

London Air Quality Network: Ratification Report for July to December 2001

A M Woolley B P Sweeney and D M Butterfield

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A M Woolley B P Sweeney and D M Butterfield
Centre for Optical and Analytical Measurement

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National Physical Laboratory
Queens Road, Teddington, Middlesex, TW11 0LW

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Approved on behalf of Managing Director, NPL
by D H Nettleton, Head of Centre for Optical and Analytical Measurement

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**London Air Quality Network
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by

A M Woolley and B P Sweeney

1. INTRODUCTION

This report has been prepared for the Department for the Environment, Food and Rural Affairs by NPL under contract EPG 1/3/123. It covers the ratification of data in the London Air Quality Network relating to the period July to December 2001. The ratified data capture percentages and specific problems at sites are presented.

Additionally, this report contains a provisional assessment of measurement uncertainty on a site-by-site basis, along the lines required by EC directives.

2. RATIFICATION PROCEDURE

The data received by NPL from the CMCU were processed and scaled according to calibrations carried out by the Local Site Operators every two weeks, and by NPL on a three monthly basis. The results of these NPL field calibrations are reported to the Department separately.

During an NPL intercomparison ozone analyser accuracy is quantified with a transfer standard photometer certified against the NPL primary photometer, while NO_x, CO and SO₂ analyser calibration responses are measured with gas mixtures certified against primary standard gases at NPL. Analyser linearities are determined by multi-point dilution of a high concentration mixture with zero air. Particulate analysers are calibrated with traceable pre-weighed masses, and sample and bypass flow rates are measured.

The data ratification process takes account of all relevant data from LSO, NPL and Equipment Service Unit calibrations. The optimum time-varying set of analyser response functions are determined and then applied to raw data to produce the ratified data set. The causes of gaps in the new data set are identified and periods for which analyser responses are seen to be unstable or changing rapidly are deleted.

3. DATA CAPTURE

The percentage data capture at each site for each pollutant is given in Table 1. For the period covered by this report the overall Network Mean data capture is 88%. Excluding Lewisham the overall mean is 94 %.

Table 1: Data capture for July to December 2001

Site Name	Percentage Data Capture by Pollutant					
	O ₃	NO _x	SO ₂	CO	PM ₁₀	Mean
Bromley		83		93		88
Camden		99			98	99
Eltham	99	99	95		98	98
Hackney	22	93		87		67
Haringey 1		99			99	99
Haringey 2	99					99
Hounslow		92		96		94
Kensington and Chelsea	99	98	99	98	95	98
Lewisham	0	0	0			0
Marylebone Road	95	89	90	94	84	90
Southwark 1	94	97	97	97		96
Southwark 2		89	87	89		88
Sutton 1		99	98	99	98	99
Sutton 3	100	100				100
Tower Hamlets		93		98		96
Wandsworth 2	99	99				99
Mean	79	89	81	95	95	
Mean (excluding Lewisham)	88	95	94	95	95	

Percentages below 90% are highlighted.

4. GENERIC REASONS FOR ABSENT RATIFIED DATA

Two general categories for ratified data loss are distinguished:

4.1 ABSENT UNRATIFIED DATA

During periods of power failure, telecommunications failure, instrument calibration and repair, or other similar circumstances, clearly there is no “raw” data to ratify, and this will be reflected directly in the data capture. Such instances are described below as periods for which the QA/QC Unit did not receive data. Typically the reasons are not investigated, as this is more of a matter for the CMCU.

4.2 UNRATIFIABLE DATA

From time to time most sites will produce data that cannot be ratified with sufficient confidence due to an analyser malfunction or a peripheral problem such as leaking pipe work. Most problems are apparent to the CMCU as they carry out regular remote checks, and they can initiate repairs promptly, preventing large amounts of data loss. The speed of repair will of course depend on the organisation responsible maintaining the instrument, which will not necessarily be the CMCU for affiliated sites.

The instances described in this Report are those where either the repair took a significant time, or the problem was not readily apparent remotely. In these cases the problem is usually noticed at a visit by the LSO or QA/QC Unit, then reported and remedied. As LSO visits on the London Network are fortnightly (and QA/QC Unit visits quarterly) this can lead to periods of data lasting several weeks being deleted. The crucial elements in minimising data loss are experience in recognising the problems, clear communication of the problem to the CMCU, and prompt remedial action. To a limited extent the experience of these problems can be used to modify LSO, CMCU, ESU or QA/QC Unit procedures, or extend the training of LSOs.

In some instances, the cause of ratified data loss is an underlying problem, which can be predicted to recur, and preventative action can therefore be recommended.

5. SPECIFIC PROBLEMS AT SITES

The sites with data capture of less than 90% for any pollutant are listed here and reasons are given for the absence of the data.

5.1 Bromley (NO_x 83% data capture)

Absent Unratified Data

15th to 19th November (122 hours). These data were lost owing to a power failure at the site.

Unratifiable Data

12th to 19th July (168 hours). Data were deleted owing to a sample inlet leak following a QA/QC unit visit. The problem was rectified at a subsequent LSO calibration.

13th to 30th August (440 hours). Data were deleted as a result of an analyser pump failure on 24th August. Prior to the actual failure the analyser output was showing excessive noise, and therefore measurements had to be deleted as far back as the 13th.

5.2 Hackney (CO 87%, Ozone 22% data capture)

Absent Unratified Data

One hourly average was lost each during the period 1st July to 30th September owing to incompatibilities between the auto-calibration system and the site data logger.

29th July to 8th August (251 hours). Owing to a problem with the site air conditioning system measurements were temporarily suspended for all pollutants at this site.

Unratifiable Data

1st July to 21st November (3447 hours of Ozone data). During ratification it was not possible to determine a factor for the analyser response as it varied significantly between each calibration. Since there was no further information from the auto-calibration data the measurements had to be deleted until the routine ESU service on 21st November.

8th to 16th July (204 hours of CO data). Data appeared to show a truncated zero baseline and thus were deleted.

14th to 16th August (45 hours of CO data). The analyser zero appeared to change over a short timescale and since it was not possible to assign a satisfactory zero data were deleted.

5.3 Lewisham (NO_x 0%, Ozone 0% SO₂ 0% data capture)

Unratifiable Data

1st July to 31st December (4416 hours). The site was decommissioned on June 18th to allow major building work to be carried out. Although the instruments were re-installed on 13th December there was insufficient calibration history to rigorously ratify the data and so all of the measurements for this site from this period were deleted.

5.3 Marylebone Road (NO_x 89%, PM₁₀ 84% data capture)

Unratifiable Data

1st to 4th July (84 hours of NO_x data). These data were deleted as a result of excessive drift in the analyser zero point, probably caused by a failure in the site air conditioning system at that time.

2nd to 4th July (50 hours of PM₁₀ data). Data were deleted as a result of the air conditioning failure outlined above.

5th to 6th July (26 hours of PM₁₀ data). The TEOM analyser suffered from a flow fault caused by an internal leak. This was rectified by the ESU.

14th to 27th August (312 hours of NO_x data). Initially excessive analyser zero drift caused data to be deleted to the ESU service on 16th August. However, following the service the zero could still not be satisfactorily determined until the 27th August, from when the auto-calibration data showed that the analyser characteristics were consistent with those prevailing at the LSO calibration that was performed on 29th August.

18th to 22nd August (96 hours of PM₁₀ data). Data were lost owing to an analyser flow fault that was fixed by the ESU.

16th to 24th October (188 hours of PM₁₀ data). These data were deleted because the analyser response was excessively noisy - most likely due to a badly seated instrument filter.

12th to 16th November (110 hours of PM₁₀ data). Data were deleted by the CMCU as a result of an analyser flow fault. The ESU replaced part of the instrument as a result of repeated faults of this type.

23rd to 28th December (137 hours of PM₁₀ data). Data were deleted by the CMCU as a result of an analyser flow fault. The entire instrument was replaced owing to continuing faults of this nature.

5.4 Southwark 2 (NO_x 89% SO₂ 87%, CO 89% data capture)

Absent Unratified Data

26th to 29th September (64 hours of CO data, 49 hours of NO_x and SO₂ data). These measurements are missing as a result of an unusually long site service.

Unratifiable Data

8th to 11th August (78 hours of NO_x and CO data, 86 hours of SO₂ data). Data were deleted owing to problems traceable to the site air-conditioning unit.

19th to 22nd September (72 hours of SO₂ data). Data were deleted because the analyser zero point could not be adequately determined.

23rd November – 6th December (314 hours of all data). These data were lost owing to a failure of the site air conditioning unit.

6. RATIFIED DATA UNCERTAINTY

The EC Daughter Directives for the pollutants monitored contain Data Quality Objectives for both data capture and measurement uncertainty, which in the case of NO₂, SO₂, CO and ozone is 15% at the 95% confidence level. A common method of evaluating the measurement uncertainty has been published in a CEN Report CR 14377, while the detailed procedures for acceptable measurements are being set out in individual CEN standards drafted by CEN TC 264 WG 12. These are not yet finalised, and these estimates of uncertainty are therefore provisional.

Overall measurement uncertainty may be calculated by the combination of a number of factors, each giving an insight into how a particular analyser system is capable of performing under a given set of circumstances. Thus quantities such as analyser drift uncertainty, zero and span noise, analyser linearity error and transfer standard uncertainty may be combined to give an overall standard uncertainty, calculated by accepted methodology, which for these purposes should be less than 15%. Table 2 gives results from the LAQN sites based on actual or representative data. In a few cases assumptions have had to be made to simplify calculation, and in this first survey the particulate data have not been included.

Table 2. Uncertainty Calculation for Ratified Datasets (95% Confidence)

Site Name	Percentage Uncertainty			
	O ₃	NO _x	SO ₂	CO
Bromley		11		10
Camden		11		
Eltham	9	15	10	
Hackney	9	13		11
Haringey 1		12		
Haringey 2	9			
Hounslow		11		10
Kensington and Chelsea	10	11	9	9
Lewisham	-	-	-	
Marylebone Road	8	12	9	12
Southwark 1	8	12	11	10
Southwark 2		11	11	12
Sutton 1		12	9	13
Sutton 3	9	12		
Tower Hamlets		13		10
Wandsworth 2	9	15		

It can be seen from these results that where data from sites are present, no measurements are made with uncertainties of greater than 15%. Currently the most significant sources of

uncertainty are those associated with the determination of the analyser linearity - for some datasets the analyser calibration drift is equally important. Analysers such as the Wandsworth and Eltham NO_x are not historically problematic in this area but on this occasion because the calibration drift term is significant their overall uncertainties are being pushed towards the 15% limit. Ultimately these problems will have to be noted and rectified by the CMCU quite rigorously in order to avoid possible poor data quality markings on the grounds of excessive measurement uncertainty.

This first attempt at quantifying the overall uncertainty has included certain sources where the typical errors are currently not well characterised, and therefore some assumptions have had to be made. These sources include interference from other gaseous species, analyser temperature dependency and uncertainty in the drift in concentration of calibration mixtures. When these terms are added in to future iterations of this procedure it may be possible to reduce their overall contribution if their effects can be better quantified. Sample degradation occurring in the sample manifold is not included in the calculation. The draft CEN standard requires regular checking and cleaning of the manifold as part of ongoing QA/QC and assumes that there is no contribution to the uncertainty budget.

7. RECOMMENDATIONS TO IMPROVE DATA QUALITY / CAPTURE

7.1 Site Manifold Sampling Systems

In the Ratification Report for the period January to June 2001 (NPL COAM 3) the problems of verifying the integrity of the sampling systems at sites Southwark 1 and Southwark 2 were highlighted. We recommend that these sampling systems should be replaced if possible.

7.2 Ongoing Quality Control

When ESUs change the sample lines at the annual service, it would be useful if they could leave the old sample lines on site, so that the QA/QC unit can collect them and test them for sample degradation.

8. INVENTORY

The DETR assets held by NPL for this work are shared with the Automatic Rural Network and are given in the corresponding report.