

UK Automatic Rural Network: Ratification Report for January to June 1999

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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 1999. There were no significant changes made to the Rural Network during this period.

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 purchase 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 once a month, 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 and SO₂ analyser calibration responses are measured with gas mixtures certified against NPL primary standard gases. 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 LSOs, 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 January to June 1999

Site Name	Percentage Data Capture by Pollutant				
	O ₃	NO _x	SO ₂	PM ₁₀	Mean
Aston Hill	99	-	-	-	99
Bottesford	97	-	-	-	97
Bush	99	-	-	-	99
Eskdalemuir	91	-	-	-	91
Glazebury	91	-	-	-	91
Great Dun Fell	84	-	-	-	84
Harwell	83	75	97	-	85
High Muffles	99	-	-	-	99
Ladybower	98	98	98	-	98
Lough Navar	99	-	-	99	99
Lullington Heath	97	92	98	-	96
Narberth	73	32	55	67	57
Rochester	97	97	95	96	96
Sibton	99	-	-	-	99
Somerton	99	-	-	-	99
Strath Vaich	93	-	-	-	93
Teddington	77	99	90	-	90
Wicken Fen	93	84	93	-	90
Yarner Wood	97	-	-	-	97
Mean	93	84	89	87	

4. GENERIC REASONS FOR ABSENT RATIFIED DATA

We distinguish three general categories for ratified data loss:

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 data was 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 ISOLATED INSTRUMENT MALFUNCTIONS

From time to time most instruments will produce some data that cannot be ratified with sufficient confidence due to an analyser problem, leaking pipework etc that is 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 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.

4.3 RECURRENT INSTRUMENT MALFUNCTIONS

In some instances, not common in established sites such as those in the Rural Network, 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.

Great Dun Fell: (Ozone 84% data capture)

Recurrent Instrument Malfunction

January - April 1999 (633 hours in total). Data were deleted due to suspected manifold blockages. Environmental conditions at the site were such that ice formed on the manifold inlet, and in extreme situations this causes a blockage in the manifold, although at present this can only be determined indirectly. The CMCU are currently giving consideration to some sort of remote flow measurement device in order to detect this problem.

Harwell: (Ozone 83% data capture, NO_x 75% data capture)

Absent unratified data

8 - 11 April (45 hours) as no data were received from CMCU

15 - 18 June (44 hours) due to a power failure.

Instrument malfunction

NO_x

16 - 31 March (376 hours) as a result of excessive zero drift following an LSO callout on 15 March. This was apparent from examination of the raw data and this fault prevented the data from being correctly scaled. The analyser drift stopped without any outside intervention.

26 April - 17 May (510 hours) due to analyser malfunction following the ESU service. The ESU were called out and fixed the fault on 17 May.

O₃

1 - 26 April (637 hours) due to a leak in the analyser main valve. This was repaired at the ESU service. The problem was apparent upon examination of the daily auto-calibrations, but it is not clear whether the CMCU were aware of it.

Narberth: (Ozone 73 % data capture) (NO_x 32% data capture) (SO₂ 55% data capture) (PM₁₀ 67% data capture)

Absent unrati ed data

15 - 16 January (25 hours of all data) where no data were received from CMCU.

27 January - 26 February (728 hours of all data) in order for the ESU to carry out essential maintenance work on the entire instrument system.

26 February - 3 March (118 hours of all data) due to incorrect configuration of instrument software following upgrade.

PM₁₀ only:

27 April - 3 May (141 hours) due to invalid data following a power interruption.

Instrument malfunction

NO_x

3 March - 27 May (2073 hours) due to inconsistent results from the manual calibrations performed on the analyser. The standard deviation of the NO_x factor from the first three calibrations following the service was 27%, with similar results for NO. These calibrations were carried out on 8 April and 27 April by the LSO, and 11 May by the QA/QC unit. No reliable analyser factors could therefore be determined, especially as the autocalibration data did not display agreement with the trend from the manual calibrations. The calibration on 27 May was in good agreement with the following calibrations and the data could therefore be scaled from this point on. The problem was apparent from examination of the calibration data, and the LSO had indicated the drift between the calibrations on 8 and 27 April.

SO₂

3 March - 31 March (696 hours) as no calibration was performed on the analyser following the reconfiguration of the instrument software. Data were scaled from 1 April as the autocalibration data could then be combined with that from the manual calibrations.

Action. ESU to ensure full pre- and post-calibration of site instruments before and after commencing any maintenance work at sites

18 - 30 June (303 hours) due to an unstable analyser zero, which was apparent on examination of the raw data. The ESU were called out to attend a fault on 25 June but repetitive analyser malfunction appeared to continue into July.

PM₁₀

4 - 8 April (109 hours) due to excessive noise following a possible power interruption. The LSO attended the site for a routine calibration on 8 April when the problem was resolved.

20 - 26 April (142 hours) due to excessive instrument noise. No further details are known.

Teddington (Ozone 77% data capture)Instrument malfunction

January - May (966 hours approx. in total) resulting from an intermittent fault in either the analyser or the data logging/communications system. The ESU attempted to fix the fault in February but were unsuccessful and the data continued to be affected until the routine ESU service visit on 12 May. During February a replacement analyser was installed whilst the ESU attempted to identify the analyser fault, but this was not sufficiently calibrated in order to correctly scale the data and thus approximately 210 hours of data could not be used (included in the above total).

Action. ESU to ensure full pre- and post-calibration of site instruments before and after commencing any maintenance work at sites

Wicken Fen: (NO_x 84% data capture)Absent unrati ed data

12 - 21 January (220 hours) as a result of a faulty modem.
10 - 12 February (49 hours) caused by logger corruption.
10 - 14 June (110 hours) due to invalid data.

Instrument malfunction

21 April - 2 May (250 hours) caused by an unstable analyser zero which manifested itself in the raw data. This immediately followed an ESU service visit on 21 April, but the problem disappeared without any outside intervention.

1 June - 2 June (25 hours) due to an unstable analyser zero, apparent from the raw data. The analyser continued with a number of minor faults and the ESU were subsequently called out on 11 June.

6. AUTO-CALIBRATION DATA

A number of the problems detailed in Section 5, could have been more easily diagnosed using auto-calibration data. For a minority of the sites in the Automatic Rural Network there are no working auto-calibration facilities, and therefore the QA/QC unit do not have as much information on which to base the ratification of the final datasets. Table 2 shows the sites for which the QA/QC unit received valid autocalibration data during this period.

Table 2: Rural Network sites with valid auto-calibration data January - June 1999

Site Name	Measurand		
	O ₃	NO _x	SO ₂
Aston Hill	y	-	-
Bottesford	n	-	-
Bush	y	-	-
Eskdalemuir	y	-	-
Glazebury	y	-	-
Great Dun Fell	y	-	-
Harwell	y	n	n
High Muffles	y	-	-
Ladybower	y	y	n
Lough Navar	y	-	-
Lullington Heath	y	y	y
Narberth	y	y	y
Rochester	y	y	y
Sibton	y	-	-
Somerton	y	-	-
Strath Vaich	y	-	-
Teddington	n	y	y
Wicken Fen	y	y	y
Yarner Wood	y	-	-

y = valid auto-calibration data.

n = no valid auto-calibration data were received.

- = not applicable to this site.

7. 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

8. RECOMMENDATIONS FOR EQUIPMENT PURCHASES

NPL would recommend that the following items are installed:

1. Chart recorders at Eskdalemuir, Bush, Dunslair Heights, Wicken Fen and Glazebury.
2. Manifold flow sensor at Great Dun Fell.
3. An improved manifold system at Sibton to allow satisfactory sampling of ozone alongside the Ammonia sampler which shares the site.