SITE OPERATOR RESPONSIBILITIES
FOR
NITRATE MONITORING SYSTEM
RUPPRECHT AND PATASHNICK 8400N

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1.0 PROCEDURE FOR SITE OPERATION AND CALIBRATION OF THE RUPPRECHT AND PATASHNICK (R & P) 8400N AMBIENT PARTICULATE NITRATE MONITORING SYSTEM

1.1 Overview

The Division of Air Quality (DAQ) of the Department of Environment and Natural Resources (DENR) currently is operating two (2) nitrate (NO_3) monitoring systems-one at Rockwell (Rowan County) and another one at Millbrook (Wake County) sites in the State of North Carolina to continuously monitor ground level ambient concentrations. This is a major task and thus requires coordinated efforts by both Regional and Headquarters staff to collect quality nitrate data and also meet US-EPA (United States-Environmental Protection Agency) requirements.

The objectives of this document is to establish and deploy common site operations and instrument calibration procedures, at both sites for generation of quality nitrate data that may be compared and if needed, further extrapolated. Therefore it is critical that the Site Operator strictly follow these protocols and procedures to the last details. Technical assistance is available from the Electronics and Calibration Branch (ECB), Tel No. (919) 733-5235 and or Projects and Procedures Branch (PPB), Tel. No. (919) 733-1487 of the Ambient Monitoring Section (AMS), Raleigh, North Carolina.

All original records (calibration logbook, e-logbook, site logbook, etc.) must be legible, complete, dated and signed by the Site Operator and retained as a part of the permanent analyzer calibration record. The Operator's signature on the calibration logbook form certifies that the calibration has been performed in accordance with QA/SOP and that the information contained on the form is accurate. All records are to be reviewed and certified by the Regional Chemist and further audited at the Headquarters.

1.2 Continuous Monitoring Principles for the 8400N Nitrate System-Site Operator Responsibilities

1) Record any unusual events such as power failure, equipment problems, etc.
2) The monitoring site is to be inspected for required maintenance such as shelter integrity, condition of vent lines, compressor, filter changes, leak testing, data collection system, ground post connections, etc., with comments recorded in logbook.
3) Record the site building temperature
4) Verify and record nitrate monitor number and gas cylinders numbers and certification dates. The Site Operator should call the Electronics Calibration Branch (ECB) when the NOy in nitrogen cylinder reaches 500 psi and cylinders should be replaced before pressure reaches 300psi. Record the call to ECB in the site logbook. The Site Operator will call the selected vendor for

pickup of used cylinder and delivery of new nitrogen purge gas cylinder when the pressure reaches 300 psi.

5) An initial adjusted calibration (hereafter referred to as "calibration") must be performed by the ECB during the site start-up. This calibration will include analysis (see Sub-Section 2.2, "Initial Setup checks") in triplicate, of three different concentrations of the standard nitrate solution, using the aqueous standard solution that is commercially available. Ensure acceptable percent recoveries of each analysis in each instance, calculated immediately after analysis, thereby assuring that the nitrate monitoring system is operating at optimum and within the manufacturer's specification.
6) Site Operator shall visit the monitoring site at least twice-per- week, but perform "calibration check" only once a–week and this includes analysis of (see Sub-Section 2.2, "Initial Setup checks") of one blank and one nitrate aqueous standard. Acceptable recovery of nitrate standard analyses must be within ± 10%. The other site visit is only to ensure that the site is operating satisfactorily by checking on the other related parameters.
7) The "calibration check" must be performed before any changes to the nitrate monitoring system are made.
8) A "calibration check" is required (analysis of blank and one standard) whenever there is a nitrate monitoring system interruption (due to power failure, physical removal/replacement of system components or major repair/maintenance).
9) A full calibration that includes analysis of three different concentrations of nitrate aqueous standards, in triplicate is required at a minimum once-per month or whenever calibration checks fail. A full calibration is also required at the closure of the monitoring site.
10) Every two years, the Site Operator will call ECB for a routine maintenance of the pulse analyzer (NOy) using the procedure outlined in "Electronics Calibration Branch (ECB) Responsibilities for Oxides of Nitrogen Monitoring System, Sept. 30, 2005, Rev. 5". This action is recorded in the ECB logbook.

1.3 Nitrate Monitoring Instrument, Equipment and Accessories

The 8400N nitrate monitoring system includes the following main components:

1) Rupprecht and Patashnick (R & P) pulse generator- the main component of nitrate monitor
2) R & P pulse analyzer-the NOy analyzer component of the nitrate monitor
3) R & P pump to provide vacuum to operate the system
4) Gas canisters for nitrogen/zero purge gas supply and NOy in nitrogen for calibration and calibration verification
5) Commercially available standard aqueous nitrate solution
6) ESC Model 8832 Data Loggers, Primary (PDL). Data downloaded with the pulse generator (manually)

7) A site dedicated PC and Modem system

Only the main components of the nitrate monitoring system are briefly discussed here. For further details refer to "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York 12203, February 2003.

1.3.1 8400N R & P Ambient Particulate Nitrate Analyzer

The Series 8400N R & P Ambient Particulate Nitrate Monitor measures the mass concentration of ambient particulate nitrate contained in fine particulate matter (at or below $PM_{2.5}$) in near real time. It measures all forms of inorganic nitrate, with no interference from ammonium salts. The Series 8400N R & P is designed to meet the United States Environmental Protection Agency (USEPA) $PM_{2.5}$ speciation monitor requirements for the agency's national PM chemical speciation monitoring/sampling network.

1.3.2 Principle of 8400N R & P Monitor Operation

Ambient air samples are pulled through a cyclone operated at 5.5 L/min to remove particles above $PM_{2.5}$. From this, 1 L/min portion of this flow is used for nitrate analysis. The 1L/min nitrate sample flow passes through a carbon honeycomb denuder to remove potential gaseous interferences and a Nafion humidifier to ensure that the particles are wet. Wetted ambient air particles are collected by impaction onto a nichrome strip mounted in a collection and vaporization cell. Typical sample period is 8.5 minute. After sample collection, the system switches from this collection mode to the analysis mode. During analysis step, the sample flow bypasses the collection cell, while maintaining flow through the sample line, denuder and humidifier. The collection and vaporization cell is flushed with nitrogen gas, most of which is introduced at the side of the cell (called cross-flow), but with a portion introduced through the collection orifice (called orifice flow). The nitrogen flows through the cell and into a nitrogen oxide analyzer. The collection substrate is then flash-heated by a current from a battery until reaching an infrared cutoff. Typical heating times are 90-120 ms. 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. The analyzer output is integrated to yield the nitrate concentration. Additionally, the analyzer baseline is read prior to each analysis flash and subsequently removed from the integrated result, to yield the final, corrected sample pulse. At the end of the analysis period, the system returns to sample collection. The $PM_{2.5}$ cyclone precut, denuder, humidifier and collection-analysis cell are housed in a box, which is ventilated with outside air to try to maintain sampling temperature close to ambient. The system outputs nitrate concentration and system operating parameters via a serial communications line, at the end of each cycle.

The system is set up to automatically conduct two types of audits: analyzer flow audits and analyzer zero/span audits. The analyzer flow audits are done during sample

collection step, without interruption of the cycle. The analyzer flow audit value is used to set up the cross flow during the analysis step. Analyzer automated zero and span audits take the system off-line for two cycles. Analyzer audits may be done automatically at a preset time of the day, at a frequency of one to seven days, as selected by the Site Operator. Additionally, the system is calibrated manually using aqueous standards applied directly to the collection substrate.

For additional operating details refer to the "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003.

2.0 OPERATIONAL CHECKS AND CALIBRATION OF NITRATE MONITOR

Perform all of the following checks and adjustments before calibrating the 8400N nitrate monitor and document all checks, instrumental adjustments and the calibrations in the site logbook. Telephone ECB (919-733-5235) for assistance.

2.1 Site Operational Checks

Upon arrival at the site (Site Operator and or ECB staff), observe outside of the monitoring building, ground post connections and probe, looking for any vandalism or security beaches. Check the probe outside of an intact screen and any insect nest inside the probe funnel or sample line. Documents all actions in the site logbook. If there is any evidence of vandalism, contact the appropriate Law Enforcement Department (generally this one is the City Police, if the site is located within the city limits and the County Sheriff, if it is outside city limit) and also inform Regional Chemist and Headquarters.

Record all your observations in the site logbook. Phone ECB (919-733-5235) for guidance, if problems occur while making any instrumental adjustments. Conduct the following operational checks:

Power "On"-1) Verify and record that the instrument and all its related components have power "on" by observing the display and listening for the pump noise. 2) If the monitor or any of its components do not have power, determine the cause and time of power failure. 3) Invalidate nitrate ambient data for the 30-minute period after the power comes back. 4) Record all events in the site logbook and notify Supervisor and the ECB.
Site Temperature-1) Measure and record site temperature in ^{0}C. 2) Adjust the site thermostat as necessary to maintain the 20 to 30^{0}C range. 3) If the site temperature is outside of the 20 to 30^{0}C range, notify the Regional Chemist and ECB, the later for correcting the problem(s).
Check the Fan Filter-1) Locate the fan filter in the pulse generator compartment and pull the plastic latch and slide the filter out. 2) Check the filter to make sure that it is clean and undamaged. 3) Slide the filter back into the filter holder and push the plastic latch into the bracket. If cleaned, record in the logbook.

Check the Activated Carbon Denuder-1) Locate the activated carbon denuder housing and pull the back hose off the top barb. 2) Hold the bottom of the activated carbon denuder while unscrewing the top of the activated carbon denuder housing. 3) Remove the top part of the assembly from the activated carbon denuder assembly and make sure that the activated carbon denuder is not damaged and properly positioned in the holder. 4) Screw the top of the activated carbon denuder housing onto the activated carbon denuder and attach the black hose barb. Record in logbook.

Check the Cyclone Assembly- 1) Locate the cyclone assembly and unscrew the cyclone cup and remove it from the cyclone assembly. 2) Make sure that the inside of the cyclone cup is clean and clean, if needed. 3) Screw the cyclone cup into the cyclone assembly. Record in logbook.

PermaPure Humidifier-1) Make sure that the PermaPure humidifier is filled with de-ionized water. Record the action in the logbook.

Check Nichrome Flash Strip- 1) Locate the cell assembly and unscrew the knob on the front of the cell assembly. 2) Push the tab to the side to open the cell assembly. 3) Pull the bottom of the cell assembly down to display the Nichrome flash strip. 4) Ensure that the flash strip is undamaged and mounted on both post. 5) Push the bottom of the cell assembly up and line the tab up so that it holds the assembly together. 6) Tighten the knob and the pulse generator is now ready to be turned "on". Record all actions in logbook.

2.2 Initial Setup Checks

- Leak test cell and inlet as per instructions in "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003. (This manual is always readily available at the monitoring site).
- Verify system and cycle parameter settings are as per Table1 and record in logbook.

TABLE 1

SYSTEM PARAMETERS AND SETTINGS

Menu	**Value**	**Comments**
Cycle Setup		
Sample Time	515 sec	These parameters determine timing of cycle steps
Purge Time	30 sec	
Baseline Read	10 sec	
Read Time	20 sec	
Read Time	1 sec	

Base Start Time	0.10	Will start even 10-min past hour
Minimum Cycle Length		Calculated value
Desired Cycle Length	600	
Number of Cycles	0	Runs routinely
Perform Flow Audit	6	**note:** Flow audits does not stop sample time of the day for automatic analyzer audit with cal gas frequency of analyzer audit in days
Start Analyzer Audit	00:00	
Perform Analyzer Audit	1	

Audit Setup

Steady state Check	240	These parameters determine timing of audit steps
Read NOx 1	30	
Flow Balance Check	180	
Read NOx 2	30	
Line Purge	600	
Read NOx 3	30	
NOx Pulse Read	30	

8400N Setup

Conv. Fact. Calc.	Auto	These are calibration and control factors for nitrate analysis
Conv. Fact.		
Anal. Cross Flow	85%	
% Theor. Conv.	85.00%	Depends on aqueous standards results

System Setup

RS-232 Setup

Protocol	CycleDat	For automatic download of cycle data to computer
Baudrate	9600	
Com Para 1	52	
Com Para 2	75048	

Com Para 3	13010
Com Para 4	0

- Perform analyzer audit as per instructions (see sub-section 3.1 “Weekly or Twice-per-week Checks”).
- Start up the system and check analyzer readings as per instructions (see sub-section 3.1 “Weekly or Twice a week Checks”.)
- Run aqueous standards using commercially available nitrate solution. Use the following procedure:

    - On the pulse generator, press “RUN/STOP” and F 1 to finish the current cycle or F 2 to abort the current cycle.
    - Go to “Menu”-------“Service Mode”-------“Aqueous Standard”.
    - Press “Start” to run one aqueous standard cycle without applying any standard solution to the strip. (This step will remove any residual material from the strip and prepare it for aqueous nitrate standards).
    - Open the door of the pulse generator, locate the cell assembly and open the cell
    - Rinse the syringe in de-ionized water, three (3) times

        - Fill the syringe to desired volume (e. g. 0.2 µl, 0.4 µl, 0.6 µl, etc.) with the nitrate standard solution. Remove any air gaps in the syringe by drawing and depressing the syringe’s plunger several times while the syringe’s needle is immersed in the nitrate solution. Further, ensure that no nitrate solution drops are clinging to the outside of the needle and or syringe, by touching to mouth of nitrate standard bottle or container.
        - Apply standard nitrate solution **(Do not use the nitrate standard solution that the ECB staff uses for accuracy checks)** to the center of strip by emptying syringe and touching to strip.
        - Close the cell of the pulse generator and press, “Start” to analyze nitrate standard (the system will wait for 2 minutes and then only start sample analysis).
        - Press, “Edit” to enter the “Mass Deposit” value, in nanograms on the pulse generator screen.
        - Record the results on the “Aqueous Nitrate Standards Log” (see attached Table 2).
        - Rinse syringe thoroughly several times with de-ionized water.
        - Press “RUN/STOP” to resume normal operation.

- Calculate the percent difference, while at the site using the following equation:

    Percent Difference (%) = Known Standard Conc.- Observed Conc./ Known Standard Conc. x 100

If any of the three different concentrations of nitrate audit results (in triplicate) are not within the acceptable range of ± 10% of the expected values then do following:

- Repeat the three-point calibration, and if no improvement, then contact ECB Supervisor and inform him of the situation (i. e. problems with the three-point calibrations/recoveries).
- The Site Operator will flag all ambient data collected since the last acceptable nitrate standard analysis.
- Further, the Operator and or ECB staff member will (as soon as possible) go to the site, investigate any instrumental operational problem(s), fix the problems and analyze again three (3) nitrate standards in triplicate.
- Start collecting ambient nitrate data after ensuring that the standard recoveries are within acceptable ranges.

TABLE 2

AQUEOUS NITRATE STANDARDS LOG

Site ID: Date:
8400N Pulse Generator Serial No.: Time:
Nitrate Standard Conc. (ng/µl): Operator:
Nitrate Standard Solution Purchase Date@:

Vol. Deposited, (µl)	**Mass Deposited (ng)**	**Baseline (PPB)**	**Corrected Pulse (PPB)**	**Measured Mass (ng)**
0.5 Blank	0			
0.5 Blank	0			
0.5 Blank	0			
0.6	60			
0.6	60			
0.6	60			
0.4	40			
0.4	40			
0.4	40			
0.2	20			
0.2	20			
0.2	20			
% Theoretical Conversion----------	R-Squared----------			

Using the data recorded, graph the "mass deposited" readings (x-axis) verses the "measured mass" readings (y-axis). Then determine the slope of the graphed line, and

enter the slope in the "% of theoretical conversion". Field in the 8400N setup screen and in the bottom line of aqueous nitrate standards log.

@Ensure that this standard is **not** older than 6 months (from the date of purchase). If it is, make arrangements, through ECB to obtain a newer standard.

2.3 Instrument Calibration Overview

- The NOx monitor is to be set to perform automatic zero and span audits as per preset intervals using high purity nitrogen and a 5-PPM calibration gas.
- The time of the day and frequency are selected in the cycle setup window.
- The system user manually resets the span when a 10% difference is exhibited from the true concentrations.
- Field blanks are to be measured once every 2-weeks by placing a particulate filter between the cyclone and the denuder.
- The complete system is calibrated with the aqueous nitrate standards as described above in sub-section 2.2 "Initial Setup Checks".

2.4 Instrument Operation

- Turn "On" power to both the pulse generator and pulse analyzer. Allow at least 30 minutes for ozone generator in the pulse analyzer begin operating.
- Re-confirm that all system parameters are set as per Table 1- "System Parameters and Settings".
- Press "RUN/STOP" to begin sampling and analysis. The 8400N is designed automated operation and will continue sampling and analysis indefinitely, barring further Operator intervention or malfunction.
- The Site Operator should check the instrument and complete the weekly (or bi-weekly) checklist log (see Table 3). If any of these parameters are not within the specified limits, contact ECB for guidance.
- Pressing "RUN/STOP" again will halt sampling (with an option to abort immediately or finish the current 10 minute cycle)
- Power can then turn off to both the pulse generator and pulse analyzer.

TABLE 3

WEEKLY CHECKLIST LOG (OR TWICE-PER-WEEK)

Site	**Date**
8400N Pulse Generator Serial Number	**Time**
8400N Pulse Analyzer Serial Number	**Operator**

Item Check **Yes/No**

Nitrogen cylinder pressure (> 300 psi)_____
NO Cylinder pressure (> 300 psi)_____
Nitrogen secondary gauge pressure (> 5 psi)_____
NO secondary gauge pressure (> 5 psi)_____

Pulse analyzer status light green_____
R-cell pressure (4.8- 5.2)_____
Analyzer zero value at 0 (+/- 5PPB)_____
Analyzer span value at 500 PPB (+/- 10%)_____
Analyzer audit data checked_____

Pulse generator status light off_____
Water reservoir re-filled_____
Flash Duration (90-140 ms)_____
Sample flow during sample (0.9-1.1 L/min)_____
Makeup during analysis (3-5 L/min)_____
Orifice flow rotometer during sample (0 cc/min)_____
Orifice flow during analysis (3-5 cc/min)_____
Front vacuum gauge between –15 and –17_____
Back vacuum gauge between -20- -30_____
Pressure gauge at 3-5 psig dynamic_____
Cyclone checked_____
Performed aqueous standard zero/span check_____
Corrective actions taken_____
Were monthly or bi-weekly checks conducted_____

Comments:

_____

_____

_____

3.0 SCHEDULE OF OPERATIONAL TASKS

3.1 Weekly (or Twice-Per Week) Checks

These following checks are straight forward and fast and must be performed at least twice-per-week.

- **Check the Nitrogen Cylinder-**Twice-per-week check the pressure of the nitrogen cylinder. Replace the cylinder when the pressure is below 300 psi. and/ or when cylinder certification date has expired.

- **Check Calibration Gas Cylinder-** Twice-per-week check the pressure of the calibration gas cylinder. Replace the cylinder when the pressure is below 300 psi. and/or when cylinder certification date has expired.
- **Conduct Pulse Analyzer Routine Checks-** 1) Verify steady green light of the pulse analyzer. 2) If **no** steady green light, then press "msg", note the message and press "clear" to reset (you will get message upon any power failure or the ozone generator may not be turn "On" for 30 minutes.
- **Check NOx R-Cell pressure-**1) Look for a value in the middle of the pulse analyzer display and if not displayed, press "test" to scroll through parameter list. 2) If the value is not between 4.8 and 5.2 " Hg, then adjust the regulator which is located at the back of analyzer. (Record in the site logbook if you have manually adjusted the R-cell value).
- **Check Pulse Analyzer Zero-**1) This is not critical as the system records the zero before each flash. But it is always best to keep the zero within ± 5 PPB. Record in logbook.
- **Check Pulse Analyzer Span-**1) If the steady state check differs from the span gas concentration more than ± 10%, you will need to stop and reset the zero and span-follow the instruction included in "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003. (This manual is always readily available at the monitoring site).
- **Conduct a Manual Analyzer Audit**-1) 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). 2) Press "Menu", then "Enter Service Mode", and then "Perform Analyzer Audit". 3) Press "Full Audit" and this starts the audit and will take 15 to 20 minutes. 4) Record the audit value in site logbook and at the end of the audit, press "Menu", then "Exit Service Mode" to get back to the main screen and then "RUN/STOP" to resume normal operation.
- **Check and Record Analyzer Audit data**-1) If the 8400N is set to do automatic analyzer audits, then all that is needed is to record the data. With the system running, press "Data', then "Select Data", "Audit Data" and record the most recent values in the site logbook.
- **Routine Check, Pulse Generator**-1) Check that the pulse generator status light is "Off". 2) If blinking or "On" check and note status codes in the upper left hand corner. 3) Correct and/or clear using "Reset Status" soft key. 4) Display should show "Run" mode and is active. 5) Display should show "Water Reservoir OK" and "Flash Strip OK". Record in logbook.
- **Refill Water Reservoir-** 1) Display should show "Water Reservoir OK". 2) If not, open the cap at top of the reservoir water bottle, replenish with de-ionized water. 3) Replace the top loosely (Do not tighten, but allow for air to penetrate the headspace). 4) Check that there appears to be water in the lines to the humidifier. 5) If not and lines are dry, loosen the ¼" nut on the side of the upper tee of the humidifier and let the humidifier fill from the bottle. Record in logbook.

- **Check Flash Strip**-1) Display should show "Flash Strip OK". 2) Check that flash duration is between 90-120 ms with newly installed strips and 90-140 ms in-use flash strips. 3) From the main screen press "data"-the flash duration is the last value listed. 4) Press "ESE" to return to main screen, verify and then press in "Run" mode. Record in logbook.
- **Check Sample Flow**-1) Check sample flow rate when "CURRENT STEP" reads "Sample". Flow should be between 0.9 and 1.1 L/min. 2) If "CURRENT STEP" reads "PURGE", "BASELINE", "READ" or "WAIT" then the indicated flow is **not** the sample flow. 3) Wait for system to enter step labeled "SAMPLE" and then read flow. 4) If the flow is lower than above- mentioned range (0.9 and 1.1 L/min), clean the collection orifice as described in "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003. (This manual is always readily available at the monitoring site). Record in logbook.
- **Makeup Flow**-1) Open pulse generator front door and check upper rotometer readings-makeup flow should read between 3 and 5 L/min. 2) If not, follow instructions included in "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003. 3) Close door and verify that system is on main screen and in "RUN" mode. Record in logbook. (A copy of this manual is always readily available at the monitoring site).
- **Record Orifice Flow Rotometer**-1) Open the pulse generator front door and check lower rotometer readings. The orifice flow rotometer is the lower of the two rotometers, located inside the pulse generator cabinet. 2) Orifice flow should read "0" during "SAMPLE", if not, follow instructions given in"Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003. 3) Orifice flow should read 3-5 cc/min. x 100 during analysis ("PURGE", "BASELINE" or "READ 1" steps), if not, follow instruction in "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003. (A copy of this manual is always readily available at the monitoring site). 4) Close door and verify that the system is "on " main screen and in "RUN" mode.
- **Check Vacuum Gauges**-1) Open the pulse generator front door and if any readings are out of range, record their values before changing and then adjust and note value after adjustment. 2) Cell (front) vacuum gauge should read between -15 and –17" Hg, and if not, follow instructions included in "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003. 3) Makeup flow vacuum gauge should read between –20 and –30" Hg, and if not, follow instruction included in "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003. (A copy of this manual is always readily available at the monitoring site). 4) Close door and verify that system is "On" main screen and in "RUN" mode. Record in logbook.

- **Check Pressure Gauges-**1) The pressure gauge should read between 3 and 5 psi. 2) Purge pressure gauge is read during "PURGE", "BASELINE" or "READ". If any readings are out of range, record their values before changing. Then adjust and note value after adjustment. 2) If purge pressure is less than 3 then follow instructions in"Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003. 3) If purge pressure is greater than 5 then follow instructions in"Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203. (A copy of this manual is always readily available at the monitoring site). Record all actions in logbook.
- **Check Cyclone-**1) If it has just rained, then dry the cyclone and unscrew the bottom, dry and replace. 2) Note the time and check while the system is running. 3) Also note if a lot of water is present. Record in logbook.
- **Perform Aqueous Standard Span and Zero-**Performed only once a-week. 1) As per instructions included in sub-section 2.2 "Initial Setup Checks". Record in logbook. The other site visit during twice-a-week visit is to ensure that the site is operating satisfactorily by checking various other related parameters.
- **Note Corrective Actions taken-**1) Note in the logbook any corrective actions taken in the site logbook, specifically if cell orifice was cleaned or flash strip was replaced or semi-monthly tests were run.
- **Note if Monthly or Semi-monthly Checks Run-**1) Note in the logbook if monthly or semi-monthly checks were conducted in the site logbook. Fill out the "Routine Maintenance Log Sheet (See Table 4).

TABLE 4

ROUTINE MAINTENANCE TASKS

Site	**Date**
8400N Pulse Generator Serial Number	**Time**
8400N Pulse Analyzer Serial Number	**Operator**

Tasks	**Comments**
Semi-monthly	
Measure Field Blank	_____
Clean Cyclone Trap	_____
Conduct Sample Flow Audit	_____

Monthly

Clean Sample Collection Orifice _____
Replace Flash Strip _____
Check Makeup Flow Filter _____
Check Analyzer Flow Filter _____
Conduct Leak Test _____
Verify Ambient Temperature _____
Verify Ambient Pressure _____
Aqueous Standards Calibration _____
Clean PVC Rain Cap _____

Quarterly

Clean Generator battery _____
Clean/Replace Pulse Generator
Fan Filter _____

6-Months

Replace Carbon Filter _____
Clean/Replace Al Sample Line _____
Calibrate Sample Flow Sensor _____
Calibrate Cross Flow Sensor _____

Once-Per-Year

Clean Reaction Cell _____
Replace CPU battery _____
Replace Memory Battery _____
Replace/Rebuilt Pump _____

Additional Comments_____
_____
_____

3.2 Bi-Weekly (Once Every Two Weeks) Tasks

These following checks must be performed at least once every 2-weeks and recorded in logbook:

- **Measure Field Blank**-1) Press “RUN/STOP” and F 1 to finish current sample. 2) Open pulse generator front door and connect Ballston particulate filter in line to the top of the black tubing above denuder. 3) Go to “Cycle Setup” and adjust

"Based Start Time" to "Immed". 4) Press "ESC" to return to main screen and push "RUN/STOP" to run for two cycles.5) Record values in site logbook and re-enter "Cycle Setup" and adjust "Base Start Time" back to "00:10". 6) Remove filter, reconnect sample line, press "RUN/STOP to resume normal operation.

- **Clean Cyclone**-1) Unscrew the bottom of the cyclone and clean with water and Q-tip and re-install. (If you are quick, you need not stop system for this cleaning, but do note the time on the Semi-Monthly Checks log sheet).
- **Conduct Sample Flow Audit**-1) While the unit is in sample mode, attach a flow measuring device (e. g. Dry Cal) to black tubing above the activated carbon denuder. 2) Record the front panel "Sample Flow" and dry cal readings in the site logbook (If dry cal reading differs from the front panel reading more than 10%, the sample flow meter needs to be calibrated.

3.3 Monthly Tasks

These following monthly checks must be performed and recorded in logbook:

- **Clean Collection Orifice**-1) Check that the front vacuum gauge reads between –15 and –17" Hg and if less than –15 then re-adjust and check sample flow reading during the "Sample" step. 2) If the flow is still low then the orifice needs cleaning. 3) Stop the running cycle by pressing "RUN/STOP" and F 1 and open the cell and unscrew the orifice using yellow handled nut driver and large socket. 4) Clean the orifice with de-ionized water using a squirt bottle, dry with portable air and re-install, while assuring the orifice is tight, so that the 0-ring provides a vacuum seal. 5) Press "RUN/STOP" to resume normal operation.
- **Replace Flash Strip-** The Site Operator needs to check flash duration times and change the strip if the flash duration is greater than 120 ms. For changing the strip- 1) Press "RUN/STOP" and F 1 to finish current cycle and open cell and unscrew the strip using yellow handled nut driver and small socket. 2) Remove the nuts, the washers and the strip and replace a new formed nichrome strip on the posts, with the loop facing up. 3) Put the washers and nuts back on the posts and go to "Menu"—"Service"----- "FlashIR Setup". 4) Press "Reset Flash Fault" and then press "Test Flash" and make sure the flash looked even and no sparks were seen. 5) Close the cell and check the flash duration (should be between 90-125 ms). 6) If OK then exit the service mode and press "RUN/STOP" to resume normal operation. Record in logbook. Also, if the flash strip is replaced, a full three-point aqueous standard calibration must be performed, 24 hours after a flash strip change.
- **Conduct a Manual Analyzer Audit**-1) This should be performed once a month by pressing "RUN/STOP" and F 1 to finish current cycle. For details of the procedure refer to sub-section 3.1 "Weekly (or Twice-per-Week) Checks".
- **Check Make-Up Flow**-1) For details of the procedure refer to sub-section 3.1 "Weekly (or Twice-per-Week) Checks". Follow instruction included in "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003.

- **Check Analyzer Filter**-1) This task should be performed every four (4) months. 2) Unscrew the filter holder mounted on the back of the pulse generator and carefully remove the 25 mm Teflon filter and place a new 25 mm Teflon filter between the black O-ring and the filter screen inside the holder. 3) Screw the filter holder back together and tighten until leak tight.
- **Leak Check-** 1) With system running in "READY" mode, close the green valve above the cyclone and close the front vacuum valve below the vacuum gauge. 2) Let the system pump down for several minutes and then close valve below back vacuum gauge. 3) Watch cell pressure reading on front panel and make sure that the drift should be less than 0.01 atms/min. 4) If Ok, slowly reopen valve above cyclone and reopen both vacuum valves.
- **Verify Ambient Temperature**-1) Insert reference thermometer in probe in temperature shield and verify that ambient temperature displayed on the main screen is within $\pm 2^0$C. 2) If not, follow instruction included in "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003. (A copy of this manual is always readily available at the monitoring site).
- **Verify Ambient Pressure**-1) Using NIST-referenced barometer, determine the current ambient pressure in mm Hg and verify that the ambient pressure in the main screen is within ± 10 mm Hg. 2) if not, follow instruction included in "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003. (A copy of this manual is always readily available at the monitoring site).
- **Calibration with Aqueous Standards**-1) Refer to sub-section 2.2 "Initial Setup Checks" for a detailed procedure.
- **PVC Rain Cap**-1) Inspect and clean the PVC rain cap once a month or as necessary. 2) Be sure to install the inlet tubing through the centering hole in the rain cap. For additional information refer to "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003. (A copy of this manual is always readily available at the monitoring site).

4.0 8400N R AND P NITRATE MONITORING SYSTEM MAINTENANCE

4.1 Preventive Maintenance (record all actions in logbook)

4.1.1 Quarterly Tasks

- **Pulse Generator Battery**-Clean any corrosion on the battery terminals of the pulse generator on quarterly basis
- **Pulse Generator Fan Filter**-Clean or replace fan filter on the pulse generator. For additional details refer "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company,

Albany, New York, 12203, February 2003. . (A copy of this manual is always readily available at the monitoring site).

4.1.2 6-Months Tasks

- **Activated Carbon Denuder**-Replace or recharge (by Baking out absorbed material) the carbon denuder every six (6) months, or as necessary. Further details are included in "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003. . (A copy of this manual is always readily available at the monitoring site).
- **Aluminum Inlet Line-**Clean or replace the aluminum inlet line every six (6) months.
- **Calibrate Sample Flow Sensor-** Instructions included in "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003. . (A copy of this manual is always readily available at the monitoring site).
- **Calibrate Cross Flow Sensor-** Instructions included in "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003. . (A copy of this manual is always readily available at the monitoring site).

4.1.3 Annual Tasks

- **Clean Reaction Cell-**It is ECB's responsibility to clean and re-build the reaction cell inside the pulse analyzer every year, or as necessary. Make sure that the Site Operator calls ECB. Also note the call date and time in site logbook. The ECB will follow instructions included in "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003. . (A copy of this manual is always readily available at the monitoring site).
- **CPU Battery**-Replace the 3 V Lithium CPU battery every year. Instructions are included in "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003. . (A copy of this manual is always be readily available at the monitoring site).
- **Data Backup battery**-Replace 3 V Lithium battery every year. Instructions are included in "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003. . (A copy of this manual is always readily available at the monitoring site).
- **Pump**-The pump of the nitrate monitor has a lifetime of about 12 months. If the pump performance deteriorates, it should be re-build (ECB may be asked for help on this task) or replaced with anew pump.

4.2 Corrective Maintenance

All corrective maintenance aspects of 8400N R & P nitrate monitoring system have not been fully addressed by the system's manufacturer. However, it is expected that related issues will be experienced and added to this list, upon further extended field deployment of the system.

4.3 Routine Maintenance

As a part of routine maintenance and or during (including during site audit) any site visits, perform and record in logbook:

- Document the day, time and reason for the site visit in the Site Logbook.
- Check that the site building temperature is between 20^0C and 30^0C.
- Check that the probe and sample line are connected and secure.
- Check air conditioner, heater and lines for proper functions.
- Check that the site building is secure. Vandalism is to be reported to the Law and Enforcement Officials and ECB Supervisor.
- Check the site building for any problems (e. g. leaks, infestations, etc.).
- Check that the heat tape is working and the site insulation is adequate
- Checks that all nitrate monitoring system's components such as the pulse generator, pulse analyzer, 8400N R and P pump, etc., are operating within the prescribed ranges.
- Down any channels for nitrate monitor's component(s) repaired, replaced or audited during the repair, replacement or audit.
- Up any channels for nitrate monitor's component(s) repaired, replaced or audited during the repair, replacement or audit.
- Ensure that the "Scheduler" has been engaged before leaving the monitoring site.
- If appropriate, time duration wise change the probe every 2 years.
- Every two years, ECB staff will perform routine maintenance of the pulse analyzer (NOx) at each monitoring site using the procedures outlined in the "Electronics Calibration Branch (ECB) Responsibilities for Oxides of Nitrogen Monitoring System, Sept. 30, 2005, Rev. 5".

5.0 TROUBLE SHOOTING

5.1 Status Codes

The 8400N responds to a variety of conditions and malfunctions with status code messages and these can be viewed by pressing "Status Codes" from the main screen. Every data code record contains a representation of these codes in a hexadecimal number called the "OP" code. See Table 5 for a list of "OP" codes, status codes and their description.

TABLE 5

8400N STATUS CODES

OP Codes	Status Code	Description
00000000	OK	No Status Condition
00000001	Y	System Reset
00000002	Z	Power failure
00000004	H1	A/D Failure
00000008	**S1**	**Ambient Temperature Out of Range**
00000010	S2	Ambient Pressure Out of Range
00000020	S3	Cell Comp Temp Out of Range
00000040	E	Electronics Temp Out of Range
00000080	**W**	**Check H_2O Reservoir**
00000100	**X**	**Flask Failure**
00000200	**FS**	**Sample Flow Sensor Failure**
00000400	FC	Cross Flow Sensor Fail
00000800	**C1**	**Cross Flow Control Fail**
00001000	P1	Abs Pressure Out of Range
00002000	C2	Abs Pressure Control Fail
00004000	P2	Sample Pressure Out of Range
00008000	D	Cell dp Out of Range
00010000	R	Cycle Aborted
00020000	**A1**	**Analyzer Warning**
00040000	A2	Analyzer Communication Failure
00080000	A3	Analyzer Data Capture Start
00100000	A4	Analyzer Data Capture Checksum
00200000	A5	Analyzer Data Capture Incomplete
00400000	A6	Analyzer Data Capture Timeout
00800000	U	Amb Temp Sensor Not Used

- **NOTE:** 1) This hexadecimal system for "OP" codes is used so that combinations of status codes can be easily identified. 2) **Bold** entries are for the critical codes that affect data quality. 3) Codes and for their remedies refer to "Series 8400N Ambient Particulate Nitrate Monitor/Operating Manual", by Rupprecht and Patashnick (R & P) Company, Albany, New York, 12203, February 2003. (A copy of this manual is always readily available at the monitoring site).

6.0 DATA MANAGEMENT

6.1 Data Acquisition

There are three (3) types of data "Cycle", "Audi" and "Standards". With the communication protocol set to "CycleDat" the "Cycle" data are automatically downloaded via RS-232 port to the site data acquisition system. The data file is described

in Table 6. Audit and standards data can be downloaded manually. Cycle data can also be downloaded manually.

TABLE 6

OUTPUT FORMAT AND EXPECTED VALUES FOR 8400N CYCLE DATA

Name (Data Sys.)	Name (8400N)	Units	Acept. Range
Date	Record Date	None	
Time	Record Time	(PST)	
Tamb	Amb. Temp.	(^{0}C)	
Ramb	Amb. Pres	(atm)	
RHCond	Cond % RH	(%)	70-100
Tbox	Cell Comp T	(^{0}C)	Tamb ±10
Qsmp	Sample Flow	(L/m)	0.9-1.1
Qxflo	Cross Flow	(L/m)	80± 5% of Qanal
Qanal	Analyzer Flow	(L/m)	0.7-1.0
Psmp	Ave. Sam. Pres	(atm)	0.35-0.5
DPanal	Cell dp	(in H_2O)	-6 to –10, change< ± 1
Pricell	Rcell Pres	(in Hg-A)	4.7-5.3
tsmp	Sample Time	(s)	Set Value (515 at LR)
tread1	Read 1 Time	(s)	20
Noxamb	Average NOx	(PPB)	0-300
BslnArea	Baseline Area	(PPB*s)	<100
FlsArea	Pulse 1 Area	(PPB*s)	
ThConvFact	Conv Fac	(PPB*s/ng)	20-30
CalFact	Theor Conv %	(%)	>70
DtFls	Flash Dur	(ms)	90-140
NO3	Nitrate Conc	($\mu g/m^3$)	0-100
OP	None	None	000000

6.2 Data Review

The “Cycle” data from the 8400N are reviewed by the Site Operator on a monthly basis to ensure that the system parameters are within an acceptable range-as listed in Table 6.

6.3 Data Validation

Site logbook is kept and used for validation of data. Invalid and suspect data are flagged using the in-house approved data flagging codes and procedure outlined in Standard Section-III for data review.

6.4 Records Management

The aqueous standards and on-site observations are recorded by the Site Operator on the respective log sheets. Overall there are three (3) log sheets plus a site logbook. These log sheets are: 1) Weekly (Twice-Per Week) Checklist (see Table 3), 2) Routine Maintenance Tasks Checklist (see Table 4) and 3) Aqueous Standards log sheet (see Table 2).