

**UK Automatic Rural Network:
Ratification Report for
January to June 2001**

A M Woolley, D M Butterfield and B P Sweeney

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Approved on behalf of Managing Director, NPL
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by

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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 Rural Network relating to the period January to June 2001. During this time an additional site was affiliated on to the Rural Network at Weybourne in Norfolk. Data for this site are valid from 25th May 2001.

The ratified data capture percentages and specific problems at sites are presented. An inventory of Department equipment held by NPL, and a list of recommendations for items to be purchased are also given.

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 91%.

Table 1. Data capture for January to June 2001

Site Name	Percentage Data Capture by Pollutant					Mean
	O ₃	NO _x	SO ₂	CO	PM ₁₀	
Aston Hill	95					95
Bottesford	99					99
Bush	97					97
Eskdalemuir	99					99
Glazebury	99					99
Great Dun Fell	99					99
Harwell	98	92	97			96
High Muffles	60					60
Ladybower	24	95	96			72
Lough Navar	99				94	97
Lullington Heath	98	91	92			94
Narberth	95	69	82		94	85
Rochester	98	98	98		87	95
Sibton	99					99
Somerton	99					99
Strath Vaich	81					81
Teddington	99	99	98			99
Wicken Fen	96	95	98			96
Yarner Wood	100					100
Mean	91	91	94	---	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 are no “raw” data to ratify, and this will be reflected directly in the data capture. Such instances are described below as periods for which data were not received by the QA/QC Unit. 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 for 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 Rural Network are monthly (and QA/QC Unit visits are 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 that 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.

High Muffles (O₃ 60% data capture)

Absent Unratified Data

4th – 5th February. 29 hours were deleted by the CMCU as a result of analyser response instability.

Unratifiable Data

15th February – 26th April. 1679 hours were deleted owing to the malfunction of a temporary replacement analyser. The ESU calibrated the analyser upon installation and this was consistent with the QA/QC calibration eight days later on 15th February. However, the following LSO calibration on 15th March showed a significant and unexplained change in analyser response. Since there were no autocalibration data for this short period, and the ESU did not calibrate the temporary replacement analyser before removing it, data were deleted from the QA/QC calibration up until the original analyser was repaired and restored to the site owing to an unknown analyser response factor.

Narberth (NO_x 69%, SO₂ 82% data capture)

Absent Unratified Data

24th February – 3rd March. 165 hours of NO_x and SO₂ data were lost as no data were received from CMCU.

7th March – 9th March. 48 hours of SO₂ and NO_x data were not received from the CMCU.

Unratifiable Data

3rd – 7th March. 157 hours of SO₂ data were deleted owing to a significant change in the analyser response factor. Data could not be reliably scaled as there were no calibration details relating to this period of change.

9th March – 11th March. 37 hours of NO_x data were deleted following a data gap until the analyser response became stable.

4th April – 6th April, 11th May – 13th May, 21st May – 31st May and 25th June – 27th June. 401 hours of SO₂ data in total were deleted owing to excessive drift of the analyser zero offset.

5th May – 6th June and 20th – 30th June. 1038 hours in total were deleted as the data were showing unrealistic diurnal variation, which followed LSO and QA/QC site visits. The cyclical nature of these data was obviously suspect upon inspection.

Ladybower (O₃ 24% data capture)Absent Unratified Data

19th – 22nd, 25th - 27th January and 13th – 16th February. 196 hours of O₃ data in total were deleted by the CMCU.

Unratifiable Data

23rd February – 30th June. 3054 hours of O₃ data were deleted due to analyser malfunction. The site analyser developed a problem that could not be repaired on site, and so the ESU installed a replacement analyser. Unfortunately this replacement was installed and calibrated by the ESU with an internal leak, which was detected by the QA/QC unit at the following quarterly visit. All of the data recorded by the replacement analyser was deleted.

Rochester (PM₁₀ 87% data capture)Absent Unratified Data

25th April – 17th May. 538 hours of PM₁₀ data were deleted by CMCU as a result of instrument malfunction.

Strath Vaich (O₃ 81% data capture)Absent Unratified Data

11th – 15th February. 100 hours of O₃ data were deleted by the CMCU.

Unratifiable Data

31st May – 30th June. 733 hours of O₃ data were lost owing to analyser malfunction. The QA/QC unit discovered an internal analyser leak at the intercalibration visit in May and although the ESU visited the site for a 6-monthly service on 5th June, this leak was still present at the following QA/QC visit in August.

6. AVAILABILITY OF AUTO-CALIBRATION DATA

All relevant instruments within the Automatic Rural Network now have working auto-calibration equipment.

7. RECOMMENDATIONS TO IMPROVE DATA QUALITY / CAPTURE

7.1 Site Sampling Manifolds

Recent tests have been carried out by NPL on-site sampling manifold arrangements. These tests have highlighted significant measurement losses at some sites, for certain pollutants. It may therefore be the case that some sites in the AURN are under-reporting measured pollutant concentrations as the pollutants are being in some removed by contact with the inner surfaces of the manifolds. As a result of these tests it is recommended that all Teflon-coated metal manifolds currently operating on the AURN should be changed. In addition, all other types of manifold should be routinely cleaned at the six-monthly service.

7.2 Internal Sampling

LSOs should always 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.

7.3 Timing of internal zero and span

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.

7.4 Failure to calibrate replacement analysers

On a number of occasions the ESU has been unable to repair an analyser on site and has had to remove the faulty analyser for repair. There have been instances where the ESU installed a replacement analyser at the site, but failed to calibrate this analyser, or did not calibrate it before its subsequent removal. These events occur in between QA/QC visits, and so often no calibrations are performed on the analysers. This is a particular problem in the case of ozone instruments, as there is no on-site standard for use by the LSO and therefore no response factors may be calculated.

The ESU must perform a full calibration on an analyser when it is installed and removed from site. The ESU must also record the serial numbers of any artefacts used to calibrate analysers.

The CMCU should check that a replacement analyser has been calibrated at installation and removal.

7.5 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.

8. INVENTORY

The DETR owned assets used for this work are as follows:

1 PC (486-66)

NPL-developed ratification software

Cylinders, regulators and measurement instruments with individual values of less than £1000

9. RECOMMENDATIONS FOR EQUIPMENT PURCHASES

NPL would recommend that the following items be installed:

1. A Permapure dryer for Harwell NO_x analyser.
2. Chart recorders at Eskdalemuir, Bush, Dunslair Heights, Wicken Fen and Glazebury.
3. Consideration should be given to the installation of new analysers at Lullington Heath.
4. New manifold sampling systems for Aston Hill, Eskdalemuir, Harwell, High Muffles Ladybower, Lullington Heath, Strath Vaich, Wicken Fen and Yarnar Wood. Also, a replacement for the existing system at Bush should be considered as this system is currently impossible to verify due to its high sampling flow-rate.