMCU. This is easily correctable, and will not affect data capture for the site.

The analyser at Wigan Leigh was seen to drift significantly over the time between LSO calibration and the QA/QC audit. This should be correctable during ratification, with minimal consequences for data capture.

Comparison of the network average results against the actual audit cylinder concentrations showed that, overall, the network measures SO_2 concentrations to within 1%, with a percentage standard deviation of 4.2%. This is an excellent result, and demonstrates that measurements are accurate, consistent and traceable to metrology standards.

The efficiency of the hydrocarbon “kicker” was evaluated with a 1 ppm m-xylene cylinder. The kicker selectively removes hydrocarbons from the sample inlet prior to analysis. This is an

important test, because m-xylene behaves in a similar manner to SO_2 when exposed to UV light, and could therefore interfere with the analyser response, if the kicker doesn't function properly.

To pass the test, the analyser must not respond by more than 1% (10 ppb) of the m-xylene cylinder concentration. However, it should be noted that this particular test is very demanding; typical ambient hourly maximum concentrations of this pollutant rarely exceed 50 ppb, and annual concentrations rarely exceed 5 ppb.

The following 9 analysers were significantly outside the required standard:

1. Belfast East (16 ppb)
2. Bury Roadside (30 ppb)
3. Coventry Memorial Park (17 ppb)
4. Derry (24 ppb)
5. Exeter Roadside (18 ppb)
6. London Hillingdon (19 ppb)
7. Manchester South (19 ppb)
8. Nottingham Centre (20 ppb)
9. Wolverhampton Centre (19 ppb)

The kicker at Manchester South was also identified as an outlier at the previous exercise.

These results are the same as the previous intercalibration, when 9 analyser kickers were identified as outliers. However the magnitude of the responses to m-xylene was lower; none of these results give immediate cause for concern.

To put these results into perspective, at the expected maximum ambient concentrations of m-xylene (50ppb), the worst kicker would show an interference response of around 2 ppb.

In addition, there were 7 analysers that were just outside the 10ppb acceptance criteria (between 10 and 15ppb). These will be carefully checked at the next intercalibration, and remedial action recommended as necessary.

7 Particulates

7.1 TEOM ANALYSERS

Evaluation of the TEOM instrument k_0 calibration constants, using a series of pre-weighed filters, showed that five analysers were outside the ± 2.5% acceptance limit:

1. Belfast Centre (-3.2%)
2. Coventry Memorial Park (-4.6%)
3. Northampton (-2.7%)
4. Portsmouth (-2.9%)
5. Preston (-6.2%)

The analysers at Coventry Centre and Preston were repeat outliers, having been identified at the winter intercalibration. The Preston analyser had been adjusted at the winter intercalibration (as an outlier of –24%), but it seems that this adjustment has not been completely successful. It should be possible to rescale the data from these sites with no loss of data.

The remainder of the outliers were minor in magnitude, and it should be relatively straightforward to rescale the datasets.

These k_0 results should be verified by the appropriate ESU, and remedial action taken as necessary

Recommendation: ESUs to verify the results at the above sites, and take remedial action as necessary

These results give some cause for concern: there are more outliers identified at this intercalibration exercise than have been recorded in total for the nine years of operation of the TEOM in the network. There do not appear to be any clear trends to identify reasons for these outliers; the analysers are a wide range of ages, types and direct funded/affiliated instruments. NETCEN is working closely with the ESU / manufacturer to resolve this position and particular attention will be paid to this test at the next intercalibration

The analyser at Thurrock was in the process of being repaired following water damage at the time of the audit.

The flow rates of the analysers at Bristol Centre and London Bloomsbury were found to be significantly below the required 16.67 l/min. Data from these instruments will be carefully examined, and it is possible that some data will need to be rejected as a result. No significant flow errors or leaks were found at any of the other sites.

7.2 BAM ANALYSER

The flow rate of the analyser at Belfast Clara Street was found to be within acceptable limits.

7.3 PARTISOL ANALYSERS

These gravimetric daily samplers have been or are being installed at the following sites in the network:

1. Dumfries (not commissioned at the time of the audit)
2. Inverness
3. Wrexham (yet to be commissioned)
4. Bournemouth (not tested at the audit)
5. Northampton (not operational at the time of the audit)
6. London Westminster (yet to be commissioned)

At the time of the Inverness intercalibration visit, the analyser reported a filter exchange fault, preventing a flow test being carried out.

8 Site Cylinder Concentrations

During the intercalibration, the concentrations of the on-site cylinders were evaluated using the audit cylinder standards. The calculated results showed that 26 of the 274 cylinders (~9%) appear to be outside the ±10% acceptance criterion. This is similar to the previous intercalibration, where 8% of the cylinders were found to be out of specification. The site cylinder evaluations are performed by calibrating the analysers with audit and site cylinder gas through the same inlet system, and using the conditioned site cylinder regulators, thus minimising any possible errors due to contaminated tubing or regulators.

4 NO cylinder outliers were identified. Of these, the cylinders at Cwmbrân, Glasgow Centre and Stockton-on-Tees Yarm are of most concern, as the NO concentrations alone have changed significantly, suggesting the cylinders may have become contaminated. These should be returned to NPL for replacement at the earliest opportunity.

Recommendation: NPL to replace the Cwmbrân and Glasgow Centre NO cylinders

21 NO_2 outliers were found. Of the outliers identified, only the cylinder at Aberdeen gives any cause for concern, as it was found to be 33% different from its certified value. However, as NO_2 cylinders are not routinely used to scale NOx data, the requirement for replacement is not urgent. The calculated concentration of this cylinder will be carefully checked at the next intercalibration.

Only one SO_2 outlier was identified. The calculated concentration of the cylinder at London Cromwell Road 2 appears to have drifted by 35% from its stated values. The calculated concentrations of this cylinder will be carefully checked at the next intercalibration.

As with earlier exercises, the site cylinder concentrations evaluated at the on-site audit are not used to update the cylinder databases. This is because the certified values provided by the Calibration Laboratories at NPL and NETCEN have much better uncertainties associated with their calculations. The field calculation is used as a check to identify possible outlier cylinders, which can be subsequently assessed by returning the cylinder for re-certification.

All of the revised calculations will be carefully assessed at the next intercalibration exercise, and any recurring outlier cylinders will be reported to NPL.

9 Assessment of sampling inlets

During this intercomparison exercise, the potential losses of sample gas to the inlet systems were assessed, using audit cylinder gas.

At a scheduled fortnightly calibration, the LSO introduces gases into the analysers through dedicated, clean gas cylinder inlets. These calibrations are then used to scale raw data from the analysers.

Audit cylinder gases and site cylinder gases were introduced to the analysers at the sample inlet, and the responses compared to the previous LSO calibration, to determine any significant differences between the two methods.

In previous intercalibrations, affected analysers were seen to exhibit pressure sensitivity when audit gases were introduced into the sample inlets. This meant that if the excess flows to the analyser were increased, even by a small amount, the analyser responses would increase, and vice versa. As a result, it has proved extremely difficult to reliably estimate losses to the manifolds for the analysers at affected sites.

At this exercise, the vast majority of the sites showed losses of less than 10% to the sample inlet. Only the NOx analyser at Derry was seen to exhibit apparent losses to the sampling / calibration system. This is an encouraging result, continuing the trend of progressively fewer incidences of sample gas losses to the inlet manifold, since the phenomenon was first observed.

10 LSO Audits

During the intercalibration, 32 of the 65 Local Site Operators were audited; to assess their performance in undertaking scheduled calibrations. As with previous audit exercises, the majority of LSO's undertake calibrations competently, and are very knowledgeable about the equipment used on site and procedures employed in the network. During the intercalibration, we have also undertaken a number of assessments of relatively new LSO's (for example at Inverness, Dumfries, Northampton and Cwmbrân), to ensure that their training has been successfully undertaken. These were very successful, with very few adjustments of their operating techniques required to fully conform to the Operator Manual.

This LSO audit exercise once again demonstrates that operators are generally competent, enthusiastic and knowledgeable about their sites, which is a major contributing factor in ensuring the continued high performance of the network.

11 Certification

Appended to this report is the Network Certificate of Calibration. This certificate presents the results of the individual analyser scaling factors on the day of the audit visit, as calculated by NETCEN using the audit cylinder standards, in accordance with our UKAS accreditation.

12 Summary

The intercalibration exercise has demonstrated its value as an effective tool in determining overall site performance and assessing the reliability and traceability of air quality measurements from a large scale network. The results from this intercalibration will be used to assess data quality during the ratification of the network datasets for the 6-month period January – June 2001.

Appendices

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Appendix 1
Certificate of Calibration

CERTIFICATE OF CALIBRATION

AEA Technology Environment

Culham, Abingdon, Oxfordshire OX14 3ED. Telephone 01235 463099 Facsimile 01235 463011

UKAS CALIBRATION

0401
0401 S1

Certificate No: 00606
AEA Identification Number: 20568104

Approved Signatories: ✓K. Stevenson
S. Eaton

Signed: Date:

Date of issue: 12 December 2001

Customer Name and Address: Mr Alan Irving
AEQ Division
Department for Environment, Food and Rural Affairs
Ashdown House (Zone E14)
123 Victoria Street
London SW1E 6DE

Description: Calibration factors for monitoring stations in the Automatic Urban Monitoring Network

1. Carbon Monoxide

Date Year =2001	Site	Analyser number	[1]Zero output	Uncertainty (ppm)	[2]Calibration Factor	Uncertainty (%)	*R^2
	Scottish Sites						
12/09	Aberdeen	10269	-45	0.3	0.010	3.0	0.9918
23/07	Edinburgh Centre	co11m-79	55	0.3	0.047	3.0	0.9974
24/07	Glasgow Centre	gra410-009	-2	0.3	0.049	3.0	0.9980
24/07	Glasgow City Chambers	m300-721	-9	0.3	0.047	4.0	0.9987
24/07	Glasgow Kerbside		9	0.3	0.054	4.7	0.9988
11/09	Inverness	300-1500	-28	0.3	0.010	3.0	0.9990
	Welsh Sites						
22/08	Cardiff Centre	co11m080	30	0.3	0.052	3.0	1.0000
21/07	Swansea	m300-070	-4	0.3	0.050	3.0	0.9999
	N.Irish Sites						
17/07	Belfast Centre	769	19	0.3	0.049	3.0	0.9999
18/07	Derry	J AR 009	0	0.3	0.054	3.0	1.0000

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

AEA TECHNOLOGY ENVIRONMENT

CERTIFICATE OF CALIBRATION

UKAS CALIBRATION

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Certificate No: 00606
AEA Identification Number: 20568104

Date Year =2001	Site	Analyser number	[1]Zero output	Uncertainty (ppm)	[2]Calibration Factor	Uncertainty (%)	*R^2
	English Sites						
11/07	Bath Roadside	eti11388	-27	0.3	0.053	3.0	0.9987
23/07	Birmingham Centre	92376	45	0.3	0.051	3.0	0.9993
26/07	Birmingham East		-17	0.3	0.054	3.0	0.9997
31/07	Blackpool		2	0.3	0.046	3.0	0.9954
11/07	Bolton	2392	1	1.5	1.142	6.9	0.9987
06/09	Bradford Centre		-2	0.3	0.053	3.0	0.9999
30/08	Brighton Roadside	api300-14	20	0.3	0.049	3.0	0.9995
31/07	Bristol Centre	CO11 - 2	42	0.5	0.057	3.0	0.9994
30/07	Bristol Old Market	n121	20	0.3	0.054	3.0	0.9997
10/07	Bury Roadside	1357	0	0.3	0.972	5.0	0.9987
12/07	Coventry Memorial Park		-2	0.3	0.046	3.0	1.0000
01/08	Exeter Roadside	244	11	0.3	0.055	3.0	0.9998
30/08	Hove Roadside	1433	-28	0.3	0.053	3.0	0.9999
20/08	Hull Centre	co11m-77	128	1.0	0.048	6.5	0.9984
19/07	Leamington Spa	219b	61	0.3	0.052	3.0	0.9980
07/09	Leeds Centre		47	0.3	0.048	3.0	0.9999
17/08	Leicester Centre	c011m-104	103	0.3	0.049	3.0	0.9999
07/08	Liverpool Centre	93097	50	0.3	0.051	3.9	0.9984
04/07	London A3 Roadside		-3	0.3	0.052	3.0	0.9991
03/07	London Bexley	M300-079	19	0.3	0.051	3.0	0.9973
04/07	London Bloomsbury	159	67	0.3	0.047	3.0	0.9999
16/07	London Brent	9830-33	66	0.7	0.055	3.8	0.9990
29/08	London Cromwell Road 2	10776	9	0.3	0.051	3.0	0.9992
02/07	London Hillingdon	410-005	-3	0.3	0.047	3.0	0.9989
08/08	London Westminster	300-867	5	0.3	0.050	3.0	0.9999
01/08	Manchester Piccadilly	gra0410-0	15	0.7	0.052	3.9	0.9941
02/08	Manchester Town Hall	m300-720	-1	0.3	0.047	3.0	0.9993
14/08	Middlesbrough	m300-214	9	0.3	0.053	3.0	0.9998
14/08	Newcastle Centre	co11m-91	45	0.3	0.053	3.0	0.9999
13/08	Norwich Centre		9	0.3	0.054	3.0	Failed leak test
21/08	Nottingham Centre		-39	0.3	0.047	3.0	0.9991
02/08	Plymouth Centre	410-200	37	0.3	0.006	3.0	0.9990

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Date Year =2001	Site	Analyser number	[1]Zero output	Uncertainty (ppm)	[2]Calibration Factor	Uncertainty (%)	*R^2
25/07	Preston		-7	0.3	0.051	3.0	0.9999
03/07	Reading		8	0.3	0.056	3.0	0.9999
13/08	Redcar	m300-610	10	0.3	0.050	3.0	0.9999
01/08	Salford Eccles	9830-43	0	0.3	0.995	5.0	0.9995
20/07	Sandwell West Bromwich	94603	7	0.3	0.053	3.0	0.9997
03/09	Sheffield Centre	0410-006	4	0.3	0.051	3.0	0.9998
03/09	Sheffield Tinsley	828	-2	0.3	0.047	3.0	0.9998
05/07	Southampton Centre	c011m-90	19	0.3	0.057	3.0	0.9998
07/08	Southend-on-Sea		-5	0.3	0.052	3.0	0.9999
12/07	Stockport	1701	21	0.3	0.052	3.0	0.9987
09/07	Stoke-on-Trent Centre	AR 003	-1	0.3	0.053	3.0	0.9994
07/08	Thurrock	300-262	2	0.3	0.060	3.0	0.9996
29/08	West London	92915	71	0.3	0.048	3.0	0.9996
24/07	Wirral Tranmere		-7	0.3	0.049	3.0	1.0000
30/07	Wolverhampton Centre	gra0410-007	-3	0.3	0.058	3.0	0.9983

2. Sulphur Dioxide

Date Year =2001	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*R^2	m-xylene interference (ppb)
	Scottish Sites							
12/09	Aberdeen	12182	0	4	0.216	5.0	0.9978	2.2
23/07	Edinburgh Centre	m100-50	19	4.2	0.208	5.0	0.9987	6.4
24/07	Glasgow Centre	477-018	-48	4.9	0.244	5.0	0.9978	11.7
23/07	Grangemouth	703B-274	1	4.2	1.017	5.0	0.9987	5.1
	Welsh Sites							
22/08	Cardiff Centre	m100-054	9	4.1	0.201	5.0	0.9933	2.8
20/08	Cwmbran	350e-4080	5	4.1	0.941	5.0	0.9917	5.6
22/08	Port Talbot	m100-943	1	4.3	1.073	5.0	0.9914	3.5
21/07	Swansea	m100-168	8	4	0.201	5.0	0.9968	3.0
	N.Irish Sites							
17/07	Belfast Centre	m100-052	18	4	0.197	5.0	0.9994	7.9
17/07	Belfast East	703	3	4.2	0.802	5.0	0.9998	15.8
18/07	Derry	j-ar-009	0	4.1	0.838	5.0	0.9998	23.5
	English Sites							
04/09	Barnsley 12	706	3	4.2	0.977	5.0	1.0000	4.9
04/09	Barnsley Gawber		92	5.9	1.276	5.0	0.9952	1.0

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Date Year =2001	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*R^2	m-xylene interference (ppb)
23/07	Birmingham Centre	92378	143	4.1	0.183	5.0	0.9998	0.5
26/07	Birmingham East		17	4.1	0.190	5.0	0.9996	8.8
31/07	Blackpool		17	10.6	3.018	5.0	0.9980	11.3
11/07	Bolton	2344	0	4.2	1.037	5.0	0.9978	5.2
29/08	Bournemouth	API-1179	1	4.2	1.030	5.0	0.9983	7.6
06/09	Bradford Centre		242	4.7	1.095	5.0	0.9994	1.9
31/07	Bristol Centre	115	-29	4.5	0.199	5.0	0.9997	9.4
10/07	Bury Roadside	1581	38	4.6	0.911	5.0	0.9964	29.8
12/07	Coventry Memorial Park		248	4.4	1.308	5.0	0.997	17.0
01/08	Exeter Roadside	634(1835)	20	4.4	1.026	5.0	0.9998	18.0
30/08	Hove Roadside	1178	-28	4.4	0.984	5.0	0.9988	6.4
20/08	Hull Centre	m100-205	77	4.1	0.200	5.0	0.9960	1.6
19/07	Leamington Spa	1793	24	4.3	1.054	5.0	0.9986	9.5
07/09	Leeds Centre		20	4	0.193	5.0	0.9985	0.8
17/08	Leicester Centre	m100-204	-27	4.1	0.210	5.0	0.9911	7.2
07/08	Liverpool Centre	93099	10	4	0.224	5.0	0.9992	1.8
03/07	London Bexley	M100-066	1	4.5	1.186	5.0	0.9971	11.3
04/07	London Bloomsbury	92329	22	4.6	0.22	5.0	0.9997	4.0
16/07	London Brent	9850-63	21	4.2	1.002	5.0	0.9983	12.0
29/08	London Cromwell Road 2	10779	1	4.2	1.065	5.0	1.0000	4.3
02/07	London Hillingdon	477-017	30	4	0.199	5.0	0.9974	18.5
08/08	London Westminster	100a-705	2	4.1	0.881	5.0	0.9999	7.9
01/08	Manchester Piccadilly	gra0477-0	6	5.4	0.211	5.0	0.9947	13.2
31/07	Manchester South	E4770104	-20	5.6	0.222	5.0	0.9990	19.4
14/08	Middlesbrough	m100-161	9	4.1	0.216	5.0	0.9997	7.3
14/08	Newcastle Centre	m100-116	-8	4.1	0.213	5.0	0.9995	5.9
09/07	Northampton	890563033	1	4.1	0.796	5.0	0.9977	1.6
13/08	Norwich Centre		104	5.7	1.102	5.0	0.9990	8.5
21/08	Nottingham Centre	477-016	360	10.5	0.463	5.0	0.9955	20.0
02/07	Oxford Centre	3768-161	103	4.1	0.961	5.0	0.9993	2.9
02/08	Plymouth Centre	43a-35689-251	11	4.4	0.104	5.0	0.9998	14.2
10/07	Portsmouth	578323093	1	4.3	1.162	5.0	0.9969	1.2
25/07	Preston		63	4.4	1.351	5.0	0.9996	6.8
03/07	Reading		190	4.1	0.812	5.0	0.9999	8.1
05/09	Rotherham Centre	d4770109	-4	4.4	1.101	5.0	0.9999	-7.2
01/08	Salford Eccles	9850-79	1	4.3	1.010	5.0	0.9987	12.6

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20/07	Sandwell West Bromwich	93082	4	4.2	0.998	5.0	0.9993	4.0
20/08	Scunthorpe		-1	4.2	1.024	5.0	0.9999	8.2
03/09	Sheffield Centre	0477-015	-7	4.1	0.203	5.0	0.9998	1.6
05/07	Southampton Centre	m100-203	-16	4.1	0.188	5.0	0.9999	4.1
07/08	Southend-on-Sea		100	4.5	1.249	5.0	0.9999	6.6
12/07	Stockport	1690	19	4.8	0.998	5.0	0.9982	8.0
09/07	Stoke-on-Trent Centre	AR 003	252	11.7	1.063	5.0	0.9992	5.6
15/08	Sunderland	m100-508	-2	4.1	0.862	5.0	0.9999	5.2
07/08	Thurrock	100A-555	3	4.2	1.011	5.0	0.9999	6.1
08/08	Wigan Leigh		1	4.3	1.042	5.0	0.9991	6.5
24/07	Wirral Tranmere		151	6.8	1.092	5.0	0.9994	7.6
30/07	Wolverhampton Centre	gra477-014	8	7.8	0.206	5.0	0.9905	18.9

3. Ozone

Date Year =2001	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*R^2
	Scottish Sites						
23/07	Edinburgh Centre	m400-053	-13	3	0.096	3.2	0.9999
24/07	Glasgow Centre	427-013	-10	3	0.201	3.4	0.9994
	Welsh Sites						
22/08	Cardiff Centre	m400-057	29	3	0.102	3.1	1.0000
22/08	Port Talbot	api300-83	2.5	3	0.497	3.1	1.0000
21/07	Swansea	api400-156	14	3	0.097	3.1	1.0000
	N.Irish Sites						
17/07	Belfast Centre	m400-051	8	3	0.094	3.1	1.0000
18/07	Derry	j-ar-009	0	3	1.019	3.1	0.9999
	English Sites						
04/09	Barnsley Gawber		3	3	1.107	3.1	0.9998
23/07	Birmingham Centre	92379	23	3	0.105	3.1	1.0000
26/07	Birmingham East	92456	5	3	0.097	3.1	1.0000
31/07	Blackpool	l-ar-010	0	3	0.992	3.6	0.9998
11/07	Bolton	2871	3	3	0.996	3.1	0.9999
06/09	Bradford Centre		0	3	0.997	3.1	0.9999
31/07	Bristol Centre	m400-95	14	3	0.092	3.1	1.0000
10/07	Bury Roadside	1453	2	3	1.000	3.1	0.9999
12/07	Coventry Memorial Park		0	3	1.002	3.1	0.9995

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01/08	Exeter Roadside	9812-94	20	3	1.22	3.5	0.9999
20/08	Hull Centre	m400-219	0	3	0.103	3.1	0.9999
19/07	Leamington Spa	1469	20	3	1.055	3.2	0.9999
07/09	Leeds Centre	m400 056	-7	3	0.102	3.1	1.0000
17/08	Leicester Centre	M400 218	-10	3	0.098	3.1	1.0000
03/07	London Bexley	m400-062	3	3	0.477	3.1	0.9999
04/07	London Bloomsbury	92371	8	3	0.123	3.2	0.9998
16/07	London Brent	9812-12	17	3	0.487	3.4	0.9998
02/07	London Hillingdon	427-012	8	3	0.099	3.1	0.9994
08/08	London Westminster	400-879	8	3	0.475	3.1	1.0000
01/08	Manchester Piccadilly	E4270102	-10	3	0.194	3.5	0.9998
31/07	Manchester South	ETI93122	-8	3	0.095	3.2	0.9999
14/08	Middlesbrough	m400-149	13	3	0.095	3.1	1.0000
14/08	Newcastle Centre	m400-96	-3	3	0.1	3.1	1.0000
13/08	Norwich Centre	gra0427-0	1	3	1.017	3.1	0.9996
21/08	Nottingham Centre	427-011	-1	3	0.111	3.1	0.9982
02/08	Plymouth Centre	35925-251	13	3	0.049	3.1	1.0000
25/07	Preston		0	3	1.09	3.1	1.0000
03/07	Reading	h-ar-004	4	3	1.146	3.1	0.9997
13/08	Redcar	799	3	3	0.472	3.1	1.0000
05/09	Rotherham Centre	D4270106	1	3	1.009	3.1	0.9997
01/08	Salford Eccles	194	-8	6.8	0.887	4.5	0.9968
20/07	Sandwell West Bromwich	93083	0	3	0.493	3.1	0.9996
03/09	Sheffield Centre	427-010	-15	3	0.106	3.1	1.0000
05/07	Southampton Centre	m400-217	8	3	0.091	3.1	0.9999
07/08	Southend-on-Sea		0	3	0.978	3.1	0.9999
09/07	Stoke-on-Trent Centre	AR 003	3	3	0.972	3.1	0.9996
07/08	Thurrock	400-1040	0	3	0.484	3.1	0.9999
24/07	Wirral Tranmere	10788	0	3	0.954	3.1	0.9999
30/07	Wolverhampton Centre	0427-009	0	3	0.074	3.2	0.9999

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4. Oxides of Nitrogen

Date Year =2001	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*R^2	*Converter efficiency (%)
	Scottish Sites								
12/09	Aberdeen	NO	10268	4	5	0.253	5.0	0.9981	
		NOx		5	5.2	0.256	5.0	0.9982	92.2
10/09	Dumfries	NO	200-1494	5	5	0.426	5.0	0.9977	
		NOx		2	5.4	0.43	5.0	0.9980	98.5
23/07	Edinburgh Centre	NO	m200-092	-9	5	0.47	5.0	0.9981	
		NOx		1	5.4	0.473	5.0	0.9981	99.3
24/07	Glasgow Centre	NO	gra447-011	-6	5	0.443	5.0	0.9973	
		NOx		3	5.5	0.455	5.0	0.9973	90.5
24/07	Glasgow City Chambers	NO	m200-575	1	5	1.297	5.0	0.9984	
		NOx		2	5.5	1.307	5.0	0.9982	95.2
24/07	Glasgow Kerbside	NO	Ambirak H	10	6.8	2.511	5.0	0.9966	
		NOx		9	8.4	2.551	5.0	0.9964	98.6
23/07	Grangemouth	NO	700B-312	-1	5	1.036	5.0	0.9987	
		NOx		-1	5.4	1.068	5.0	0.9988	97.5
11/09	Inverness	NO	m200-1489	-2	5	0.394	5.0	0.9976	
		NOx		-1	5.2	0.398	5.0	0.9977	98.7
	Welsh Sites								
22/08	Cardiff Centre	NO	m200-033	7	5	0.336	5.0	0.9999	
		NOx		1	5.3	0.33	5.0	0.9999	99.1
20/08	Cwmbran	NO	350e-4060	1	5	1.051	5.0	0.9992	
		NOx		4	5.5	1.142	5.0	0.9993	99
22/08	Port Talbot	NO	m200-320	-1	5	1.037	5.0	0.9995	
		NOx		-2	5.4	1.03	5.0	0.9997	100
21/07	Swansea	NO	api200-148	0	5	0.585	5.0	0.9998	
		NOx		-3	6.2	0.583	5.0	0.9999	95.2
	N.Irish Sites								
17/07	Belfast Centre	NO	m200-038	2	5	0.33	5.0	0.9999	
		NOx		-9	5.3	0.326	5.0	1.0000	99
18/07	Derry	NO	j-ar-009	19	5.1	1.968	5.0	0.9977	
		NOx		12	6.8	1.897	5.0	0.9912	97.2
	English Sites								
04/09	Barnsley Gawber	NO		34	11.3	3.179	5.0	0.9987	
		NOx		34	13.5	3.17	5.0	0.9987	85.9
11/07	Bath Roadside	NO	eti11690	1	5	1.12	5.0	0.9972	
		NOx		1	5.3	1.122	5.0	0.9981	95.1
14/08	Billingham	NO	574	5	5.3	2.185	5.0	0.9999	
		NOx		5	7	2.169	5.0	1.0000	96.6
23/07	Birmingham Centre	NO	92377	-10	5	0.416	5.0	0.9999	
		NOx		3	5.2	0.424	5.0	1.0000	99

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Date Year =2001	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*R^2	*Converter efficiency (%)
26/07	Birmingham East	NO NOx	92457	-3 -3	5 5.8	0.451 0.453	5.0 5.0	0.9997 0.9997	98.8
31/07	Blackpool	NO NOx	l-ar-010	41 41	10.4 11.1	2.896 2.913	5.0 5.0	0.9953 0.9946	96.1
11/07	Bolton	NO NOx	2359	1 2	5 5.6	0.921 1.261	5.0 5.0	0.9981 0.9986	97.2
29/08	Bournemouth	NO NOx	API-522	2 1	5 5.6	1.11 1.112	5.0 5.0	0.9978 0.9980	95.4
06/09	Bradford Centre	NO NOx		22 23	6.6 8.7	2.439 2.487	5.0 5.0	0.9980 0.9980	98.2
30/08	Brighton Roadside	NO NOx	592B-263	99 100	6.9 9.4	2.461 2.706	5.0 5.0	0.9991 0.9991	101.7
31/07	Bristol Centre	NO NOx	m200-105	-8 -5	5 5.2	0.415 0.417	5.0 5.0	0.9999 0.9999	98.6
30/07	Bristol Old Market	NO NOx	m200-653	5 5	5.6 7.3	2.249 2.265	5.0 5.0	0.9999 1.0000	99.5
10/07	Bury Roadside	NO NOx	1710	-1 2	5 5.7	0.894 0.915	5.0 5.0	0.9987 0.9986	98.3
17/07	Cambridge Roadside	NO NOx	42c-55355	0 0	5 5.3	1.059 1.065	5.0 5.0	0.9989 0.9989	95.9
06/08	Canterbury	NO NOx	200A-1147	2 3	5 5.4	1.197 1.195	5.0 5.0	0.9999 0.9999	98.9
12/07	Coventry Memorial Park	NO NOx		5 5	8.6 9.8	2.883 2.873	5.0 5.0	0.9995 0.9992	95.4
01/08	Exeter Roadside	NO NOx	9841-85	21 21	8.6 9.7	2.748 2.817	5.0 5.0	0.9998 0.9999	100
30/08	Hove Roadside	NO NOx	6158-273	100 99	5 6.6	2.004 2.021	5.0 5.0	0.9989 0.9989	101.2
20/08	Hull Centre	NO NOx	m200-186	-9 -20	5 5.7	0.493 0.478	5.0 5.0	0.9981 0.9981	99.6
19/07	Leamington Spa	NO NOx	53	24 21	5.1 6.9	2.066 2.074	5.0 5.0	0.9979 0.9967	104
07/09	Leeds Centre	NO NOx	106	-8 -15	5 5.2	0.416 0.411	5.0 5.0	0.9999 0.9999	97.4
17/08	Leicester Centre	NO NOx	M200 191	-9 -21	5 5.7	0.478 0.488	5.0 5.0	0.9998 0.9997	97.7
07/08	Liverpool Centre	NO NOx	93098	-17 -26	5 5.3	0.441 0.442	5.0 5.0	0.9996 0.9996	100.2
04/07	London A3 Roadside	NO NOx	Ambirak H	101 101	10.8 11.9	3.147 3.175	5.2 5.0	0.9916 0.9914	95.6
03/07	London Bexley	NO NOx	m200-059	1 0	5 6.9	2.013 2.02	5.0 5.0	0.9973 0.9973	97.5

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

CERTIFICATE OF CALIBRATION

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Certificate No: 00606

AEA Identification Number: 20568104

Date Year =2001	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*R^2	*Converter efficiency (%)
16/07	London Brent	NO NOx	1852	23 28	6.8 8.4	2.395 2.394	5.0 5.0	0.9983 0.9983	102.9
29/08	London Cromwell Rd 2	NO NOx	10775	-1 -1	6.8 8.2	2.519 2.511	5.0 5.0	0.9999 1.0000	98.1
02/07	London Hillingdon	NO NOx	447-010	25 24	5 5.3	0.401 0.408	5.0 5.0	0.9929 0.9932	97.9
08/08	London Westminster	NO NOx	200a-573	2 -1	15.7 15.7	3.94 3.85	5.0 5.0	0.9999 0.9999	98.1
01/08	Manchester Piccadilly	NO NOx	447-006	-17 -15	5 5.2	0.386 0.408	5.0 5.0	0.9913 0.9917	96.5
31/07	Manchester South	NO NOx	GRA0447	90 90	5 5.8	0.624 0.637	5.0 5.0	0.9971 0.9972	98.8
02/08	Manchester Town Hall	NO NOx	M200-846	0 1	6.0 8.0	2.359 2.358	5.0 5.0	0.9976 0.9977	99
14/08	Middlesbrough	NO NOx	M200-139	-13 -16	5 5.3	0.4 0.399	5.0 5.0	0.9999 0.9999	98.5
14/08	Newcastle Centre	NO NOx	37	-15 -29	5 6.2	0.518 0.503	5.0 5.0	1.0000 1.0000	99.2
09/07	Northampton	NO NOx	851318061	0 -4	5 5.3	0.985 0.986	5.0 5.0	0.9998 0.9998	101.6
13/08	Norwich Centre	NO NOx	Ambirak	-1 -3	6.7 7.7	2.497 2.373	5.0 5.0	0.9976 0.9970	100
14/08	Norwich Roadside	NO NOx	94604	-3 -4	5 5.4	1.176 1.175	5.0 5.0	0.9985 0.9979	85.1
21/08	Nottingham Centre	NO NOx	447-009	3 2	5 5.5	0.606 0.613	5.0 5.0	0.9986 0.9987	99.5
02/07	Oxford Centre	NO NOx	411B-179	100 105	5 6.6	1.139 1.181	5.0 5.0	0.9998 0.9999	95.1
02/08	Plymouth Centre	NO NOx	49c66639-353	3 4	5 5.4	0.202 0.208	5.0 5.0	0.9998 0.9999	99.5
10/07	Portsmouth	NO NOx	903005	0 0	5 5.3	0.992 0.996	5.0 5.0	1.0000 1.0000	99.3
25/07	Preston	NO NOx	Ambirak	36 36	12.5 13.4	3.415 3.422	5.0 5.0	0.9995 0.9986	100
03/07	Reading	NO NOx	AR-004	-1 0	9.6 8.7	2.591 2.65	5.0 5.0	0.999 0.9992	98.5
13/08	Redcar	NO NOx	497	1 3	5 5.7	1.053 1.054	5.0 5.0	1.0000 1.0000	96.7
05/09	Rotherham Centre	NO NOx	D4470108	2 3	5 5.2	0.714 0.733	5.0 5.0	0.9999 1.0000	95.1
01/08	Salford Eccles	NO NOx	488	0 1	5 5.9	1.276 1.325	5.0 5.0	0.9985 0.9985	101.1

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Certificate No: 00606

AEA Identification Number: 20568104

Date Year =2001	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*R^2	*Converter efficiency (%)
20/07	Sandwell W Bromwich	NO NOx	93081	13 10	5 5.8	1.584 1.593	5.0 5.0	0.9994 0.9993	99.4
03/09	Sheffield Centre	NO NOx	447-008	5 5	5 5.2	0.473 0.475	5.0 5.0	1.0000 1.0000	97.1
03/09	Sheffield Tinsley	NO NOx	847	-2 -2	6.6 8	2.478 2.457	5.0 5.0	0.9999 0.9999	99.1
05/07	Southampton Centre	NO NOx	m200-187	-10 -12	5 5.6	0.461 0.457	5.0 5.0	0.9999 0.9999	100.6
07/08	Southend-on-Sea	NO NOx	AR-011	66 66	5 6.4	1.108 1.128	5.0 5.0	0.9991 0.9995	95.9
12/07	Stockport	NO NOx	1853	19 21	7.7 9.5	2.586 2.783	5.0 5.0	0.9976 0.9967	103.4
13/08	Stockton-on-Tees Yarm	NO NOx	9841a-118	0 -1	5 5.5	1.072 1.114	5.0 5.0	0.9996 1.0000	95.7
09/07	Stoke-on-Trent Centre	NO NOx	AR-003	36 35	7.7 9.2	2.472 2.528	5.0 5.0	0.9973 0.9971	96.9
07/08	Thurrock	NO NOx	11004	-3 -1	5 5.4	1.136 1.141	5.0 5.0	1.0000 1.0000	97.7
05/09	Walsall Alumwell	NO NOx	848	0 0	7 8.6	2.566 2.607	5.0 5.0	0.9999 0.9999	98.4
16/07	Walsall Willenhall	NO NOx	1337	6 7	5 5.3	0.915 0.926	5.0 5.0	1.0000 1.0000	97.3
29/08	West London	NO NOx	10774	2 3	5 5.5	1.39 1.392	5.0 5.0	1.0000 0.9999	96.1
08/08	Wigan Leigh	NO NOx	Horiba - n	0 0	5 5.3	0.975 0.971	5.0 5.0	0.9990 0.9989	99.3
24/07	Wirral Tranmere	NO NOx	Ambirak	24 24	6.6 8.4	2.439 2.511	5.0 5.0	0.9993 0.9992	99.4
30/07	Wolverhampton Centre	NO NOx	gra0447-007	37 30	5 5.3	0.49 0.493	5.0 5.0	0.9968 0.9962	97

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

5. Particulate Analysers

Date Year =2001	Site	Analyser number	Calculated Spring Constant k_0	Uncertainty (%)	[4]k_0 accuracy (%)	[3]Measured Main Flow	Uncertainty (%)	[3]Measured Total Flow	Uncertainty (%)
	Scottish Sites								
12/09	Aberdeen	21371	9938	1	-2.1	1.77	5	15.82	4
23/07	Edinburgh Centre	1200-1209	12472	1	-0.1	2.06	5	17.21	4
24/07	Glasgow Centre	20913	13089	1	-1.9	2.00	5	16.94	4
24/07	Glasgow Kerbside	21316	13556	1	-1.0	2.01	5	18.14	4
23/07	Grangemouth	1200c1522	12339	1	-2.5	2.97	5	16.81	4
	Welsh Sites								
22/08	Cardiff Centre	2165	11200	1	0.6	2.02	5	16.39	4
20/08	Cwmbran	21557	12489	1	-0.4	3.06	5	16.36	4
22/08	Port Talbot	1200-1868	10668	1	0.7	3.08	5	17.08	4
21/07	Swansea	1200-1260	14316	1	-1.7	1.99	5	17.02	4
	N.Irish Sites								
17/07	Belfast Centre	1818	13111	1	-3.2	2.58	5	17.12	4
17/07	Belfast Clara St					n/a	n/a	17.35	4
18/07	Derry	49608	10816	1	-0.7	2.05	5	16.88	4
	English Sites								
23/07	Birmingham Centre	2297	11852	1	-1.9	2.00	5	16.67	4
26/07	Birmingham East	92454	16760	1	-1.5	2.05	5	17.50	4
31/07	Blackpool	22980	12881	1	-2.0	2.00	5	16.71	4
11/07	Bolton	21197	14785	1	-2.5	2.92	5	16.51	4
06/09	Bradford Centre	21494	11185	1	-1.5	2.02	5	16.22	4
31/07	Bristol Centre	1200-1198	11925	1	0.2	Failed leak test			
10/07	Bury Roadside	658	11386	1	-1.8	1.96	5	16.52	4
06/08	Canterbury	1200-1260	13876	1	-1.1	3.04	5	16.75	4
12/07	Coventry Memorial Park	21918	12776	1	-4.6	3.05	5	17.40	4
20/08	Hull Centre	2299	14007	1	-1.2	1.84	5	15.51	4
19/07	Leamington Spa	9408	10870	1	-0.7	Not tested		16.69	4
07/09	Leeds Centre	2032	12931	1	0.7	1.97	5	16.33	4
17/08	Leicester Centre	1817	11466	1	0.9	2.02	5	16.34	4
07/08	Liverpool Centre	2034	13828	1	-2.1	1.96	5	16.42	4

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Certificate No: 00606

AEA Identification Number: 20568104

Date Year =2001	Site	Analyser number	Calculated Spring Constant k_0	Uncertainty (%)	[4]k_0 accuracy (%)	[3]Measured Main Flow	Uncertainty (%)	[3]Measured Total Flow	Uncertainty (%)
04/07	London A3 Roadside	21314	10262	1	-1.9	1.75	5	16.38	4
03/07	London Bexley	2000	10243	1	-2.2	2.09	5	17.23	4
04/07	London Bloomsbury	92373	9418	1	-0.1	Failed leak test			
16/07	London Brent	21145	17184	1	-1.9	2.93	5	16.57	4
02/07	London Hillingdon	209039506	8410	1	-1.9	2.04	5	16.61	4
01/08	Manchester Piccadilly	20914	11923	1	-1.1	Not tested			
14/08	Middlesbrough	2143	8110	1	0.2	2.00	5	16.68	4
14/08	Newcastle Centre	ETI92388	11891	1	-1.1	1.98	5	16.55	4
09/07	Northampton	21621	10852	1	-2.7	2.95	5	16.23	4
13/08	Norwich Centre	21495	11931	1	-2.3	1.93	5	16.45	4
21/08	Nottingham Centre	209159507	8585	1	-1.0	1.97	5	16.47	4
02/08	Plymouth Centre	1200b135169	12736	1	-0.7	2.01	5	16.37	4
10/07	Portsmouth	21578	10267	1	-2.9	2.94	5	16.27	4
25/07	Preston	22881	12742	1	-6.2	1.91	5	17.30	4
03/07	Reading	140ab2131	12907	1	-2.2	1.96	5	16.69	4
13/08	Redcar	21344	11666	1	-1.0	2.93	5	16.66	4
01/08	Salford Eccles	21168	14237	1	-1.2	1.94	5	16.44	4
20/08	Scunthorpe	2129	4919	1	-1.4	Not tested – unsafe access			
03/09	Sheffield Centre	20904	11059	1	-2.3	1.98	5	16.16	4
05/07	Southampton Centre	2298	13599	1	-1.7	1.94	5	16.17	4
07/08	Southend-on-Sea	1200c1548	13353	1	-0.3	Not tested		16.67	4
12/07	Stockport	659	10342	1	-0.7	2.92	5	16.45	4
13/08	Stockton-on-Tees Yarm	22885	13956	1	-2.4	3	5	14.88	4
09/07	Stoke-on-Trent Centre	21317	18014	1	-1.9	1.97	5	16.47	4
24/07	Wirral Tranmere	22883	12963	1	-2.5	1.88	5	17.4	4
30/07	Wolverhampton Centre	20917	13428	1	-2.3	2.09	5	17.23	4

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor k = 2, providing a level of confidence of approximately 95%. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

The above factors have been calculated using certified standards. The analysers listed above have been tested for zero response, calibration factor, linearity, converter efficiency (NOx analysers), m-xylene interference (SO_2 analysers), k_0 / main flow rate (for TEOM analysers) and total flow rate (for particulate analysers), by documented methods. Note that the test results are valid on the day of test only, as analyser drift over time cannot be quantified.

The calibration results for NOx, NO, CO, SO_2, O_3 and Particulates are those that fall within our scope of accreditation. Results marked with an asterisk (*) on this certificate are not UKAS accredited, but have been included for completeness.

[1]The zero response is the zero reading on the logging system of the analyser when audit zero gas was introduced to the analysers under test.

[2]The calibration factor is the multiplying factor required to scale the reading on the data logging system into concentration units (ppb for NO, NOx and SO_2, ppm for CO – 1ppm = 1000 ppb). It should be used in conjunction with the analyser output and the zero response, according to the following equation:

$$Concentration = (output - zero\ response) \times Calibration\ factor$$

[3]The calculated main flow rate (where this is applicable) is the flow rate through the sensor unit of a TEOM analyser. The calculated total flow rate is the flow rate through a particulate analyser.

[4]The k_0 accuracy value (specifically for TEOM analysers) indicates the closeness of the calculated result to the manufacturer's specified value of k_0.

*R^2 is the correlation coefficient of linearity

*Converter is the measured efficiency of the NO_2 to NO converter in the Oxides of Nitrogen analyser

*meta-xylene interference is the response of the SO_2 analyser when supplied with approx 1ppm meta-xylene

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