REPORT

Intercalibration Report for the Automatic Urban Network, Jan - Mar 2002

Brian Stacey

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Brian Stacey
AEA Technology Environment
Culham Science Centre
Abingdon
Oxfordshire
OX14 3ED
Telephone 01235 463177
Facsimile 01235 463011

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	Name	Signature	Date
Author	Brian Stacey		
Reviewed by	Steve Telling		
Approved by	Ken Stevenson		

Executive Summary

In January to March 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	17	47	36%
NOx analyser	18	77	23%
CO analyser	2	60	3%
SO_2 analyser	8	63	13%
TEOM analyser	3	53	6%
Partisol analyser	-	6	n/a
Total	48	306	16%

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, 5 of the 203 site cylinders (2.5%) used to scale instrument data into concentrations 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 is broadly similar to the previous exercise. At the summer 2001 intercalibration, 15% 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 43 of the 66 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

netcen has undertaken an intercalibration of air quality monitoring sites in the Automatic Urban Network (AUN) in January to March 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 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 measurement of NO_2 to be undertaken, so it must work acceptably.
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 Section 2.

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 82nd site at Walsall Alumwell was not visited as a result of newly imposed safety restrictions at **netcen**; the site is currently awaiting improved safety measures to allow us to revisit.

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.

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, 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.

- 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 Scotland						
15/01/02	Aberdeen	A	A	A		A
04/02/02	Dumfries	A	A			A
12/01/02	Edinburgh Centre	A	A	A	A	A
06/02/02	Glasgow Centre	-	A	A	A	B
06/02/02	Glasgow City Chambers	A	A			
05/02/02	Glasgow Kerbside	A	A			A
05/02/02	Grangemouth	A		A		A
13/01/02	Inverness	A	A			-
Sites in Wales						
05/03/02	Cardiff Centre	A	A	B	A	A
04/03/02	Cwmbrân	B		A		A
05/03/02	Port Talbot	A		A	A	A
06/03/02	Swansea	A	A	A	A	A
27/02/02	Wrexham	A	A	A		A
Sites in Northern Ireland						
29/01/02	Belfast Centre	B	A	A	B	A
29/01/02	Belfast Clara St					A
29/01/02	Belfast East			A		
30/01/02	Derry	B	A	B	B	A
Sites in England						
12/03/02	Barnsley 12			A		
12/03/02	Barnsley Gawber	-		-	B	
16/01/02	Bath Roadside	A	A			
18/02/02	Billingham	A				
28/01/02	Birmingham Centre	A	A	A	B	A
31/01/02	Birmingham East	A	A	A	A	A
05/02/02	Blackpool	D	A	A	B	A
24/01/02	Bolton	A	A	A	A	A
06/03/02	Bournemouth	B		A		A
14/03/02	Bradford Centre	A	A	A	A	A
05/03/02	Brighton Roadside	B	A			
12/02/02	Bristol Centre	A	A	A	B	A
11/02/02	Bristol Old Market	A	A			
22/01/02	Bury Roadside	B	A	A	A	B
22/01/02	Cambridge Roadside	A				
10/01/02	Canterbury	A				A
17/01/02	Coventry Memorial Park	D	A	A	A	B
13/02/02	Exeter Roadside	C	A	A	A	
05/03/02	Hove Roadside	B	A	A		
03/01/02	Hull Centre	B	C	A	A	A
25/01/02	Leamington Spa	B	A	A	A	A
15/03/02	Leeds Centre	A	A	A	A	A
13/02/02	Leicester Centre	A	A	B	B	A
19/02/02	Liverpool Centre	A	A	B	A	A
09/01/02	London A3 Roadside	A	A			A
09/01/02	London Bexley	B	A	A	A	A
10/01/02	London Bloomsbury	B	A	A	A	B
21/01/02	London Brent	A	A	A	A	A
07/03/02	London Cromwell Road 2	A	A	B		
07/01/02	London Hillingdon	A	A	A	B	A

Date visited	Site	NOx	CO	SO_2	O_3	PM_{10}
20/03/02	London Westminster	A	A	A	B	-
06/02/02	Manchester Piccadilly	D	A	A	A	A
06/02/02	Manchester South	A		A	B	
07/03/02	Manchester Town Hall	A	A			
19/02/02	Middlesbrough	A	A	A	A	A
20/02/02	Newcastle Centre	A	A	A	A	A
14/01/02	Northampton	A		A		A
26/02/02	Norwich Centre	A	A	B	C	B
26/02/02	Norwich Roadside	A				
25/02/02	Nottingham Centre	A	A	A	A	A
03/01/02	Oxford Centre	A	A	A		
14/02/02	Plymouth Centre	A	A	A	A	A
15/01/02	Portsmouth	C		B		A
30/01/02	Preston	A	A	A	A	B
07/01/02	Reading	A	A	A	B	A
19/02/02	Redcar	A	A	A	A	A
13/03/02	Rotherham Centre	D		A	B	
21/02/02	Salford Eccles	A	A	A	-	A
23/01/02	Sandwell West Bromwich	B	A	A	A	
26/02/02	Scunthorpe			A		A
11/03/02	Sheffield Centre	A	A	A	B	A
11/03/02	Sheffield Tinsley	A	A			
08/01/02	Southampton Centre	A	A	B	A	A
14/02/02	Southend-on-Sea	B	A	A	A	A
23/01/02	Stockport	A	A	A		A
18/02/02	Stockton-on-Tees Yarm	A				A
21/01/02	Stoke-on-Trent Centre	A	A	A	C	A
21/02/02	Sunderland			A		
08/01/02	Thurrock	A	A	A	A	A
	Walsall Alumwell	-				
28/01/02	Walsall Willenhall	A				
07/03/02	West London	A	A			
20/02/02	Wigan Leigh	A		A		A
29/01/02	Wirral Tranmere	A	A	A	C	A
04/02/02	Wolverhampton Centre	A	C	A	A	A

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

Grade	A	B	C	D	E	Not tested
No of instruments	248	40	7	4	0	7

From the above table, it is clear that the vast majority of analysers (290 of the 306 analysers, 95%) in the network are functioning well. This compares well with the summer exercise, where 93% 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

Eighteen of the 77 analysers tested (23%) 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 26% of the analysers were found to be outliers.

Close investigation of the results showed that 14 of these outliers were of minor grade B, 2 of grade C and 2 of grade D. A further 2 Grade D sites, at Blackpool and Coventry Memorial Park, arose as a result of poor converter tests.

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 Portsmouth was seen to exhibit some 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 data from the site will be closely examined during ratification, and action taken as necessary

The analyser calibration factor at Exeter Roadside appears to have drifted significantly between LSO visits, causing the outlier result. This should be easily correctable, and is unlikely to affect data capture for the site.

The analysers at Barnsley Gawber and Glasgow Centre broke down during the audit visit; thus their performance could not be fully evaluated. It is unlikely that data will need to be rejected as a result of these findings.

Due to safety restrictions, the Walsall Alumwell site was not audited.

Comparison of the network average results against the actual cylinder concentrations showed that the network underestimates NO concentrations by approximately 2% of actual concentrations, with a percentage standard deviation around this value of 4.2%. 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 4%, with a percentage standard deviation around this value of 4.9%. 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. Blackpool 94%
2. Coventry Memorial Park 91%
3. Manchester Piccadilly 93%
4. Rotherham 92%

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 at these sites to ensure optimal performance.

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

4 Carbon Monoxide

Just two of the 60 analysers (3%) were identified as an outlier. This is similar to the previous exercise, when only one analyser was found to be outside the acceptance limits.

The analyser at Hull Centre was found to have an excessively noisy response, which contributed to its poor result. 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.

The analyser at Wolverhampton Centre was 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 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 2.9%. This is an excellent result, demonstrating that measurements are accurate, consistent and traceable to metrology standards.

Recommendation: Stanger to replace the CO analyser at Hull Centre when the site is recommissioned.

5 Sulphur Dioxide

The analysers at eight of the 62 sites (13%) 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 similar to the previous intercalibration, when six analysers were found to be outliers.

The outliers at Liverpool Centre and Portsmouth 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 outliers at London Cromwell Road 2 and Norwich Centre were seen as a result of changes in site cylinder concentration. This is easily correctable, and will not affect data capture for the sites.

The analysers at Derry, Leicester Centre and Southampton Centre were all seen to exhibit slight differences in response when gas was introduced through the sample inlet, as opposed to the dedicated cylinder inlet. This may well have some consequences for ambient data, as the results from the scheduled calibrations do not appear to accurately represent what the analysers sample from ambient air. The data from the 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.

The analyser at Barnsley Gawber broke down during the audit visit; thus its performance could not be fully 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 audit cylinder concentrations showed that, overall, the network continues to measure SO_2 concentrations to within 1%, with a percentage standard deviation of 3.3%. 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 10 analysers were outside the required standard:

1. Belfast East (11 ppb)
2. Blackpool (16 ppb)
3. Derry (19 ppb)
4. Exeter Roadside (16 ppb)
5. London Brent (16 ppb)
6. London Westminster (17 ppb)
7. Manchester Piccadilly (23 ppb)
8. Manchester South (20 ppb)
9. Plymouth (19 ppb)
10. Wolverhampton Centre (23 ppb)

The kickers at Belfast East, Derry, Exeter Roadside and Wolverhampton Centre were all Identified as outliers at the summer 2001 intercalibration. The kicker at Manchester South was identified as an outlier at the previous two exercises.

These results are similar to 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 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 17 of the 47 analysers (36%) were found to be greater than 5% from the **netcen** standard at this intercalibration. The overall result is two analysers worse than the previous exercise, when 32% of the analysers were identified as outliers. Of the 17 outliers, 14 were minor grade B; the analysers at Norwich Centre, Stoke on Trent Centre and Wirral Tranmere were grade C. It is most likely that the grade C outliers arose from the pressure dependency that has been observed for these analysers before. **netcen** will make use of all the available data from these sites and rescale the data as necessary during ratification.

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 Salford Eccles was not available for testing.

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.

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. Coventry Memorial Park (-4.7%)
2. London Bloomsbury (+2.6%)
3. Preston (-2.9%)

The analysers at Coventry Centre and Preston were repeat outliers, having been identified at the previous 2 intercalibrations. The Preston analyser has been adjusted a number of times, but it seems that these adjustments have not been completely successful. It should be possible to rescale the data from all these sites with no loss of data.

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

The flow rates of the analysers at Bury Roadside, Glasgow Centre and Norwich Centre were all 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.

netcen and the equipment suppliers have been investigating possible reasons for the significant number of k_0 outliers identified at recent audits. These investigations have examined every aspect of the k_0 determination, from procedures used, through multi filter tests and the calculation itself, to the symmetry of the filter / tapered element union.

Tests to examine the variance of calculated k_0 using a large number of different filters was undertaken. The investigation revealed that the original metal foil backed filters (which have been used since the analysers were first operated in the network) gave significantly variable responses. This variability can be attributed in part to the manual nature of the production of these filters.

The latest long-life filters are assembled in plastic, using fully automated methodologies, which reduces the amount of variability in the finished product. Tests using these filters have been very encouraging, with reduced variability in the calculated results.

Recommendation: To improve data quality, all site TEOM filters should be changed to the newer plastic filter cartridges.

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 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 and Dumfries, and all were found to be within limits.

The Inverness analyser was awaiting repair at the time of the intercalibration visit, while safety restrictions prevented tests at London Westminster.

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 5 of the 203 cylinders (2.5%) 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 similar to the previous intercalibration, where 9% 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.

2 NO cylinder outliers were identified. Of these, the cylinder at Stoke-on-Trent Centre is of most concern, as the concentrations have changed significantly, suggesting the cylinders may have become contaminated. This should be returned to NPL for replacement at the earliest opportunity.

Recommendation: NPL to replace the Stoke-on-Trent Centre NO cylinder

19 NO_2 outliers were found. Of the outliers identified, the cylinder at Aberdeen gives cause for concern, as it was again found to be significantly 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.

Recommendation: NPL to replace the Aberdeen NO_2 cylinder

3 SO_2 outliers were identified. The calculated concentration of the cylinder at London Cromwell Road 2 again appears to have drifted significantly (by 19%) from its stated values, and should be replaced as soon as possible. The cylinders at Norwich Centre and Stoke-on-Trent Centre will be carefully checked at the next intercalibration.

Recommendation: NPL to replace the London Cromwell Road 2 SO_2 cylinder

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. The following analysers exhibited apparent losses to the sampling / calibration system:

NOx analyser at Portsmouth
CO analyser at Wolverhampton Centre
SO_2 analysers at Derry, Leicester Centre and Southampton Centre
O_3 analysers at Norwich Centre, Stoke-on-Trent Centre and Wirral Tranmere

This is somewhat worse than the summer 2001 result, where only one analyser was seen to behave in this manner. The ESU's are reminded of the importance of cleaning the entire sample inlet system (manifold, tubes, and solenoids), and the requirement to do this every six months at the scheduled service.

10 LSO Audits

During the intercalibration, 43 of the 66 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 and Local Site Operators are not exposed to unsafe practices while working. In conjunction with Stanger, we have identified a number of areas that require attention in order to minimise operator risk. These are:

- Safe access to particulate analyser inlets to test flow rates, chiefly 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. London Westminster
  12. Manchester Piccadilly
  13. Plymouth Centre
  14. Scunthorpe
  15. Southend-on-Sea
  16. Stockport
  17. Thurrock

- Safe access, lifting facilities and security barriers at the Walsall Alumwell site

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 July to December 2001.

Appendices

CONTENTS

Appendix 1
Certificate of Calibration

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

UKAS CALIBRATION 0401

Certificate No: 00706
AEA Identification Number: 20568104

Approved Signatories: ✔ K. Stevenson
S. Eaton

Signed: Date:

Date of issue: 1 August 2002

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						
15/01	Aberdeen	10269	25	0.3	0.010	3.0	0.9990
04/02	Dumfries	api300-14	-192	0.3	0.011	3.0	0.9995
12/01	Edinburgh Centre	co11m-79	49	0.3	0.062	3.0	0.9955
06/02	Glasgow Centre	GRA0410	5	0.3	0.046	3.0	0.9977
06/02	Glasgow City Chambers	api300-72	-1	0.3	0.050	3.0	0.9989
05/02	Glasgow Kerbside	0	0	0.3	0.058	3.0	0.9985
13/01	Inverness	m3001500	-91	0.3	0.009	3.0	0.9955
	Welsh Sites						
05/03	Cardiff Centre	co11m-80	20	0.3	0.051	3.0	0.9969
04/03	Cwmbran	103006	-2	0.3	0.990	3.0	0.9980
06/03	Swansea	m300-070	6	0.3	0.049	3.0	0.9977
27/02	Wrexham	12556	-19	0.3	0.010	3.0	0.9992
	N.Irish Sites						
29/01	Belfast Centre	CO11M-78	20	0.3	0.051	3.0	0.9983
30/01	Derry	Ambirak-J	2	0.3	0.055	3.0	0.9987

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.

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Certificate No: 00606
AEA Identification Number: 20568104

Date Year =2002	Site	Analyser number	[1]Zero output	Uncertainty (ppm)	[2]Calibration Factor	Uncertainty (%)	*R^2
	English Sites						
16/01	Bath Roadside	11388	14	0.3	0.052	3.0	0.9997
28/01	Birmingham Centre	co11m68	54	0.3	0.052	3.0	0.9991
31/01	Birmingham East		0	0.3	0.049	3.0	0.9952
05/02	Blackpool	L AR 010	-2	0.3	0.051	3.0	1.0000
24/01	Bolton	2392	18	1.0	0.994	5	0.9999
14/03	Bradford Centre		3	0.3	0.055	3.0	0.9999
05/03	Brighton Roadside	1434	4	0.3	0.049	3.0	0.9996
12/02	Bristol Centre	CO11M-24	28	0.3	0.056	4.4	0.9986
11/02	Bristol Old Market	eti92524	0	0.3	0.050	3.0	0.9997
22/01	Bury Roadside	1357	2	1.0	1.010	5.1	0.9953
17/01	Coventry Memorial Park		2	0.3	0.053	3.0	0.9999
13/02	Exeter Roadside	ml-244	10	0.3	0.059	3.0	0.9983
05/03	Hove Roadside	1433	-16	0.3	0.052	3.0	0.9991
25/01	Leamington Spa	9830-219B	53	0.3	0.050	3.0	0.9998
15/03	Leeds Centre	148	46	0.3	0.050	3.0	0.9989
13/02	Leicester Centre	co11m 104	23	0.3	0.054	3.0	0.9999
19/02	Liverpool Centre	93097	56	0.3	0.055	3.0	0.9995
09/01	London A3 Roadside		-6	0.3	0.051	3.0	0.9982
09/01	London Bexley	m300-79	-5	0.3	0.052	3.0	0.9994
10/01	London Bloomsbury	eti00159	36	0.3	0.048	3.0	0.9966
21/01	London Brent	9830-339	20	0.3	0.050	3.0	0.9991
07/03	London Cromwell Road 2	868	3	0.3	0.049	3.0	0.9595
07/01	London Hillingdon	gra041000	24	0.3	0.047	3.0	0.9999
20/03	London Westminster	api300-86	11	0.3	0.048	3.0	0.9996
06/02	Manchester Piccadilly	414 Hot S	-52.5	0.3	0.046	3.0	0.9999
07/03	Manchester Town Hall	720	23	0.3	0.049	3.0	0.9998
19/02	Middlesbrough	94721	2	0.3	0.050	3.0	0.9961
20/02	Newcastle Centre	92537	15	0.3	0.047	3.0	0.9964
26/02	Norwich Centre		-1	0.3	0.051	3.0	0.9983
25/02	Nottingham Centre		-9	0.3	0.048	3.0	0.9999
03/01	Oxford Centre		100	0.3	0.049	3.0	0.9983
14/02	Plymouth Centre	H-RAO-410	-1	0.3	0.064	3.0	0.9970
30/01	Preston		-1	0.3	0.053	3.0	0.9997
07/01	Reading	H-AR-004	3	0.3	0.055	3.0	0.9964
19/02	Redcar	10194	8	0.3	0.053	3.0	0.9982
21/02	Salford Eccles	ml-2386	0	1.0	0.956	4.8	0.9998
23/01	Sandwell West Bromwich	94603	22	0.3	0.052	3.0	0.9968

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

Date Year =2002	Site	Analyser number	[1]Zero output	Uncertainty (ppm)	[2]Calibration Factor	Uncertainty (%)	*R^2
11/03	Sheffield Centre	410-006	1	0.3	0.053	3.0	0.9999
11/03	Sheffield Tinsley	847	48	0.3	0.050	3.0	0.9999
08/01	Southampton Centre	co11m-90	54	0.3	0.055	3.0	0.9966
14/02	Southend-on-Sea		-5	0.3	0.051	3.0	0.9999
23/01	Stockport	1701	19	0.3	0.052	3.0	0.9998
21/01	Stoke-on-Trent Centre		0	0.3	0.072	3.2	0.9998
08/01	Thurrock	m300-262	5	0.3	0.047	3.0	0.9987
07/03	West London	92915	71	0.3	0.049	3.0	0.9999
29/01	Wirral Tranmere		-2	0.3	0.059	3.0	0.9998
04/02	Wolverhampton Centre		-1	0.3	0.037	3.0	0.9990

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							
15/01	Aberdeen	12182	-10	4	0.208	5.0	0.9963	2.1
12/01	Edinburgh Centre	m100-50	-4	4.2	0.199	5.0	0.9942	
06/02	Glasgow Centre	GRA447-01	60	4	0.208	5.0	0.9959	7.3
05/02	Grangemouth		0	4.2	0.920	5.0	0.9963	3.5
	Welsh Sites							
05/03	Cardiff Centre	m100-054	13	4	0.188	5.0	0.9986	7.9
04/03	Cwmbran	408001	6	4.5	0.913	5.0	0.9979	5
05/03	Port Talbot	m100-943	0	4.2	1.036	5.0	0.9986	7.2
06/03	Swansea	m100-168	11	4	0.218	5.0	0.9981	7.4
27/02	Wrexham	12183	5	4.1	0.197	5.0	0.9992	2.6
	N.Irish Sites							
29/01	Belfast Centre	M100-052	17	4.1	0.195	5.0	0.9917	8.1
29/01	Belfast East	API100A-7	-5	4.3	1.007	5.0	0.9906	11.3
30/01	Derry		78	4.3	0.901	5.0	0.9640	18.5
	English Sites							
12/03	Barnsley 12	10781	1	4.2	1.000	5.0	1.0000	6
28/01	Birmingham Centre	51	243	4	0.194	5.0	0.9968	0.8
31/01	Birmingham East		20	4	0.181	5.0	0.9999	
05/02	Blackpool	L AR 010	51	4.8	0.932	5.0	0.9993	15.6
24/01	Bolton	2344	0	4.2	0.997	5.0	0.9998	1.9
06/03	Bournemouth	Api571	1	4.2	0.995	5.0	0.9999	5.9
14/03	Bradford Centre		40	4.3	1.321	5.0	0.9998	5.3
12/02	Bristol Centre	API100-11	0	4	0.197	5.0	0.9985	8.9
22/01	Bury Roadside	1581	15	4.2	1.036	5.0	0.9930	1
17/01	Coventry Memorial Park		103	4.6	1.500	5.0	0.9954	8.6

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

UKAS CALIBRATION

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Certificate No: 00606

AEA Identification Number: 20568104

Date Year =2002	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*R^2	*m-xylene interference (ppb)
13/02	Exeter Roadside	ml1835	19	4.2	1.122	5.0	0.9905	15.7
05/03	Hove Roadside	1178	-1	4.2	0.998	5.0	0.9999	1
03/01	Hull Centre	m100-205	67	4.1	0.195	5.0	0.9991	6.9
25/01	Leamington Spa	9850-1793	22	4.2	1.053	5.0	0.9964	8.4
15/03	Leeds Centre	m100-053	-14	4.1	0.191	5.0	0.9999	0.8
13/02	Leicester Centre	m100 204	-5	4.4	0.252	5.0	0.9997	1.6
19/02	Liverpool Centre	api100-11	9	4.1	0.232	5.0	1.0000	
09/01	London Bexley	m100-66	9	4.1	0.207	5.0	0.9955	6.4
10/01	London Bloomsbury	m100-055	34	4.1	0.197	5.0	0.9933	
21/01	London Brent	9850-633	20	4.2	0.948	5.0	0.9931	16.1
07/03	London Cromwell Road 2	704	0	4.2	1.065	5.0	0.9502	8.5
07/01	London Hillingdon	gra047701	46	5.6	0.187	5.0	0.9984	10.1
20/03	London Westminster	api100a-7	2	4.2	1.007	5.0	0.9999	17.1
06/02	Manchester Piccadilly	G-RA0477	-81	7.2	0.224	5.0	0.9997	22.5
06/02	Manchester South		-36	7.6	0.227	5.0	0.9989	20.2
19/02	Middlesbrough	93123	13	4	0.191	5.0	0.9981	
20/02	Newcastle Centre	92545	0	4	0.200	5.0	0.9985	0.2
14/01	Northampton	890563033	-4	4.1	0.826	5.0	0.9987	1.7
26/02	Norwich Centre		79	4.4	1.813	5.0	0.9914	5.4
25/02	Nottingham Centre	477016	305	4	0.214	5.0	0.9997	
03/01	Oxford Centre	3768-161	101	4.1	0.916	5.0	0.9973	7.3
14/02	Plymouth Centre	43A-35689	17	4.7	1.122	5.0	0.9919	19.9
15/01	Portsmouth	578323093	-3	4.1	0.243	5.0	0.9970	0.1
30/01	Preston		128	4.6	1.592	5.0	0.9995	
07/01	Reading	H-AR-004	160	4.2	1.059	5.0	0.9934	6.4
19/02	Redcar	10355	3	4.2	1.024	5.0	0.9979	2
13/03	Rotherham Centre	d4470109	0	4.5	1.048	5.0	0.9999	4.2
21/02	Salford Eccles	ml-2346	-1	4.3	0.988	5.0	0.9999	1.2
23/01	Sandwell West Bromwich	93082	6	4.3	1.026	5.0	0.9936	6.4
26/02	Scunthorpe	10276	6	4.2	0.991	5.0	0.9999	
11/03	Sheffield Centre	477-015	3	4	0.212	5.0	1.0000	1.7
08/01	Southampton Centre	m100-203	23	4	0.165	5.0	0.9932	1.2
14/02	Southend-on-Sea		108	7.6	1.292	5.0	0.9955	2.6
23/01	Stockport	1690	21	4.3	0.971	5.0	0.9996	
21/01	Stoke-on-Trent Centre		40	4.2	1.199	5.1	0.9988	
21/02	Sunderland	10438	6	4.2	0.957	5.0	0.9976	4.8
08/01	Thurrock	m100-555	4	4.2	0.952	5.0	0.9993	2.9
20/02	Wigan Leigh	Apsa-360a	0	4	0.110	5.0	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.

CERTIFICATE OF CALIBRATION

UKAS CALIBRATION

0401
0401 S1

Certificate No: 00606

Date Year =2002	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*R^2	*m-xylene interference (ppb)
29/01	Wirral Tranmere		11	4.2	1.172	5.0	0.9999	9.4
04/02	Wolverhampton Centre	G-RA0477	126	7.6	0.224	5.0	0.9980	23.4

3. Ozone

Date Year =2002	Site	Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*R^2
	Scottish Sites						
12/01	Edinburgh Centre	m400-53	27	3.0	0.103	3.1	1.0000
06/02	Glasgow Centre	GRA427-01	-23	3.0	0.208	4	0.9996
	Welsh Sites						
05/03	Cardiff Centre	m400-057	28	3.0	0.113	3.1	0.9994
05/03	Port Talbot	m400-339	2	3.0	0.507	3.1	0.9998
06/03	Swansea	m400-156	15	3.0	0.105	3.1	0.9998
	N.Irish Sites						
29/01	Belfast Centre	M400-051	5	3.0	0.094	3.1	1.0000
30/01	Derry		1	3.0	1.238	3.2	0.9999
	English Sites						
12/03	Barnsley Gawber		-1	3.0	1.176	3.1	0.9996
28/01	Birmingham Centre	55	15	3.0	0.109	3.1	1.0000
31/01	Birmingham East		13	3.0	0.106	3.1	0.9993
05/02	Blackpool	L AR 010	0	3.0	1.075	3.5	0.9998
24/01	Bolton	2871	6	3.0	1.099	3.1	0.9934
14/03	Bradford Centre		0	3.0	1.031	3.1	0.9999
12/02	Bristol Centre	API400-09	10	3.0	0.110	3.1	0.9992
22/01	Bury Roadside	1453	4	3.0	1.053	3.1	0.9998
17/01	Coventry Memorial Park		0	3.0	1.004	3.1	1.0000
13/02	Exeter Roadside	ml1317	21	3.0	1.065	3.2	0.9991
03/01	Hull Centre	m400-219	-6	3.0	0.106	3.2	0.9996
25/01	Leamington Spa	9812-1469	19	3.0	1.022	3.1	0.9999
15/03	Leeds Centre	m400-056	-15	3.0	0.103	3.1	1.0000
13/02	Leicester Centre	m400 218	20	3.0	0.093	3.1	0.9999
19/02	Liverpool Centre	api400-09	11	3.0	0.097	3.1	1.0000
09/01	London Bexley	m400-62	33	3.0	0.096	3.2	0.9999
10/01	London Bloomsbury	m100-052	6	3.0	0.100	3.1	0.9998
21/01	London Brent	9812-129	20	3.0	0.515	3.1	1.0000
07/01	London Hillingdon	gra042701	-13	3.0	0.089	3.1	0.9999
20/03	London Westminster	api400-87	14	3.0	0.472	3.1	0.9997
06/02	Manchester Piccadilly	G-RA0427-	-4	3.9	0.210	3.5	1.0000
06/02	Manchester South	E4270102	36	3.0	0.108	3.1	0.9999
19/02	Middlesbrough	93122	15	3.0	0.101	3.1	1.0000
20/02	Newcastle Centre	92546	-15	3.0	0.099	3.1	1.0000
26/02	Norwich Centre	GRA-0427-	0	3.0	1.303	3.1	0.9996
25/02	Nottingham Centre	427011	0	3.0	0.100	3.1	0.9999

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
14/02	Plymouth Centre	49-35925-	1	3.0	0.511	3.1	0.9983
30/01	Preston		0	3.0	1.053	3.1	1.0000
07/01	Reading	H-AR-004	1	3.0	1.110	3.1	1.0000
19/02	Redcar	10195	3	3.0	0.491	3.1	0.9999
13/03	Rotherham Centre	d4270106	1	3.1	1.013	3.3	0.9996
23/01	Sandwell West Bromwich	m400-121	0	3.0	0.512	3.1	0.9999
11/03	Sheffield Centre	427-019	71	3.0	0.121	3.1	0.9984
08/01	Southampton Centre	m400-217	-8	3.0	0.099	3.1	1.0000
14/02	Southend-on-Sea		0	3.0	0.984	3.2	0.9999
21/01	Stoke-on-Trent Centre		4	3.0	1.431	3.1	0.9979
08/01	Thurrock	m400-400	0	3.0	0.479	3.1	1.0000
29/01	Wirral Tranmere		2	3.0	1.420	3.1	0.9998
04/02	Wolverhampton Centre	G-RA0427-	3	3.0	0.104	3.3	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								
15/01	Aberdeen	NO NOx	10268	3 -1	5.0 5.4	0.257 0.259	5.0 5.0	0.9979 0.9980	97.9
04/02	Dumfries	NO NOx	api200a-1	1 -8	5.0 5.2	0.399 0.391	5.0 5.0	0.9974 0.9976	97.1
12/01	Edinburgh Centre	NO NOx	m200-42	5 30	5.0 6.1	0.448 0.467	5.0 5.0	0.9979 0.9977	100.2
06/02	Glasgow City Chambers	NO NOx	api200a-5	6 5	5.0 5.5	1.780 1.764	5.0 5.0	0.9977 0.9978	95.6
05/02	Glasgow Kerbside	NO NOx		-7 -7	5.0 5.5	1.790 1.805	5.0 5.0	0.9941 0.9938	99.4
05/02	Grangemouth	NO NOx		1 1	5.0 5.3	1.182 1.223	5.0 5.0	0.9980 0.9981	96.6
13/01	Inverness	NO NOx	m2001489	2 3	5.0 5.2	0.379 0.377	5.0 5.0	0.9980 0.9982	98.4
	Welsh Sites								
05/03	Cardiff Centre	NO NOx	m200-033	-3 0	5.0 5.2	0.455 0.453	 5.0	0.9977 0.9985	98.7
04/03	Cwmbran	NO NOx	406003	3 3	5.0 5.3	0.995 0.957	5.0 5.0	0.9985 0.9984	96.7
05/03	Port Talbot	NO NOx	m200-320	0 -1	5.0 5.3	1.011 0.998	5.0 5.0	0.9983 0.9982	98.6
06/03	Swansea	NO NOx	m200-148	4 2	5.0 5.4	0.458 0.454	5.0 5.0	0.9974 0.9976	99.6
27/02	Wrexham	NO NOx	12185	0 -13	5.0 5.2	0.205 0.200	5.0 5.0	1.0000 1.0000	98.6

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

UKAS CALIBRATION

0401
0401 S1

Certificate No: 00606

Date Year =2002	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*R^2	*Converter efficiency (%)
	N.Irish Sites								
29/01	Belfast Centre	NO NOx	ml9841B-8	32 20	5.0 5.2	0.400 0.376	5.0 5.0	0.9974 0.9978	96.9
30/01	Derry	NO NOx		42 42	5.0 5.5	1.963 1.939	5.0 5.0	0.9815 0.9845	98.9
	English Sites								
16/01	Bath Roadside	NO NOx	12758	4 4	5.0 5.3	1.273 1.260	5.0 5.0	0.9999 0.9999	97.7
18/02	Billingham	NO NOx	10440	1 -1	5.0 5.4	1.317 1.308	5.0 5.0	0.9974 0.9977	96.8
28/01	Birmingham Centre	NO NOx	51	43 40	5.0 5.2	0.364 0.373	5.0 5.0	0.9992 0.9991	97.9
31/01	Birmingham East	NO NOx		10 3	5.0 5.2	0.451 0.446	5.0 5.0	0.9994 0.9991	97.5
05/02	Blackpool	NO NOx	L AR 010	43 43	5.0 7.1	2.550 2.554	5.0 5.0	0.9994 0.9995	94.3
24/01	Bolton	NO NOx	2359	-2 0	5.0 5.4	1.081 1.063	5.0 5.0	0.9997 0.9997	101.5
06/03	Bournemouth	NO NOx	api-571	1 1	5.0 5.3	0.960 0.950	5.0 5.0	1.0000 0.9999	98.6
14/03	Bradford Centre	NO NOx		23 24	5.0 5.6	1.929 1.979	5.0 5.0	0.9990 0.9989	98.3
05/03	Brighton Roadside	NO NOx	263	100 100	5.0 5.6	1.939 2.074	5.0 5.0	0.9999 0.9998	98.8
12/02	Bristol Centre	NO NOx	API200-10	-5 -1	5.0 5.7	0.475 0.476	5.0 5.0	0.9990 0.9992	98.7
11/02	Bristol Old Market	NO NOx	api 200a-	-2 -3	5.0 7.3	3.690 3.658	5.0 5.0	0.9983 0.9979	98.4
22/01	Bury Roadside	NO NOx	1710	0 0	5.0 5.3	1.015 1.022	5.0 5.0	0.9997 0.9998	96.4
22/01	Cambridge Roadside	NO NOx	42c-55355	-2 -2	5.0 5.3	1.048 1.047	5.0 5.0	0.9994 0.9994	97.9
10/01	Canterbury	NO NOx	m200-	1 0	5.0 5.4	1.047 1.040	5.0 5.0	0.9998 0.9999	98.1
17/01	Coventry Memorial Park	NO NOx		5 5	5.0 6.3	1.813 1.834	5.0 5.0	0.9986 0.9992	91.3
13/02	Exeter Roadside	NO NOx	ml9841A	21 21	5.0 5.7	2.225 2.243	5.0 5.0	0.9970 0.9969	95.2
05/03	Hove Roadside	NO NOx	12486	99 100	5.0 5.9	1.985 1.998	5.0 5.0	0.9996 0.9995	101.2
03/01	Hull Centre	NO NOx	m200-186	-12 -24	5.0 6.6	0.456 0.485	5.0 5.0	0.9975 0.9985	100
25/01	Leamington Spa	NO NOx	9841A-170	23 21	5.0 5.8	2.527 2.582	5.0 5.0	0.9951 0.9980	104.4
15/03	Leeds Centre	NO NOx	106	1 -20	5.0 5.2	0.439 0.427	5.0 5.0	0.9997 0.9996	99.1
13/02	Leicester Centre	NO NOx	m200 191	7 -38	5.0 5.6	0.445 0.426	5.0 5.0	0.9994 0.9993	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 =2002	Site		Analyser number	[1]Zero output	Uncertainty (ppb)	[2]Calibration Factor	Uncertainty (%)	*R^2	*Converter efficiency (%)
19/02	Liverpool Centre	NO NOx	93098	25 10	5.0 5.2	0.543 0.528	5.0 5.0	0.9998 0.9997	100
09/01	London A3 Roadside	NO NOx	N004793-0	59 60	5.0 5.8	1.806 1.810	5.0 5.0	0.9950 0.9939	97.8
09/01	London Bexley	NO NOx	m200-59	2 -14	5.0 5.3	0.427 0.420	5.0 5.0	0.9998 0.9997	95.6
10/01	London Bloomsbury	NO NOx	m200-039	2 15	5.0 5.4	0.361 0.364	5.0 5.0	0.9985 0.9983	100.4
21/01	London Brent	NO NOx	ML-9481A-	22 27	5.0 6.1	2.233 2.240	5.0 5.0	0.9990 0.9986	98.4
07/03	London Cromwell Road2	NO NOx	844	-2 -2	5.0 5.8	2.624 2.624	5.0 5.0	0.9997 0.9999	98.5
07/01	London Hillingdon	NO NOx	gra044701	10 12	5.0 5.5	0.475 0.477	5.0 5.0	0.9974 0.9975	97.6
20/03	London Westminster	NO NOx	api200-57	2 -1	5.0 6.3	2.513 2.477	5.0 5.0	0.9998 0.9997	98
06/02	Manchester Piccadilly	NO NOx	G-RA0447-	-30 -28	5.0 5.4	0.340 0.340	5.0 5.0	0.9990 0.9989	93.4
06/02	Manchester South	NO NOx	J-RA0447-	-14 -15	5.0 5.2	0.473 0.468	5.0 5.0	0.9952 0.9954	96.3
07/03	Manchester Town Hall	NO NOx	846	0 -1	5.0 5.7	2.457 2.450	5.0 5.0	0.9999 0.9999	96.1
19/02	Middlesbrough	NO NOx	ET93072	-28 -63	5.0 5.2	0.186 0.182	5.0 5.0	0.9992 0.9989	101.9
20/02	Newcastle Centre	NO NOx	92384	5 -5	5.0 5.2	0.545 0.523	5.0 5.0	0.9977 0.9980	100.3
14/01	Northampton	NO NOx	851318061	1 1	5.0 5.4	1.028 0.999	5.0 5.0	1.0000 1.0000	100.2
26/02	Norwich Centre	NO NOx		12 13	5.0 5.8	2.447 2.492	5.0 5.0	0.9941 0.9946	98.6
26/02	Norwich Roadside	NO NOx	94804	1 -2	5.0 5.3	1.208 1.195	5.0 5.0	0.9982 0.9986	98.5
25/02	Nottingham Centre	NO NOx	447009	-35 -38	5.0 5.2	0.496 0.499	5.0 5.0	0.9999 0.9999	96
03/01	Oxford Centre	NO NOx	4118-179	99 103	5.0 5.3	1.157 1.172	5.0 5.0	0.9971 0.9975	100.5
14/02	Plymouth Centre	NO NOx	42C-66639	1 2	5.0 5.7	2.123 2.232	5.0 5.0	0.9967 0.9969	105
15/01	Portsmouth	NO NOx	903005	0 0	5.0 5.2	0.161 0.148	5.0 5.0	0.9999 0.9999	105
30/01	Preston	NO NOx		11 10	5.0 5.7	2.279 2.355	5.0 5.0	0.9994 0.9991	97
07/01	Reading	NO NOx	H-AR-004	-1 -1	5.0 5.6	2.183 2.201	5.0 5.0	0.9946 0.9949	98.1
19/02	Redcar	NO NOx	10196	0 -2	5.0 5.4	1.364 1.361	5.0 5.0	0.9974 0.9971	97.9
13/03	Rotherham Centre	NO NOx	d4470108	2 2	5.0 5.8	0.992 1.024	5.0 5.0	0.9998 0.9998	92.1

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 (%)
21/02	Salford Eccles	NO NOx	ml-2381	0 2	5.0 5.6	1.385 1.479	5.0 5.0	0.9998 0.9998	104.5
23/01	Sandwell West Bromwich	NO NOx	93081	-2 -1	5.0 5.8	1.209 1.192	5.0 5.0	0.9978 0.9979	97.9
11/03	Sheffield Centre	NO NOx	447-008	10 8	5.0 5.2	0.512 0.515	5.0 5.0	0.9999 0.9999	96.1
11/03	Sheffield Tinsley	NO NOx	1856	-1 -1	5.0 5.7	2.447 2.428	5.0 5.0	0.9997 0.9998	98.4
08/01	Southampton Centre	NO NOx	m200-187	0 0	5.0 5.2	0.464 0.463	5.0 5.0	0.9956 0.9961	99.5
14/02	Southend-on-Sea	NO NOx	Ambirak	64 63	5.0 6	1.127 1.130	5.0 5.0	0.9990 0.9988	97.5
23/01	Stockport	NO NOx	1853	20 20	5.0 6.8	4.116 4.358	5.0 5.0	0.9990 0.9988	98.9
18/02	Stockton-on-Tees Yarm	NO NOx		5 5	5.0 5.9	1.188 1.228	5.0 5.0	0.9981 0.9979	99.5
21/01	Stoke-on-Trent Centre	NO NOx	AR-003	36 37	5.0 5.6	1.947 1.996	5.0 5.0	0.9994 0.9993	100
08/01	Thurrock	NO NOx	m200-920	0 -2	5.0 5.4	1.277 1.273	5.0 5.0	0.9998 0.9996	97.2
28/01	Walsall Willenhall	NO NOx	ML9841A-1	7 7	5.0 5.4	1.124 1.125	5.0 5.0	0.9962 0.9964	98.5
07/03	West London	NO NOx	10734	1 1	5.0 5.4	1.377 1.361	5.0 5.0	0.9998 0.9998	96.2
20/02	Wigan Leigh	NO NOx	Horiba-71	0 0	5.0 5.2	0.091 0.088	5.0 5.0	0.9999 0.9999	100.6
29/01	Wirral Tranmere	NO NOx		21 21	5.0 5.8	2.569 2.560	5.0 5.0	0.9994 0.9993	96.6
04/02	Wolverhampton Centre	NO NOx	G-RA0447-	-26 -35	5.0 5.3	0.529 0.523	5.0 5.0	0.9996 0.9998	96.8

5. Particulate Analysers

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 (%)
	Scottish Sites								
15/01	Aberdeen	21371	10104	1	-0.5	1.96	6.3	15.74	4
06/02	Dumfries		n/a	n/a	n/a	n/a	n/a	16.81	4
12/01	Edinburgh Centre	2144	12562	1	0.6	Not tested			
06/02	Glasgow Centre	20913	13636	1	2.2	1.85	6.3	4.49	4

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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 (%)
05/02	Glasgow Kerbside	21316	13899	1	1.5	Not tested			
05/02	Grangemouth	22763	12581	1	-0.5	Not tested			
	Welsh Sites								
05/03	Cardiff Centre	2165	11240	1	0.9	1.93	6.3	16.20	4
04/03	Cwmbran	21557	12595	1	0.5	2.92	6.3	16.23	4
05/03	Port Talbot	9402	10785	1	1.8	2.99	6.3	17.20	4
06/03	Swansea	2130	14260	1	-2.1	1.96	6.3	15.96	4
	Wrexham					n/a	n/a		
	N.Irish Sites								
29/01	Belfast Centre	1818	13407	1	-1.0	1.96	6.3	15.02	4
17/07	Belfast Clara St					n/a	n/a	Not tested	
30/01	Derry		10925	1	0.3	2.05	6.3	17.28	4
	English Sites								
28/01	Birmingham Centre	2297	11921	1	-1.3	2.07	6.3	15.69	4
31/01	Birmingham East	2119	16814	1	-1.2	2.11	6.3	15.81	4
05/02	Blackpool	22980	12851	1	-2.2	2.06	6.3	16.51	4
24/01	Bolton	21197	14889	1	-1.8	Not tested			
06/03	Bournemouth		n/a	n/a	n/a	n/a	n/a	16.25	4
14/03	Bradford Centre	21494	11313	1	-0.4	1.94	6.3	16.08	4
12/02	Bristol Centre	RP2141	7085	1	1.9	3.01	6.3	16.51	4
22/01	Bury Roadside	658	11345	1	-2.2	2.06	6.3	12.13	4
10/01	Canterbury	20931	13690	1	-2.4	Not tested			
17/01	Coventry Memorial Park	21918	12770	1	-4.7	Not tested			
03/01	Hull Centre	2299	14077	1	-0.7	1.99	6.3	16.01	4
25/01	Leamington Spa	20705	10880	1	-0.6	Not tested			
15/03	Leeds Centre	2032	12988	1	1.1	1.94	6.3	16.03	4
13/02	Leicester Centre	2145	11557	1	1.7	1.92	6.3	16.02	4
19/02	Liverpool Centre	2034	14256	1	0.9	Not tested			
09/01	London A3 Roadside	1200b13 51	10507	1	0.5	Not tested			
09/01	London Bexley	2000	10218	1	-2.4	1.96	6.3	16.47	4
10/01	London Bloomsbury	1200-1904	9669	1	2.6	Not tested			
21/01	London Brent	1334	17699	1	1.0	Not tested			
07/01	London Hillingdon	20903	8404	1	-2.0	2.08	6.3	17.02	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.

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Certificate No: 00606

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 (%)
06/02	Manchester Piccadilly	20914	11944	1	-0.9	Not tested			
19/02	Middlesbrough	2143	8222	1	1.6	2.08	6.3	16.33	4
20/02	Newcastle Centre	2146	12122	1	0.8	2.09	6.3	16.27	4
14/01	Northampton	2162	10920	1	-2.1	2.99	6.3	16.35	4
26/02	Norwich Centre	21495	11929	1	-2.3	1.85	6.3	14.67	4
25/02	Nottingham Centre	59507	8790	1	1.3	1.97	6.3	16.39	4
14/02	Plymouth Centre	21308	12902	1	0.6	Not tested			
15/01	Portsmouth	1381	10493	1	-0.8	Not tested			
30/01	Preston	22881	12584	1	-2.9	2.17	6.3	15.82	4
07/01	Reading	2000	12975	1	-1.7	1.9	6.3	16.46	4
19/02	Redcar	21344	11805	1	0.2	3.01	6.3	16.37	4
21/02	Salford Eccles	21168	14409	1	0.0	1.9	6.3	16.28	4
26/02	Scunthorpe	2033	4924	1	-1.3	Not tested			
11/03	Sheffield Centre	21244	12321	1	1.2	1.93	6.3	15.74	4
08/01	Southampton Centre	2298	13753	1	-0.6	1.92	6.3	16.26	4
14/02	Southend-on-Sea	22927	13215	1	-1.3	Not tested			
23/01	Stockport	659	10390	1	-0.3	Not tested			
18/02	Stockton-on-Tees Yarm	22885	14157	1	-0.9	3.08	6.3	16.12	4
21/01	Stoke-on-Trent Centre	21317	18058	1	-1.7	2.05	6.3	16.65	4
20/02	Wigan Leigh		13220	1	1.3	Not tested			
29/01	Wirral Tranmere	22883	13077	1	-1.6	2.06	6.3	16.09	4
04/02	Wolverhampton Centre	20917	13635	1	-0.8	2.02	6.3	16.39	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.

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.

[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) 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

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