A SITE OPERATIONAL PROCEDURES

A.1 Introduction

A major factor in ensuring high quality from the Automatic Urban and Rural Network will be the regular visits to each monitoring site carried out by locally based personnel. These site visits will allow the following functions to be undertaken:

(1) Precalibration checks;

(2) Changing the particulate monitor filter;

(3) Calibration of analysers;

(4) Postcalibration checks, safety and security inspection.

Together with these routine functions, there will be instances when non-routine site visits will be necessary, in the event of apparent instrument or system malfunction.

Local site operators will be trained in all aspects of normal equipment operation by the CMCU, and in the relevant calibration procedures by the QA/QC Unit. Operators must retain copies of instrument manuals at each site, and are required to familiarise themselves with normal operating principles and characteristics of the instrumentation.

Calibration procedures differ from instrument to instrument, but the basic principle is common to all analyser types, with the exception of the particulate analyser. As described in Chapter 10, routine calibrations will take the form of a simple two-point calibration. More detailed instrument tests will be undertaken by QA/QC Unit personnel, in combination with the 6 monthly instrument intercalibration and servicing exercises (see Chapter 13).

Each analyser must be calibrated exactly *as found*. In this way, any instrumental drifts which may have occurred since the previous calibration will be exactly quantified, with there being no possibility that changes in response have been caused by any operator action.

Acting only on advice from the CMCU, instrument adjustments may be performed to optimise analyser sensitivity. If such adjustments are found to be necessary, the instrument will be recalibrated after a suitable initial stabilisation period typically 15 minutes, so allowing the production of provisional revised calibration factors. However, full stabilisation of the instrument may take several hours and hence, ideally the instrument should be recalibrated after a further 24 hours. The CMCU will advise on this. It is not anticipated that instrument adjustments of this sort will be required frequently.

The following sections of the manual describe step-by-step procedures which must be followed during site visits. It is essential that the procedures are followed as written, for both routine and non-routine site visits, to ensure that reliable and accurate air quality measurements are made. However, the sequence in which zero and span calibrations are performed is not critical.

A.2 Preparation

1. Upon arrival at the site, check the pollutant levels on the front panel of each analyser and the chart trace to see if an episode is occurring i.e. pollution levels during the last hour are above, or close to, the trigger values as discussed in Section 10.6 (O_3 >~70 ppb, NO_2 >~75 ppb, SO_2 >~90 ppb and CO >~10 ppm). If an episode is occurring phone CMCU before proceeding any further.

2. Take a new set of check and calibration sheets and enter Site, Date and Operator and Start Time.

3. Ensure the Operational Manual is to hand, and follow the instructions carefully.

4. Ensure that the toolkit supplied with the site is complete.

A.3 Precalibration Checks

In this section, a number of initial visible checks are made on the equipment. Some checks require a tick and some require a value to be recorded on the precalibration sheet. Complete all the checks for all the analysers and ancillary equipment. When all checks are complete, inform the CMCU if any are not correct, before proceeding with the calibration.

A.3.1 CO Analyser

The Rotork Analysis Model 416 CO analyser has a split numeric display which shows the current CO concentration and the instrument running range, two flowmeters, a range of instrument diagnostic LEDs and a series of control buttons on the front panel. If a fault condition is detected, a fault alarm will be displayed, replacing the running range display.

1. In normal operation, the instrument will display CO concentration in ppm and the current operating range of the analyser. The LED above "MEAS" (for measure) will be illuminated. All other LEDs will be off. Check the display and record the current readings on the precalibration checklist.

2. If a fault message is displayed on the front panel, record the code on the checklist, and press the "ENT" button. It is possible that a number of other error messages will appear after the "ENT" button is pressed. In this event, record all the codes displayed, pressing "ENT" each time to cycle through the messages. If the instrument faults have been rectified, the error messages will not reappear, and will be replaced by the running range. If, however, the fault is still occurring, the error code will be redisplayed after a short time.

3. If the "MEAS" LED is not displayed, press the "FUNC" button to cycle through the LEDs until the "MEAS" LED is lit. The instrument continues to measure CO even if the light is off, but the concentrations are not displayed on the front panel.

4. The two flowmeter balls should be within the white area of the range. Check and record the results on the checklist.

A.3.2 NO_X Analyser

The Rotork Analysis Model 447 NO_X analyser has a single line numeric display, showing concentrations of NO, NO_2, and NOx, plus a flashing indicator for the converter, a vacuum meter and a range of switches controlling the instrument on the front panel.

1. In normal operation, the instrument will display NO, NO_2 and NOx concentrations in the main display. The converter symbol will also flash on and off periodically. Check these and record on the precalibration checklist.

2. A number of the switches on the front panel will have a small LED glowing on. Specifically, the LED's under "2", "OZONE", "PUMP" and "SAMPLE" should all be glowing. Check and record on the precalibration checklist.

3. The three calibration pots on the bottom right hand corner of the analyser are used by the ESU to adjust the instrument sensitivity during services. The pots should not be adjusted by the LSO unless instructed to do so by the CMCU. The number displayed on each pot should be noted on the precalibration checklist.

A.3.3 SO_2 Analyser

The Rotork Analysis Model 477 SO_2 analyser has an alphanumeric display, showing the concentration and name of the pollutant measured, 3 diagnostic LED display lights, labelled "ERROR", "SYSTEM", and "STATUS", a sample flow meter, a vacuum meter and a range of switches controlling the instrument, located on the front panel.

1. In normal operation, the instrument will display SO_2 concentrations in the main display. The sample flowmeter will display a flow of 1.5 litres per minute and the chamber vacuum gauge will read a pressure of 19 inches of mercury. Check these and record the results on the precalibration checklist.

2. The diagnostic LEDs provide an indication of the performance of the analyser. The SYSTEM LED will be on, the STATUS LED may flash on periodically, and the ERROR LED should be off. Check these and record on the precalibration checklist.

3. The three calibration adjusters on the bottom right hand corner of the analyser are used by the ESU to adjust the instrument sensitivity during services. The pots should not be adjusted by the LSO unless instructed to do so by the CMCU. The number displayed on each pot should be noted on the precalibration checklist.

4. The LEDs above the rows of three buttons on the front panel; ZERO, SPAN, (no label), OPTIC TEST and DISPLAY STEP, should all be off, while the AVG LED should be on. Check these and record the findings on the precalibration checklist.

A.3.4 Ozone Analyser

The Rotork Analysis Model 427 O_3 analyser has an alphanumeric display, showing the concentration and name of the pollutant monitored, 3 diagnostic LED display lights; "ERROR", "SYSTEM", and "STATUS", a sample flow meter and a range of switches controlling the instrument, located on the front panel.

1. In normal operation, the instrument will display O_3 concentrations in the main display. The sample flowmeter will display a flow of 1.5 litres per minute. Check these and record the results on the precalibration checklist.

2. The diagnostic LEDs provide an indication of the performance of the analyser. The SYSTEM LED will be on, the STATUS LED may flash on periodically, and the ERROR LED should be off. Check these and record on the precalibration checklist.

3. The two calibration adjusters on the bottom right hand corner, and the output adjuster in the middle of the analyser, are used by the ESU to adjust the instrument sensitivity during services. The pots should not be adjusted by the LSO unless instructed to do so by the CMCU. The number displayed on each pot should be noted on the precalibration checklist.

4. The LEDs above the three buttons on the front panel, labelled CAL, O_3, and VARIABLE, should all be off. The LEDs above the P/T and AVG buttons should be on, while the LED above the DISPLAY STEP button should be off. Check these and record the findings on the precalibration checklist.

A.3.5 TEOM Particulate Monitor

The R & P TEOM instrument has a 4 line display screen, as shown in Figure D6 Appendix D. The top line is fixed, and displays, from left to right, current status code, current operating mode, percentage of filter lifetime used, current RS-232 mode and current time. This top line is fixed, whilst the other 3 lines of the display can be used to scroll through a list of 16 information lines displaying various parameters. Use the cursor keys on the keypad to scroll up and down.

Two lights marked "POWER" and "STATUS" are also visible on the front panel.

Record the following checks on the precalibration checklist.

1. In normal operation, the "POWER" switch will be on and the "STATUS" light off. Check these and record on the precalibration checklist.

2. Record current status code, current operating mode, percentage of filter lifetime used, current RS-232 mode and current time from the top line of the display.

3. Record the first three information lines in the appropriate space on the precalibration checklist.

4. Press ↓ to scroll through all information lines and record the information.

5. Press ↑ to return to the top of the information lines.

A.3.6 Air Sampling Manifold (where fitted)

Record the following checks on the precalibration checklist.

1. Check that the sample manifold is intact and shows no sign of possible leakage.

2. Check that the blower motor is operating by listening and feeling for vibration on the motor housing.

3. Check that the instrument sample inlet tubes are connected to the manifold and the sample inlet port at the back of the rack and that these connections are secure and leak-tight.

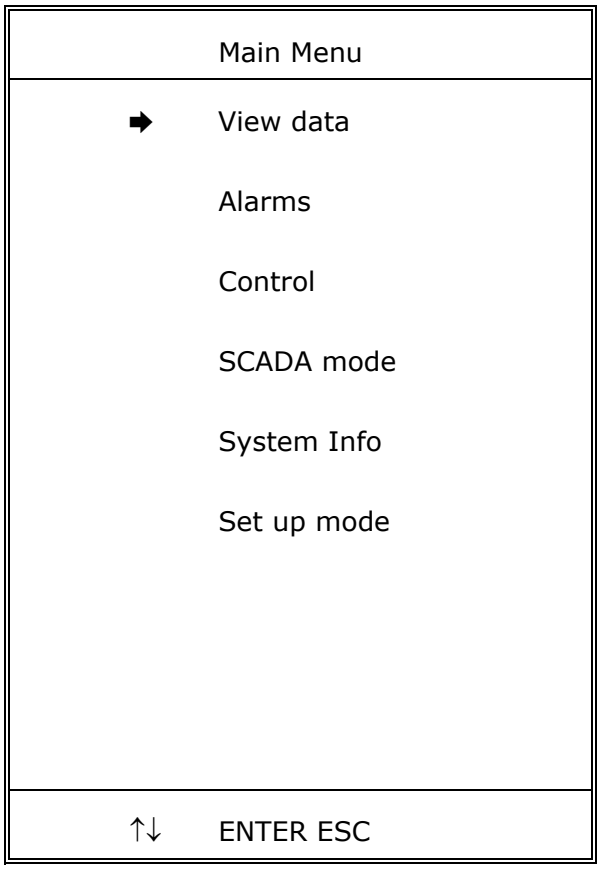
A.3.7 Modem (where fitted)

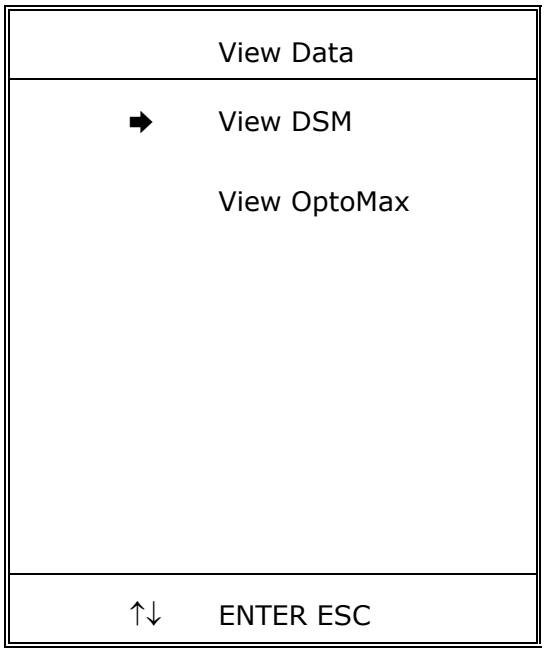
1. Check that the AA, TR and MR red lights are displayed on the modem and record on the precalibration checklist.

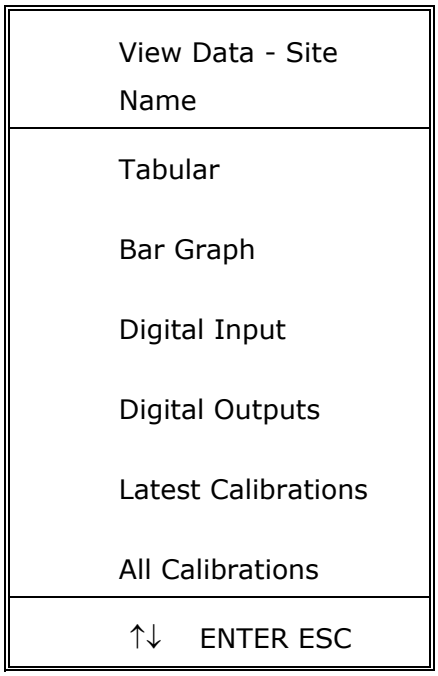
A.3.8 DSM 3260 Data Logger (where fitted)

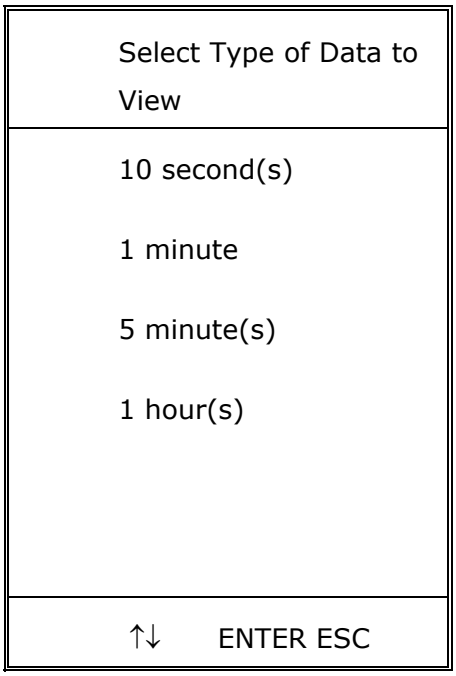
The illumination of the LCD display on the logger is automatically turned off after a period, therefore the screen will usually be dark. To use the logger to display analyser analogue voltages, press '**ENTER**' on the keypad. The screen will become brighter and display the channel outputs as shown on the following page.

If the display is not as shown, press **ESC** until the 'Main Menu' window appears and select **View data** using the arrow keys and **ENTER**. Select **View DSM** and press ENTER. Next select **Tabular** from the 'View Data - site name' window, or if preferred, select **Bar Graph**. Select **10 Seconds**, and press **ENTER.**


Main Menu
➡ View data
Alarms
Control
SCADA mode
System Info
Set up mode
↑↓ ENTER ESC


View Data
➡ View DSM
View OptoMax
↑↓ ENTER ESC


View Data - Site Name
Tabular
Bar Graph
Digital Input
Digital Outputs
Latest Calibrations
All Calibrations
↑↓ ENTER ESC


Select Type of Data to View
10 second(s)
1 minute
5 minute(s)
1 hour(s)
↑↓ ENTER ESC

DSM 3260 12/7/91
10:40:10

Name	Value	Status	Units	Range
1 NO_x	35	ok	mVolts	0/5000
2 NO	10	ok	mVolts	0/5000
3 NO_2	25	ok	mVolts	0/5000
4 SO_2	8	ok	mVolts	0/5000
5 CO	2	ok	mVolts	0/1000
6 O_3	60	ok	mVolts	0/5000
7 Tconc Dust	32	ok	mVolts	0.00/10.00
8 Tload FLPR	65	ok	%	0/100
9 RTemp	25	ok	DEG	0/100
10 RHumid	60	ok	%	0/100
11 CO Span	1.9	ok	Lit	0.0/2.0

The displayed voltages will automatically update every 10 seconds.

Perform the following logger checks and record the results on the precalibration check list.

1. The logger clock is displayed in the upper right hand corner of the screen. This clock is automatically updated to agree with the network central computer clock, each time data is collected from the site by telemetry. Check that the date and time displayed are correct to within 5 minutes of the current time GMT. Note that the network operates on GMT throughout the year and the clocks are not adjusted for BST.

2. Check that the time displayed on the small LCD above the data cartridge agrees with the screen display.

3. Check that the 'reading 10 second values' message appears on the display followed by an update of the values column.

4. Check that all the Status column entries are 'ok'.

A.3.9 Chart Recorder

Perform the following visual check and record on the precalibration checklist.

1. Check that the RCD light in the top left hand corner of the display is on.

2. Check that the 6 traces are clearly visible on the chart paper.

3. Inspect the chart paper to see that it is not jammed.

4. If the BAT light appears in the top left hand corner of the display then the battery back-up is low. Contact CMCU as soon as possible.

A.3.10 Zero Air Generator

Check the condition of the scrubbers, two of which are self indicating; silica gel turns from orange to clear and purafil from purple to brown as it becomes exhausted. A diagram of the zero air generator is shown in Figure D5.

1. Check that at least 25% of the silica gel is still orange. If less than 25% of the silica gel is orange proceed to section A.3.11 - Changing the Silica Gel.

2. Check that at least 25% of the purafil is still purple. If less than 25% of the purafil is purple, note on the calibration record sheet, but continue with calibration.

3. Check that all connections are secure and tight.

A.3.11 Changing the Silica Gel

If it is necessary to change the silica gel proceed as follows.

NOTE: If no silica gel is available, proceed with the full calibration of all analysers as normal, noting the fact that the silica gel needs replacing on the record sheet. Inefficient silica gel will only affect the zero on the CO analyser.

1. Remove the canister containing the silica gel from the zero air assembly. Use two spanners to remove the swagelock compression fittings from the canister.

2. Remove the metal screw top, spring, metal and fabric spacer from the canister.

3. Empty the spent silica gel into a suitable container. The spent silica gel can be regenerated in an oven by the LSO or returned to **netcen** for regeneration. Take care not to breathe in any silica gel dust, as it is harmful.

4. Refill the canister with the fresh silica gel retained on site.

5. The packing order of the components should be as shown in Figure D5.

6. Replace the metal and fabric spacers. Replace the spring. Ensure that the rubber "O" ring is situated in the screw on top of the canister. Screw the metal top of the canister on to the canister.

7. Using two spanners, reconnect the swagelock compression fittings onto the canister. Take care not to crack the sides of the plastic canister by over-tightening the fittings.

8. Mark the date on the "Date of Change" sticker on the silica gel canister.

9. Reassemble the zero air generator assembly.

A.3.12 Completion of Precalibration Checks

If any of the above checks are not correct, inform CMCU before proceeding with calibration.

If all correct, proceed to section A.4.

A.4 TEOM Particulate Monitor

The TEOM particulate monitor filter cartridge must be changed either every 4 weeks or when the "percentage of filter lifetime used", as shown on the top line of the instrument display is 80% or greater. It is recommended that the TEOM filter cartridge box is stored in the sensor unit of the TEOM analyser so they are pre-conditioned before they are changed with existing filters.

Whenever the filter cartridge is changed, the PM_{10} head must be cleaned as detailed below. Since the analyser requires at least one hour to stabilise after filter cartridge changing, it is recommended that this operation be undertaken before the calibration of the gas analysers. Whenever the filter is changed, complete the TEOM Filter Cartridge record sheet.

A.4.1 Cleaning the PM_{10} Head

The PM_{10} head is located on the sample inlet tube above the roof of the monitoring station. Use the ladder, with due regard to personal safety, to gain access to the cabinet roof. Extra care should be taken if raining as the roof of the cabinet may be slippery when wet.

The PM_{10} inlet needs to be cleaned each time the TEOM filter cartridge is changed to ensure optimal performance. The cleaning materials required are a small brush, lint free tissues, cotton buds, Decon 90 (1% in H_2O), silicon grease, and distilled water. All components are to be cleaned by soaking Decon 90 on lint-free tissues or cotton buds as appropriate. The component should then be rinsed with distilled water to remove any Decon 90 and wiped dry with a lint-free tissue.

A.4.2 Removing the PM_{10} Head

1. Switch the TEOM "out of service" switch to ON. The control will show a flashing red indicator when activated.

2. Carefully lift the complete PM_{10} head assembly from the TEOM inlet tube.

3. Protect the inlet tube so that rain or snow cannot enter at any time whilst the head is removed, and take the head inside the monitoring cabinet.

4. Separate the upper and lower inlet halves by unscrewing (counter-clockwise) the acceleration assembly from the collector assembly (see Fig. D7).

A.4.3 Cleaning the Acceleration Assembly

1. Mark the upper and lower plates of the assembly with a pencil so that the unit can be correctly aligned on reassembly.

2. Unscrew the four Philips screws from the top plate and remove the top plate and four spacers.

3. Clean the top plate, deflector cone, insect screen, internal walls and the underside plate.

4. Inspect the large diameter o-ring for wear and replace if necessary. Wipe any grease off with a tissue, and apply a thin coating of fresh silicon grease to the o-ring and the aluminium threads.

5. Careful reassemble, using the pencil marks to align the top and bottom plates.

A.4.4 Cleaning the Collector Assembly

1. Clean the walls, the three vent tubes and the base of the assembly with a lint-free cloth soaked in Decon 90. Rinse with distilled water.

2. Use cotton buds and Decon 90 to clean the three vent tubes, base of the assembly and weep hole in the collector plate where the moisture runs out to the moisture trap. Rinse with distilled water.

3. Disconnect rain jar assembly from lower collector plate assembly. Clean inside brass tube with cotton buds and Decon 90. Rinse with distilled water.

4. Remove the rain jar and clean. For units with a cork sealing ring inside the cap of the jar, put a thin coating of silicon grease on the gasket and install the jar. If the sealing gasket is neoprene, no silicon grease is required.

5. Reconnect rain jar assembly to lower collector assembly. Ensure rain jar is sitting vertically.

6. Inspect the two inlet tube o-rings for wear and replace if necessary. Wipe off any grease present, and apply a thin coating of fresh silicon grease to the o-rings.

7. Clean the internal threads of the assembly with Decon 90 on a lint-free tissue.

A.4.5 Replacing the Head

1. Screw the Acceleration and Collector assemblies together until the threads are hand tight. DO NOT OVER-TIGHTEN.

2. Place the complete assembly back onto the TEOM inlet tube.

A.4.6 Filter Cartridge Exchange Procedure

1. Refer to Figs D8 and D9 when following the instructions for filter exchange. It is recommended that the TEOM filter cartridge box is stored in the sensor unit of the TEOM analyser so they are pre-conditioned before changing.

2. Check that the TEOM 'out of service' switch is ON. The control will show a flashing red indicator when activated.

3. Open the door of the TEOM sensor unit.

4. Carefully lift the handle of the mass transducer to swing the transducer into its filter changing position and expose the filter.

5. Carefully insert the filter exchange tool under the filter cartridge so that the filter disk is between the fork and the upper plate of the tool (with the hub of the filter between the tines of the lower form). Gently lift the

filter from the tapered element with a straight pull - DO NOT TWIST OR PULL SIDEWAYS.

6. Discard the exposed cartridge and wipe clean the exchange tool with a tissue.

7. Use the exchange tool to remove a new cartridge from the box - DO NOT TOUCH THE FILTER WITH YOUR FINGERS. Note that the box of new filters should be stored inside the TEOM sensor unit, to maintain them at a constant temperature.

8. Hold the new filter in line with the tapered element and lightly insert the hub of the filter onto the tip of the tapered element. Apply a downward pressure to set the filter firmly in place and then carefully retract the exchange tool. Problems with excessive response noise may be experienced if the filter is not seated correctly and firmly on the tip of the tapered element. The filter should, therefore, be positioned with particular care.

9. Gently move the horizontal handle downwards to close the mass transducer; allow the springs to pull it closed for the last centimetre.

10. Close the door of the TEOM sensor unit.

11. After 5 minutes, open the sensor unit and mass transducer again and push down on the filter with the base of the exchange tool. This is to ensure that no movement of the cartridge has occurred during heating of the transducer.

12. Close the door of the TEOM sensor unit.

13. Press <F1> on the TEOM control unit and allow one hour for system to reset.

14. Switch the TEOM 'out of service' switch to 'off'.

15. After one hour check that TEOM noise level on the chart recorder trace is within 60 $\mu g/m^3$ (~7 vertical chart divisions). If greater than this, attempt to re-seat the filter. If still excessively noisy, contact CMCU.

A.5 Analyser Calibration Procedure

Results of the calibration will be taken from both the data logger display and the instrument's display for recording on the calibration record sheets. The on-site chart recorder is to be used to determine that the instrument has fully stabilized in its response to the gas sample being introduced at its inlet.

When closing the gas cylinder valves, care should be taken not to overtighten the valves on the gas regulator. Overtightening can damage the needle valve mechanism resulting in the outlet valve failing to open. The main valve on the top of each cylinder should, however, be tightly closed to avoid venting the cylinder.

In order to have a full and complete set of instructions for each analyser, instructions for opening gas cylinder valves are contained within the calibration procedure for each analyser. However, when all analysers are being calibrated, it will be advantageous for all cylinders to be opened at the same time, after ensuring that the needle valves in the cabinet are closed. All cylinders can then be closed at the same time at the end of the calibration session.

A.5.1 Instructions for Changing Chart Speed Prior to Calibrations

1. Open the chart recorder door to allow access to programming controls.

2. Press and hold the "MENU" key for 3 seconds. The display should now show either:

   ALArm CHArt or CLoCK.

   Use the ↑ and ↓ keys until the display shows CHArt and press the ↵ key.

3. The display should now show either "SPd_1" or "SPd_2". Select SPd_1 using the ↑ and ↓ keys and press the ↵ key.

4. The display should now be displaying "10", which is the chart speed in mm/hour. Press the ↑ key until the display shows "60" and press the ↵ key. The display should return to the CHArt setting

5. Press and hold the "MENU" key for three seconds to return the display to normal channel cycling mode.

A.5.2 CO Analyser

The two point calibration of a carbon monoxide analyser will be carried out as follows:

1. Record the instrument number on the calibration record sheet.

2. Switch CO "out of service" control to on. The control will show a flashing red indicator when activated. This allows calibration data to be flagged.

3. (a) Uncap CO zero air inlet situated on the front of the instrument rack.

   (b) Turn the BLACK CO valve on the front panel from "SAMPLE" to "CAL".

4. Connect the zero air generator to this zero air inlet. Plug in or switch on zero air generator. Check that flow indicator shows a flow of 2.0 ± 0.1 litres per minute. Adjust if necessary using the tap on the output of the zero air generator.

5. Allow the analyser to stabilise on zero air for a period of not less than 10 minutes. Verify that stabilisation has occurred on the chart recorder, i.e. the CO recorder trace does not vary by more than 1 scale division in one centimetre along the time axis. The CO trace is channel number 4 and is coloured blue.

6. Record three consecutive CO readings from the data-logger and instrument display, i.e. after 3 ten second updates on the data logger display.

7. Switch off the zero air generator and disconnect it from the zero air port. Replace the cap on the zero air inlet and tighten until finger-tight. Then, with a spanner, tighten further by one quarter turn.

8. Open CO in air cylinder main valve by turning it fully anticlockwise. Read cylinder pressure from right hand dial and cylinder number from tag on cylinder, and enter these on the calibration record. Do not attempt to use the cylinder if the pressure indicated is less than 300 psi. In this event contact CMCU.

9. Adjust the regulator secondary pressure to 15 psi, as read from left hand dial, by turning regulator primary (right hand) valve. Slowly open the regulator outlet (left hand) valve fully.

10. By gradually turning the CO calibration gas control valve inside the hut, adjust the flow through the CO span flow meter to produce 1.2 ± 0.1 litres per minute.

11. Allow the analyser to stabilise on this sample for a period of not less than 10 minutes. Ensure that the flow measured by the flow meter remains stable during this time. Adjust the flow, if necessary, to 1.2 litres per minute. Verify that stabilisation has taken place by examining the chart recorder, i.e. the CO recorder trace does not vary by more than 1 scale division in one centimetre along the time axis.

12. Record three consecutive CO readings from the data logger and the instrument display. The signal should show a large deflection from the zero point previously obtained.

13. Turn the BLACK valve from "CAL" to "SAMPLE".

14. In the following order, fully close the CO calibration gas control valve (in hut), the regulator outlet valve (do not overtighten), the main cylinder valve (tightly) and the primary regulator valve. This traps gas in the regulator, thus ensuring a positive pressure and hence, no ingress of ambient air. Note that the pressure regulator dials should remain at their previous setting, if a marked decrease is observed there is a leak in the system, and the CMCU should be informed.

15. By considering previous calibration results and the chart recorder trace obtained from the calibration just performed, satisfy yourself that the calibration has proceeded successfully. The zero value should not differ by more than 5 mV (~0.25 ppm) from the previous calibration. The span calibration value should not differ by more than 5% from that obtained during the previous calibration. If in doubt, repeat the relevant procedure. If the results of this are also unsatisfactory, contact the CMCU.

16. Change the CO analyser sample inlet filter, following the instructions given in part A.5.6 of this section.

17. Switch the CO "out-of-service" control to "off".

A.5.3 NO_X Analyser

The two-point calibration of the nitrogen oxides analyser will be carried out as follows:

1. Record the instrument number and instrument running range on the calibration record sheet.

2. Switch NO_X analyser "out of service" control to on. The control will show a flashing red indicator when turned on. This allows calibration data to be flagged.

3. Uncap NO_X zero air inlet situated on the front of the instrument rack.

4. Connect the zero air generator to the zero air inlet of the nitrogen oxides analyser. Plug in or switch on zero air generator. Check that flow indicator shows a flow of 2.0 ± 0.1 litres per minute. Adjust if necessary using the tap on the output of the zero air generator.

5. Allow the analyser to stabilise on zero air for a period of not less than 10 minutes. Verify that stabilisation has occurred on the chart recorder, i.e. the NO and NO_X recorder traces do not vary by more than 1 scale division in one centimetre along the time axis. The NO and NO_X traces are channels 2 and 1, and are coloured red and purple respectively.

6. Record three consecutive sets of NO_X, NO and NO_2 readings from the data-logger and instrument display, i.e. after 3 ten second updates on the data logger display.

7. Switch off the zero air generator and disconnect it from the zero air port. Replace the cap on the zero air inlet and tighten until finger-tight. Then, with a spanner, tighten further by one quarter turn.

8. Open NO in nitrogen cylinder main valve by turning it fully anticlockwise. Read cylinder pressure from right hand dial and cylinder number from tag on cylinder, and enter these on the calibration record. Do not attempt to use the cylinder if the pressure indicated is less than 300 psi. In this event contact CMCU.

9. Adjust the regulator secondary pressure to 15 psi, as read from left hand dial, by turning regulator primary (right hand) valve. Slowly open the regulator outlet (left hand) valve fully.

10. By gradually turning the NO calibration gas control valve inside the hut, adjust the flow through the flow meter to produce 1.7 (±0.1) litres per minute.

11. Allow the analyser to stabilise on this sample for a period of not less than 10 minutes. Ensure that the flow measured by the flow meter remains stable during this time. Adjust the flow, if necessary, to 1.7 litres per minute. Verify that stabilisation has taken place by examining the chart recorder, i.e. the NO and NO_X recorder traces do not vary by more than 1 scale division in one centimetre along the time axis.

12. Record three sets of NO_X, NO and NO_2 readings from the data logger and instrument display. The readings should be taken as close as possible to each other, but need not be in consecutive 10 sec periods if this is not possible. The NO signal should be similar to the NO_X signal, and show a large deflection from the zero point previously obtained. The NO_2 signal should be close to zero.

13. In the following order, fully close the NO calibration gas control valve (in hut), the regulator outlet valve (do not overtighten), the main cylinder valve (tightly) and the primary regulator valve. This traps gas in the regulator, thus ensuring a positive pressure and hence, no ingress of ambient air. Note that the pressure regulator dials should remain at their previous setting, if a marked decrease is observed there is a leak in the system, and the CMCU should be informed.

14. Turning now to the NO_2 in air calibration cylinder, repeat steps 8 to 11.

15. Record three sets of NO_X, NO and NO_2 readings from the data logger and instrument display. The readings should be taken as close as possible to each other, but need not be in consecutive 10 sec periods if this is not possible. Verify that the readings are reasonable: the NO signal should be close to that obtained while performing the zero calibration, with the NO_X and NO_2 signals showing approximately the same large deflection from this zero point.

16. Repeat step 13.

17. By considering previous calibration results and the chart recorder trace obtained from the calibration just performed, satisfy yourself that the calibration has proceeded successfully. The zero values on all channels should not differ by more than 10 mV (~4 ppb) from the previous calibration. The span calibration values should not differ by more than 5% from those obtained during the previous calibration. If in doubt, repeat the relevant procedure. If the results of this are also unsatisfactory, contact the CMCU.

18. Change the NO_X analyser sample inlet filter following the instructions given in part A.5.6 of this section.

19. Switch the NO_X "out-of-service" control to "off".

A.5.4 SO_2 Analyser

The two-point calibration of a sulphur dioxide analyser will be carried out as follows:

1. Record the instrument number on the calibration record sheet.

2. Switch SO_2 "out of service" control to "on". The control will show a flashing red indicator when turned on. This allows calibration data to be flagged.

3. Uncap SO_2 zero air inlet situated on the front of the instrument rack.

4. Connect the zero air generator to this zero air inlet. Plug in or switch on zero air generator. Check that flow indicator shows a flow of 2.0 ± 0.1 litres per minute. Adjust if necessary using the tap on the output of the zero air generator.

5. Allow the analyser to stabilise on zero air for a period of not less than 10 minutes. Verify that stabilisation has occurred on the chart recorder, i.e. the SO_2 recorder trace does not vary by more than 1 scale division in one centimetre along the time axis. The SO_2 trace is channel 3 and is coloured green.

6. Record three consecutive SO_2 readings from the data logger and instrument display, i.e. after 3 ten second updates on the data logger display.

7. Switch off the zero air generator and disconnect it from the zero air port. Replace the cap on the zero air inlet and tighten until finger-tight. Then with a spanner, tighten further by one quarter turn.

8. Open SO_2 in air cylinder main valve by turning it fully anticlockwise. Read cylinder pressure from right hand dial and cylinder number from tag on cylinder, and enter these on the calibration record. Do not attempt to use the cylinder if the pressure indicated is less than 300 psi. In this event contact CMCU.

9. Adjust the regulator secondary pressure to 15 psi, as read from left hand dial, by turning regulator primary (right hand) value. Slowly open the regulator outlet (left hand) valve fully.

10. By gradually turning the SO_2 calibration gas control valve inside the hut, adjust the flow through the flow meter to produce 1.7 (±0.1) litres per minute.

11. Allow the analyser to stabilise on this sample for a period of not less than 10 minutes. Ensure that the flow measured by the flow meter remains stable during this time. Adjust the flow, if necessary, to 1.7 litres per minute. Verify that stabilisation has taken place by examining the chart recorder, i.e. the SO_2 recorder trace does not vary by more than 1 scale division in one centimetre along the time axis.

12. Record three consecutive SO_2 readings from the data logger and instrument display. The signal should show a large deflection from the zero point previously obtained.

13. In the following order, fully close the SO_2 calibration gas control valve (in hut), the regulator outlet valve (do not overtighten), the main cylinder valve (tightly) and the primary regulator valve. This traps gas in the regulator, thus ensuring a positive pressure and hence, no ingress of ambient air. Note that the pressure regulator dials should remain at their previous setting, if a marked decrease is observed there is a leak in the system, and the CMCU should be informed.

14. By considering previous calibration results and the chart recorder trace obtained from the calibration just performed, satisfy yourself that the calibration has proceeded successfully. The zero value should not differ by more than 20 mV (~4 ppb) from the previous calibration. The span calibration value should not differ by more than 5% from that obtained during the previous calibration. If in doubt, repeat the relevant procedure. If the results of this are also unsatisfactory, contact the CMCU.

15. Change the SO_2 sample inlet filter, following the instructions given in part A.5.6 of this section.

16. Switch the SO_2 out-of-service control to "off".

A.5.5 Ozone Analyser

1. Record the instrument number on the calibration record sheet.

2. Switch the O_3 "out-of-service" control to on. The control will show a flashing red indicator when turned on. This allows calibration data to be flagged.

3. Press the "CAL" button to start the zero calibration. The LED above the button should light up.

4. Allow the analyser to stabilise on this sample for a period of not less than 10 minutes. Verify that stabilisation has occurred on the chart recorder, i.e. the O_3 recorder trace does not vary by more than 1 scale division in one centimetre along the time axis. The O_3 trace is channel 5 and is coloured brown.

5. Record three consecutive O_3 readings from the data logger and instrument display.

6. Press the "O_3" button to start the span calibration. Both the CAL and O_3 LEDs should now be on.

7. Allow the analyser to stabilise on this sample for a period of not less than 10 minutes. Verify that stabilisation has occurred on the chart recorder, i.e. the O_3 recorder trace does not vary by more than 1 scale division in one centimetre along the time axis.

8. (a) Record three consecutive O_3 readings from the data logger and instrument display

   (b) To exit "SPAN" mode, press both the "O_3" and the "CAL" buttons. Both LEDs should go out.

9. By considering previous calibration results and the chart recorder trace obtained from the calibration just performed, satisfy yourself that the calibration has proceeded successfully. The zero value should not differ by more than 20 mV (~2 ppb) from the previous calibration. The span calibration value should not differ by more than 5% from that obtained during the previous calibration. If in doubt, repeat the relevant

procedure. If the results of this are also unsatisfactory, contact the CMCU.

10. Change the O_3 analyser sample inlet filter, following the instructions given in part A.5.6 of this section.

11. Switch the O_3 "out-of-service" control to "off".

A.5.6 Changing Analyser Sample Inlet Filters

The analyser sample inlet filters situated on the front of the instrument rack will be changed on a fortnightly basis at all sites. In the event of a filter appearing badly soiled, the site operator shall inform the CMCU.

Detailed instructions for sample inlet filter changing:

1. Unscrew 2 brass nuts on filter holder.
2. Lift top cover of filter holder off bottom section.
3. Remove "O" ring and used filter.
4. Inspect filter for signs of excessive soiling and inspect "O" ring.
5. Take clean filter from box using the tweezers supplied and insert into base of filter holder.
6. Replace "O" ring in filter holder.
7. Replace top of filter holder and secure with brass nuts. The brass nuts should be hand tightened.
8. Check that teflon lines to filter holder are well secured.

A.5.7 Chart Recorder

A.5.7.1 Instructions for Changing Chart Speed After Calibration:

1. Open the chart recorder door to allow access to programming controls.

2. Press and hold the "MENU" key for 3 seconds. The display should now show either:

   ALArm CHArt or CLoCK.

   Use the ↑ and ↓ keys until the display shows CHArt and press the ↵ key.

3. The display should now show either "SPd_1" or "SPd_2". Select SPd_1 using the ↑ and ↓ keys and press the ↵ key.

4. The display should now be displaying "60", which is the chart speed in mm/hour. Press the ↓ key until the display shows "10" and press the ↵ key. The display should return to the CHArt setting

5. Press and hold the "MENU" key for three seconds to return the display to normal channel cycling mode.

   Check if the recorder chart paper needs to be replaced by following the instructions below.

A.5.7.2 Instructions on Inspecting Chart Paper Supply and Replacement of Paper

1. Open door of chart recorder.

2. Press "RCD" key. The small RCD light in the top left corner of the display should go off, indicating that the chart recorder is no longer in record mode.

3. Access the paper feed compartment by pressing the button located in the bottom centre of the chart cassette. The whole cassette will swing out, allowing its complete removal from the recorder.

4. Inspect the paper supply by pressing the two stoppers a the top of the chart and opening the lid. Ensure that there is sufficient paper to last for at least two weeks. This can be done by considering the amount of

paper used since the previous calibration. If supplies are adequate, go to step 9.

5. If supplies are inadequate, lift the two chart retaining clips at each end of the roller.

6. Remove entire chart from recorder.

7. Take a new 20 metre chart from its packing and inspect for possible damage which may cause the chart to jam at a later date. Place chart on a surface and unfold the top 4 sections of paper. Place the main body of the chart paper in the paper supply compartment, and allow the 4 unfolded sections to drape down into the paper collection compartment. These sections should then be neatly folded into the collection compartment.

8. Ensure that the chart feed sprockets protrude through the paper feed holes evenly on both sides of the paper. Replace the chart retaining clips into their original positions.

9. Locate the lugs on the side of the paper compartment into the recesses of the chart recorder, and swing the compartment into its original position. You will hear a distinct click indicating that it is now secure.

10. Press "FEED" control and verify that the paper is running smoothly through the feed mechanism.

11. Record the date, site name, time, and operator name on both the chart in the recorder, and any that may have been removed.

12. Press "RCD" key. The small yellow light in the top left corner of the display should go on, indicating that the YEW is in record mode.

Check and reset if required the date and time of the chart recorder to agree with the data logger, following the instructions given below:

A.5.7.3 Instructions for resetting date/time

1. Open the chart recorder door to allow access to programming controls.

2. Press and hold the "MENU" key for 3 seconds. The display should now show either:

   ALArm CHArt or CLoCK.

   Use the ↑ and ↓ keys until the display shows CLoCK and press the ↵ key.

3. The display should now show the current year, month and day, with the first number of the year flashing. Adjust if necessary using the ↑, ↓ and → keys and then press the ↵ key.

4. The display should now be displaying the time, which can be adjusted as earlier. When adjustments are complete, press the ↵ key. The display should return to the CLoCK setting

5. Press and hold the "MENU" key for three seconds to return the display to normal channel cycling mode.

A.5.8 Changing the daily CO cylinder.

The CO analyser uses a second cylinder to perform daily checks on the performance of the instrument. Because of this, it will be necessary for LSOs to replace this cylinder periodically and check to make sure the flow rates are correctly set.

1. If not already fitted, connect the regulator to the cylinder using the spanner provided. Ensure that the regulator is tightly fitted to the cylinder, and that the teflon tubing is tightly connected to the analyser.

2. Turn the CO out of service control to on. The control will show a flashing red indicator when activated, allowing data to be flagged.

3. Open the cylinder main valve by turning it fully anticlockwise. Check that there are no leaks from around the reguator seals, using the SNOOP provided. Tighten the regulator, if necessary. Record the cylinder pressure from the right hand dial.

4. Adjust the regulator secondary pressure to 15 psi, as read from the left hand dial, by turning the regulator primary (right hand) valve. Slowly open the regulator outlet valve (left hand) fully.

5. Press the "span" button on the CO analyser, located on the bottom right hand side of the front panel. The LED above the button should flash, indicating that the instrument is now in span mode.

6. Check the flow on the "CO DAILY" flow meter is 1.2 $\pm$ 0.1 litres per minute. Adjust the flow if necessary using the CO daily gas control valve inside the hut.

7. Allow the analyser to sample calibration gas for a period of not less than 5 minutes. Check that the analyser responds to the calibration gas, and that the flow rate remains stable during this period.

8. To end the calibration, press the "Span" button again. The LED should go out, and the analyser will return to sampling ambient gas.

9. Wait for 5 minutes and turn off the CO out of service switch.

A.6 Postcalibration Checks, Safety and Security Inspection

As the AURN reports time-averaged concentration data, it is important that operators critically assess the operating condition of the analysers over the time scales used in making discrete measurements. Such assessments may not be possible by consideration of averaged data, as the averaging process may mask such factors as excessive analyser noise or cyclic response changes. Information on analyser performance over very short time periods is important, as this will alert network managers and the QA/QC Unit as to whether instrumentation faults are developing.

Performing calibration checks at regular scheduled intervals, as detailed previously, is an excellent means of assessing instrument performance characteristics. For instance, excessive rise or fall times, possibly due to flow constrictions having developed, will be easily noted by a simple calibration of the analyser. Similarly, "noisy" analyser outputs, which may be caused by inefficient photomultiplier tube cooling systems, will be immediately apparent by observing the analyser output while sampling zero air.

Operators will also be expected to examine backup chart recorder traces (if available) whilst on-site. These again may highlight problems which are not apparent by consideration of telemetry data. Considering each trace in turn, the operator should verify that the traces are normal. The trace should show some degree of variation with time: for instance, in the case of primary pollutants such as NO_X and CO, there should normally be a peak corresponding to the morning rush hour. Pollutants such as NO_X and CO would be expected to rise and fall in phase with each other, whereas NO_X and O_3 traces would generally be out of phase. The operator should verify that a continuous trace is being recorded i.e. there are not excessively high levels of instrument noise, and that the daily zero span autocalibration cycle has taken place. The chart traces for the autocalibrations should be examined closely to verify that the instrument fully stabilises on both zero and span gas during the autocalibration cycle. In addition, seemingly unimportant occurrences, such as an analyser air pump being noisy, may be indicative that the unit is liable to malfunction; this should be reported by the operator.

Obviously, the level to which these problems will be detected will depend upon the experience and familiarity with the equipment of each individual operator,

but the operator must critically review the calibration he/she has undertaken and comment on any unusual or suspect results or occurrences. In addition, the postcalibration check sheet must be completed as follows:

1. All checks detailed in section A.3 must now be repeated and recorded on the postcalibration check sheet as follows:

   (i) CO Analyser

   (ii) NO_X Analyser

   (iii) SO_2 Analyser

   (iv) Ozone Analyser

   (v) TEOM (not required when filter not changed)

   (vi) Air Sampling Manifold (not required if precalibration was OK)

   (vii) Modem

   (viii) DSM 3260 Data Logger

   (xi) Chart Recorder

2. Complete the final check section of the postcalibration check sheet.

3. Complete the calibration end time.

4. Inspect the cabinet inside and outside for security and safety purposes, paying particular attention to electrical and telephone connections. Check for any signs of vandalism, especially if this may affect safety or lead to a deterioration in data quality. Immediate action must be taken to rectify any situation which may lead to members of the public or monitoring personnel being at risk.

5. Check that the roof area and fittings are secure, that there are no loose items left on the roof and then stow the ladder safely inside the hut.

6. Check that all cylinders except the CO autocal cylinder are firmly closed and the cylinder store locked.

7. Ensure the cabinet is clean and tidy.

8. Upon returning to your office, the calibration record sheets should be faxed to the CMCU, fax number 020 7261 1425 **and** also to the QA/QC Unit, fax number 0870 190 6610. Keep the copies at your office and, when you next visit the site return the original calibration sheets to the monitoring site. In this way, a backup will be kept of the calibration history of all the instruments.