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UK Automatic Rural Network: Ratification Report for July to December 2000

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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 2000. 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.

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 SO_2 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 July to December 1999

	Percentage Data Capture by Pollutant					
Site Name	**O_3**	**NO_x**	**SO_2**	**CO**	**PM_{10}**	**Mean**
Aston Hill	**82**	---	---	---	---	82
Bottesford	100	---	---	---	---	100
Bush	98	---	---	---	---	98
Eskdalemiur	98	---	---	---	---	98
Glazebury	**57**	---	---	---	---	57
Great Dun Fell	95	---	---	---	---	95
Harwell	98	**75**	98	---	---	98
High Muffles	95	---	---	---	---	95
Ladybower	95	95	95	---	---	95
Lough Navar	99	---	---	---	99	99
Lullington Heath	**87**	**88**	**89**	---	---	88
Narberth	**55**	**52**	**74**	---	**79**	65
Rochester	100	**83**	100	---	99	96
Sibton	**85**	---	---	---	---	85
Somerton	95	---	---	---	---	95
Strath Vaich	99	---	---	---	---	99
Teddington	99	99	96	---	---	98
Wicken Fen	**55**	**81**	**84**	---	---	73
Yarner Wood	99	---	---	---	---	99
Mean	89	82	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 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.

Glazebury (57% data capture)

15th August – 27th October (1766 hours) lost due to the ESU replacing a faulty analyser with another analyser and failing to calibrate the replacement analyser at installation or removal. Therefore, the response factor of the replacement analyser was not determined.

Harwell (NO_x 75% data capture)

19th – 28th October (216 hours) lost due to analyser malfunction. This fault was not detected by the CMCU.

27th November – 31st December (831 hours) lost due to analyser malfunction, from ESU service to subsequent repair. The CMCU did not detect this fault until notified by the QA/QC unit.

Narberth (55% O_3 data capture, 52% NO_x data capture, SO_2 74% data capture and PM_{10} 79% data capture)

29th July – 17th September (O_3 only, 1224 hours) lost due to analyser malfunction resulting in an unknown response factor. This fault was detected by the CMCU, but the ESU took numerous visits to solve the problem.

19th October – 16th November (O_3 only, 677 hours) lost due to analyser malfunction or internal sampling between the LSO visits on these dates. This problem was not detected by the CMCU.

1st January – 31st December (O_3 only, ~220 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.

21st June – 18th September (NO_x only, 2151 hours) lost due to inconsistency in LSO calibrations and therefore no valid response factors could be calculated. This fault was detected by the CMCU, but the ESU took numerous visits to solve the problem.

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 every day of the year. This fault should have been detected by the CMCU.

21st June – 19th July (SO_2 only, 677 hours) lost due to analyser malfunction resulting in unknown zero offsets. This fault was not detected by the CMCU.

29th July – 2nd August (SO_2 only, 109 hours) lost due to analyser malfunction after ESU service visit. This fault was detected by the CMCU.

14th –21st August (SO_2 only, 165 hours) lost due to analyser malfunction resulting in unknown zero offsets. This fault was detected by the CMCU.

5th – 17th September (SO_2 only, 301 hours) lost due to analyser malfunction resulting in unknown zero offsets. This fault was detected by the CMCU.

1st January – 31st December (SO_2 only, ~200 hours) lost due to individual hours data loss at random times during the day, spread evenly across the year.

28th July – 2nd August (PM_{10} only, 111 hours) lost due to analyser malfunction. This fault was detected by the CMCU.

5th – 18th September (PM_{10} only, 318 hours) lost due to filter not being installed correctly. This fault was detected by the CMCU.

7th – 21st December (PM_{10} only, 340 hours) lost due to filter not being installed correctly. This fault was detected by the CMCU.

Rochester (NO_x 83% data capture)

12th September – 12th October (NO_x only, 730 hours) lost due to instrument malfunction. This fault was detected by the CMCU.

Wicken Fen (O_3 55% data capture, NO_x 81% data capture and SO_2 84% data capture)

4th July – 22nd September (O_3 only, 1931 hours) lost due to excessive soiling of the sample inlet filter, leading to a blocked sample line. This occurred because the CMCU failed to supply the LSO with new sample filters when requested. The ESU also visited the site to investigate the change in auto-span, but failed to notice the blocked sample filter. On the 15th September the ESU removed the analyser and installed a temporary replacement analyser, which they failed to calibrate. Therefore, no response factor for this instrument could be calculated and the data was deleted between the 15th and 22nd September.

23rd October – 9th November (NO_x only, 413 hours) lost due to instrument malfunction. This fault was detected by the CMCU.

14th September – 11th October (SO_2 only, 652 hours) lost due to instrument malfunctions and only one calibration point for a replacement analyser. These faults were detected by the CMCU.

Aston Hill (O_3 82% data capture)

1st – 30th November (709 hours) lost due to analyser malfunction. This fault was detected by the CMCU.

Sibton (O_3 85% data capture)

28th September – 16th October (436 hours) lost due to a leaking filter holder and therefore not a true atmospheric sample being measured. This fault was not detected by the CMCU.

28th October – 2nd November (117 hours) lost due to analyser malfunction and contamination of the sample line with water. This fault was detected by the CMCU.

Lullington Heath (O_3 87% data capture, NO_x 88 %data capture and SO_2 89%data capture)

8th – 10th, 11th – 14th October and 22nd – 23rd November (all species, 207 hours) lost due to power supply problems. This fault was detected by the CMCU.

17th – 21st December (all species, 55 hours) lost due to data logger malfunction. This fault was detected by the CMCU.

29th October – 10th November (O_3 only, 300 hours) lost due power failure and subsequent analyser malfunctions. This fault was detected by the CMCU.

28th October – 6th November (NO_x only, 194 hours) lost due power failure and subsequent analyser malfunctions. This fault was detected by the CMCU.

29th October – 5th November (SO_2 only, 189 hours) lost due power failure and subsequent analyser malfunctions.

6. AVAILABILITY OF AUTO-CALIBRATION DATA

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

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.

ESU fails to calibrate replacement analysers

On a number of occasions the ESU has failed to repair an analyser on site and has had to remove the faulty analyser for repair. The ESU installed a replacement analyser at the site, but failed to calibrate this analyser. The replacement analyser was also not calibrated when it was subsequently removed from the site. As these events occurred in between QA/QC visits, no calibrations were performed on the analysers and therefore no response factors could 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.

CMCU failed to supply consumables

On at least one occasion the CMCU has failed to supply sample inlet filters to a site. This lead to the continued use of one filter and subsequent blocking of this filter. The analyser failed to correct for the induced pressure drop and therefore the data was deleted. The filter remained unchanged for so long that the vacuum in the analyser caused failure of some of the components of the analyser.

The CMCU failed to supply filters to this site for five months, even though the LSO requested new filters to be dispatched, on each of their calibration sheets over this period.

The CMCU must supply consumables when requested by the LSO.

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.