

London Air Quality Network: Ratification Report for July to December 2000

D M Butterfield, A M Woolley and B P Sweeney

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**London Air Quality Network
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by

D M Butterfield, A M Woolley and B P Sweeney

1. INTRODUCTION

This report has been prepared for the Department of the Environment, Transport and the Regions 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 2000.

The ratified data capture percentages and specific problems at sites are presented, and the benefits of autocalibration data, which are not available for all instruments, are highlighted.

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.

Table 1: Data capture for July to December 2000

Site Name	Percentage Data Capture by Pollutant					
	O ₃	NO _x	SO ₂	CO	PM ₁₀	Mean
Kensington and Chelsea	94	97	96	96	96	96
Bromley	---	67	---	81	---	74
Camden	---	99	---	---	99	99
Eltham	99	96	96	---	98	98
Hackney	79	99	---	90	---	89
Haringey 1	---	94	---	---	98	96
Haringey 2	97	---	---	---	---	97
Hounslow	---	98	---	99	---	99
Lewisham	0	0	0	---	99	25
Marylebone Road	98	94	99	99	---	98
Southwark 1	96	96	96	96	---	96
Southwark 2	---	93	87	99	---	93
Sutton 1	---	81	76	80	84	80
Sutton 3	100	83	---	---	---	92
Tower Hamlets	---	86	---	91	---	89
Wandsworth 2	94	95	---	---	---	95
Mean	84	85	79	92	96	
Mean (excluding Lewisham)	95	91	92	---	---	

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.

Bromley (NO_x 67% data capture, CO 81% data capture)

5th to 17th July (NO_x and CO, 288 hours) data lost between LSO visits due to internal sampling. This was only evident by examination of extended time series and inter-comparisons of other sites time series. This fault would not easily be spotted by the CMCU examining real-time data.

21st July – 4th August (NO_x only, 454 hours) lost due to instrument malfunction. Data was deleted by the CMCU.

14th – 28th November (NO_x only, 348 hours) lost due to instrument malfunction. Data was deleted by the QA/QC Unit and would not have easily been detected by the CMCU unit in real-time, until the LSO reported a fault in a regular calibration visit.

22nd – 31st December (NO_x only, 231 hours) lost due to instrument malfunction. This fault was detected by the CMCU.

21st July – 9th August (CO only, 453 hours) lost due to instrument malfunction caused by air conditioning failure. Data was deleted by the CMCU.

1st January – 31st December (NO_x only, ~220 hours) lost due to incorrectly set auto-calibration times resulting in an hour's data loss in the majority of the days during the year. This fault should have been detected by the CMCU.

Hackney (O₃ 79% data capture)

6th September – 3rd October (656 hours) lost due to analyser malfunction. This fault was detected by the CMCU.

1st January – 31st December (366 hours) lost due to incorrectly set auto-calibration times resulting in an hour's data loss in every day of the year. This fault should have been detected by the CMCU.

Lewisham (O₃ 0% data capture, NO_x 0% data capture, SO₂ 0% data capture)

20th June – 31st December 2000 (4669 hours) lost due to the installation of new analysers and a leaking sample manifold. This manifold does not take a true sample of ambient atmosphere. The CMCU are aware of this fault.

Southwark 2 (SO₂ 87% data capture)

2nd – 25th October (540 hours) due to analyser malfunction. This fault was detected by the CMCU.

Sutton 1 (NO_x 81% data capture, SO₂ 76% data capture, CO 80% and PM₁₀ 84% data capture)

11th – 25th August (NO_x only, 329 hours) lost due to analyser malfunction. This fault was detected by the CMCU.

9th – 13th September (NO_x only, 103 hours) lost due to power supply problems.

26th September – 11th October (NO_x only, 362 hours) lost due to analyser malfunction. This fault was detected by the CMCU.

9th – 30th August (SO₂ only, 506 hours) lost due to power supply problems and analyser malfunction. This fault was detected by the CMCU.

9th – 30th September (SO₂ only, 527 hours) lost due to analyser malfunction. This fault was detected by the CMCU.

10th – 24th August (CO only, 343 hours) lost due to analyser malfunction. This fault was detected by the CMCU.

9th – 13th September (CO only, 104 hours) lost due to power supply problems.

15th – 31st December (CO only 403 hours) lost due to analyser malfunction. This fault was detected by the CMCU.

9th – 30th August (PM₁₀ only, 505 hours) lost due to analyser malfunction. This fault was detected by the CMCU.

1st – 3rd September (PM₁₀ only, 46 hours) lost due to incorrectly seated filter. This fault was detected by the CMCU.

9th – 13th September (PM₁₀ only, 103 hours) lost due to incorrectly seated filter. This fault was detected by the CMCU.

Sutton 3 (NO_x 83% data capture)

13th – 19th September (147 hours) lost due to analyser malfunction caused by the failure of the PMT cooler. This fault was detected by the CMCU.

7th December to 22nd January 2001 (1100 hours) lost due to leaving the maximum of the analyser measurement range less than the concentration of the site calibration cylinder. Therefore the analyser saturated during calibration and no response factor could be determined. The CMCU was aware of this fault.

Tower Hamlets (NO_x 86% data capture)

13th – 20th September (NO_x only, 163 hours) lost due to analyser malfunction. This fault was detected by the CMCU.

28th September to 12th October (NO_x only, 346 hours) lost due to analyser malfunction. This fault was detected by the CMCU.

13th – 16th November (NO_x only, 72 hours) lost due to analyser malfunction leading to an unstable zero offset. This fault was not detected by the CMCU.

6. AVAILABILITY OF AUTO-CALIBRATION DATA

There was at least one incidence where an analyser malfunction was detected upon examination of the available autocalibration data. The majority of sites in the LAQN now have full auto-calibration facilities, but the two Southwark sites are only partially equipped. As such the QA/QC unit do not have as much information on which to base the ratification of the final datasets.

Table 2: Sites in the LAQN with valid auto-calibration data July – December 2000

Site Name	Pollutant of Interest			
	Ozone	NO _x	SO ₂	CO
Southwark 1	y	n	n	n
Southwark 2	-	n	y	n

y = valid auto-calibration data.

n = no valid auto-calibration data were received.

- = not applicable to this site.

The reasons for absent autocalibration data in these cases are not known, and may be due to a number of factors such as empty permeation tubes or unsuitable logger configuration. We would recommend that the availability of autocalibration data be restored where practical.

7. RECOMMENDATIONS TO REDUCE DATA LOSS

Internal Sampling

LSOs need to be reminded by the CMCU to check that analyser sample lines have been correctly connected to the sample manifold and the sample inlet of the analyser. There is a check box on the LSO's calibration pro forma to remind them to check this.

Internal sampling is very difficult to detect by examining real-time data and it would be very difficult for a CMCU to detect this fault without devoting excessive time to examining the data.

Time of internal zero and span set incorrectly

A number of sites had the time of the daily IZS set so that both the zero and span gases were introduced into the analyser in the same hour. This resulted in that hour's data being invalid. If this fault is not rectified for a whole year, then this data loss corresponds to 4% of the year!

The CMCU should check that the same hour of data is not missing every day.

ESUs should also check for this fault at the bi-annual services.

ESU incorrectly repairs / calibrates the analyser

On a number of occasions the ESU left an analyser incorrectly repaired or in a state that when calibration gas is introduced, the analyser goes over range. In nearly all cases these faults have not been quickly detected, because either no post-repair/service calibration was performed or the analyser had not been left to satisfactorily warm up before a post-repair/service calibration was performed.

The ESU must perform a satisfactory post-repair calibration at all visits. If possible, the ESU should also perform a pre-repair / service calibration at all visits. The ESU must also record the serial numbers of any artefacts used to calibrate analysers.

The CMCU should check that an analyser has been calibrated at both pre and post-repair/service.

On Going Quality Control

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

Automatic calibrations at Lewisham

Presently the analysers are directly calibrated with gas from NPL certified gas mixtures on a daily basis as well as being calibrated by the LSO on a fortnightly basis. A comparison between these daily calibrations and the LSO calibrations is under way. If there is found to be good agreement between daily and fortnightly calibrations then the interval between the auto-calibrations will be extended. There is also a possibility that LSO calibrations will be unnecessary in future.

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.