

UK Automatic Rural Network: Ratification Report for July to December 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 July to December 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 be purchased are also given. Sites at Harwell, Lullington Heath and Narberth are discussed in view of their reduced data capture statistics in the previous two years.

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 1999

Site Name	Percentage Data Capture by Pollutant				
	O ₃	NO _x	SO ₂	PM ₁₀	Mean
Aston Hill	99	-	-	-	99
Bottesford	94	-	-	-	94
Bush	94	-	-	-	94
Eskdalemuir	100	-	-	-	100
Glazebury	98	-	-	-	98
Great Dun Fell	50*	-	-	-	50
Harwell	99	32	99	-	77
High Muffles	99	-	-	-	99
Ladybower	97	79	97	-	91
Lough Navar	76	-	-	94	85
Lullington Heath	97	39	97	-	78
Narberth	97	96	18	94	76
Rochester	96	95	96	92	95
Sibton	92	-	-	-	92
Somerton	99	-	-	-	99
Strath Vaich	95	-	-	-	95
Teddington	99	97	99	-	98
Wicken Fen	98	90	98	-	95
Yarner Wood	99	-	-	-	99
Mean	94	84	89	87	

* There remains a question over the validity of the entire Great Dun Fell dataset. See Section 4 for further details.

Percentages below 90% are highlighted.

4. GENERIC REASONS FOR ABSENT RATIFIED DATA

We distinguish two 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 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 pipework. 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 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.

Great Dun Fell: (Ozone 50% data capture)

Unratifiable data

1 October - 31 December (2208 hours). Data were deleted pending investigation of suspected manifold damage. The manifold runs underground from the sampling point to the analyser and it is supposed that frost damage may have been sustained causing a leak and possible ingress of dirt or water. A second analyser has since been installed at the site with a separate sample line, and calibrated by the QA/QC unit. Side-by-side trials will show whether there is a problem with the current sample manifold. This issue became apparent upon examination of previous data from the site and may affect measurements made as far back as 1996.

Harwell: (NO_x 32% data capture)

Unratifiable data

1 July - 2 November (2992 hours) as a result of excessive analyser zero drift. This was most immediately apparent from examination of the auto-calibration data. This is a recurrent problem caused by moisture entering the ozonator and NPL have previously reported that it could be remedied by the installation of a permapure drier.

This case emphasises the need for regular monitoring of auto-calibration data for anomalous behaviour, particularly for rural ozone instruments which receive a reliable calibration only once a quarter.

Table 2. Data capture statistics for Harwell since January 1998

PERIOD	Percentage Data Capture by Pollutant			
	O ₃	NO _x	SO ₂	MEAN
Jan-Jun 1998	93	72	91	85
Jul-Dec 1998	98	85	97	93
Jan-Jun 1999	83	75	97	85
Jul-Dec 1999	99	32	99	77

Percentages below 90% are highlighted.

As can be seen from Table 2, historical data capture statistics show a consistent problem with the NO_x Analyser. This is partly due to the moisture problem outlined above and serious consideration should be given to remedying this.

Ladybower: (NO_x 79% data capture)Unratifiable data

16 October - 19 November (818 hours) due to an unstable analyser factor - apparent from examination of calibration data. The ESU were called out on 19 October but were unable to repair the fault. The analyser was serviced on 8 November but the analyser factor continued to drift excessively. The ESU returned to the site on 19 November and repaired the analyser.

Lough Navar (Ozone 76% data capture)Unratifiable data

21 November - 31 December (979 hours) resulting from a leak in the analyser. This fault was discovered at a QA/QC visit in January, and could be dated from the auto-calibration data for the site.

Lullington Heath (NO_x 39% data capture)Unratifiable data

1 July - 8 July (178 hours) due to an analyser fault discovered at the QA/QC visit on 7 July. The ESU were called out and repaired the analyser.

8 July - 11 October (2185 hours). During the ESU callout above, the analyser response settings were altered and the post-repair calibration was offscale on the logger. Further LSO calibrations during August and September were also offscale. It was therefore not possible to assign an analyser factor for this period. The analyser was rescaled at the QA/QC visit on 11 October.

The problem was unusual but is clearly preventable in future. It was not immediately apparent at the time because the offscale reading from the logger is not an obvious number such as 9999. The position has been explained to the CMCU, and NPL are actively considering the introduction of 200 ppb NO_x standards (as opposed to the current 450 ppb) in order to prevent this recurring either at this site or elsewhere on the Rural Network.

7 - 10, 21 - 23 December, (114 hours in total) due to an intermittent analyser fault. This was repaired by the ESU on 23 December.

Table 3. Data capture statistics for Lullington Heath since January 1998

PERIOD	Percentage Data Capture by Pollutant			
	O ₃	NO _x	SO ₂	MEAN
Jan-Jun 1998	89	66	92	82
Jul-Dec 1998	86	91	83	85
Jan-Jun 1999	97	92	98	96
Jul-Dec 1999	97	39	97	78

Percentages below 90% are highlighted.

As can be seen from Table 3, the historical data capture for Lullington Heath highlights some faults. These could be attributed to the age of the instruments at the site which were first installed approximately 13 years ago.

Narberth: (SO₂ 18% data capture)Instrument malfunction

1 July - 27 August (1378 hours) due to an unstable analyser zero. This was apparent from both the raw data and the daily autocalibrations. Data could be scaled following the LSO calibration on 27 August.

1 October - 31 December (2208 hours) caused by an unstable analyser. The analyser zeros were unstable, as before, and the successive LSO calibrations throughout the period showed 15 - 20 % drift with no overall trend. In addition to this the autocalibration data were unstable.

Table 4. Data capture statistics for Narberth since January 1998

PERIOD	Percentage Data Capture by Pollutant				
	O₃	NO_x	SO₂	PM₁₀	MEAN
Jan-Jun 1998	88	63	87	89	79
Jul-Dec 1998	91	89	71	89	85
Jan-Jun 1999	73	32	55	67	57
Jul-Dec 1999	97	96	18	94	76

Percentages below 90% are highlighted.

As can be seen from Table 4, the historical data capture statistics for Narberth are problematic. The quality of maintenance of this site raises doubts about its continued use as an affiliate site.

6. AVAILABILITY OF 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 5 shows the sites for which the QA/QC unit received valid autocalibration data during this period.

Table 5: 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. 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