

SOP AAQGEN-033		Page 1 of 14
Title: Thermo Environmental (TECO) 17C Ammonia Analyzer		
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## 1. Purpose

To establish a standard operating procedure (SOP) for University Hygienic Laboratory (UHL) Ambient Air Quality personnel to ensure compliance with the manufacturer's manual, Environmental Protection Agency Quality Assurance Handbook and Iowa DNR CAFO Sampling Manual in operating the Thermo Environmental (TECO) 17C Ammonia Analyzer

## 2. Scope

This procedure is intended for use by UHL staff during routine monitoring site operation using the TECO Model 17C Ammonia Analyzer. This procedure is not a replacement for the manufacturer's manual but provides site-specific guidance for equipment operation and site operator objectives.

## 3. Outline of Procedure

1. Summary of Method
2. Installation and Startup
3. Monitoring Site Operation
4. Routine Operation
5. Full Scale Checks
6. Multi Point Calibration
7. Preventative Maintenance

## 4. Reference

Operating Manual Thermo Environmental (TECO) 17C Ammonia Analyzer

Quality Assurance Handbook for Air Pollution Measurement Systems, Environmental Protection Agency

Iowa DNR CAFO Sampling Manual

## 5. Procedure

## 5.1 Summary of Method

The Thermo Environmental (TECO) Model 17C Ammonia Analyzer is a Chemiluminescent analyzer. It operates on the principle that Nitric Oxide (NO) and Ozone (O<sub>3</sub>) react to produce a characteristic luminescence with an intensity linearly proportional to the NO concentration. Infrared light emission results when electronically excited NO<sub>2</sub> molecules decay to lower energy states. Specifically,



The sample is drawn into the Model 17C by an external pump. After it reaches the reaction chamber, it mixes with ozone, which is generated by the internal ozonator. The chemical reaction above then takes place. This reaction produces a characteristic luminescence with intensity proportional to the concentration of NO. Specifically, light emission results when electronically excited NO<sub>2</sub> molecules decay to lower energy states. The light emission is detected by a photomultiplier tube, which in turn generates a proportional electronic signal. The electronic signal is processed by the microcomputer into a NO concentration reading.

To measure the NO<sub>x</sub> (NO + NO<sub>2</sub>) concentration, NO<sub>2</sub> is transformed to NO prior to reaching the reaction chamber. This transformation takes place in a molybdenum converter heated to approximately 325 °C. Upon reaching the reaction chamber, the converted molecules along with the original NO molecules react with ozone. The resulting signal represents the NO<sub>x</sub> reading.

To measure the Nt (NO + NO<sub>2</sub> + NH<sub>3</sub>) concentration, both the NO<sub>2</sub> and NH<sub>3</sub> are transformed to NO prior to reaching the reaction chamber. This transformation takes place in a stainless steel converter heated to approximately 750 °C. (**Note:** Factory settings for this temperature are normally around 750°C but it may be necessary to raise the temperature to values as high as 815°C in order to have Ammonia conversion of >75%. This higher temperature may result in more frequent failures of a thermal fuse that is attached to the outside of the high temperature converter's heater unit.) Upon reaching the reaction chamber, the converted molecules along with the original NO molecules react with ozone. The resulting signal represents the Nt reading.

The NO<sub>2</sub> concentration is determined by subtracting the signal obtained in the NO mode from the signal obtained in the NO<sub>x</sub> mode.

$$\text{NO}_x - \text{NO} = \text{NO}_2$$

The NH<sub>3</sub> concentration is determined by subtracting the signal obtained in the NO<sub>x</sub> mode from the signal obtained in the Nt mode.

$$\text{Nt} - \text{NO}_x = \text{NH}_3$$

The Model 17C outputs NO, NO<sub>2</sub>, and NH<sub>3</sub> concentrations to the front panel display and NO, NO<sub>2</sub>, NH<sub>3</sub>, and NO<sub>x</sub> concentrations to the analog outputs.

## 5.2 Installation and Start-up

The operator should first read the manufacturer's manual to understand and become familiar with the analyzer's operations, controls, settings and various possible operating configurations. The operator should then decide which of these settings will best serve the IDNR and UHL Air Quality department's requirements and needs. Some functions of the analyzer are mandatory to the department's requirements, while others will not be utilized.

The site operator should be thoroughly familiar with the monitor, its manual and any supporting equipment, to avoid the possibility of mechanical damage to the instrumentation or any personal injury such as electrical shock or mishap while working with high pressure gas calibration devices.

### 5.2.1 Installation

- 5.2.1.1 Refer to the TECO Model 17 C Manual for full initial instrument installation instructions.
- 5.2.1.2 Place the converter and analyzer at the monitoring site, in an area where they will be accessible for operating the controls, performing maintenance and attaching calibration devices.
- 5.2.1.3 Connect a "sample line" to the "sample" bulkhead at the rear of the converter module and extend it out of the monitoring site shelter so that it meets EPA QA "sample train" criteria for placement, length, etc. The sample line should be constructed of ¼ inch o.d. Teflon tubing, be < 10 feet in length and be connected to the analyzer with stainless steel or Teflon compression nuts and ferrules. (Nte: Total length of inlet line should always be minimized to prevent unwanted reactions) In the sample line, relatively close to the analyzer inlet, install a Teflon particulate filter cartridge containing a 5-micron pore size Teflon filter. It is recommended that the sample line, inside the site shelter, be covered with an insulating material to avoid the risk of condensation inside the sample line and moisture being drawn into the analyzer. Due to the reactive state of ammonia in an ambient air stream it may be necessary, if moisture appears in the sample line, to use a heat tape as well as thermal insulation on the inlet line.
- 5.2.1.4 Connect an air dryer to the "Dry Air" bulk head using ¼ inch o.d. teflon tubing. Connect the inlet (stainless steel fitting) of the twin headed vacuum pump to the Chamber bulkhead of the analyzer module. It is critical that the vacuum port and not the exhaust port of the vacuum pump be connected to the bulkhead labeled Chamber. Connect the "Exhaust" bulkhead of the pump to a suitable vent or ozone/NO<sub>x</sub> scrubber. The exhaust line should be ¼" OD with a minimum 1/8" ID and length of < 10 feet. Care should be taken with the placement of the exhaust line since the exhaust stream, prior to scrubbing, contains significant concentrations of ozone and oxides of nitrogen.
- 5.2.1.5 Connect the **NO Out**, **NO<sub>x</sub> Out**, and **Nt OUT** bulkheads on the converter module rear panel to the **NO In**, **NO<sub>x</sub> In**, and **Nt In** bulkheads on the analyzer module rear panel

using 1/4"OD Teflon® tubing, using stainless steel or Teflon compression nuts and ferrules. Keep tubing lengths as short as possible but allow for the possible repositioning of instruments during periods of maintenance.

- 5.2.1.6 With appropriate signal wire, connect the analyzer's analog outputs to the site data logging system and strip chart recorders (if used). At a minimum, the NO<sub>x</sub>, NO and NH<sub>3</sub> outputs should be wired to the ESC datalogger. If sufficient analog inputs are available on the logger, then the NO output should also be included. (See step 5.2.1.10)
- 5.2.1.7 If used, Connect the "status/relay" information cable from the back of the analyzer to the data logging system. (See step 5.2.1.10)
- 5.2.1.8 Connect a RS232 communication cable from the analyzer to the data logging system or multi communication switching device (if used). (See step 5.2.1.10)
- 5.2.1.9 Connect the converter, analyzer and pump's power cords to a stable voltage source. It is recommended that a "surge protecting power strip" be placed in line between the instruments components and the electrical source.
- 5.2.1.10 All "data logging system" signal terminals and voltages will be determined by the site installation operator and coordinated with the department's data acquisition section to ensure correct channel configuration and data monitoring take place.
- 5.2.1.11 Record installation, equipment make, model and serial numbers, data system channel and voltage settings and data collection "start time" in the "site log book". This information should also be returned to the laboratory for inventory documentation and data acquisition section Notification.

## 5.2.2 Start Up

- 5.2.2.1 Plug the external sample pump into a surge protection power strip and turn the pump on.
- 5.2.2.2 Turn the converter and analyzer power on by means of their front panel switches.
- 5.2.2.3 Allow analyzer a 90 minute warm-up period.
- 5.2.2.4 Until the operator becomes familiar with the analyzer front panel menu buttons, consult the manual in order to select and set the instrument parameters. Although the analyzer may be capable of a number of different parameter options, the normal network selection is as follows:

In "Range" menu, select	"Single"
In "Gas Units" menu, select	"PPB"
In " NO Range" menu, select	"2000"
In " NO <sub>2</sub> Range" menu, select	"2000"
In " NO <sub>x</sub> Range" menu, select	"2000"
In " NH <sub>3</sub> Range" menu, select	"2000"
In " Nt Range" menu, select	"2000"
In "Averaging Time" menu, select	"300"
In "Instrument Controls" -	
In "Temperature Correction" menu, select	"On"
In "Pressure Correction" menu, select	"On"
In "Ozonator" menu, select	"On"
In "PMT Supply" menu, select	"On"

In "Auto/Manual Mode" menu, select	Auto "NO/NOx./Nt"
In "Baud Rate" menu, select	"9600"
In "Time", menu, select	"Current Time"
In "Date", menu, select	"Current Date"

5.2.2.5 A "multi-point" NO/NOx/NH<sub>3</sub> calibration must be performed before data collection may begin. This procedure is discussed in the "Routine Site Operation" section of this SOP.

### 5.3 Monitoring Site Operation

Upon completion of "Installation and Start-up" and calibration, the analyzer is ready to begin normal, continuous sample operation for the detection of NO/NOx/Nt/NH<sub>3</sub>. The site operator will visit each monitoring site analyzer to conduct "zero, span and precision" checks at a minimum of every 14 days.. The site operator will conduct "multi-point" calibration checks when the analyzer is newly installed, repaired, when zero or span drift more than 12% and minimally once per calendar quarter. All data will be gathered and transmitted to the laboratory electronically through the use of a monitoring site data logging system.

### 5.4 Routine Operation

5.4.1 When visiting a monitoring site, the operator should first conduct a visual inspection of the site itself and all instrumentation. This may assist in identifying any problems before beginning any equipment operation. The analyzer's front panel display should be checked for any "alarm" status. Unusual conditions may require action that deviates from routine procedures.

5.4.2 In the "site log book", the operator should first enter the date and initials.

5.4.3 A number of analyzer and support equipment component statuses are selected to be monitored during each routine visit. Deterioration or degradation can be charted, assisting the operator in identifying problems during malfunctions and for preventive maintenance measures. From the analyzer "Diagnostics Menu", monitor and record in the site log book:

- PMT voltage
- Internal temperature
- Internal pressure
- Pump flow rate sample
- Pump flow rate ozonator
- Reaction chamber pressure
- Flow Rate (on-site cal.)
- Flow system pressure (on-site cal.)

5.4.4 Disconnect the analyzer sample line at the filter cartridge inlet.

- 5.4.5 Attach a 'zero air' device to the sample line cartridge inlet and allow the analyzer to sample zero air until a stable reading is obtained (minimally 15 minutes).
- 5.4.6 Record in the logbook the expected zero value and the measured zero value observed on the data logger display for each of the components, NO<sub>x</sub>, NO, NH<sub>3</sub> and NO<sub>2</sub> (if datalogger is set up for NO<sub>2</sub>).
- 5.4.7 Disconnect the zero air device from the analyzer sample line inlet.
- 5.4.8 Connect the output port of a Thermo Environmental Model 146C multi-gas calibrator (a gas phase titration (GPT) system) to the sample line cartridge inlet by using an atmospheric bypass tube. (See SOP AAQGEN-0330 for operation instructions for the Thermo Environmental mutigas calibrataor.)
- 5.4.9 Attach the zero air device to the zero air port of the 17C.
- 5.4.10 Using the software and entries that are prompted from the multi-gas calibrator adjust the calibrator dilution flowmeter so that a 'precision value' (160-200 ppb) of NO will be supplied to the analyzer.
- 5.4.11 Allow the analyzer to sample the precision range gas until a stable reading is obtained (minimally 15 minutes).
- 5.4.12 Record in the logbook the expected precision value and the measured precision value for NO and NO<sub>x</sub> taken from the data logger display.
- 5.4.13 Using prompts from the 146Ccalibrator, adjust the calibrator dilution flowmeter so that a "span value" (70-90% of analyzer full scale) of NO gas will be supplied to the analyzer.
- 5.4.14 Allow the analyzer to sample the span range gas until a stable reading is obtained (minimally 15 minutes).
- 5.4.15 Record in the logbook the expected span value and the measured span value for NO and NO<sub>x</sub> observed on the data logger display.
- 5.4.16 If the measured calibration values deviate from the expected value, the operator may choose to adjust the analyzer so that the measurement is more representative of the "true or expected" concentration. This will be mandatory if zero/span has deviated by more than 12ppb/12% of the "true or expected" concentration.
- 5.4.17 **(Optional)** Repeat steps 5.4.11 – 5.4.17 for a similar value of NO<sub>2</sub> using the ozonator on board the multi-gas calibrator to provide a source of O<sub>3</sub> to convert the NO calibration gas to NO<sub>2</sub>. . (NO<sub>2</sub> checks are not critical to the determination of NH<sub>3</sub> concentrations.)
- 5.4.18 Switch gas source to an NH<sub>3</sub> tank. Repeat steps 5.4.11 – 5.4.17 for similar concentration levels of NH<sub>3</sub>.

**Note:** Ammonia is a polar gas and tends to adsorb or stick to sample lines and instrument surfaces. This "stickiness" makes the time necessary for generating "good" ammonia gas concentration extremely instrument and calibrator dependent. The system must be allowed to equilibrate until a stable reading is obtained. A stable reading can be defined as being < 1% variance in the generated concentration values over a period of 5 minutes .

Due to the "stickiness" and adsorption characteristics of NH<sub>3</sub>, over saturating the calibrator and sample lines with cylinder concentration of ammonia for several minutes prior to conducting ammonia level checks may accelerate the equilibration. If this procedure is used, span level ammonia should be determined prior to precision level gas.

This change will not be a significant alteration of this SOP. If the span level is determined first, no adjustment may be made to the span calibration prior to measuring the precision level. Any adjustment to the span calibration must be made after the routine precision level check has been completed. The analyzer must be allowed to equilibrate to span level NH<sub>3</sub> for a minimum of 90 minutes during a routine bi-weekly check. A minimum span level equilibration time of 120 minutes must be used during audits or multipoint calibrations, or if adjustments of the span are made. Record expected and measured values for the precision and span levels in the site logbook.

- 5.4.19 To correct the analyzer measurements, disconnect the multi-gas calibrator from the sample inlet and supply the analyzer with “zero air” until a stable reading is achieved.
- 5.4.20 Switch the analyzer from “Remote” to “Local” operation by pressing the “Enter” pushbutton.
- 5.4.21 Press the front panel “Menu” pushbutton to display the “Main Menu”. Press the “down arrow” pushbutton to move the cursor to “Calibration” and press “Enter” to display the “Calibration menu”.
- 5.4.22 Press “Enter” to select Calibrate NO BKG/NO<sub>x</sub> BKG/Nt BKG”. The “Calibrate NO BKG/NO<sub>x</sub> BKG/Nt BKG” screen appears. The calibrator display will show the current NO, NO<sub>x</sub> and Nt readings. Press “Enter” to set the NO, NO<sub>x</sub> and Nt Background readings to zero. Press the “Menu” pushbutton to return to the “Calibration” menu.
- 5.4.23 Reconnect the multi-gas calibrator to the analyzer and operate as described in steps 5.4.7 through 5.4.11. Adjust the calibrator to supply “span range” NO gas (70-90%) of analyzer full scale to the analyzer. Allow the analyzer to come to a stable signal on the NO and NO<sub>x</sub> readings.
- 5.4.24 Press the front panel “down arrow” to move the cursor to “Calibrate NO/NO<sub>x</sub>/Nt” as appropriate and press “Enter” to display the “Calibrate NO/NO<sub>x</sub>/Nt” screen. Use the “left and right” pushbuttons to move the cursor left and right. Use the “up and down” pushbuttons to increment and decrement the digit to the “expected NO/NO<sub>x</sub>/Nt concentration. Press the “Enter” pushbutton to calibrate the analyzer to the NO/NO<sub>x</sub>/Nt calibration gas. Repeat this process to calibrate the span for all three parameters (NO/NO<sub>x</sub>/Nt).
- 5.4.25 On at least a semi-annual basis, NO<sub>2</sub> conversion efficiency should be measured. Turn on the ozonator on the multi-gas calibrator. Increase the ozone to produce a span value (70-90%) of NO<sub>2</sub>. Sample the NO<sub>2</sub> gas until you have a stable reading on the NO, NO<sub>2</sub> and NH<sub>3</sub> channels. From the Calibration menu choose Calibrate NO<sub>2</sub>. The first line of the Calibrate NO<sub>2</sub> screen displays the current NO<sub>2</sub> reading. The third line of the display is where the NO<sub>2</sub> calibration gas concentration is entered. Set the NO<sub>2</sub> calibration gas concentration to the NO<sub>2</sub> concentration. Use the ← and → pushbuttons to move the cursor right and left and use the ↑ and ↓ pushbuttons to increment and decrement each digit. Press **“Enter”** to calibrate the NO<sub>2</sub> channel to the NO<sub>2</sub> calibration gas. The message “Saving Parameter(s)” is briefly displayed to indicate that the NO<sub>2</sub> span coefficients have been calculated, stored, and is being used to correct the NO<sub>2</sub> reading.
- 5.4.27 Turn off the ozonator. Disconnect the NO/NO<sub>2</sub> gas source from multi-gas calibrator and hook up a source of NH<sub>3</sub> gas. Introduce a span level (70-90% of FS) of NH<sub>3</sub> into the analyzer. After a minimum of 90 minutes and the NH<sub>3</sub> value has stabilized, (See

- 5.4.18) choose “Calibrate” from the main menu. From the Calibration menu choose calibrate NH<sub>3</sub>. The first line of the Calibrate NH<sub>3</sub> screen displays the current NH<sub>3</sub> reading. The third line of the display is where the NH<sub>3</sub> calibration gas concentration is entered. Set the NH<sub>3</sub> calibration gas concentration to the NH<sub>3</sub> Concentration. Use the ← and → pushbuttons to move the cursor right and left and use the ↑ and ↓ pushbuttons to increment and decrement each digit. Press **“Enter”** to calibrate the NH<sub>3</sub> channel to the NH<sub>3</sub> calibration gas. The message. Saving Parameter(s). Is briefly displayed to indicate that the NH<sub>3</sub> span coefficients have been calculated, stored, and are being used to correct the NH<sub>3</sub> reading.
- 5.4.28 Verify other levels of NH<sub>3</sub> concentration using the audit gas levels in section 5.6.2.
- 5.4.29 Press the “Menu” pushbutton two times to return to the “Main menu”. Move the cursor down and select “Calibration Factors” and press the “Enter” pushbutton. The NO and NO<sub>x</sub> “Background” and NO “Coefficient” will now be displayed. Enter these values in the logbook. Using the “down arrow” you may also observe the NO<sub>x</sub>, NO<sub>2</sub>, N<sub>t</sub> and NH<sub>3</sub> “Coefficient”. Record these values in the logbook.
- 5.4.30 Press the “Run” push button to return the analyzer display to the “operation” mode.
- 5.4.31 Press the “Enter” pushbutton to return the analyzer from “Local” to “Remote” operation.
- 5.4.32 Remove the multi-gas calibrator from the analyzer and reconnect the sample line to the analyzer, changing the particulate filter at this point, if and when needed.
- 5.4.33 Along with the logbook entries addressed above also record in the logbook:
- Monitoring site ambient “temperature and barometric pressure” (taken during period of site visit)
  - Observe and Note if “MET mph/deg” sensors appear to be operating properly and corresponds with the “data logger” display
  - Multi-gas calibrator and serial number used for calibrations
  - NO NIST traceable and NH<sub>3</sub> cylinder gas ID number(s) and expiration date, used for calibrations
  - Any maintenance or service to the site and its contents
  - The time period for which the operator has interrupted normal data collection and the reason of interruption.
- 5.4.34 Complete a “Precision/Audit, Void Hour” form, using the above information and supply it to the department’s data acquisition section.
- 5.4.35 Logbook entries are to be made in ink with date and initials of personnel. Corrections are to be struck with a single line and the entry personnel’s initials and date written along side. After each logbook page has been filled, the “carbon copy” should be removed and returned to the laboratory for archiving.

## 5.5 Full Scale checks

The analyzer “zero and full scale” output voltages will be checked on an annual basis. However it is a desirable to conduct this check prior to beginning a “multi-point” calibration.

- 5.5.1 From the analyzer front panel, select and press the “Enter” pushbutton to place the analyzer into the “Local” operation mode.



- 5.5.2 Press the “Menu” pushbutton and move the cursor down to select the “Diagnostics” menu. Press the “Enter” pushbutton.
- 5.5.3 Press the “down arrow” key to place the cursor at “Test analog outputs” and press the “Enter” pushbutton.
- 5.5.4 The cursor will be at the “Zero Output” selection. Press the “Enter” pushbutton to view “zero output” on the analyzer display and at the “electronic data logger” display.
- 5.5.5 Press the “up/down” arrow keys to correct the “zero output: if needed and press “Enter” to store the correction.
- 5.5.6 Monitor the input voltage to the datalogger with a calibrated voltmeter. Adjust the appropriate trim pot on the instrument “analog output card” to read 0.000VDC (if needed). See instrument instruction manual for details on analog adjustments.
- 5.5.7 Press the “**Menu**” pushbutton again to re-enter the “output selection” screen and move the cursor down to select “Full Scale Output” and press “**Enter**”.
- 5.5.8 Press the “**Enter**” pushbutton to view “Full Scale Output” on the analyzer display and at the electronic data logger” display.
- 5.5.9 Press the “up/down” arrow keys to correct the “full scale output” (if needed) and press “**Enter**” to store the correction.
- 5.5.10 Monitor the input voltage to the data logger with a calibrated voltmeter. Adjust the appropriate trim pot on the instrument “analog output card” to read 10.000 VDC (if needed). See instrument instruction manual for details on analog adjustments.
- 5.5.11 Continue this process, without making any analog adjustments, setting the instrument to several output voltages to check instrument linearity, (100, 75, 50 and 25% ranges are recommended).
- 5.5.12 If instrument voltages are not linear, consult data logger instruction manual for analog input voltage, calibration procedure.
- 5.5.13 Press the “**Menu**” pushbutton to return to the “Main Menu”.
- 5.5.14 Press the “**Run**” pushbutton to return to the “operate mode”.
- 5.5.15 Press the “**Enter**” pushbutton to return the analyzer to “Remote”.

## 5.6 Multi-Point Calibrations

Multi-point calibrations employ the same procedure and operation as those addressed above, with the exception that more calibration points/ranges are measured and the EPA/CFR designated calibration levels (increased by a factor of 2) must be included in the range selection. Quarterly multi-point calibrations will be performed with a multi-gas calibrator and NO-EPA protocol gas and NH<sub>3</sub> gas that are the same as that used to conduct routine “precision, span and calibration” checks. A minimum of 25% of the network’s monitors will have quarterly “audits” conducted using a multi-gas calibrator and NH<sub>3</sub> gas that is different than that used for precision, span and multi-point calibration checks. (See section 5.9) Minimum equilibration times for Ammonia measurement will apply as detailed earlier in this SOP(see 5.4.18).

- 5.6.1 Conduct the steps outlined in 5.4.19 through 5.4.31.
- 5.6.2 After completion of steps 5.4.19 through 5.4.31, adjust the multi-gas calibrator to supply calibration gas to the analyzer at levels for NO/NO<sub>x</sub> of at least:

Level #1	60-160 PPB
(Precision)	160-200 PPB
Level #2	300-400 PPB
Level #3	700-900 PPB
Level #4	1600-1800 PPB

- 5.6.3 Enter the known and measured values for the five point calibration (Zero and Levels 1-4) into the NH<sub>3</sub> multi-point calibration Excel spreadsheet -NOMultipt.xls . (See diagram for example of spreadsheet. The spreadsheet will calculate the relative percent difference (rpd), the least squares best fit line slope, intercept and r-squared value (rsq), measured value predicted from least squares slope (forecast), difference between the actual measured value and the predicted measured value (distance to least squares line), acceptable distance for the “distance to least squares line” and an indication of the point’s acceptability (pass/fail). This spreadsheet should be saved and printed out once the field operator arrives back at UHL with a copy going to the Senior Field Chemist and the file. Results of the known, measured and rpd values should also be entered in the site instrument log book.
- 5.6.4 Acceptance criteria for an NH<sub>3</sub> multipoint calibration are that all calibration points must be within  $\pm 2\%$  of full scale for the linear regression best fit straight line. (Quality Assurance Handbook for Air Pollution Measurement Systems Volume II MS 2.9.2) The NH<sub>3</sub> calibration spreadsheet will indicate if these criteria have been met. Should the criteria not be met for all points the Senior Field Chemist should be contacted and a Corrective Action form submitted for maintenance to bring the analyzer back into the range of this performance standard. A multipoint calibration showing acceptable performance must be conducted following this maintenance. Please use the maintenance and trouble shooting sections of the TECO manual and contact the Senior Field Chemist for guidance on proper maintenance procedures to follow.

NO/NOx Multi-Point Calibration  
Spreadsheet

**Analyzer:** TECO Model 17C  
**Serial No.:** 64178-342  
**Site:** Clarion  
**Full Scale:** 2000 ppb  
**2% of Full Scale:** 40 ppb  
**Date:** Jan. , 2003  
**Zero Set Pt Prior:** 0  
**Span Set Pt Prior:**  
**Zero Set Pt Post:** 0  
**Span Set Pt Post:**  
**Zero/Span Adjust Made?:**

NO Calibration	Known Conc.	Measured Conc.	rpdrpd	slopeslope	interceptintercept	rsqrsq	forecastforecast	distance to least squares linedistance to least squares line	acceptable distanceacceptable distance	Pass/FailPass/Fail
	0	0	n/a	0.9836	7.2025	0.9997	7.2025	7.2025	40.000	_____
	65	67	3.1%				71.1393	4.1393	40.000	_____
	165	167	1.2%				169.5037	2.5037	40.000	_____
	390	395	1.3%				390.8234	4.1766	40.000	_____
	800	814	1.8%				794.1171	19.8829	40.000	_____
	1650	1620	-1.8%				1630.2139	10.2139	40.000	_____

NOx Calibration	Known Conc.	Measured Conc.	rpdrpd	slopeslope	interceptintercept	rsqrsq	forecastforecast	distance to least squares linedistance to least squares line	acceptable distanceacceptable distance	Pass/FailPass/Fail
	0	0	n/a	0.9800	4.0806	0.9998	7.2025	7.2025	40.000	_____
	65	68	4.6%				71.1393	3.1393	40.000	_____
	165	164	-0.6%				169.5037	5.5037	40.000	_____
	390	382	-2.1%				390.8234	8.8234	40.000	_____
	800	805	0.6%				794.1171	10.8829	40.000	_____
	1650	1614	-2.2%				1630.2139	16.2139	40.000	_____

Nt Calibration	Known Conc.	Measured Conc.	rpdrpd	slopeslope	interceptintercept	rsqrsq	forecastforecast	distance to least squares linedistance to least squares line	acceptable distanceacceptable distance	Pass/FailPass/Fail
	0	0	n/a	0.9997	-0.4481	1.0000	7.2025	7.2025	40.000	_____

53	53.6	1.1%	59.3356	5.7356	40.000	_____
95	95.8	0.8%	100.6486	4.8486	40.000	_____
188	184.5	-1.9%	192.1275	7.6275	40.000	_____
399	398	-0.3%	399.6762	1.6762	40.000	_____
847	847	0.0%	840.3484	6.6516	40.000	_____

NO2 Impurity, ppb 79  
Ozone Flow, sccm 150  
GPT Flow, sccm 63.8

NO2 Calibration									
Known Conc.	Measured Conc.	rp	slope	intercept	rsq	forecast	distance to least squares line	acceptable distance	Pass/Fail
0	0	n/a	0.9998	-1.1405	1.0000	7.2025	7.2025	40.000	_____
53	52.9	-0.2%				59.3356	6.4356	40.000	_____
95	95	0.0%				100.6486	5.6486	40.000	_____
188	184	-2.1%				192.1275	8.1275	40.000	_____
399	396	-0.8%				399.6762	3.6762	40.000	_____
847	847	0.0%				840.3484	6.6516	40.000	_____

NH3 Calibration									
Known Conc.	Measured Conc.	rp	slope	intercept	rsq	forecast	distance to least squares line	acceptable distance	Pass/Fail
0	0	n/a	0.9997	-0.4481	1.0000	7.2025	7.2025	40.000	_____
53	53.6	1.1%				59.3356	5.7356	40.000	_____
95	95.8	0.8%				100.6486	4.8486	40.000	_____
188	184.5	-1.9%				192.1275	7.6275	40.000	_____
399	398	-0.3%				399.6762	1.6762	40.000	_____
847	847	0.0%				840.3484	6.6516	40.000	_____

## 5.7 Preventive Maintenance

Along with good laboratory practice, refer to Chapter 5 of the TECO Model 42 C Instruction Manual for routine preventive maintenance measures.

## 5.8 Quarterly Audits for Accuracy

On a quarterly basis, at least 25% of the network's NH<sub>3</sub> analyzers will have an accuracy audit conducted. Multi-point audits employ the same procedure and operation as those addressed in the zero/span section with the exception that more audit points/ranges are measured and the EPA designated audit levels must be included in the range selection. Quarterly multi-point audits will be performed with a multi-gas calibrator and NH<sub>3</sub> gas that is different from that used to conduct routine "precision, span and calibration" checks.

5.8.1 After completing the hook up of the audit calibrator to the input/sample line of the monitor to be audited, follow and conduct the steps outlined in 5.8.2 through 5.8.3.

5.8.2 Adjust the multi-gas calibrator to supply calibration gas to the analyzer at levels of at least:

Zero	0 PPB
Level #1	60-160 PPB
(Precision)	160-200 PPB (Optional)
Level #2	300-400 PPB
Level #3	700-900 PPB
Level #4	1600-1800 PPB

to check the NH<sub>3</sub> channel.

5.8.3 Calculate the percent difference between the known concentration and the measured concentration for all concentration levels. The following equation should be used for calculating the difference:

$$\% \text{ Difference} = \frac{\text{Measured} - \text{Known}}{\text{Known}} \times 100$$

If any % Difference is greater than 12% then a Corrective Action Request for maintenance should be initiated on the instrument to restore it to the method's operational specifications.

5.8.4 Record values for the known and measured concentrations and the % difference in the site instrument log book. The values for this quarterly audit should also be submitted to the Data Acquisition section for inclusion in the PARS data of the AIRS database.

Acceptability of the network's performance on Accuracy will be tracked using the 95% confidence level generated in the AIRS AMP 245 report.

- 5.8.5 Network acceptance values for accuracy are  $\pm 20\%$  for a yearly average. These values should be tracked on a minimum quarterly basis to assure that the  $\pm 20\%$  goal for the year is met.

<b>Summary of QA Procedures and Criteria for 17C Ammonia Monitors</b>			
<b>Requirement</b>	<b>Frequency</b>	<b>Acceptance</b>	<b>Notes</b>
Multi-Point Calibration with at least 5 points with each gas standard, NO, NO <sub>x</sub> and NH <sub>3</sub>	At least once per quarter, after failure of a QC check, after monitor maintenance	All points within 2% of full scale of the best fit straight line.	Zero gas and at least four upscale calibration points. 0-10%, 15-25%, 35-50%, 50-70%, & 70-90 of Full Scale
Zero and Span Check with NO and NH <sub>3</sub>	Every 2 weeks	Zero Drift $\pm 15$ ppb Span Drift $\pm 15\%$	Invalidate data to last acceptable zero/span check, adjust analyzer, and perform multipoint calibration.
Multipoint audit NH <sub>3</sub> only	25% of network per quarter	$\pm 15\%$ difference on any of 5 points	Corrective action request initiated
Precision Checks NO and NH <sub>3</sub>	Every 2 weeks	$\pm 12\%$	Recalibrate analyzer