Report

Intercalibration Report for the Automatic Urban Network, Summer 2002

Report to Department for Environment, Food and Rural Affairs, The Scottish Executive, Welsh Assembly Government and Department of the Environment in Northern Ireland

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Executive Summary

In July to September 2002, **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	46	33%
NOx analyser	25	75	33%
CO analyser	9	65	14%
SO_2 analyser	6	61	10%
TEOM analyser	3	52	6%
Partisol analyser	-	6	n/a
Total	58	305	19%

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, 10 of the 201 site cylinders (5%) used to scale instrument data into concentrations appeared to have drifted by more than 10% from their certificated values. During this exercise, no NOx converters were outside the 95% acceptance limit.

The number of analyser outliers identified is slightly worse than the previous exercise. At the winter 2002 intercalibration, 16% 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 39 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.

The next intercalibration report (Winter 2003) will include all sites in the Urban Network, Rural Network and sites in the London air quality monitoring network.

Contents

1 Introduction

netcen undertook an intercalibration of air quality monitoring sites in the Automatic Urban Network (AUN) in July to September 2002. 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 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 measurement of NO_2 to be undertaken, so it must work with an efficiency of no less than 95%.
7. **TEOM k_o 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** takes 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. 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 utilises audit gas cylinders transported to each site 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 the provisional data supplied to the web/teletext.
- 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 the following Section.

The procedures used to determine network performance are documented in **netcen** 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. The site at Hull Centre was closed in January 2002, and has been relocated since this exercise to Hull Freetown.

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.

Future reports will incorporate the results from all 120 monitoring stations in the AUN, Rural Network and the 14 affiliated sites from the London Air Quality Network. The sites will be audited in a combined intercalibration exercise, scheduled to take place between January and March 2003.

2 Analyser Performance

As with previous intercalibration reports, 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:

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.

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.

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.

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.

E This grade indicates either a very poorly performing analyser. The results of the tests have highlighted a very serious fault, or the analyser has completely malfunctioned during the course of the tests. 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.

- In the event of an analyser not being tested, a "**-**" result is presented. It may be that the analyser had been removed for repair, or broken down during testing. Depending upon the exact nature of the fault, it should be possible to save data from the analyser, but it is possible 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 England						
03/09/02	Barnsley 12			A		
08/07/02	Barnsley Gawber	A	A	A	B	
09/07/02	Bath Roadside	A	A			
12/08/02	Billingham	A				
12/07/02	Birmingham Centre	B	A	A	A	A
15/08/02	Birmingham East	A	A	A	B	A
24/07/02	Blackpool	A	A	A	A	A
11/07/02	Bolton	A	A	A	A	A
15/07/02	Bournemouth	B	A	A		A
05/09/02	Bradford Centre	A	A	A	D	A
12/09/02	Brighton Roadside	A	A			
16/07/02	Bristol Centre	A	A	A	B	A
15/07/02	Bristol Old Market	A	C			
10/07/02	Bury Roadside	B	B	A	A	A
30/08/02	Cambridge Roadside	A				
25/07/02	Canterbury	A	A			A
10/07/02	Coventry Memorial Park	C	A	A	A	A
18/07/02	Exeter Roadside	B	A	A	A	
12/09/02	Hove Roadside	B	A	A		
16/07/02	Leamington Spa	A	B	A	A	A
06/09/02	Leeds Centre	A	A	A	A	A
13/02/02	Leicester Centre	A	A	A	A	D
05/08/02	Liverpool Centre	A	A	A	A	A
18/07/02	London A3 Roadside	A	A			A
24/07/02	London Bexley	B	A	B	A	A
17/07/02	London Bloomsbury	B	A	A	A	A
29/08/02	London Brent	B	A	A	B	A
09/09/02	London Cromwell Road 2	A	A	A		
11/09/02	London Hillingdon	A	A	A	A	A
07/08/02	London Westminster	B	A	A	A	-
22/07/02	Manchester Piccadilly	B	A	A	A	A
23/07/02	Manchester South	A		A	A	
22/07/02	Manchester Town Hall	A	A			
13/08/02	Middlesbrough	B	A	A	A	A
14/08/02	Newcastle Centre	B	A	B	A	A
12/07/02	Northampton	B	A	A		A
17/09/02	Norwich Centre	B	A	A	A	A
31/07/02	Norwich Roadside	A				
22/08/02	Nottingham Centre	A	A	A	A	A
29/07/02	Oxford Centre	A	A	A		
17/07/02	Plymouth Centre	B	C	A	A	A
28/08/02	Portsmouth	A	A	A		A
13/07/02	Preston	A	A	A	B	A
11/07/02	Reading	A	E	A	E	A
12/08/02	Redcar	B	C	A	B	A
04/08/02	Rotherham Centre	A		A	A	
23/07/02	Salford Eccles	A	A	A	A	A
22/07/02	Sandwell West Bromwich	B	A	B	A	
20/08/02	Scunthorpe			A		A
02/09/02	Sheffield Centre	A	A	A	B	A
03/09/02	Sheffield Tinsley	A	A			

Date visited	Site	NOx	CO	SO_2	O_3	PM_{10}
29/08/02	Southampton Centre	A	A	A	A	A
26/09/02	Southend-on-Sea	A	A	A	A	A
09/07/02	Stockport	A	A	A		A
13/08/02	Stockton-on-Tees Yarm	A	B			A
08/07/02	Stoke-on-Trent Centre	A	A	A	A	A
14/08/02	Sunderland			B		
23/07/02	Thurrock	A	A	A	B	A
	Walsall Alumwell	A				
19/08/02	Walsall Willenhall	A				
09/09/02	West London	A	A			
06/08/02	Wigan Leigh	A	A	A	B	B
13/07/02	Wirral Tranmere	B	B	A	B	A
25/07/02	Wolverhampton Centre	A	A	A	B	A
Sites in Northern Ireland						
20/08/02	Belfast Centre	B	A	A	A	B
20/08/02	Belfast Clara St					-
20/08/02	Belfast East			A		
20/08/02	Derry	A	A	B	B	A
Sites in Scotland						
06/08/02	Aberdeen	A	A	A		A
29/07/02	Dumfries	A	A			A
05/08/02	Edinburgh Centre	B	A	B	A	A
31/07/02	Glasgow Centre	B	B	A	A	A
30/07/02	Glasgow City Chambers	A	A			
30/07/02	Glasgow Kerbside	C	A			A
30/07/02	Grangemouth	A		A		A
07/08/02	Inverness	A	A			A
Sites in Wales						
25/09/02	Cardiff Centre	A	A	A	A	A
24/09/02	Cwmbrân	B	A	A		A
25/09/02	Port Talbot	A		A	A	A
26/09/02	Swansea	A	A	A	B	A
13/07/02	Wrexham	B	A	A	A	A

Grade	A	B	C	D	E	Not tested
No of instruments	251	49	5	2	2	2

From the above table, it is clear that the vast majority of analysers (300 of the 311 analysers, 96%) in the network are functioning well. This compares well with the summer exercise, where 95% of the analysers were grade A or B. This reflects an improving trend in analyser performance: over the last 2 years, the number of grade A/B analysers has improved continuously from 91%.

Of the remaining analysers, it is likely 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 Nitrogen Oxides

Twenty-five of the 75 analysers tested (33%) were identified as outliers, giving calculated values that were more than 10% from the network mean response. This result is worse than the previous intercalibration, when 23% of the analysers were found to be outliers.

Close investigation of the results showed that 23 of these outliers were of minor grade B and 2 of grade C.

12 of the grade B outliers were 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 remaining grade B outliers arose as a result of small drifts in cylinder concentrations. These will be easily corrected during ratification, without any data loss.

The analyser at Glasgow Kerbside was seen to exhibit considerable variability in response when gas was introduced through the sample inlet, as opposed to the dedicated cylinder inlet. This could have 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 data from the site will be closely examined during ratification, and action taken as necessary.

The calibration cylinder at Coventry Memorial Park has drifted significantly between intercalibration visits, causing the outlier result. This should be easily correctable, and is unlikely to affect data capture for the site. The cylinder was approaching the end of it's usable life, and was replaced in August.

The analyser at Hove Roadside was seen to drift significantly between LSO calibrations, causing the outlier to arise. The data should be salvageable during ratification, and will be closely examined during ratification, and action taken as necessary.

The remainder of the outliers arose as a result of differences in response when NO_2 audit gas was introduced through the sample inlet, as opposed to the dedicated cylinder inlet. This may well have consequences for ambient data, as these results do not appear to accurately represent what the analyser samples from ambient air. The data from the affected sites will be closely examined during ratification, and action taken as necessary.

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 4.3%. 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 3.3%, with a percentage standard deviation around this value of 4.7%. This is also a good result, which demonstrates that measurements of NO_2 are accurate, consistent and traceable to metrology standards.

As part of the intercalibration exercise, the performance of the NOx converters was assessed. To satisfactorily pass the test, the analyser must convert at least 95% of a 500 ppb sample of NO_2 introduced into the sample inlet.

At this exercise, no analysers were found to have fallen below the 95% acceptance limit. This is an excellent result, which reflects the amount of effort LSO's and the ESU's have put into resolving this perennial issue.

4 Carbon Monoxide

Nine of the 65 analysers (14%) were identified as outliers. This is worse than the previous exercise, when only two analysers were found to be outside the acceptance limits. Of these nine outliers, 5 were grade B, 3 were grade C and 1 was 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 remaining analysers were all seen to exhibit differences in response to varying extents when gas was introduced through the sample inlet, as opposed to the dedicated cylinder inlet. This may have some 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 data from these sites will be closely examined during ratification, but it is possible that some data will need to be rejected as a result of these findings.

In addition, the analyser at Reading failed to respond to calibration gas at the audit, thereby preventing any meaningful results. The data from the site will be closely examined during ratification, but it is possible that some 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 3.3%. This is an excellent result, demonstrating that measurements are accurate, consistent and traceable to metrology standards.

5 Sulphur Dioxide

The analysers at six of the 61 sites (10%) were identified as outliers, giving calculated values that were more than 10% from the network mean response. All these outliers were grade B. This result is slightly better than the previous intercalibration, when eight analysers were found to be outliers.

The outlier at Sunderland was caused by a small drift in site cylinder concentration. This is easily correctable, and will not affect data capture for the site.

The outliers at the remaining sites 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.

Comparison of the network average results against the actual audit cylinder concentrations showed that, overall, the network continues to measure SO_2 concentrations to within 1%, with a percentage standard deviation of 3.2%. 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 does not 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 14 analysers were outside the required standard:

1. Bradford Centre (16 ppb)
2. Bristol Centre (11 ppb)
3. Derry (16 ppb)
4. Coventry Memorial Park (23 ppb)
5. Exeter Roadside (12 ppb)
6. Middlesbrough (11 ppb)
7. Plymouth (17 ppb)
8. Reading (15 ppb)
9. Sandwell West Bromwich (13 ppb)
10. Stockport (14 ppb)
11. Aberdeen (11 ppb)
12. Edinburgh Centre (17 ppb)
13. Glasgow Centre (17 ppb)
14. Port Talbot (13 ppb)

The kicker at Plymouth Centre was identified as an outlier at the winter 2002 intercalibration. The kickers at Exeter Roadside and Derry were identified as outliers at the previous two exercises.

These results are slightly worse than the previous intercalibration, when 10 analyser kickers were identified as outliers. However as the magnitude of the responses to m-xylene was low, 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 1 ppb.

6 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 46 analysers (30%) were found to be greater than 5% from the **netcen** standard at this intercalibration. The overall result is better than the previous exercise, when 36% of the analysers were identified as outliers. Of the 15 outliers, 13 were minor grade B; the analyser at Bradford Centre was grade D, where a major leak was identified. **netcen** will make use of all the available data from this site to determine whether the data can be salvaged during ratification. It is possible that significant portions of data may need to be rejected as a result of this finding.

Subsequent investigations revealed instrument response drift as the main reason for all of the grade B outlying analysers. Ratification of the data from these sites should be relatively straightforward, no data loss should occur.

The analyser at Reading did not respond to calibration gas at the time of the audit, preventing meaningful results being obtained. **netcen** will make use of all the available data from this site and rescale the data as necessary during ratification.

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

7 Particulates

7.1 TEOM ANALYSERS

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

1. Wigan Leigh (+2.8%)
2. Belfast Centre (+2.6%)
3. Leicester Centre (+27.6%)

Both of the results for Wigan and Belfast are “first time offences” for these analysers, and are only just outside the acceptance limit. There will be no loss of data from these sites.

The outlier at Leicester arises from a difference in the calculated value of k_0 from the stamped value on the sensor. As this is an old 1400e model, the software value (which is used in calculating mass concentrations) cannot be obtained by QA/QC unit. This software value will be required to determine appropriate courses of action in ratifying this dataset.

RECOMMENDATION: The ESU must confirm the software k_0 value at the Leicester Centre site, which will determine whether the data require rescaling.

These k_0 results will be carefully checked at the next intercalibration, and remedial action requested, or data rescaling will take place if necessary.

No significant flow errors or leaks were found at any of the sites tested.

7.2 BAM ANALYSER

Because of safety restrictions, the flow rate of the analyser at Belfast Clara Street was not assessed at this audit.

7.3 PARTISOL ANALYSERS

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

1. Dumfries
2. Inverness
3. Wrexham
4. Bournemouth
5. Northampton
6. London Westminster

Flow tests were undertaken at Bournemouth, Northampton, Wrexham, Inverness and Dumfries, and all were found to be within limits.

The London Westminster analyser was awaiting commissioning at the time of the intercalibration visit.

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 10 of the 201 cylinders (5%) used to scale analyser data into concentrations (NO, CO and SO_2) appear to be outside the ±10% acceptance criterion. In addition, the concentrations of 19 NO_2 cylinders appear to have drifted by more than 10%. This is slightly worse than the previous intercalibration, where 10% 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.

9 NO cylinder outliers were identified. Of these, the cylinder at Coventry Memorial Park is of most concern, as the NO concentration had changed significantly, suggesting the cylinders may have become contaminated. The cylinder was replaced in August.

1 SO_2 outlier was identified, at Sunderland. This was only slightly outside the 10% acceptance limit, and 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 Laboratory at **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 concentrations will be carefully assessed at the next intercalibration exercise, and any recurring outlier cylinders will be replaced.

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, a number of 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. The effect seems to be remedied by cleaning of the manifold inlet and replacement of sample tubing at the servicing visits.

At this exercise, the vast majority of the sites showed losses of less than 10% to the sample inlet. The following analysers exhibited apparent losses to the sampling / calibration system:

NOx analyser at Glasgow Kerbside
CO analysers at Northampton, Plymouth, Redcar and Wirral Tranmere
SO_2 analysers at Derry, Leicester Centre and Southampton Centre

This is similar to the Winter 2002 result, where eight analysers were also seen to exhibit similar response characteristics.

Reminder: The ESU's are reminded of the importance of maintaining the entire sample inlet system (cleaning manifolds and solenoids, and replacing PTFE tubing), and the requirement to do this every six months at the scheduled service.

10 LSO Audits

During the intercalibration, 39 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. The audits 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 Safety

netcen has undertaken extensive risk assessments of all its activities on site, to ensure that its staff are not exposed to unsafe practices while working. These assessments are then compiled into a list, which, in conjunction with Stanger, identify areas that require attention in order to minimise operator risk. At this intercomparison, these are:

Safe access to particulate analyser inlets to test flow rates, at the following sites:

1. Bolton
2. Canterbury
3. Coventry Memorial Park
4. Edinburgh Centre
5. Glasgow Roadside
6. Grangemouth
7. Leamington Spa
8. London A3 Roadside
9. London Bloomsbury
10. London Brent
11. Belfast Clara Street
12. Manchester Piccadilly
13. Plymouth Centre
14. Scunthorpe
15. Southend-on-Sea
16. Stockport
17. Thurrock

Many of these upgrades are in progress. As they are completed, **netcen** will reassess the risk to operators and update as necessary.

12 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.

13 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 have been used to assess data quality during the ratification of the network datasets for the 6-month period January to June 2002.

Appendix

CONTENTS

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

CERTIFICATE OF CALIBRATION

UKAS CALIBRATION 0401

Approved Signatories: ✔ K. Stevenson
S. Eaton

Signed: Date:

Date of issue: 14 February 2003

Customer Name and Address: Dr Janet Dixon
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 =2002	Site	Analyser number	[1]Zero output	Uncertainty (ppm)	[2]Calibration Factor	Uncertainty (%)	*R^2
	Scottish Sites						
06/08	Aberdeen	m300-614	0	0.3	1.055	3	0.9993
29/07	Dumfries	m3001498	25	0.3	0.010	3	0.9994
05/08	Edinburgh Centre	m300-470	5	0.3	0.047	3	0.9991
31/07	Glasgow Centre	gra410-00	-1	0.3	0.045	3	0.9999
30/07	Glasgow City Chambers	m300-721	-8	0.3	0.050	3	0.9995
30/07	Glasgow Kerbside		-1	0.3	0.043	3	0.9998
07/08	Inverness	m3001500	-38	0.3	0.010	3	0.9994
	Welsh Sites						
25/09	Cardiff Centre	co11m828	21	0.3	0.048	3	0.9999
24/09	Cwmbran	103006	-3	0.3	0.953	3	0.9995
26/09	Swansea	70	8	0.3	0.051	3	0.9997
13/07	Wrexham	12556	49	0.3	0.010	3	0.9993
	N.Irish Sites						
20/08	Belfast Centre	78	34	0.3	0.050	3	0.9972
20/08	Derry	J-AR-009	-3	0.3	0.050	3	0.9988

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.

Date Year =2002	Site	Analyser number	[1]Zero output	Uncertainty (ppm)	[2]Calibration Factor	Uncertainty (%)	*R^2
	English Sites						
08/07	Barnsley Gawber		-4	0.3	0.049	3	0.9998
09/07	Bath Roadside	api300-10	-5	0.3	0.051	3	0.9996
12/07	Birmingham Centre	13072	29	0.3	0.050	3	0.9980
15/08	Birmingham East	93208	18	0.3	0.053	3	0.9996
24/07	Blackpool	l-ar-010	0	0.3	0.054	3	0.9986
11/07	Bolton	9830-440	0	0.3	1.004	3	0.9979
15/07	Bournemouth	m3001501	1	0.3	0.995	3	0.9997
05/09	Bradford Centre	Ambirak	-4	0.3	0.068	3	0.9998
12/09	Brighton Roadside	1434	-8	0.3	0.051	3	0.9989
16/07	Bristol Centre	24	26	0.3	0.056	3	0.9973
15/07	Bristol Old Market	CO11m-12	201	0.3	0.135	3	0.9976
10/07	Bury Roadside	9830-277	0	0.3	0.901	3	0.9982
10/07	Coventry Memorial Park		-1	0.3	0.056	3	0.9998
18/07	Exeter Roadside	244	37	0.3	0.048	3	0.9977
12/09	Hove Roadside	1433	-16	0.3	0.051	3	0.9989
16/07	Leamington Spa	2198	26	0.3	0.049	3	0.9996
06/09	Leeds Centre	148	71	0.3	0.05	3	0.9998
21/08	Leicester Centre	co11m104	26	0.3	0.053	3	0.9996
05/08	Liverpool Centre	150	72	0.3	0.051	3	0.9996
18/07	London A3 Roadside		0	0.3	0.054	3	0.9997
24/07	London Bexley	79	12	0.3	0.054	3	0.9999
17/07	London Bloomsbury	co11m-82	61	0.3	0.047	3	0.9998
29/08	London Brent	399	21	0.3	0.050	3	0.9984
09/09	London Cromwell Road 2	m300-868	20	0.3	0.049	3	0.9980
11/09	London Hillingdon	gra0410	-3	0.3	0.046	3	0.9989
07/08	London Westminster	10777	-3	0.3	0.048	3	0.9987
22/07	Manchester Piccadilly	GRA410-0	-9	0.3	0.048	3	0.9994
22/07	Manchester Town Hall	10442	3	0.3	0.050	3	0.9993
13/08	Middlesbrough	API300-30	11	0.3	0.050	3	0.9948
14/08	Newcastle Centre	91	20	0.3	0.045	3	0.9957
12/07	Northampton	890541010	2	0.3	1.363	3	0.9977
17/09	Norwich Centre		-2	0.3	0.057	3	0.9996
22/08	Nottingham Centre		1	0.3	0.048	3	0.9996
29/07	Oxford Centre	376b-161	100	0.3	0.048	3	0.9986
17/07	Plymouth Centre	h-rao-410	-1.3	0.3	0.101	3	0.9978
28/08	Portsmouth	902015	-0.1	0.3	1.065	3	0.9996
13/07	Preston	Ambirak N	-18	0.3	0.051	3	0.9992
12/08	Redcar	300	7	0.3	0.096	3	0.9993
23/07	Salford Eccles	ml-2386	0	0.3	0.995	3	0.9980
22/07	Sandwell West Bromwich	94603	-26	0.3	0.058	3	0.9991
02/09	Sheffield Centre	410-006	1	0.3	0.059	3	0.9998
03/09	Sheffield Tinsley	1856	34	0.3	0.048	3	0.9991

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.

Date Year =2002	Site	Analyser number	[1]Zero output	Uncertainty (ppm)	[2]Calibration Factor	Uncertainty (%)	*R^2
29/08	Southampton Centre	co11m-90	30	0.3	0.057	3	0.9994
26/09	Southend-on-Sea		-4	0.3	0.052	3	0.9955
09/07	Stockport	9830-340	19	0.3	0.049	3	0.9983
13/08	Stockton-on-Tees Yarm	ML9830BM 399	1	0.3	1.021	3	0.9932
08/07	Stoke-on-Trent Centre	AR003	7	0.3	0.063	3	0.9989
23/07	Thurrock	262	17	0.3	0.042	3	0.9995
09/09	West London	2287	72	0.3	0.049	3	0.9986
06/08	Wigan Leigh	6011	-0.1	0.3	1.057	3	0.9991
13/07	Wirral Tranmere	Ambirak	-27	0.3	0.072	3	0.9996
25/07	Wolverhampton Centre	414 HOT SWAP	-4	0.3	0.049	3	0.9977

2. Sulphur Dioxide

Date Year =2002	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*R^2	*m-xylene interference (ppb)
	Scottish Sites							
06/08	Aberdeen	100a1180	2	4.3	0.980	5	0.9996	11.0
05/08	Edinburgh Centre	m100a208	9	4.2	1.042	5	0.9998	16.7
31/07	Glasgow Centre	gra477-01	-8	4.1	0.319	5	0.9982	16.9
30/07	Grangemouth	703B-274	2	4.2	0.824	5	0.9997	1.4
	Welsh Sites							
25/09	Cardiff Centre	eti00097	-10	4.1	0.191	5	0.9996	8.1
24/09	Cwmbran	408001	8	4.3	0.947	5	0.9996	3.3
25/09	Port Talbot	943	-1	4.3	1.048	5	0.9997	13.4
26/09	Swansea	168	19	4.2	0.201	5	0.9999	8.3
13/07	Wrexham	12183	-4	4	0.251	5	0.9998	2.5
	N.Irish Sites							
20/08	Belfast Centre	52	29	4.1	0.187	5	0.9948	7.7
20/08	Belfast East	703	1	4.2	1.021	5	0.9970	9.2
20/08	Derry	J-AR-009	100	4.1	0.851	5	0.9978	16.2
	English Sites							
03/09	Barnsley 12	2839	11	4.1	0.841	5	0.9996	8.4
08/07	Barnsley Gawber		36	4.3	1.134	5	0.9999	7.7
12/07	Birmingham Centre	92378	110	4	0.202	5	0.9985	
15/08	Birmingham East	92458	25	4	0.202	5	0.9994	0.6
24/07	Blackpool	l-ar-010	55	4.2	1.025	5	0.9984	
11/07	Bolton	9850-780	1	4.2	0.969	5	0.9948	7.8
15/07	Bournemouth	m1001179	4	4.2	0.971	5	0.9996	8.7
05/09	Bradford Centre	Ambirak	60	6.2	1.586	5	0.9996	15.9
16/07	Bristol Centre	115	15	4.1	0.197	5	0.9946	10.8
10/07	Bury Roadside	9850-559	1	4.6	0.970	5	0.9956	5.6
10/07	Coventry Memorial Park	Ambirak	96	5.7	1.473	5	0.9990	22.5
18/07	Exeter Roadside	9850-634	19	4.2	0.976	5	0.9981	11.7
12/09	Hove Roadside	1178	-3	4.3	1.001	5	1.0000	4.8

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.

Date Year =2002	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*R^2	*m-xylene interference (ppb)
16/07	Leamington Spa	1793	22	4.8	0.974	5	0.9997	9.5
06/09	Leeds Centre	53	23	4	0.190	5	0.9998	3.4
21/08	Leicester Centre	M100-204	7	4.1	0.208	5	0.9992	4.7
05/08	Liverpool Centre	114	10	4	0.196	5	0.9975	3.9
24/07	London Bexley	93031	-10	4.1	0.193	5	0.9997	0.7
17/07	London Bloomsbury	m100-055	-20	4.9	0.193	5	0.9995	9.3
29/08	London Brent	633	21	4.2	1.002	5	0.9972	7.0
09/09	London Cromwell Road 2	m100-704	-1	4.8	1.014	5	0.9976	10.1
11/09	London Hillingdon	gra0477-0	39	4.6	0.179	5	0.9998	8.9
07/08	London Westminster	10780	2	4.2	0.959	5	0.9966	9.6
22/07	Manchester Piccadilly	G-RA0477-	30	4	0.200	5	0.9977	
23/07	Manchester South	E4770104	3	4	0.219	5	0.9983	
13/08	Middlesbrough	ETI93123	15	4	0.206	5	0.9961	11.3
14/08	Newcastle Centre	116	3	4	0.234	5	0.9917	6.3
12/07	Northampton	890563033	1	4.3	0.790	5	0.9982	3.5
17/09	Norwich Centre		86	4.6	2.135	5	0.9999	8.5
22/08	Nottingham Centre	0477-016	374	4.1	0.198	5	0.9982	2.7
29/07	Oxford Centre	214b-127	100	4.2	0.987	5	0.9962	1.0
17/07	Plymouth Centre	43a-35689-251	-1	4.6	0.976	5	0.9938	17.3
28/08	Portsmouth	578323093	7	4.2	1.066	5	0.9998	1.6
13/07	Preston	Ambirak N	185	4.2	1.240	5	0.9999	
12/08	Redcar	482	5	4.3	1.090	5	0.9964	9.5
04/08	Rotherham Centre	447 0109	8	5.9	1.010	5	0.9993	8.8
23/07	Salford Eccles	ml-2346	-1	4.1	0.706	5	0.9973	3.5
22/07	Sandwell West Bromwich	93082	-2	4.2	0.993	5	0.9993	12.9
20/08	Scunthorpe	10276	8	4.2	0.993	5	0.9997	8.9
02/09	Sheffield Centre	477-015	-13	4.1	0.195	5	0.9999	6.1
29/08	Southampton Centre	m100-203	8	4.1	0.199	5	0.9996	2.6
26/09	Southend-on-Sea		144	5.3	1.089	5	0.9901	9.5
09/07	Stockport	9850-742	20	4.2	0.996	5	0.9918	13.9
08/07	Stoke-on-Trent Centre	ar003	43	5.7	1.255	5	0.9979	9.7
14/08	Sunderland	api100a-5	2	4.3	0.908	5	0.9972	8.6
23/07	Thurrock	555	0	4.2	0.969	5	0.9997	3.9
06/08	Wigan Leigh	2	4	4.2	1.037	5	0.9973	3.1
13/07	Wirral Tranmere	Ambirak	25	4.2	1.237	5	0.9996	
25/07	Wolverhampton Centre	GRAO447009	-23	4.1	0.494	5	0.9981	6.4

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.

3. Ozone

Date Year =2002	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*R^2
	Scottish Sites						
05/08	Edinburgh Centre	m400-604	3	3	0.506	3.1	1.0000
31/07	Glasgow Centre	gra427-01	-5	3	0.207	3.6	0.9997
	Welsh Sites						
25/09	Cardiff Centre	m400 057	29	3	0.097	3.1	1.0000
25/09	Port Talbot	339	3	3	0.491	3.1	1.0000
26/09	Swansea	156	31	3	0.094	3.1	1.0000
	N.Irish Sites						
20/08	Belfast Centre	51	4	3	0.105	3.1	1.0000
20/08	Derry	J-AR-009	0	3	1.138	3.1	0.9993
	English Sites						
08/07	Barnsley Gawber		0	3	1.146	3.1	0.9995
12/07	Birmingham Centre	92379	19	3	0.105	3.1	0.9999
15/08	Birmingham East	92456	53	3	0.095	3	0.9998
24/07	Blackpool	l-ar-010	29	3	0.956	3.1	0.9999
11/07	Bolton	9812-195	3	3	1.017	3.1	0.9999
16/07	Bristol Centre	95	10	3	0.133	3.1	1.0000
10/07	Bury Roadside	9812-106	1	3	1.047	3.1	0.9992
10/07	Coventry Memorial Park		0	3	1.002	3.2	1.0000
18/07	Exeter Roadside	1317	18	3	1.002	3.1	0.9998
16/07	Leamington Spa	1469	20	3	0.987	3.1	1.0000
06/09	Leeds Centre	56	-28	3	0.104	3.1	1.0000
21/08	Leicester Centre	M400-218	5	3	0.105	3.1	0.9999
05/08	Liverpool Centre	94	10	3	0.099	3.1	0.9999
24/07	London Bexley	62	15	3	0.097	3.1	0.9999
17/07	London Bloomsbury	M100-052	70	3	0.101	3.6	0.9966
29/08	London Brent	123	19	3	0.538	3.1	0.9998
11/09	London Hillingdon	gra0427-012	-11	3	0.100	3.1	1.0000
07/08	London Westminster	10444	10	3	0.475	3.1	0.9997
22/07	Manchester Piccadilly	427-0102	-8	3	0.195	3.1	0.9986
23/07	Manchester South	E427012	-10	3	0.103	3.1	0.9999
13/08	Middlesbrough	ETI93122	12	3	0.101	3.1	0.9998
14/08	Newcastle Centre	96	5	3	0.105	3.1	0.9996
17/09	Norwich Centre		0	3	1.025	3.1	0.9995
22/08	Nottingham Centre	0427-011	-10	3	0.104	3.1	0.9994
17/07	Plymouth Centre	49-35925-251	1	3	0.494	3.1	1.0000
13/07	Preston	Ambirak N	1	3	1.256	3.1	
12/08	Redcar	400	3	3	0.463	3.1	1.0000
04/08	Rotherham Centre	d4270106	0	3	0.945	3.1	0.9998
23/07	Salford Eccles	194	5	3	0.954	3.1	0.9942
22/07	Sandwell West Bromwich	93083	-4	3	0.487	3.1	1.0000
02/09	Sheffield Centre	427-010	3	3	0.095	3.1	0.9999
29/08	Southampton Centre	m400-217	5	3	0.098	3.1	0.9999
26/09	Southend-on-Sea		3	3	1.015	3.1	0.9998
08/07	Stoke-on-Trent Centre	AR003	6	3.1	1.058	3.3	0.9990
23/07	Thurrock	1040	2	3	0.463	3.1	1.0000
06/08	Wigan Leigh	4009	4	3	0.949	3.1	0.9997
13/07	Wirral Tranmere	Ambirak	2	3	1.282	3.1	0.9996

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.

Date Year =2002	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*R^2
25/07	Wolverhampton Centre	O427-009	3	3	0.107	3.1	1.0000

4. Oxides of Nitrogen

Date Year =2002	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*R^2	*Converter efficiency (%)
	Scottish Sites								
06/08	Aberdeen	NO NOx	m200a-519	0 0	5 5.4	1.366 1.373	5 5	0.9999 0.9998	98.4
29/07	Dumfries	NO NOx	m200a-149	12 6	5 5.5	0.467 0.465	5 5	0.9998 0.9997	95.7
05/08	Edinburgh Centre	NO NOx	m200a-267	1 1	5 5.6	2.061 2.056	5 5	0.9999 0.9999	99.2
31/07	Glasgow Centre	NO NOx	gra447-01	6 10	5 5.5	0.367 0.402	5 5	0.9992 0.9992	95.2
30/07	Glasgow City Chambers	NO NOx	m200a-575	2 2	5 5.5	1.241 1.24	5 5	0.9998 0.9998	97.6
30/07	Grangemouth	NO NOx	700b-312	0 0	5 5.4	1.245 1.296	5 5	0.9997 0.9994	95.2
07/08	Inverness	NO NOx	m200a-148	4 5	5 5.2	0.403 0.402	5 5	0.9999 0.9999	98.6
	Welsh Sites								
25/09	Cardiff Centre	NO NOx	m200 033	8 0	5 5.2	0.436 0.435	5 5	0.9997 0.9998	98.5
24/09	Cwmbran	NO NOx	406003	1 6	5 5.4	0.945 0.936	5 5	0.9997 0.9997	99.4
25/09	Port Talbot	NO NOx	320	1 -3	5 5.4	1.014 0.994	5 5	0.9997 0.9997	101.2
26/09	Swansea	NO NOx	148	-4 -4	5 5.6	0.39 0.39	5 5	0.9999 0.9999	98.9
13/07	Wrexham	NO NOx	12185	9 9	5 5.2	0.471 0.456	5 5	0.9998 0.9999	98.3
	N.Irish Sites								
20/08	Belfast Centre	NO NOx	38	-2 -1	5 8.3	0.525 0.525	5 5	0.9984 0.9986	99.8
20/08	Derry	NO NOx	J-AR-009	43 43	5 5.7	2.376 2.421	5.2 5	0.9931 0.9941	97.4
	English Sites								
08/07	Barnsley Gawber	NO NOx		69 69	5 6.3	2.296 2.299	5 5	0.9998 0.9998	95.6
09/07	Bath Roadside	NO NOx	api200a11	3 2	5 5.3	1.191 1.191	5 5	0.9997 0.9998	97.9
12/08	Billingham	NO NOx	api200a-5	-1 -3	5 5.4	1.46 1.451	5 5	0.9972 0.9980	97.9
12/07	Birmingham Centre	NO NOx	92377	13 20	5 5.2	0.372 0.404	5 5	0.9999 0.9999	99.9
15/08	Birmingham East	NO NOx	92457	0 -8	5 5.2	0.381 0.379	5 5	0.9999 0.9999	99.1
24/07	Blackpool	NO NOx	l-ar-010	41 31	5 5.8	2.714 2.592	5 5	0.9978 0.9994	96

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.

Date Year =2002	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*R^2	*Converter efficiency (%)
11/07	Bolton	NO NOx	9841a-433	-1 -1	5 5.5	1.162 1.167	5 5	0.9977 0.998	103.7
15/07	Bournemouth	NO NOx	m200a522	1 -5	5 6.3	1.119 1.099	5 5	0.9998 0.9997	95.7
05/09	Bradford Centre	NO NOx	Ambirak	26 26	5 6	2.207 2.15	5 5	0.9981 0.9983	97.5
12/09	Brighton Roadside	NO NOx	263	100 101	5 6	2.671 3.035	5 5	0.9995 0.9997	98.4
16/07	Bristol Centre	NO NOx	105	-11 -6	5 5.2	0.449 0.445	5 5	0.9971 0.9972	97.9
15/07	Bristol Old Market	NO NOx	API200A-6	-6 -6	5 5.9	2.801 2.79	5 5	0.9976 0.9976	97.9
10/07	Bury Roadside	NO NOx	9800-1710	1 2	5 5.8	0.927 0.931	5 5	0.9977 0.9978	95.1
30/08	Cambridge Roadside	NO NOx	42C55355-	-1 -1	5 5.2	0.098 0.098	5 5	0.9948 0.995	96.6
25/07	Canterbury	NO NOx	11666	5 4	5 5.3	1.177 1.157	5 5	0.9997 0.9997	99.1
10/07	Coventry Memorial Park	NO NOx	ambirak	8 10	7.3 8.6	4.873 4.829	5 5	0.9993 0.9994	94.8
18/07	Exeter Roadside	NO NOx	9841a-85	21 21	5 6.4	2.614 2.616	5 5	0.9982 0.9987	98.4
12/09	Hove Roadside	NO NOx	615b273	98 100	5 6	1.508 1.537	5 5	0.9998 0.9997	98.7
16/07	Leamington Spa	NO NOx	1705	23 20	5 5.7	2.324 2.33	5 5	0.9995 0.9983	102.1
06/09	Leeds Centre	NO NOx	106	9 -7	5 5.4	0.476 0.463	5 5	0.9994 0.9992	98.2
21/08	Leicester Centre	NO NOx	M200-191	6 -33	5 5.6	0.456 0.443	5 5	0.9993 0.9995	98.8
05/08	Liverpool Centre	NO NOx	104	-19 -20	5 5.5	0.432 0.427	5 5	0.9985 0.9989	100.3
18/07	London A3 Roadside	NO NOx	Ambirak H	67 67	5 6.8	2.905 2.845	5 5	0.9988 0.9987	99
24/07	London Bexley	NO NOx	59	5 3	5 5.2	0.575 0.581	5 5	0.9998 0.9999	98.3
17/07	London Bloomsbury	NO NOx	m200-039	11 2	5 5.3	0.41 0.4	5 5	0.9999 0.9998	97.4
29/08	London Brent	NO NOx	283	23 28	5 6.2	2.447 2.452	5 5	0.9985 0.9982	96.3
09/09	London CromwellRoad2	NO NOx	m200a864	-2 1	5 7.3	2.633 2.687	5 5	0.9976 0.9973	97.1
11/09	London Hillingdon	NO NOx	gra0447-0	36 38	5 5.2	0.54 0.55	5 5	0.9984 0.9985	98.8
07/08	London Westminster	NO NOx	10439	2 0	5 8.2	4.479 4.501	5 5	0.9982 0.9981	98.2
22/07	Manchester Piccadilly	NO NOx	G-RA0447-	18 20	5 5.2	0.665 0.671	5 5	0.9931 0.9934	97.5
23/07	Manchester South	NO NOx	J-RA0447-010	-13 -8	5 5.2	0.411 0.422	5 5	0.9968 0.9968	95.1
22/07	Manchester Town Hall	NO NOx	10779	-2 -7	5 5.7	2.312 2.258	5 5	0.9981 0.9983	99.1
13/08	Middlesbrough	NO NOx	200A-2287	10 10	5 5.2	0.221 0.22	5 5	0.9975 0.9975	96.3

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.

Date Year =2002	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*R^2	*Converter efficiency (%)
14/08	Newcastle Centre	NO NOx	m200-037	1 6	5 5.4	0.49 0.487	5 5	0.9963 0.9963	99.8
12/07	Northampton	NO NOx	851318061	0 0	5 5.3	0.984 0.98	5 5	0.9999 0.9999	101.5
17/09	Norwich Centre	NO NOx	Ambirak	11 12	5 6.4	3.642 3.65	5 5	0.9993 0.9992	96.6
31/07	Norwich Roadside	NO NOx	94604	-2 -2	5 5.3	1.153 1.159	5 5	0.9984 0.9980	100.3
22/08	Nottingham Centre	NO NOx	447-009	-10 -9	5 5.5	0.527 0.531	5 5	0.9999 0.9999	96.3
29/07	Oxford Centre	NO NOx	411b-179	100 101	5 5.3	1.15 1.155	5 5	0.9978 0.9976	96.6
17/07	Plymouth Centre	NO NOx	42c-999c-343	1 1	5 5.7	2.276 2.342	5 5	0.9976 0.9974	101.5
28/08	Portsmouth	NO NOx	903005	0 0	5 5.3	0.969 0.937	5 5	0.9998 0.9998	100.5
13/07	Preston	NO NOx	Ambirak	66 66	5 5.9	2.766 2.808	5 5	0.9995 0.9997	96.6
11/07	Reading	NO NOx	ambirak-n	2 3	5 6.9	2.254 3.222	5 5	0.9980 0.9986	95.5
12/08	Redcar	NO NOx	api200a-4	2 2	5 5.3	1.162 1.168	5 5	0.9973 0.9973	95.9
04/08	Rotherham Centre	NO NOx	d4470108	-30 -31	5 5.6	1.169 1.129	5 5	0.9997 0.9996	97.0
23/07	Salford Eccles	NO NOx	ml-2381	-1 2	5 5.3	1.165 1.262	5 5	0.9986 0.9984	100
22/07	Sandwell West Bromwich	NO NOx	93081	-2 -3	5 5.3	1.027 1.021	5 5	0.9998 0.9998	99.4
02/09	Sheffield Centre	NO NOx	447-008	-10 -14	5 5.3	0.492 0.507	5 5	0.9999 0.9998	97.2
03/09	Sheffield Tinsley	NO NOx	847	1 0	5 8.9	2.324 2.29	5 5	0.9997 0.9997	99.1
29/08	Southampton Centre	NO NOx	m200-187	-9 -5	5 5.2	0.438 0.439	5 5	0.9980 0.9982	98.5
26/09	Southend-on-Sea	NO NOx	Ambirak	61 60	5 9.2	2.548 2.547	5 5	0.9897 0.9876	97.9
09/07	Stockport	NO NOx	9800-1853	19 19	5 5.7	2.174 2.246	5 5	0.9967 0.9969	102
13/08	Stockton-on-Tees Yarm	NO NOx	ML9841A-113	2 13	5 5.5	1.115 1.178	5 5	0.9983 0.9982	96
08/07	Stoke-on-Trent Centre	NO NOx	Ambirak H	36 36	5 6.3	2.293 2.362	5 5	0.9950 0.9959	98.1
23/07	Thurrock	NO NOx	920	0 0	5 5.3	1.208 1.197	5 5	0.9999 0.9997	98.6
19/08	Walsall Willenhall	NO NOx	ml9841a-1	9 9	5 5.6	1.115 1.119	5 5	0.9978 0.9971	98.8
09/09	West London	NO NOx	845	-2 -7	5 13	1.323 1.299	5 5	0.9977 0.9965	97.5
06/08	Wigan Leigh	NO NOx	712015	0 1	5 5.3	1.017 1.012	5 5	0.9985 0.9986	100
13/07	Wirral Tranmere	NO NOx	Ambirak	20 20	5 5.7	2.312 2.281	5 5	0.9997 0.9993	97.7
25/07	Wolverhampton Centre	NO NOx	GRAO4470	-15 -25	5 5.2	0.555 0.554	5 5	0.9977 0.9978	98.3

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 =2002	Site	Analyser number	Calculated Spring Constant k_0	Uncertainty (%)	$^4k_0$ accuracy (%)	^{3}Measured Main Flow (l/min)	Uncertainty (%)	^{3}Measured Total Flow (l/min)	Uncertainty (%)
	Scottish Sites								
06/08	Aberdeen	21371	10260	1	1.1	2.9	6.3	16.26	4
29/07	Dumfries		n/a	n/a	n/a	n/a	n/a	16.88	4
05/08	Edinburgh Centre	2144	12776	1	2.3	2.03	6.3	16.5	4
31/07	Glasgow Centre	20913	13489	1	1.1	2.01	6.3	16.74	4
30/07	Glasgow Kerbside	21316	13760	1	0.5	1.97	6.3	15.94	4
30/07	Grangemouth	22763	12431	1	-1.7	3.03	6.3	16.43	4
07/08	Inverness	2025a2125	n/a	n/a	n/a	n/a	n/a	16.48	4
	Welsh Sites								
25/09	Cardiff Centre	1735	11295	1	1.4	Not tested		15.83	4
24/09	Cwmbran	21557	12651	1	0.9	Not tested			
25/09	Port Talbot	9402	10837	1	2.3	3.01	6.3	16.8	4
26/09	Swansea	2130	14448	1	-0.8	1.81	6.3	16.52	4
	Wrexham					n/a	n/a		
	N.Irish Sites								
20/08	Belfast Centre	1818	13457	1	2.6	1.99	6.3	14.91	4
20/08	Belfast Clara St		n/a	n/a	n/a	n/a	n/a	Not tested	
20/08	Derry	49608	11120	1	2.1	2.09	6.3	16.92	4
	English Sites								
12/07	Birmingham Centre	2297	12170	1	0.8	1.87	6.3	15.93	4
15/08	Birmingham East	92454	17102	1	0.5	2	6.3	16.74	4
24/07	Blackpool	22980	13028	1	-0.9	1.95	6.3	16.14	4
11/07	Bolton	21197	15167	1	0	Not tested			
15/07	Bournemouth		n/a	n/a	n/a	n/a	n/a	15.96	4
05/09	Bradford Centre	21494	11359	1	0.1	1.98	6.3	16.47	4
16/07	Bristol Centre	1137	7036	1	1.2	3.1	6.3	16.75	4
10/07	Bury Roadside	658	11570	1	-0.2	2	6.3	16.16	4
25/07	Canterbury	95295	14007	1	-0.2	3.05	6.3	16.73	4
10/07	Coventry Memorial Park	21918	13109	1	-2.2	Not tested			
16/07	Leamington Spa	9408	11024	1	0.8	Not tested			
06/09	Leeds Centre	2032	13152	1	2.4	2.04	6.3	17.96	4
21/08	Leicester Centre	rp2145	11579	1	27.6	1.94	6.3	16.51	4
05/08	Liverpool Centre	2034	14058	1	-0.5	2.01	6.3	16.98	4
18/07	London A3 Roadside	21314	10462	1	0	2.01	6.3	16.69	4
24/07	London Bexley	10241	10579	1	1.1	2.03	6.3	16.77	4
17/07	London Bloomsbury	2140	9380	1	-0.5	Not tested			

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Date Year =2002	Site	Analyser number	Calculated Spring Constant k_0	Uncertainty (%)	[4]k_0 accuracy (%)	[3]Measured Main Flow (l/min)	Uncertainty (%)	[3]Measured Total Flow (l/min)	Uncertainty (%)
29/08	London Brent	21145	17730	1	1.2	Not tested			
11/09	London Hillingdon	20903	8558	1	-0.2	2.03	6.3	16.27	4
22/07	Manchester Piccadilly	20914	12095	1	0.4	Not tested			
13/08	Middlesbrough	2000	15650	1	2.2	Not tested			
14/08	Newcastle Centre	1738	12305	1	2.3	Not tested			
12/07	Northampton	21621	11098	1	-0.5	2.95	6.3	15.57	4
17/09	Norwich Centre	21495	12111	1	-0.8	1.95	6.3	16.56	4
22/08	Nottingham Centre	59507	11121	1	-1.8	1.98	6.3	16.37	4
17/07	Plymouth Centre	21308	12940	1	0.9	Not tested			
28/08	Portsmouth	2157	10458	1	-1.1	3.03	6.3	16.77	4
13/07	Preston	22881	12828	1	-1	2.01	6.3	17.79	4
11/07	Reading	2000	13324	1	0.9	1.86	6.3	16.62	4
12/08	Redcar	21344	11978	1	1.7	2.99	6.3	16.35	4
23/07	Salford Eccles	21168	14518	1	0.7	1.94	6.3	16.42	4
20/08	Scunthorpe	2129	10488	1	0.5	Not tested			
02/09	Sheffield Centre	21244	12286	1	0.9	2.01	6.3	16.41	4
29/08	Southampton Centre	2298	13866	1	0.2	1.98	6.3	16.63	4
26/09	Southend-on-Sea	22927	13243	1	-1.1	Not tested			
09/07	Stockport	2000	10555	1	1.3	Not tested			
13/08	Stockton-on-Tees Yarm	22885	14367	1	0.5	2.81	6.3	16.55	4
08/07	Stoke-on-Trent Centre	21317	18203	1	-0.9	1.95	6.3	16.05	4
23/07	Thurrock	2077	6385	1	0.4	1.91	6.3	16.16	4
06/08	Wigan Leigh	22015	13415	1	2.8	3.01	6.3	16.47	4
13/07	Wirral Tranmere	22883	13080	1	-1.6	1.94	6.3	16.89	4
25/07	Wolverhampton Centre	20917	13768	1	0.2	2.01	6.3	15.69	4

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

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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) x 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

This certificate is an electronic representation of a master copy, signed by Ken Stevenson on 14 February 2002, that is held at AEA Technology Environment. Hard copies of this document are available on request.

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