NPL
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Report

NPL REPORT
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CPEA 28: Airborne Particulate Concentrations and Numbers in the United Kingdom (phase 2)

State of Network Report

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Executive Summary

The main problems found with the Network were the operational state of the real-time carbon and nitrate analysers at the Harwell, Belfast, North Kensington and Marylebone Road sites and the condensation particle counter at the Birmingham site. At handover all of the above analysers were faulty. Also some instruments had not been serviced or calibrated since 2002. These faults have been rectified and the instruments returned to service.

The main changes made by NPL to improve the running of the network are the introduction of remote communications to all instruments on the network to improve data capture rates and eliminate delays in fault finding In addition, all of the sites have been audited by NPL to improve data quality.

Further information on the state of the network before handover will be available when the ratified data up to 31/05/05 is finalised by the previous contractor.

Introduction

In June 2005 the National Physical Laboratory (NPL), under contract to the Department of the Environment, Food and Rural Affairs (Defra), took over the running of the Airborne Particulate Concentrations and Numbers in the UK Network from Casella Stanger. This report describes the state of the network as found by NPL and the changes implemented by NPL to improve its running.

In the first month of the contract NPL visited all of the sites to audit their performance. The aim of these audits was primarily to calibrate the analysers using a common set of measurement standards to help ensure intercomparability of data from the monitoring sites. Details of these visits can be seen in Section 1.

Section 2 covers the changes implemented by NPL to the network to improve its operation. These changed include the remote communication with Condensation Particle Counting (CPC) and Scanning Mobility Particle Sizer (SMPS) analysers, the remote loading of Partisol filter numbers and the calibration of CPCs.

A significant number of instruments on the network were not in working order when the contract was handed over, so remedial work was initiated on the faulty equipment. Other equipment had not been calibrated or serviced for a number of years according to the available service records. This work is described in Section 3.

Local Site Operator (LSO) manuals have been rewritten to incorporate the changes in the network implemented by NPL. NPL undertook to write these LSO manuals in the first four months of the contract. Copies of the LSO manuals can be seen in Appendix A.

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CPEA 28: AIRBORNE PARTICULATE CONCENTRATIONS AND NUMBERS IN THE UNITED KINGDOM (PHASE 2)

State Of Network Report

Contents

1 'As Found' State of Instruments and Remedial Work

When the network was taken over the following equipment was found to be faulty:

- Real-time carbon — Harwell, Belfast, North Kensington and Marylebone Road
- Real-time nitrate — Harwell, Belfast and Marylebone Road
- Condensation Particle Counter — Birmingham

The following sections detail the faults found.

NPL contracted in the instrument supplier as the Equipment Support Unit for the analysers produced by Rupprecht & Patashnick, to get a better support service. This should lead to improved data capture rates for these instruments.

1.1 Real-time Carbon

All four carbon analysers were not functioning at handover. The analysers were removed from service and returned to the supplier. Each instrument was refurbished and recalibrated.

All instruments have now been returned to site and automatic auto-calibrations with zero nitrogen and two CO_2 in nitrogen gas standards have been instituted.

All four carbon analysers required replacement collector cartridges. These should be changed routinely during service visits. It is suggested that the ongoing faults with the carbon analysers were due to poor maintenance and not due to the age of the equipment.

1.2 Real-time Nitrate

The NO_x analysers attached to the nitrate pulse generators at both the Harwell and Marylebone Road sites had faulty PMT coolers, which needed replacing. The pressure gauges on the nitrate analyser at Marylebone Road were also found to be faulty. The Equipment Support Unit performed all these replacements on site.

1.3 Condensation Particle Counter

The analyser at Birmingham was reportedly broken and out of operation since February by the previous contract. The analyser was returned to the supplier for repair, who subsequently found no faults. The analyser was serviced, recalibrated and returned to site.

2 Site Audit Reports

2.1 Site Infrastructure

The floor of the hut at the Harwell site is in a poor condition. Defra is already aware of the problem and the site is going to be relocated to a permanent building close by.

2.2 Instrument Availability

The following table details the dates of the audits and the overall status of the analysers at each site during the audit.

Site	Date of audit	CPC 3022A	SMPS 3934	Automatic carbon 5400	Automatic sulphate 8400S	Automatic nitrate 8400N	Daily sulphate Partisol 2025
Belfast	28th June	Ok	-	n/w	-	Ok	Ok
Birmingham	27th June	n/w	-	-	-	-	-
Bloomsbury	8th June	-	n/w	-	-	-	-
Glasgow	17th June	Ok	-	-	-	-	-
Harwell	9th June	-	Ok	n/w	-	Ok	Ok
Manchester	22nd June	Ok	-	-	-	-	-
Marylebone Road	7th June	Ok	Ok	n/w	-	Ok	Ok
North Kensington	8th June	Ok	-	n/w	-	-	Ok
Port Talbot	21st June	Ok	-	-	-	-	-

Ok signifies the analyser was measuring ambient data on arrival
n/w signifies that the analyser was at the site but was, for whatever reason, not measuring ambient data.
\- indicates that this analyser type was not installed at the site.

2.3 Results of the Condensation Particle Counter (CPC) Model 3022A Audits

It is not possible, at present, to inject a known and traceable number of particles into this analyser type, in-situ, which would act as a calibration for the analyser. Therefore, the sample flow rate and zero reading were measured. A 'zero' sample was produced sampling through a HEPA (high efficiency particle attenuator) filter. It was also possible to check the analyser self-diagnostics.

The results of these checks are shown in Table 2 below.

Site	HEPA filter response, particles/cm^3	Sample flow (lo), vl/min[1] **set point 0.300**	Sample flow (hi), vl/min[1] **set point 1.50**	Diagnostics
Port Talbot	<0.1	0.320	1.64	Ok
Belfast	<0.1	0.309	1.59	Ok
Manchester	<0.1	0.305	1.61	Ok
Glasgow	<0.1	0.303	1.75	Ok
Marylebone Rd	<0.1	0.303	1.66	Ok
North Kensington	<0.1	0.297	1.59	Ok

[1] vl/min = litres per minute by volume at ambient temperature

To reduce the effects of particle losses to the sampling system, the flow rates were changed from low flow to high flow at the audit visits. Both sets of flow rates are given above. The uncertainty in the high flow measurements, for 95% confidence limits is ± 3%. The uncertainty in the low flow measurements is estimated to be ± 5%.

It has been noted that there are large variations in analyser sensitivity when the analysers are calibrated using a particle generator by the equipment support unit before and after service. For this reason, the ESU has been asked to record the results of the calibrations both before and after service. This will allow more reliable data to be produced which will reflect the changes in sensitivity over time. When the first CPC was serviced under NPL's contract, there was found to be a difference in sensitivity on average of 20% between the as found and the serviced calibration.

2.4 Results of the Scanning Mobility Particle Sizer (SMPS) Model 3934 Audits

It is not possible, at present, to inject a known and traceable number, and size distribution, of particles into this analyser type, in-situ, which would act as a calibration for the analyser. Therefore, the sample flow rate and zero reading were measured. A 'zero' sample was produced sampling through a HEPA (high efficiency particle attenuator) filter. It was also possible to check the analyser self-diagnostics.

The results of these checks are shown in the Table below

Site	Sample flow, vl/min **set point 0.50**	Bypass flow, vl/min **set point 14.0**	Flow to cpc, vl/min **set point 0.30**	HEPA filter response, particles/cm^{3}filter
Marylebone Road	0.48	14.7	0.28	< 0.1
Bloomsbury	0.50	14.4	0.29	n/a
Harwell	0.14	11.5	0.30	< 0.1

It was not possible to check the HEPA filter response at Bloomsbury, as the analyser was not operating correctly.

The sample flow at Harwell was 0.14 vl/min as found. Following cleaning of the sample orifice this increased to 0.49 vl/min. The bypass flow at Harwell was 11.5 vl/min as found and was adjusted to 14.0 vl/min.

The pneumatic arrangement of the SMPS splits flow into sheath, mono disperse and excess flows. These flows are balanced such that it is not possible to accurately measure them individually. Correct operation of the analyser requires that these flow rates be balanced correctly. It has not been possible to confirm this at this set of visits.

2.5 Results of the Daily Sulphate Partisol Model 2024 Audits

As with the CPC measurements, the only on site calibration possible for this sampler is to measure analyser flow rate, and perform a leak check. The chemical analysis for the determination of sulphate deposited on the filters is subject to laboratory QA/QC procedures, and will be described elsewhere.

The results of the flow rate measurement and leak check on the sulphate analysers is shown in Table 3 below.

Site	Flow rate, vl/min **set point 16.67**	Leak test
Harwell	15.40	Pass
Belfast	15.76	Pass
Marylebone Rd	16.67	Pass
North Kensington	16.93	Pass

The leak test is “passed” if the flow is less than 1.5 vl/min with the sample inlet “blocked off”. A leak rate or less 1.5 vl/min produces a pressure drop that is an order of magnitude greater than the analyser would experience in normal operation. Therefore, there would not be a leak during sampling.

The uncertainty in the flow measurements, for 95% confidence limits is ± 3%.

2.6 Results of the Automatic Nitrate Analyser Audits

Unlike most other instruments deployed in the field, it is possible to carry out a calibration of the Nitrate analysers. This can be done in two ways:

1 injection of gas mixtures into the NOx analyser to determine its response, and

2 measurement of liquid solutions placed directly on the flash strip of the analyser.

Both sets of calibrations were carried out during this audit round.

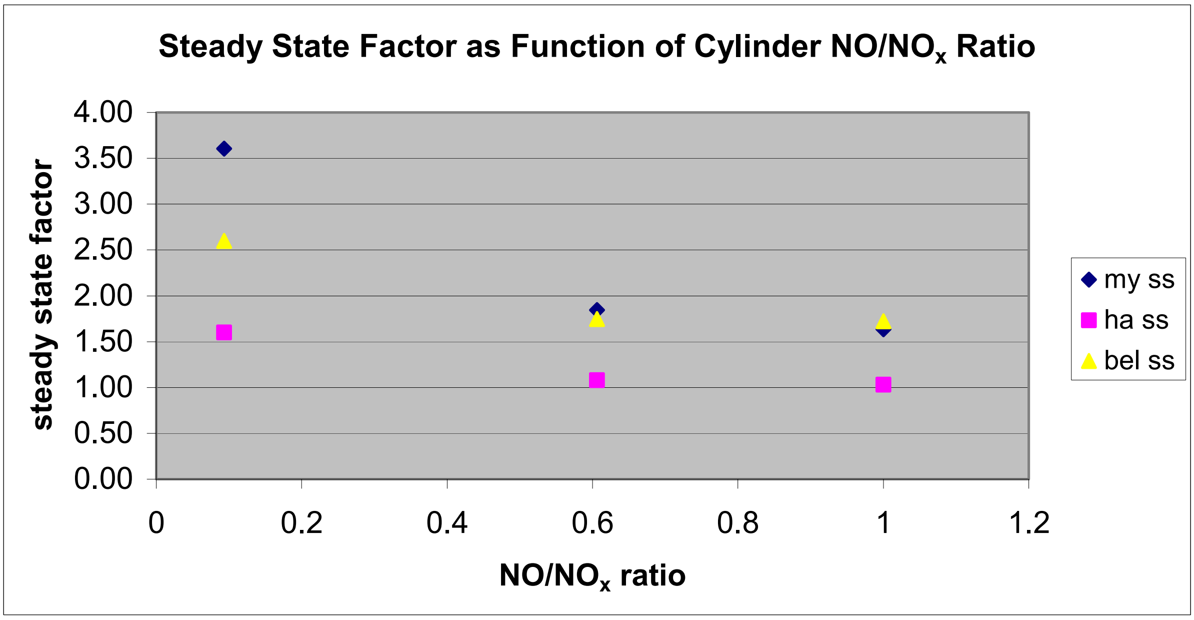
Calibration of the NO_x analyser with gas mixtures can be performed in two ways. The first is by supplying gas in a continuous manner until the analyser reports a stable value. The second is by supplying a pulse of calibration gas to the analyser and then integrating the response of the analyser over time to determine the concentration of gas supplied. This second method is how the automatic calibrations are carried out, but is a less accurate calibration method. For this audit, the NO_x analyser was calibrated by both methods.

2.6.1 Gas Calibration of Chemiluminescent Nitrate Analyser

Three gas standards were transported to each site. They were 5 ppm NO, 3 ppm NO with 2 ppm NO_2, and 7.2 ppm NO_2 with 0.7 ppm NO all in nitrogen. These standards had been prepared by gravimetric means at NPL with an uncertainty of ±2%. Their concentrations were verified by dynamic dilution techniques. Each was injected into the analyser using the audit facility in the analyser software.

Figure 1 below shows, for all sites, the analyser response factor as a function of the ratio of NO to NOx of the calibration standard used. The calibration factor is reasonably constant when the NO/NO_x ratio is in the range 0.6 to 1.0. However, with more NO_2 in the cylinder at a NO/NO_x ratio of approximately 0.1, the factor is seen to increase. This shows that the analyser is less sensitive to mixtures containing higher concentrations of NO_2. This may be due to inefficiencies in the NO_2 converter at higher NO_2 concentrations.

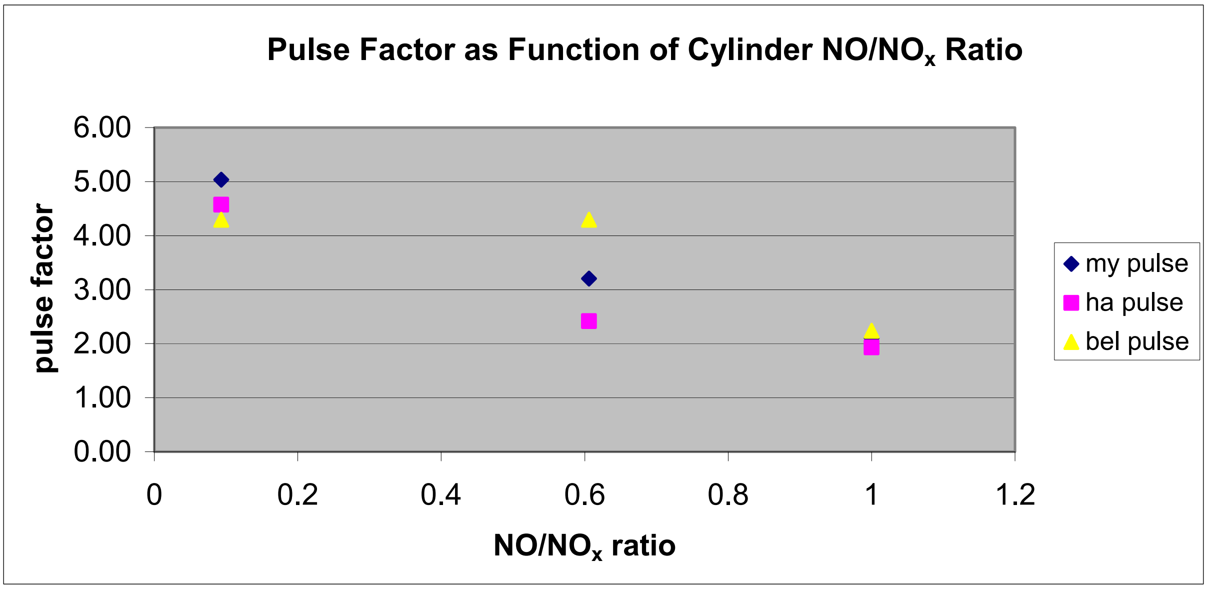
Figure 1



my ≡ Marylebone Road
ha ≡ Harwell
bel ≡ Belfast
ss ≡ Steady state

Figure 2 below shows the analyser response factors to the three calibration standards when measured as a pulsed sample.

Figure 2



my ≡ Marylebone Road
ha ≡ Harwell
bel ≡ Belfast

It can be seen that in the pulse mode the factor varies to a much larger extent depending on the NO/NOx ratio of the standard used.

The relative proportions of NO and NO_2, produced when the analyser is in ambient measurement mode, are not known. This may depend upon the relative concentrations of the particular nitrate species being sampled. Thus the effects of converter inefficiency cannot, at this stage, be reliably determined.

2.6.2 Liquid calibration of the Automatic Nitrate Analysers

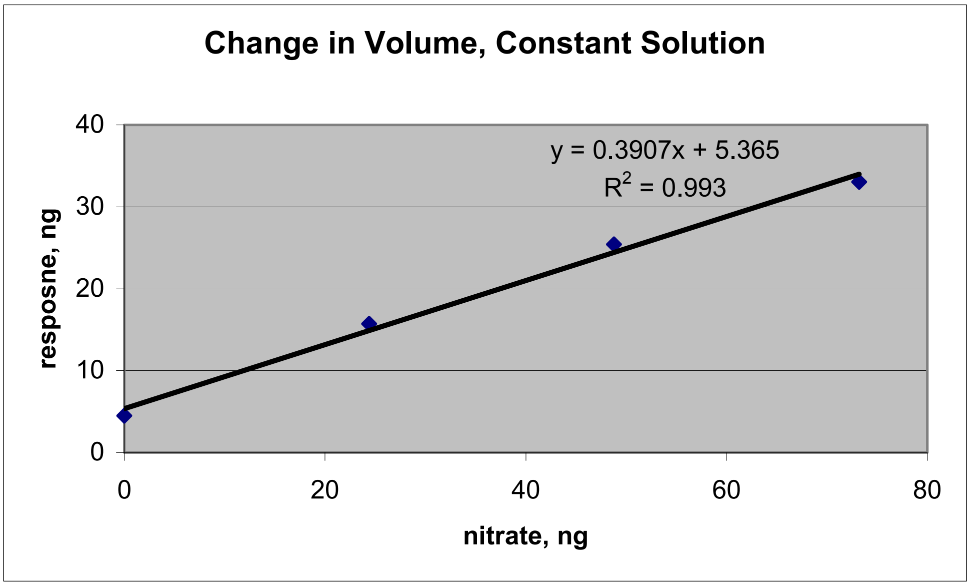
Standard solutions of Potassium Nitrate, KNO_3, were prepared at NPL. This was done by accurate weighing of KNO_3 into known volumes of deionised water. Accurately known volumes of these were injected onto the flash strip of the analyser, and the responses noted.

Also injected onto the flash strip were known volumes of double deionised water to determine the analyser zero response.

This method of calibration tests both the flash strip burning efficiency and the pulsed response of the nitrogen oxides analyser, it is therefore likely to lead to a more reliable overall determination of analyser response factors.

Figure 3 below, shows an example of the response factor as a function of volume of a single solution deposited on the flash strip of the (Marylebone Road) analyser.

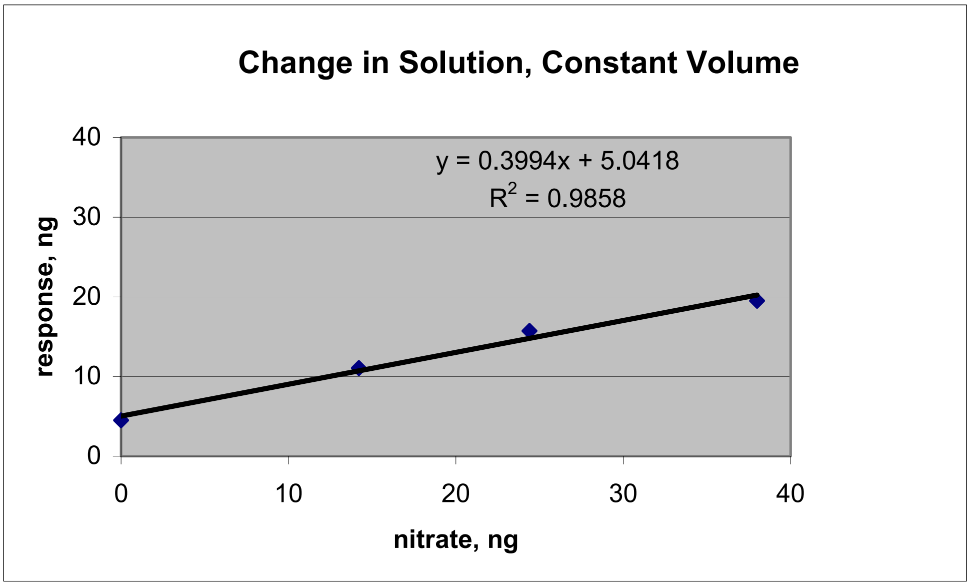
Figure 3.



As can be seen, there is a reasonably linear correlation between the amount of KNO_3 deposited and the instrument response.

Figure 4 below, shows the response factor as a function of concentration at a constant volume of solution deposited on the flash strip of the Marylebone road analyser.

Figure 4.



Again, there is a linear correlation between instrument response and concentration of solution used.

The response factors from both sets of calibrations are tabulated below, along with the analyser zero response and standard deviation of the zero readings obtained for all sites.

Table 4 Nitrate analyser response factors

Site	Slope of response vs concentration for constant volume of different solutions	Slope of response vs concentration for different volumes of same solution	Response to dd[1] water, ng KNO_3	Standard deviation of response to dd[1] water, ng KNO_3
Belfast	0.448	0.462	0.5	0.4
Marylebone Rd	0.399	0.391	4.5	1.0
Harwell	0.718	0.869	0.6	0.4

[1] dd ≡ double distilled

These response factors will be used to scale ambient data, thereby producing a consistent data set.

It was noted that large variations in analyser response were sometimes obtained when using the standard solutions. This was also the case when using the deionised water for the zero readings. The data given above have had the obviously anomalous measurements removed.

2.7 Results of the Automatic Carbon Analyser Audits

None of the automatic carbon analysers could be audited, as these analysers were not working at the hand over of the contract.

2.8 Conclusions and Recommendations

Harwell site is due to be relocated due to the state of the hut floor; all other site infrastructure is in good condition.

All of the sites in the UK particles network have been audited in order to reliably determine the analysers' response factors. This will help ensure a consistent data set across the network.

Some aspects of analyser performance could not be determined as there is presently no way of generating traceable and reproducible particle concentrations, at the required flow rates, in the field. NPL is currently researching techniques and methods for generating calibration samples for these analysers, as part of the DTI Valid Analytical Measurements (VAM) programme.

At the time of the audits, none of the ambient carbon analysers were in working order, and so they could not be calibrated. NPL have produced traceable calibration gas mixtures for these instruments, which will be used at the next series of audits.

Tests carried out on the CPC and SMPS analysers have allowed the instrument flow rates and zero responses to be determined. The zero response tests showed that the analysers gave a true zero reading, indicating that the measurement system was working well and that there were no leaks in the instruments.

Flow tests carried out on the daily sulphate analysers will allow the data to be rescaled to reflect measured flow rates. All instruments passed the leak tests.

The automatic nitrate analysers were calibrated using standard liquid solutions and aspects of analyser performance were also checked using gas calibration standards, prepared by gravimetric means at NPL. In general, the nitrate analysers showed consistent response to the liquid standards. Further investigation of the analyser converter efficiency and the possible effect on measured ambient concentrations should be undertaken.

3 Changes to Network Operation

NPL implemented some changes to the operation of the network to improve performance. These changes are discussed in the following sections.

3.1 Remote Communications

It was decided to introduce remote communications to all instruments on the network and to make more use of existing communication links to improve data capture rates. The following describes the work performed.

3.1.1 Condensation Particle Counting and Scanning Mobility Particle Sizer (SMPS) analysers

Under the previous contract, the data produced from these analysers were copied from the on-site computer collecting the data to mass storage media on a monthly basis by the Local Site Operator (LSO). This data was then sent to the Central Management and Control Unit. This meant that any non-catastrophic faults with analyser were not detected until the month’s worth of data was examined and hence possibilities of low data capture rates were introduced.

To make remote communications possible, new telephone lines have been installed at the Birmingham Centre, Port Talbot, Glasgow and North Kensington sites. The telemetry links to the CPC and SMPS analysers were then established and tested at the initial site audits

Data is now being collected from the analysers on a daily basis and immediately screened for faults.

In future, the newly installed remote communication links could be used so that validated data could be sent to the Data Dissemination Unit on an hourly or daily basis for public dissemination.

3.1.2 Remote Loading Of Partisol Filter Numbers

Previously the daily sulphate measurements made by the Partisol samplers relied on the manual entering of the filter number and cassette ID into the Partisol sampler's memory by the LSO. This is a slow and labour intensive process subject to user error. As the Partisol samplers were already fitted with remote communications it was decided that the CMCU would upload this information straight to the sampler, so that it was ready for the LSO at their fortnightly visit. This reduces data entry errors as the CMCU records the filter numbers and cassette ids when filters are sent to LSOs.

3.2 CPC Calibrations

The CPC analyser counts the number of particles suspended in the sample air mass in two modes. At low particle number concentrations the CPC counts individual particles as they pass through the detector. At number concentrations of greater than 5×10^5 particles/cm^3 the CPC changes to integration mode where the detector integrates the amount of light it receives and translates the signal to the number of particles in the air stream. The amount of light received by the detector in the integration mode is directly affected by the cleanliness of the optics and therefore the amount of light received will decrease over time. This will directly lead to a change in calibration over time.

CPC instruments were previously never calibrated in an as found state before they were serviced and cleaned by the instrument supplier. Therefore this change in calibration was never quantified and the data never scaled for this change in calibration over time. NPL has instituted an as found calibration by the instrument supplier at every CPC service. This extra calibration information will be used to scale data and reduce the uncertainty of the data.

It was also found that some of the CPC units had not been serviced or calibrated since 2002. A service regime has been set up to ensure that all of the CPC analysers will been calibrated in the first six months of the contract.

3.3 Local Site Operator Changes

The flowing table outlines changes in LSOs:

Site	Old LSO	New LSO
Bloomsbury	Casella Stanger	Kings College London
North Kensington	Casella Stanger	Kings College London
Harwell	Birmingham University	NPL

3.4 Real-time Carbon Analysers

The previous contractor ran these analysers with a three hour sampling period. NPL has changed the sampling period to hourly to provide more data, which will be especially useful for episode analysis.

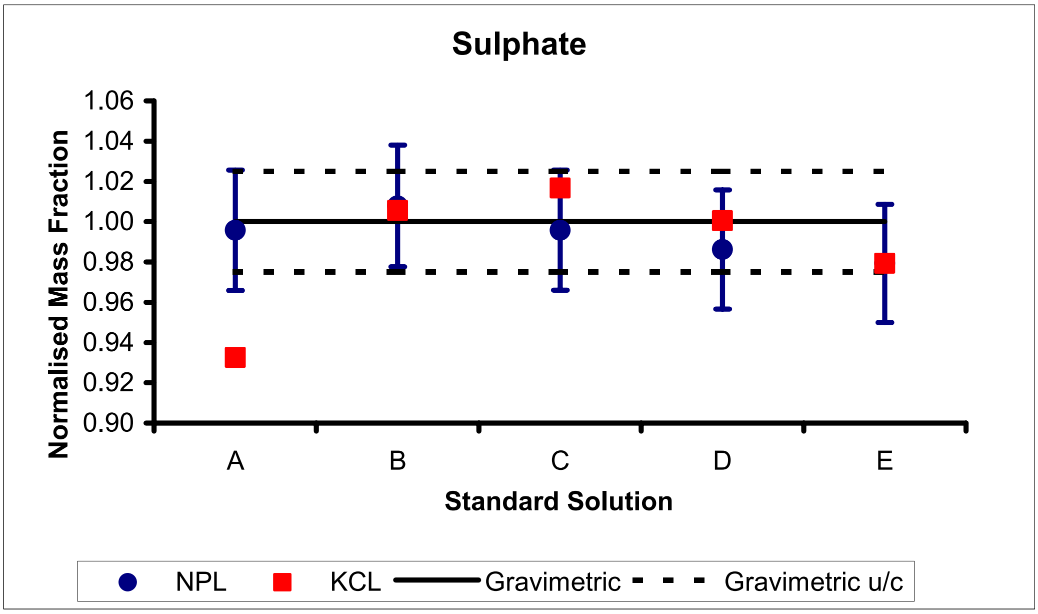
3.5 Daily Sulphate Partisol Samplers

Shortly after handover it was noticed that clogging of the pores in the PTFE filters was causing a reduction in the sample flow rate at certain sites. The filter material was changed to ‘Emfab’, which is a PTFE coated glass fibre material. These filters have been previously been assessed by NPL and found to be more suitable for ambient air monitoring of this type.

3.6 QA/QC of Ion Chromatography Analysis

On handover of the network to NPL, the laboratory used for the ion chromatography of the daily sulphate filters was changed from Birmingham University to Kings College London (KCL). To ensure continuity in results at handover an inter-comparison was organised between the laboratories for the measurement of sulphate concentrations by ion chromatography. The figure below shows the result of the intercomparison of sulphate measurements.

Figure 5



Further intercomparisons are planned with Birmingham University and bilateral intercomparisons between NPL and KCL will be carried out routinely as part of the QA/QC procedure.

4 Conclusions

All of the sites in the UK particles network have been audited in order to reliably determine the analysers' performance. This will help ensure a consistent data set across the network.

All the instruments that were found to be faulty at hand over have been repaired and returned to service. Improved ESU support will ensure more reliable running and therefore higher data capture rates.

Remote communications have been installed for all analysers on the network. This will speed the detection of analyser faults and therefore increase data capture rates.

In the future, validated data could be sent to the Data Dissemination Unit on an hourly or daily basis for public dissemination.

The calibration protocol for the condensation particle counters has been improved with the addition of an "as found calibration", which will improve the data quality.

Automatic entering of filter number and cassette ids on Partisol samplers has been implemented to reduce user-induced errors and to reduce time at LSO visits.

Intercomparisons for the measurement of sulphate, nitrate and chloride have been performed.

New LSO manuals have been written standardise and improve LSO performance across the network. This will ensure routine maintenance is performed to reduce the frequency of breakdowns and improve data capture rates.

Appendix A Local Site Operator Manuals

Page numbers referred to in the LSO manuals are not correct for this document. They are intended for use when the LSO manual is printed as an individual document.

A1.1 Real-time Carbon

Local Site Operator Procedure Manual

Airborne Particulate Concentrations and Numbers in the UK

Operation of Carbon Monitor

Procedure: DEFRA Particles 001
Issue 1.2 September 2005

National Physical Laboratory

Preface

This simplified manual sets out the procedures to be followed by the Local Site Operator in carrying out the tasks necessary to support the operation of the Rupprecht and Patashnick Ambient Carbon Particulate Monitor Series 5400 at sites in the UK. In particular it details the two-weekly routine maintenance procedures, which ensure that measured data are of acceptable quality, but also covers some basic non-routine procedures and actions, which may be useful in the event of equipment problems.

1. INTRODUCTION

The R&P Series 5400 Ambient Carbon Particulate Monitor is designed to characterise the carbon content of particulate matter on an automated basis. The instrument performs a thermal CO_2 analysis to determine the relative amounts of organic and elemental carbon present in a collected particulate sample. The Series 5400 Monitor is configured to sample through a PM_{10} size selective inlet for 1 hour. To enable continuous operation it is equipped with two particulate collectors, allowing for simultaneous sampling onto one collector while performing an analysis on the second collector. During the analysis phase the collected sample is first heated to 340°C and then to 750°C, and the CO_2 produced in each case measured in a closed loop. Thus the organic and total carbon content of the sample is recorded, with the elemental fraction being derived by difference.

The Department for Environment, Food and Rural Affairs' (DEFRA's) UK Airborne Particulate Concentrations and Numbers in the United Kingdom Network currently comprises 10 sites, located at rural, urban and kerbside locations throughout the UK.

NPL has been contracted by DEFRA to undertake this work as project manager. Day to day network management and analytical procedures will be performed by the Environmental Research Group (ERG), King's College London.

ERG is the first point of contact for LSOs, contact details can be found at the back of this manual. As the Central Management and Control Unit, ERG will dispatch consumables to LSOs, advise about instrument malfunctions and other issues. Samples and checklists, where applicable, should be returned to ERG. Data retrieval will be carried out remotely by ERG.

Where equipment malfunction occurs, ERG should be notified within 24-hours of site attendance that the monitor is not operating.

This instrument reaches very high temperatures and parts may remain hot for some time after switching off. Please do not open the door of the carbon monitor unless specifically asked to do so by ERG or the Equipment Service Unit. Local Site Operators are not expected to perform bulb changes.

2. STARTUP

2.1 Hardware Setup

Ensure that calibration and purge gases are connected to the ports at the back of the instrument. Switch on power to the 5400 and to the pump. Turn on the 5400 using the switch in the lower right-hand corner of the front panel.

Once power is applied the **Title Screen** will be displayed momentarily followed by the **Main Screen**, which is the top screen in the instrument's menu structure. This screen does not contain any editable fields.

```
OK                 Main Screen                RUN
           15:03:26      04-Aug-01

FiltA   Temp:  31  C    Beg Time:    16:00
ABrnA Temp: 751  C    Average:      1  hr
FiltB    Temp:  30  C    Coll Vol:      56.8  l
ABrnB  Temp: 749 C    Coll Flow:  16.7  l/min
```

StCode	Stats	RunDef	Data	Setup	

Status Code in the upper left-hand corner. The Status Code will either show **OK** or the first letters of any existing status conditions. Press <**F1 : StCode**> to identify the current status codes.

Instrument Operating Mode in the upper right-hand corner. When first turned on, the instrument will probably be in the **WARM Operating Mode** until the collectors and afterburners reach their set temperatures, after which it will change to the **READY Operating Mode**.

The main screen shows set points for collector and afterburner temperatures and sampling information.

The **Master Menu** provides another means of accessing screens and is often a more direct route than using the soft function keys. This is displayed by pressing <**MENU**> and the required selection made using <↑> and <↓> followed by <**ENTER**>.

2.2 Software Setup

The **Run Definition Screen** defines the operation of the monitor during the collection and analysis phases of the instrument cycle. These are controlled remotely by ERG. Do not make any changes unless specifically instructed to do so.

The **Setup Screen** defines the global parameters for the operation of the monitor. These are controlled remotely by ERG. Do not make any changes unless specifically instructed to do so.

Exit to the **Main Screen** using the <**ESC**> key.

3. ROUTINE CHECKS AND PROCEDURES

3.1 Summary

Main Screen Checks	**Fortnightly**
Nitrogen cylinder	**Fortnightly**
Calibration Gases	**Fortnightly**
Manual Calibrations	**As instructed by ERG**
Clean Sample Head	**Monthly**
Clean Filters	**Monthly**
Complete Proforma	**Fortnightly**

3.2 Main Screen Checks

Press Esc to return to the **Main Screen** and ensure that a status of **OK** is displayed. Press <**RUN/STOP**> to start or stop sampling if necessary. The monitor will begin the collection phase of its first instrument cycle according to the setting entered for **Base Time** in the **Run Definition Screen**. Record operating mode, status code and sampling and analysis parameters.

The collector temperatures, **FiltA** and **FiltB**, will depend on the monitor's operating mode. In the **RUN Operating Mode** these should be 50 ±3 °C while sampling but will increase to the burn temperatures (340 or 750 °C) during analysis. In the **READY** or **STOP Modes** these will drop to around ambient levels.
Common status codes are described below. A critical code will take the monitor out of the **RUN Mode** and into the **READY Operating Mode** at the end of the cycle current at the time of the fault. The next scheduled cycle will not begin until the fault is addressed. Please do not attempt to rectify any problems before contacting ERG.

Status Code	Definition
OK	No current status conditions
LA	Leak in analysis loop A
LB	Leak in analysis loop B
O	Instrument cannot communicate with CO2 sensor
R	Problem with interface board
S	Problem with RS232 port
Z	Power failure during instrument cycle

The Series 5400 Ambient Carbon Particulate Monitor will be interrogated remotely by ERG in order to ensure that it is operating correctly and that valid data are being generated and stored.

3.3 Nitrogen Cylinder and Calibration Gas

The CO_2 and N_2 cylinders are used to calibrate the CO_2 monitor, and this is carried out periodically by ERG or NPL. Check cylinders for leaks and record cylinder numbers, pressures and inlet pressures. Regulators should be set between 3-5 psi. The instrument is set up to perform automatic audits overnight.

3.4 Manual Calibrations

The sampler is set up to perform automatic calibrations, so it is not necessary to perform this procedure unless specifically instructed to do so.

Press <RUN/STOP> to stop sampling. Enter the "Service Mode". Press <MENU> and move the cursor to the line labelled "Calibration/Audit". With the cursor in this position, press <F2: CO_2 Cal>. This takes the user to the CO_2 Calibration Screen. Ensure that the Nitrogen and two CO_2 span gas bottle regulators are set to deliver 3-5 psi and the tubing is hooked up to the back of the Carbon Monitor. Confirm that the values shown for CO_2 Low and CO_2 High in the CO_2 Calibration Screen are correct. Change these parameters if they do not match the CO_2 concentrations of the span gas bottles attached to the instrument. Press <F2: Auto> to instruct the monitor to perform an automatic audit/calibration of the CO_2 sensor. If the instrument fails the CO_2 sensor audit, contact ERG for further advice. Exit the Service Mode.

3.5 Clean Sample Head

Every month the PM_{10} sample inlet should be dismantled and cleaned. Contact ERG to order consumable cleaning materials.

Remove the PM_{10} sample inlet by lifting the entire assembly upward off the 1¼ inch sample tube. Remove the rain jar and set it aside. Unscrew the top acceleration assembly from the lower collector assembly.

Top assembly
Mark the top plate deflector cone and lower plate with a pencil to facilitate proper orientation during reassembly. Using a Phillips screwdriver, remove the four pan head screws from the top plate and lift it off the four, threaded, spacer standoffs.

Remove and inspect the insect screen. Lift the screen off the lower plate rain deflector and brush clean or rinse with water and dry. Clean the top plate deflector cone with Decon 90 solution and dry using a lint free wipe. Clean the internal wall of the acceleration assembly and ensure that the acceleration nozzle is clean. Inspect the large diameter impactor nozzle O-ring for damage or wear, and replace if necessary. Apply a thin film of silicone grease to both the O-ring and to the aluminium threads of the acceleration assembly.

Reinstall the insect screen and align the top and lower plate markings. The four holes in the top plate should align with the four spacer standoffs. Install the top plate onto the lower plate and tighten the four pan-head screws.

Lower Assembly
Clean the collector assembly walls and plate with paper towel and Decon 90. Clean the three vent tubes using a cotton swab. Dry the assembly with paper towel and finish with lint free wipes. Clean the bottom side of the collector assembly. Using a cotton swab, clean the weep hole in the collector plate where the moisture runs out into the moisture trap. Clean the rain jar and inspect the brass nipple fitting in the cover to ensure that it is secure and free from blockages.

Inspect the two inlet tube sealing O-rings for damage or wear and replace if necessary. Apply a light coat of silicone grease to these O-rings to ensure that a seal is made when the inlet is installed on the 1¼ inch sample tube adapter. Clean the threads of the lower collector assembly to ensure a good seal when the two halves are reassembled. Lightly coat the gasket, inside the rain jar cap, with silicone grease to ensure a leak tight fit.

Reinstalling the Inlet
Reassemble the top and bottom inlet assemblies. Hand tighten only. Place the inlet on the 1¼ inch sample tube, taking care not to damage the O-rings

3.6 Clean Filters

Every month the front (door) air intake filters should be removed and cleaned. Remove the filters from the covers and clean by tapping them. Fit the filters back into their covers and fix the covers onto the fans. Return the instrument to normal operation.

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4. EMERGENCY CALL-OUT

In an emergency, the Equipment Service Unit will attend the site within 48 hours. LSOs may be required to carry out instructions from the ESU or from ERG to determine the cause of the fault. In the first instance please contact the duty officer at ERG.

5. CONTACT DETAILS

ERG

The Duty Officer should be the first point of contact for network operational matters. The Duty Officer is available during normal working hours.

Phone: 020 7848 4022
Fax: 0207848 4045
Email: airquality@erg.kcl.ac.uk

Duty Officer
Environmental Research Group
Kings College London
Franklin-Wilkins Building
150 Stamford Street
London
SE1 9NH

Note: The Duty Officer can also be contacted by email during weekends and on public holidays.

NPL

For information regarding contracts and other non-operational matters, please contact Rachel Yardley.

Phone: 020 8943 6852

Email: Rachel.Yardley@npl.co.uk

Phone: 020 8943 6391

Email: David.Butterfield@npl.co.uk

Air Monitors

Please only contact Air Monitors directly when advised to do so by ERG.

Mel Hadfield 07973 661964

Alan Walters 07973 819757

Jim Mills 07973 661931

6. EQUIPMENT AND CONSUMABLES

The following will be provided for maintenance of the Carbon monitor:

Deionised water (if requested)

Decon 90

Cotton tips and/or paper wipes

Grease

Nitrogen purge gas

Carbon dioxide calibration gases (2 concentrations)

7. PROFORMA

If you have access to a PC, please use the electronic proforma. If this is not possible, please photocopy the following page and return to ERG by fax.

DEFRA AIRBORNE PARTICULATE CONCENTRATIONS AND NUMBERS NETWORK

AMBIENT PARTICULATE CARBON

Site	……………………………….
Date	……………………………….
Operator	……………………………….
Start Time	……………………………….
End Time	……………………………….

Main Screen Checks

Instrument Date & Time	………………..
Operating Mode	………………..
Status Code	………………..
FiltA Temp	………………..
ABrnA Temp	………………..
FiltB Temp	………………..
ABrnB Temp	………………..
Beg Time	………………..
Average	………………..
Coll Vol	………………..
Coll Flow	………………..

Gas Cylinders

	Cylinder Changed	Cylinder Number	Cylinder Pressure	Inlet Pressure
Zero	Y/N	……………...	……………...	……………...
CO2 Low	Y/N	……………...	……………...	……………...
CO2 High	Y/N	……………...	……………...	……………...

Maintenance

Sample Head	Y/N
Clean Filters	Y/N

Comments and Request for Consumables

A1.2 Real-time Nitrate

Local Site Operator Procedure Manual

Airborne Particulate Concentrations and Numbers in the UK

Operation of 8400N Ambient Particulate Nitrate Monitor

Procedure: DEFRA Particles 002
Issue 1.2 September 2005

National Physical Laboratory

PREFACE

This simplified manual sets out the procedures to be followed by the Local Site Operator in carrying out the tasks necessary to support the operation of the Rupprecht and Patashnick 8400N Ambient Particulate Nitrate Monitor at sites in the UK. In particular it details the fortnightly routine maintenance procedures, which ensure that measured data are of acceptable quality, but also covers some basic non-routine procedures and actions, which may be useful in the event of equipment problems.

This procedure has been prepared by NPL, with advice from King's College London's Environmental Research Group.

1. INTRODUCTION

Ambient samples are pulled through a cyclone to remove particles above 2.5 µm. The sample flow passes through a carbon honeycomb denuder to remove potential gaseous interferences, and a Nafion humidifier to ensure that the particles are wet. Particles are collected by impaction onto a nichrome strip mounted in a collection and vaporization cell. During the analysis step the cell is flushed with nitrogen gas. The nitrogen flows through the cell and into a nitrogen oxide analyzer. The collection substrate is then flash heated by current from a battery. Evolved nitrogen oxides are carried in the nitrogen flow to the analyzer, where they are reduced to NO by a molybdenum converter, and assayed by chemiluminescence. At the end of the analysis period the system returns to sample collection. The system outputs nitrate concentration and system operating parameters via a serial communications line at the end of each cycle.

The Department for Environment, Food and Rural Affairs' (Defra's) UK Airborne Particulate Concentrations and Numbers in the United Kingdom Network currently comprises 10 sites, located at rural, urban and kerbside locations throughout the UK.

NPL has been contracted by DEFRA to undertake this work as project manager. The Environmental Research Group (ERG), Kings College London, will perform day-to-day network management and analytical procedures.

ERG is the first point of contact for LSOs, contact details can be found at the back of this manual. As the Central Management and Control Unit, ERG will dispatch consumables to LSOs, advise about instrument malfunctions and other issues. Samples and checklists, where applicable, should be returned to ERG. Data retrieval will be carried out remotely by ERG.

Where equipment malfunction occurs, ERG should be notified within 24-hours of site attendance that the monitor is not operating.

2. STARTUP

Turn on power to both the Pulse Generator and Pulse Analyzer. Approximately 30 minutes are required for the ozone generator in the Pulse Analyzer to begin operating. Confirm all system parameters are set as below:

	Menu Item	Value
Cycle Setup		
	Sample Time	815
	Purge Time	30
	Baseline Read	10
	Read 1 time	20
	Read 2 time	1
	Base Start time	00:15
	Minimum Cycle length	898
	Desired Cycle Length	900
	Number of Cycles	0
	Perform Flow Audit	6
	Start Analyser Audit	00:00
	Perform Analyser Audit	1 days

Pressing “RUN/STOP” will begin sampling and analysis. The 8400N is designed for automated operation and will continue sampling and analysis indefinitely barring further operator intervention or malfunction.

3. ROUTINE CHECKS AND PROCEDURES

3.1 Summary

Main Screen Checks	**Fortnightly**
Top up distilled water	**Fortnightly**
Check consumables	**Fortnightly**
Nitrogen cylinder	**Fortnightly**
Check Flash Strip	**Fortnightly**
Gas calibrations	**Monthly**
Clean Collection Orifice	**Monthly**
Clean Cyclone Impactor	**Monthly**
Leak Check	**Monthly**
Clean Filter	**Quarterly**
Clean Rain Cap	**Monthly**
Aqueous Standard calibrations	**Monthly**
Measure Field Blank	**As required by ERG**
Complete Proforma	**Fortnightly**

3.2 Main Screen Checks

On the main screen, check STATUS is OK, instrument is in RUN mode, reservoir and flash strip read OK. You should see an NO_3 concentration. Common Status Code descriptions are given below. For other status codes, consult R&P manual and contact ERG.

Status Code	**Description**	**Action**
OK	OK	None
S1	Ambient temp out of range	Possible failed ambient temperature probe. Ensure that the probe is properly connected to the Pulse Generator, and that the probe is dry and in good condition.
W	Check water reservoir	Add water to H_2O Reservoir water bottle. If the bottle appears full, check that the humidifier line is full of water and contains no large bubbles.
X	Flash failure	Replace the flash strip if it is visibly broken
A	Analyser warning	Note warning messages on Pulse Analyzer screen (press “MSG”). Clear messages by pressing “CLR”.

Check and record make up and orifice flows. These are indicated on the lower rotameter inside the Pulse Generator. Adjust to keep within range and record changes on the checklist.

3.3 Top up distilled water.

Replace the cap loosely, do not tighten.

3.4 Consumables.

Check consumables against list. Contact ERG to request more consumables, giving at least 6 weeks notice for nitrogen and NO (calibration gas).

3.5 Nitrogen cylinder.

A 50l cylinder should last about 4 weeks.
To change, press "RUN/STOP". Then press the soft key under "abort immediately". Shut main cylinder valve, remove regulator. Strap new cylinder in place with chain. Install regulator on new cylinder and immediately check for leaks. Leak test as follows: open the cylinder valve and regulator outlet valve to pressurize the line, then close both valves. Watch that the indicated pressure on the tank (approx 2000 psi) does not drop over two minutes. Then reopen the tank valve and outlet valve, and adjust the regulator to deliver between 4 and 6 psi. Press "RUN/STOP" to resume normal operation.

3.6 Change Flash Strip.

Only change if the status does not read 'OK'
If the cycle is running stop it by pressing "RUN/STOP" and F1 to finish current cycle or F2 to abort the run. Open the cell and unscrew the strip using the yellow handled nut driver and small socket (1/4"). Remove the nuts, the washers and the strip. Place a new-formed nichrome strip on the posts, with the loops facing up. The strips are in a small capsule container. Put the washers and then the nuts back on the posts. Go to "Menu"—"Service"—"FlashIR Setup". Press "Reset Flash Fault" if necessary and test flash. Make sure the flash looked even, no sparks were seen close the cell, and check the flash duration (should be between 70-110 ms). Perform another test flash and make sure the flash duration stays constant (+/- 5ms). If ok, then exit service mode and press "RUN/STOP" to resume normal operation. Re-install strip if flash appears uneven or flash duration is not constant.

3.7 Gas Calibrations.

Check the NO calibration gas cylinder for leaks and record the gas pressure remaining.

Each instrument should be set up to run automatic calibrations. Do not perform this procedure unless specifically asked to do so.

Press "RUN/STOP" and F1 to finish current sample. If necessary, open the main tank valve and regulator outlet valve on the calibration gas cylinder. The cal gas gauge on the 8400N should read 5 ± 2 psi. Press "Menu", then "Enter Service Mode", then "Perform Analyzer Audit". Press "Full Audit". This starts the audit and will take 15 minutes. Record audit values on checklist. At end of audit, press "Menu", then "Exit Service
Mode" to get back to the main screen and then "RUN/STOP" to resume normal operation. Close the calibration tank valve and cal gas regulator outlet valve if a leak is suspected.

3.8 Clean Collection Orifice.

If the cycle is running stop it by pressing "RUN/STOP" and F1 to finish current cycle or F2 to abort the run. Open the cell and unscrew the orifice using the yellow handled nut driver and large socket. Clean with distilled water using a squirt bottle, or in a sonic bath. Dry with "portable air", and reinstall. Assure that orifice is tight, so that O-ring provides a vacuum seal. Press "RUN/STOP" to resume normal operation.

3.9 Clean Cyclone Impactor

This is located in the top right corner of the pulse generator and can be cleaned with a dry cloth.

3.10 Leak Check

With the system in the READY mode, shut the sample inlet (green valve in the top right side of the pulse generator) and the bypass flow (below the front vacuum gauge). Wait for two minutes and then close the valve below the back vacuum gauge. The drift in cell pressure should be less than 0.01 atm per minute. If OK, reopen the valves. If there is a leak, ensure all connections are tight and repeat. If a leak is still obvious, contact ERG or the Equipment Service Unit (Air Monitors) for advice.

3.11 Clean Filter

Remove the filter from the top left side of the pulse generator (you may need to lift the latch to access the filter). Brush dust and obstructions from the filter and replace.

3.12 Clean Rain Cap

This is situated on the outside of the portacabin and can be unscrewed and wiped clean.

3.13 Aqueous Standard Calibrations

Press RUN/STOP button to stop. Abort immediately when prompted. Mode should be READY. Press MENU, select ENTER SERVICE MODE and press ENTER. Select AQUEOUS STANDARDS and press ENTER. Press EDIT, then type in the number of ng. ENTER. Open the front door of the instrument. At the bottom right, unscrew the lock and pull down to open. Transfer solution from the syringe onto the centre of the flash strip. Close and lock. Press F1 START. Display should read WAITING. If not, press F1 START again. Analysis takes about 5 minutes. Note down the result from each water and standard on the proforma. Clean plunger in deionised water.

Order of standards

	Solution	Volume (µl)	Enter mass (ng)
1	None (strip left dry)	None	0
2	Deionised water	0.5	0
3	Deionised water	0.5	0
4	Nitrate	0.2	20
5	Nitrate	0.2	20
6	Nitrate	0.4	40
7	Nitrate	0.4	40
8	Nitrate	0.6	60
9	Nitrate	0.6	60
10	Nitrate	0.8	80
11	Nitrate	0.8	80

3.14 Measure Field Blank

If you are asked to measure a field blank, press “RUN/STOP” and F1 to finish current sample. Connect disc cartridge filter in line, just above the black tubing above denuder. Use clear tubing to connect to sample line. Go to “Cycle Setup”, and adjust “Base Start Time” to “immed”. Press “Esc” to return to Main Screen and push “RUN/STOP” to run for two cycles. Reenter Cycle Setup and adjust “Base Start Time” back to “00:15”. Remove filter, reconnect sample line, press “RUN/STOP” to resume normal operation.

3.15 Complete Proforma.

Fill in all fields and note any adjustments made or problems incurred. Return to ERG.

4. EMERGENCY CALL-OUT

In an emergency, the Equipment Service Unit will attend the site within 48 hours. LSOs may be required to carry out instructions from the ESU or from ERG to determine the cause of the fault. In the first instance please contact the duty officer at ERG.

5. CONTACT DETAILS

ERG

The Duty Officer should be the first point of contact for network operational matters. The Duty Officer is available during normal working hours.

Phone: 020 7848 4022
Fax: 0207848 4045
Email: airquality@erg.kcl.ac.uk

Duty Officer
Environmental Research Group
Kings College London
Franklin-Wilkins Building
150 Stamford Street
London
SE1 9NH

Note: The Duty Officer can also be contacted by email during weekends and on public holidays.

NPL

For information regarding contracts and other non-operational matters, please contact Rachel Yardley or David Butterfield.

Phone: 020 8943 6852

Email: Rachel.Yardley@npl.co.uk

Phone: 020 8943 6391

Email: David.Butterfield@npl.co.uk

Air Monitors

Please only contact Air Monitors directly when advised to do so by ERG.

Mel Hadfield 07973 661964

Alan Walters 07973 819757

Jim Mills 07973 661931

6. EQUIPMENT AND CONSUMABLES

The following will be provided for maintenance of the Nitrate monitor:

Flash Strips

NO Calibration gas

Nitrogen purge gas

Nitrate solution

Deionised water (if requested)

High-accuracy syringe

Sonicating bath / air in a can / acetone

Grease

Cotton tips and/or paper wipes

Decon 90 (if requested)

Inlet filters

7. PROFORMA

If you have access to a PC, please use the electronic proforma. If this is not possible, please photocopy the following page and return to ERG by fax.

DEFRA AIRBORNE PARTICULATE CONCENTRATIONS AND NUMBERS NETWORK

AMBIENT PARTICULATE NITRATE

Site	……………………………….
Date	………………………………….
Operator	………………………………….
Start Time	………………………………….
End Time	………………………………….

Main Screen Checks

		Target Values
Instrument Date & Time	………………..	
Status Code	………………..	
H_2O Reservoir	………………..	
Flash Strip	………………..	
NOX Pulse Analyser	………………..	
Sample Flow	………………..	0.9 - 1.2 l/min
Cell Temp	………………..	
Cell Pressure	………………..	50% of ambient
Ambient Press	………………..	
Nitrate Concentration	………………..	

		During Sampling	During N2 Flow
Makeup Flow	………………..	3-5 l/min	
Orifice Flow	………………..	0 l/min	0.4-0.5 l/min
Distilled water topped up	Y/N		

Gas Cylinders

	Cylinder Changed	Cylinder Number	Cylinder Pressure	Inlet Pressure
NO (Calibration)	Y/N	……………....	……………....	……………....
N_2 (Purge)	Y/N	……………....	……………....	……………....

Maintenance

Flash Strip changed	Y/N
Clean Collection Orifice	Y/N
Clean Cyclone Impactor	Y/N
Leak Check	Y/N
Clean Filter	Y/N
Inspect Makeup Flow Filter	Y/N
Distilled water topped up	Y/N
Clean Rain Cap	Y/N

Aqueous Calibrations

Mass Deposited (ng)	Mass Recorded (ng)
0	....
0	....
0	....
20	....
20	....
40	....
40	....
60	....
60	....
80	....
80	....

Comments and Request for Consumables

A1.3 Daily Sulphate

Local Site Operator Procedure Manual

Airborne Particulate Concentrations and Numbers in the UK

Operation of Partisol

Procedure: DEFRA Particles 005
Issue 1.1 September 2005

National Physical Laboratory

PREFACE

This simplified manual sets out the procedures to be followed by the Local Site Operator in carrying out the tasks necessary to support the operation of the Rupprecht and Patashnick Partisol 2025 at sites in the UK. In particular it details the two-weekly routine maintenance procedures, which ensure that measured data are of acceptable quality, but also covers some basic non-routine procedures and actions, which may be useful in the event of equipment problems.

INTRODUCTION

The Partisol is designed to collect PM10 particulates onto a 47mm filter. It is equipped with magazines, which can hold up to 16 filters for sampling on consecutive days. For this network, samples will be taken on a daily (24-hour) basis, and filters will be analysed for sulphates.

The Department for Environment, Food and Rural Affairs' (Defra's) UK Airborne Particulate Concentrations and Numbers in the United Kingdom Network currently comprises 10 sites, located at rural, urban and kerbside locations throughout the UK.

NPL has been contracted by DEFRA to undertake this work as project manager. The Environmental Research Group (ERG), Kings College London, will perform day to day network management and analytical procedures.

ERG is the first point of contact for LSOs, contact details can be found at the back of this manual. As the Central Management and Control Unit, ERG will dispatch consumables to LSOs, advise about instrument malfunctions and other issues. Samples and checklists, where applicable, should be returned to ERG. Data retrieval will be carried out remotely by ERG.

Where equipment malfunction occurs, ERG should be notified within 24-hours of site attendance that the monitor is not operating.

STARTUP

Hardware Startup

Ensure the power supply is connected to the Partisol. Install the PM10 sampling head, and the ambient temperature sensor onto the side of the unit.
Press the power switch on the main panel to the 'on' position and ensure that the RS232 cable is connected.

Software Setup

Software parameters will be controlled remotely by ERG.

3. ROUTINE CHECKS AND PROCEDURES

3.1 Summary

Record Diagnostics	**Fortnightly**
Filter Exchange	**Fortnightly**
PM10 Head Cleaning	**Monthly**
Check Consumables	**Fortnightly**
Complete Proforma	**Fortnightly**

3.2 Record Diagnostics

Press Esc to return to the main screen and record the information on the proforma. If a status code is present, attempt to identify the problem and reset the status. If this is not possible, inform ERG immediately from site.

3.3 Filter Exchange

If currently sampling, the filter will not be in either of the magazines. Remove both magazines. Insert the empty magazine on the right hand side. A full magazine will have been sent to you by Kings College. Insert this on the left hand side. Return sampled filters to ERG. If you are unable to visit the site on the scheduled day, please inform ERG and they may send you an extra filter in the magazine.

Attach the pneumatic line to the magazine on the left.

Press ESC to return to the main screen. And then FILT SET and FILT LIST. The list of filter numbers and RP numbers should have been automatically programmed in. Check these agree with the supplied sheet. If not, contact Kings College and/or type in manually. Use arrow keys to move between fields, press EDIT to enter data and ENTER to accept it.

ESC to main screen. Check the sample time is as expected. If not, edit using F5 SYSTEM and F5 SETUP.

Sampler should be in RUN mode. If it displays DONE, press RUN/STOP and the screen will say WAIT. If possible, check that the partisol starts sampling at the pre-programmed time (if it wasn't already running).

.

3.4 PM10 Head Cleaning

Clean the inlet once monthly. Partisol will need to be stopped before cleaning commences (press RUN/STOP). If possible, time this so the last filter has already finished and it is in DONE mode.

Remove the PM_{10} sample inlet by lifting the entire assembly upward off the 1¼ inch sample tube. Remove the rain jar and set it aside. Unscrew the top acceleration assembly from the lower collector assembly.

Top assembly
Mark the top plate deflector cone and lower plate with a pencil to facilitate proper orientation during reassembly. Using a Phillips screwdriver, remove the four pan head screws from the top plate and lift it off the four, threaded, spacer standoffs.

Remove and inspect the insect screen. Lift the screen off the lower plate rain deflector and brush clean or rinse with water and dry. Clean the top plate deflector cone with Decon 90 solution and dry using a lint free wipe. Clean the internal wall of the acceleration assembly and ensure that the acceleration nozzle is clean. Inspect the large diameter impactor nozzle O-ring for damage or wear, and replace if necessary. Apply a thin film of silicone grease to both the O-ring and to the aluminium threads of the acceleration assembly.

Reinstall the insect screen and align the top and lower plate markings. The four holes in the top plate should align with the four spacer standoffs. Install the top plate onto the lower plate and tighten the four pan-head screws.

Lower Assembly
Clean the collector assembly walls and plate with paper towel and Decon 90. Clean the three vent tubes using a cotton swab. Dry the assembly with paper towel and finish with lint free wipes. Clean the bottom side of the collector assembly. Using a cotton swab, clean the weep hole in the collector plate where the moisture runs out into the moisture trap. Clean the rain jar and inspect the brass nipple fitting in the cover to ensure that it is secure and free from blockages.

Inspect the two inlet tube sealing O-rings for damage or wear and replace if necessary. Apply a light coat of silicone grease to these O-rings to ensure that a seal is made when the inlet is installed on the 1¼ inch sample tube adapter. Clean the threads of the lower collector assembly to ensure a good seal when the two halves are reassembled. Lightly coat the gasket, inside the rain jar cap, with silicone grease to ensure a leak tight fit.

Reinstalling the Inlet
Reassemble the top and bottom inlet assemblies. Hand tighten only. Place the inlet on the 1¼ inch sample tube, taking care not to damage the O-rings

4. EMERGENCY CALL-OUT

The Equipment Service Unit does not make site visits. LSOs may therefore be required to carry out instructions from the ESU or from ERG to determine the cause of the fault. In the first instance please contact the duty officer at ERG.

5 CONTACT DETAILS

ERG

The Duty Officer should be the first point of contact for network operational matters. The Duty Officer is available during normal working hours.

Phone: 020 7848 4022
Fax: 0207848 4045
Email: airquality@erg.kcl.ac.uk

Environmental Research Group
Kings College London
Franklin-Wilkins Building
150 Stamford Street
London
SE1 9NH

Note: The Duty Officer can also be contacted by email during weekends and on public holidays.

NPL

For information regarding contracts and other non-operational matters, please contact Rachel Yardley.

Phone: 020 8943 6852	Phone: 020 8943 6391
Email: Rachel.Yardley@npl.co.uk	Email: David.Butterfield@npl.co.uk

Air Monitors

Please only contact Air Monitors directly when advised to do so by ERG.

Mel Hadfield 07973 661964

Alan Walters 07973 819757

Jim Mills 07973 661931

6 EQUIPMENT AND CONSUMABLES

The following will be provided for maintenance of the Partisol:

Deionised water (if requested)

Decon 90

Cotton tips and/or paper wipes

Grease

Brush

7. PROFORMA

If you have access to a PC, please use the electronic proforma. If this is not possible, please photocopy the following page and return to ERG by fax.

DEFRA AIRBORNE PARTICULATE CONCENTRATIONS AND NUMBERS NETWORK

PARTISOL PLUS - 2025

Site …………………………………

Date …………………………………

Operator …………………………………

Start Time …………………………………

End Time …………………………………

Record Diagnostics

Press Esc to return to the main screen

Status Code …………………………

Fault Codes (if present) …………………………

Current Date and Time …………………………

Start Date and Time …………………………

Instrument Number …………………………

Please also record:

Filter ID which should be sampling …………………………

Filter ID Partisol thinks is sampling …………………………

Filter ID which is actually sampling …………………………

Final Checks

Pneumatic line connected Y/N

Empty magazine installed Y/N

Full magazine returned to ERG Y/N

PM10 Head Cleaned Y/N

Comments and Request for Consumables

A1.4 Condensation Particle Counter

Local Site Operator Procedure Manual

Airborne Particulate Concentrations and Numbers in the UK

Operation of Condensation Particle Counter

Procedure: DEFRA Particles 004
Issue 1.2 September 2005

NPL National Physical Laboratory

PREFACE

This simplified manual sets out the procedures to be followed by the Local Site Operator in carrying out the tasks necessary to support the operation of the TSI Condensation Particle Counter (3022A) at sites in the UK. In particular it details the two-weekly routine maintenance procedures, which ensure that measured data are of acceptable quality, but also covers some basic non-routine procedures and actions, which may be useful in the event of equipment problems.

This procedure has been prepared by NPL, with advice from King’s College London’s Environmental Research Group.

SECTION

1. INTRODUCTION

In the CPC the particles are detected and counted by a simple optical detector after a supersaturated butanol vapor condenses onto the particles, causing them to grow into larger droplets. The 3022A can detect particles greater than 7 nanometres in diameter, up to 10 million per cubic centimetre.

The Department for Environment, Food and Rural Affairs' (Defra's) UK Airborne Particulate Concentrations and Numbers in the United Kingdom Network currently comprises 10 sites, located at rural, urban and kerbside locations throughout the UK.

NPL has been contracted by DEFRA to undertake this work as project manager. The Environmental Research Group (ERG), Kings College London, will perform day to day network management and analytical procedures.

ERG is the first point of contact for LSOs, contact details can be found at the back of this manual. As the Central Management and Control Unit, ERG will dispatch consumables to LSOs, advise about instrument malfunctions and other issues. Samples and checklists, where applicable, should be returned to ERG. Data retrieval will be carried out remotely by ERG.

Where equipment malfunction occurs, ERG should be notified within 24-hours of site attendance that the monitor is not operating.

Note: Butanol is flammable. Butanol is also potentially toxic if inhaled. Use butanol only in a well-ventilated area. If you smell butanol and develop a headache, or feel faint or nauseous, leave the area at once. Ventilate the area before returning.

2. STARTUP

Hardware Startup

Place a full bottle of butanol on top of the CPC (the butanol is delivered to the CPC under gravity) and attach to the 'fill' port at the back of the CPC.
Connect the inlet to the CPC (the connection will be at the front left, side or back of the instrument).
Plug the power cord into the connector on the back panel and then plug it into the AC power source. Apply power to the CPC with the switch next to the power cord on the back panel. The front panel now displays the phrase "TSI" and begins a 10-minute warm-up sequence. After warm-up, the fluid begins to fill the internal reservoir in the saturator. If normal operating conditions are not reached within the 600-second

countdown, the CPC simply remains in the warm-up mode without further countdown until all status lamps are lit.
After warm-up, the CPC displays a value for concentration or total counts; the pump is either off or on, just as it was when the instrument was last switched off. If necessary, press the PUMP button to switch the pump on. The green flow light should appear.
The CPC also needs to be connected to the lap top computer, using the COM port at the back of the instrument.
Primary functions are accessed from the front panel's five push buttons. The labels above the buttons identify them: Pump, Display, Total, Clear, and Range. Display should read concentration in particles per cubic centimetre. The Range button should be used to select 'Autorange' and the adjacent light should switch on. There is no need to use the other buttons.

Software Setup

If the software is running Click BREAK to access menu option.

If the software is not running, open CPCount from C:\Program Files\CP Count

Select SETTINGS from main menu. In the drop down box select TIMING, the following setup should be configured:

Averaging Interval	5s
Number of Samples	178
Total Sampling Time	14 mins 50 Sec
Start Options	By Timer
Automatic Save	ON
Timer Start at	Set time to be next fifteen minute period
Repeat Every	15 mins
File naming:	C: \cpc\Sitename.001.dat
Save in LTD file	Yes
No of records in LTD file	3000

Select Settings. In drop down menu check that there is a tick against SAVE AS DEFAULT. If not, click on SAVE AS DEFAULT to put a tick against it, then close and restart cpcount. This will ensure that the default settings are those that have been entered.

3. ROUTINE CHECKS AND PROCEDURES

Summary

Condensation Particle Counter	**Fortnightly**
Computer Checks	**Fortnightly**
Butanol Check	**Fortnightly**
Check Consumables	**Fortnightly**
Complete Proforma	**Fortnightly**

Condensation Particle Counter Checks

Check that the CPC is running, producing data and there are no obvious problems or safety hazards. Note any issues in the comments box on the proforma.
Record the following parameters: Flow, Optics Temperature, Condenser Temperature, Saturator Temperature and Detector Volts. Access by pressing SHIFT and then press DISPLAY to scroll through. Return to particle counts by pressing SHIFT.
Check all status lamps are on.
Note: It is necessary to switch the pump off before recording the detector volts. Please remember to switch it back on again immediately afterwards.

3.3 Computer Checks

Log On - You may need to log onto the laptop. Select the Webaccess account and type the following password:

tanstaafl

Check that the CPCount software is running and graphing data at a reasonable concentration.
Record the laptop time on the proforma. Check that it is within five minutes of GMT. If more than five out then adjust by double clicking on the time and adjusting, record any changes made on the proforma.

3.4 Butanol Check.

Check the level of Butanol in the fill bottle and record on the proforma. Top up if necessary. Contact ERG at least two weeks before you expect to run out of Butanol. The Butanol should be drained once every fortnight. Ensure that the drain bottle is connected to the drain port on the rear of the CPC and is below the level of the CPC. Turn off the pump by pressing PUMP and disconnect the butanol from the 'fill' port at the back of the CPC. Press SHIFT/DRAIN and allow the Butanol to drain for about one minute. Reconnect the fill bottle. Press SHIFT/DRAIN to return to normal operation and restart the pump.
Note: Dispose of waste butanol properly. Contact ERG if you are unable to do so.

3.5 Check Consumables.
Contact ERG to request more consumables, giving at least 2 weeks notice for butanol.

3.6 Complete Proforma
Note any problems in the 'Comments' section of the proforma, recording any error codes or messages. Return the proforma to ERG by fax or electronically within 48 hours. Contact ERG to report any problems.

4. DRYING
Before shipping the instrument the following procedure needs to be carried out:

Ensure that the drain bottle is connected to the drain port on the rear of the CPC and is below the level of the CPC.
Turn off the pump by pressing PUMP and disconnect the butanol from the 'fill' port at the back of the CPC. Press SHIFT/DRAIN and allow the Butanol to drain for about one minute. Switch on the pump and run dry air through the counter for 24 to 48 hours.
If instructed, please return the instrument ***in its transit case*** to TSI Instruments. Please do not transport the CPC in any other container.

5. EMERGENCY CALL-OUT
The Equipment Service Unit does not make site visits. LSOs may therefore be required to carry out instructions from the ESU or from ERG to determine the cause of the fault. In the first instance please contact the duty officer at ERG.

6. CONTACT DETAILS

ERG

The Duty Officer should be the first point of contact for network operational matters. The Duty Officer is available during normal working hours.

Phone: 020 7848 4022
Fax: 0207848 4045
Email: airquality@erg.kcl.ac.uk

Environmental Research Group
Kings College London
Franklin-Wilkins Building
150 Stamford Street
London
SE1 9NH

Note: The Duty Officer can also be contacted by email during weekends and on public holidays.

NPL

For information regarding contracts and other non-operational matters, please contact Rachel Yardley or David Butterfield.

Phone: 020 8943 6852

Email: Rachel.Yardley@npl.co.uk

Phone: 020 8943 6391

Email: David.Butterfield@npl.co.uk

TSI Instruments Ltd

Please return the instrument ***in its transit case*** to TSI Instruments.

TSI Instruments
1 Beach Road West
Portishead
Bristol
BS20 7HR

7. EQUIPMENT AND CONSUMABLES

The following will be provided for maintenance of the CPC:

Butan-1-ol

Drain and fill bottles

8. PROFORMA

If you have access to a PC, please use the electronic proforma. If this is not possible, please photocopy the following page and return to ERG by fax.

DEFRA AIRBORNE PARTICULATE CONCENTRATIONS AND NUMBERS NETWORK

CONDENSATION PARTICLE COUNTER

Site	……………………………….
Date	………………………………….
Operator	………………………………….
Start Time	………………………………….
End Time	………………………………….

CPC Checks

Press SHIFT, then STATUS / DISPLAY to scroll through diagnostics

		Criteria
Flow	…………………………	5 +/- 0.5 ml
Optics Temperature	…………………………	36C
Condenser Temperature	…………………………	10C
Saturator Temperature	…………………………	35C
Detector Volts	…………………………	

Press SHIFT to return to Particle Count Display

Optics	Y/N
Condenser	Y/N
Saturator	Y/N
Laser	Y/N
Liquid Level	Y/N
Pump Flow	Y/N or Flashing

Computer Checks

CPC Count Running	Y/N
Concentration Reasonable	Y/N
PC Time Correct	Y/N
Disk Free Space (D Drive)	Y/N

Butanol Checks

Butanol within Range	Y/N
Butanol Lines Purged	Y/N

Comments and Request for Consumables

A1.5 Scanning Mobility Particle Sizer

Local Site Operator Procedure Manual

Airborne Particulate Concentrations and Numbers in the UK

Operation of Scanning Mobility Particle Sizer

Procedure: DEFRA Particles 003
Issue 1.2 September 2005

National Physical Laboratory

PREFACE

This simplified manual sets out the procedures to be followed by the Local Site Operator in carrying out the tasks necessary to support the operation of the TSI Scanning Mobility Particle Sizer at sites in the UK. In particular it details the two-weekly routine maintenance procedures, which ensure that measured data are of acceptable quality, but also covers some basic non-routine procedures and actions, which may be useful in the event of equipment problems.

This procedure has been prepared by NPL, with advice from King's College London's Environmental Research Group.

SECTION

1. INTRODUCTION

The SMPS spectrometer is a system that measures the size distribution of aerosols in the size range from 5 nm to 1000 nm. The Model 3934 SMPS system measures the number size distribution of particles using an electrical mobility detection technique. The SMPS uses a bipolar charger in the Electrostatic Classifier to charge the particles to a known charge distribution. The particles are then classified according to their ability to traverse an electrical field, and counted with a Condensation Particle Counter (CPC).

The Department for Environment, Food and Rural Affairs' (Defra's) UK Airborne Particulate Concentrations and Numbers in the United Kingdom Network currently comprises 10 sites, located at rural, urban and kerbside locations throughout the UK. NPL has been contracted by DEFRA to undertake this work as project manager. The Environmental Research Group (ERG), Kings College London, will perform day to day network management and analytical procedures.

ERG is the first point of contact for LSOs, contact details can be found at the back of this manual. As the Central Management and Control Unit, ERG will dispatch consumables to LSOs, advise about instrument malfunctions and other issues. Samples and checklists, where applicable, should be returned to ERG. Data retrieval will be carried out remotely by ERG.

Where equipment malfunction occurs, ERG should be notified within 24-hours of site attendance that the monitor is not operating.

SMPS instruments contain a radioactive source. This should NOT be removed from the instrument. Should you suspect the source has been tampered with, please call ERG <u>IMMEDIATELY</u>.

Butanol is flammable. Butanol is also potentially toxic if inhaled. Use butanol only in a well-ventilated area. If you smell butanol and develop a headache, or feel faint or nauseous, leave the area at once. Ventilate the area before returning.

2. START UP

If you are required to startup the equipment, please contact ERG for advice.

2.1 Hardware Start Up

Power should be applied to the Condensation Particle Counter (CPC) and the Electrostatic Classifier.

The analog output must be set to HOST in any CPC.

On the Classifier, the External Program switch must be "up" to allow the Classifier voltage to be controlled by the CPC, and the Analyzer Voltage control must be set to 0 volts.

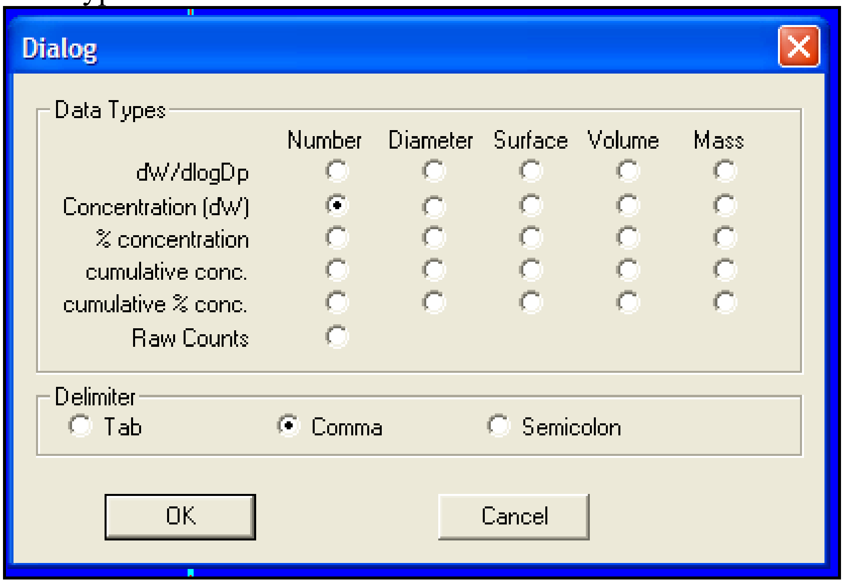
The flow rates used in the Electrostatic Classifier are:

Monodisperse Aerosol	0.5 l/min
Polydisperse Aerosol	0.5 l/min
Sheath Air	5.0 l/min
Excess Air	5.0 l/min

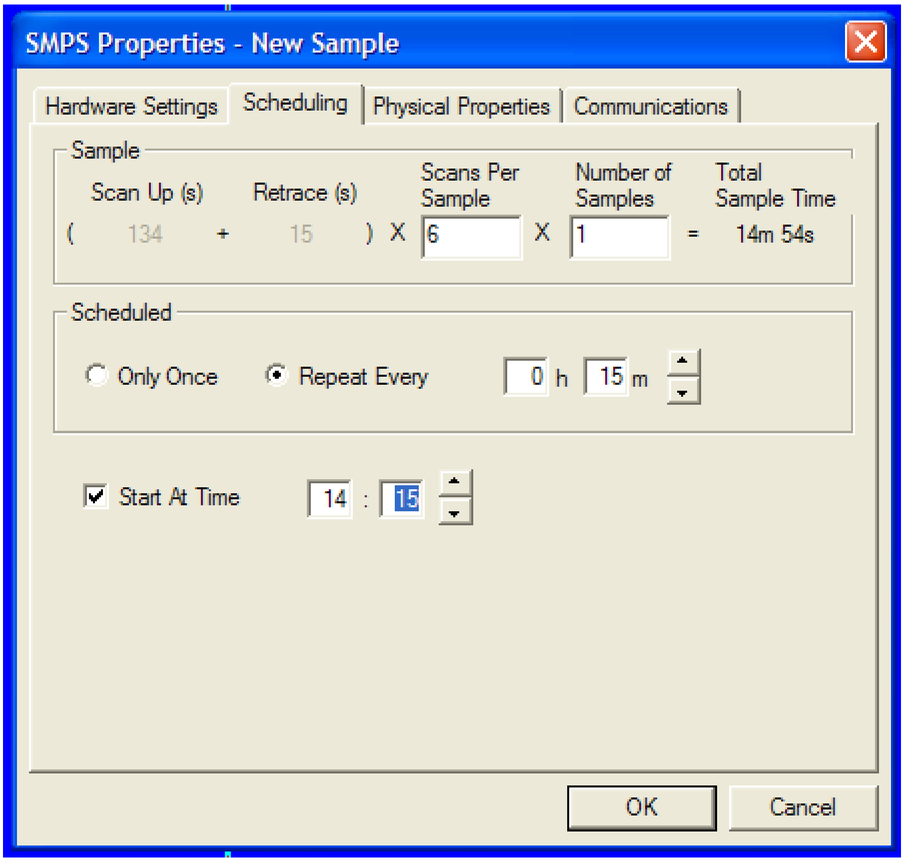
The flows are monitored using a mass flow meter and are selected and displayed on the front panel of the Classifier. These may be altered if necessary. Refer to the TSI Manual, 'Setting Flowrates' (4.5).

2.2 AIM Software Start Up

Open the Aerosol Instrument Manager software from shortcut on desktop.
Open a new file and save in C:\SMPS directory as SiteName_Date.s80, where SiteName is either Bloomsbury, Harwell of Marylebone) and Date is the 8-figure date (eg. 27072005).
It may be necessary to verify the Com Port setting. This can be found under Start, Control Panel. Contact ERG for advice.
Data needs to be exported to a csv file for collection. Select Run, Auto Export to File, then select data type as number and comma delimiter as shown below. Then click OK.



Before you begin sampling, review the run scheduling by selecting Run, Properties, Scheduling tab. Set Scheduled to repeat every 15 minutes. Tick the Start At Time box and set to time to the next 15 minute period (i.e 00, 15, 30 or 45). Then click OK. An example of this setup is shown below. Once set, the scheduled start time will be shown in the bottom right hand corner of the AIM software screen.



Note: To stop data collection after the current sample finishes select Run|Finish Current Sample. To abort the current run select Run|Abort Current Sample, the data collected for the current incomplete sample is discarded.

3. ROUTINE CHECKS AND PROCEDURES

All routine checks should be completed in conjunction with the supplied proforma. Any comments / issues should be noted on the proforma, in case of urgent issues please contact the ERG Duty Officer immediately. The proforma should be returned to ERG by email or fax within 48 hours using the contact details supplied at the end of this manual.

3.1 Summary

Electrostatic Classifier	**Fortnightly**
Condensation Particle Counter	**Fortnightly**
Butanol Check	**Fortnightly**
Computer Check	**Fortnightly**
Sample Flow	**Fortnightly**
Adjustments	**As required**
Check Consumables	**Fortnightly**
Complete Proforma	**Fortnightly**

3.2 Electrostatic Classifier Checks

Check that the SMPS is running and there are no obvious problems or safety hazards.
Set the METER RANGE switch to 10V and record the cyclone inlet flow rate indicated by the rotameter connected to the main inlet.
Rotate the METER SELECTION switch to EXCESS AIR. Wait for the reading to settle for about 30 seconds before recording.
Record ΔP from the magnehelic gauge.
Rotate the METER SELECTION switch to MONODISPERSE AEROSOL. Wait for the reading to settle for about 30 seconds before recording.

Rotate the METER SELECTION switch to SHEATH AIR. Wait for the reading to settle for about 30 seconds before recording.
Return METER SELECTION switch to ANALYSER VOLTAGE and check that the EXTERNAL PROGRAM switch is in the UP position. Indicate on the checklist whether these values lie within the specified limits. **Do not make any adjustments at this stage.**

3.3 Condensation Particle Counter Checks

Check that the CPC is running, producing data and there are no obvious problems or safety hazards. Note any issues in the comments box on the proforma.
Record the following parameters: Flow, Optics Temperature, Condenser Temperature, Saturator Temperature and Detector Volts. Access by pressing SHIFT and then press DISPLAY to scroll through. Return to particle counts by pressing SHIFT.

Check all status lamps are on.
Note: It is necessary to switch the pump off before recording the detector volts. Please remember to switch it back on again immediately afterwards.

3.4 Computer Checks

Log On - You may need to log onto the laptop. Select the Webaccess account and type the following password:

tanstaafl

Unless the system is in its 'wait' period between samples the AIM software graphical display should be updating in real time and the 'Upscan' or 'Downscan' times will be incrementing. These times are displayed at the top left of the screen under the main menu.
Record the laptop time on the proforma. Check that it is within five minutes of GMT. If more than five out then adjust by double clicking on the time and adjusting, record any changes made on the proforma.

3.5 Butanol Check

Check the level of Butanol in the fill bottle and record on the proforma. Top up if necessary. Contact ERG at least two weeks before you expect to run out of Butanol. The Butanol should be drained once every fortnight. Ensure that the drain bottle is connected to the drain port on the rear of the CPC and is below the level of the CPC. Turn off the pump by pressing PUMP and disconnect the butanol from the 'fill' port at the back of the CPC. Press SHIFT/DRAIN and allow the Butanol to drain for about one minute. Reconnect the fill bottle. Press SHIFT/DRAIN to return to normal operation and restart the pump.
Note: Dispose of waste butanol properly. Contact ERG if you are unable to do so.

3.6 Sample Flow Check

Undo the Swagelok nut connecting the sample inlet to the impactor assembly. Connect an external flow meter to the inlet of the impactor orifice and record sample flow on the checklist.
The impactor should be cleaned and greased on every visit. Undo the Swagelok coupling from the orifice then unscrew the orifice from the impactor body. Remove carbon deposits with a tissue and clear the orifice using acetone, air and /or the ultrasonic bath. Apply a small amount of grease to the impactor. Replace and reconnect the flow meter to the inlet of the impactor orifice and record the sample flow on the proforma.

3.7 Flow Adjustments

Make any adjustments if necessary then repeat all checks.

Step	Reading	Adjust Using
1	Excess Air	Excess Air Valve
2	Magnahelic	Sheath Air
3	Monodisperse Aerosol	External Valve
4	Excess Air	Excess Air Valve

Repeat steps 2, 3 and 4 to fine-tune flows

Adjustment of the SHEATH AIR valve to obtain the required sample flow may result in the sheath air being outside the limits. This is acceptable if the other flow rates are within their limits.
Contact ERG immediately if any of the parameters are outside the specified limits and cannot be adjusted satisfactorily.

3.8 Check Consumables.

Contact ERG to request more consumables, giving at least 2 weeks notice for butanol.

4 EMERGENCY CALL-OUT

In an emergency, the Equipment Service Unit will attend the site within 48 hours. LSOs may be required to carry out instructions from the ESU or from ERG to determine the cause of the fault. In the first instance please contact the duty officer at ERG.

5 CONTACT DETAILS

ERG:

The Duty Officer should be the first point of contact for network operational matters. The Duty Officer is available during normal working hours.

Phone: 020 7848 4022
Fax: 0207848 4045
Email: airquality@erg.kcl.ac.uk

Duty Officer
Environmental Research Group
Kings College London
Franklin-Wilkins Building
150 Stamford Street
London
SE1 9NH

The Duty Officer can also be contacted by email during weekends and on public holidays.

NPL:

For information regarding contracts and other non-operational matters, please contact Rachel Yardley or David Butterfield.

Phone: 020 8943 6852

Email:Rachel.Yardley@npl.co.uk

Phone: 020 8943 6391

Email:David.Butterfield@npl.co.uk

6. EQUIPMENT AND CONSUMABLES

The following will be provided for maintenance of the SMPS:

Butan-1-ol

Drain and fill bottles

Gloves if requested

Sonicating bath or air in a can or acetone

Grease

Cleaning buds or paper wipes

Flow Meter

7. PROFORMA

If you have access to a PC, please use the electronic proforma. If this is not possible, please photocopy the following page and return to ERG by fax.

DEFRA AIRBORNE PARTICULATE CONCENTRATIONS AND NUMBERS NETWORK

SCANNING MOBILITY PARTICLE SIZER

Site ………………………………….
Date ………………………………….
Operator ………………………………….
Start Time ………………………………….
End Time ………………………………….

Electrostatic Classifier Checks

Acceptable values vary between instruments and the values for one instrument can change over time. Contact ERG for up-to-date target values.

	Pre Check	Post Check	Within Range
METER RANGE set to 10 V	………………	………………	
Cyclone Inlet	………………	………………	Y/N
Excess Air	………………	………………	Y/N
Delta P	………………	………………	Y/N
Monodisperse Aerosol	………………	………………	Y/N
Sheath Air	………………	………………	Y/N
METER SELECTION set to ANALYSER VOLTAGE	………………	………………	
EXTERNAL PROGRAM set to UP	………………	………………	

CPC Checks

Press SHIFT, then STATUS / DISPLAY to scroll through diagnostics

		Criteria
Flow	....	5 +/- 0.5 ml
Optics Temperature	....	36C
Condenser Temperature	....	10C
Saturator Temperature	....	35C
Detector Volts	....	

Press SHIFT to return to Particle Count Display

Optics	Y/N
Condenser	Y/N
Saturator	Y/N
Laser	Y/N
Liquid Level	Y/N
Pump Flow	Y/N or Flashing

Computer Checks

AIM Software Running	Y/N
Concentration Reasonable	Y/N
PC Time Correct	Y/N
Disk Free Space (D Drive)	Y/N

Butanol Checks

Butanol within Range	Y/N
Butanol Lines Purged	Y/N

Sample Flow Check

	Pre Orifice Clean	Post Orifice Clean	Notes / Limits
Measured Sample Flow	………………..	………………..	500 (+/-10) ml/min
Orifice Greased		Y/N	

Comments and Request for Consumables