

NCORE Meteorological Monitoring QA Plan
Section I

Electronic Calibration Branch Responsibilities

Approval Sign-Off Sheet

I certify that I have read and approve of the contents of this version of the "NCORE Meteorological Monitoring QA Plan, Section I, Electronic Calibration Branch Responsibilities" with an effective date of October 26, 2010. **Sign, date and return to the Ambient Monitoring Section Chief.**

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2.12.1 National Core (NCORE) Meteorological Monitoring QA Plan: ECB Responsibilities.

Note: The following is a list of "significant changes" from Revision 1.3.

- 1) QA updated per QAP/SOP 2.39 "Standard Operating Procedure (SOP) for Preparing Quality Assurance Plans/SOPs".
- 2) Project and Procedures Branch updates.

The U.S. EPA is currently implementing the National Ambient Air Monitoring Strategy (NAAMS). The NAAMS goals include improvement of the scientific and technical competency of the nation's air monitoring networks and increased value in protecting public health and the environment.

The North Carolina Ambient Meteorological Monitoring System must meet or exceed the requirement that meteorological data collected at all NCore stations, as stated in the Code of Federal Regulations (CFR) Chapter 40 Section 58, Appendix D.3.b. Effective January 1, 2011, two (2) meteorological calibrations are required per year at all NCore stations. The NC ambient meteorological monitoring system consists of the following:

1. Model 062 Temperature Sensor
2. Model 083C Relative Humidity Sensor
3. Model 010C Wind Speed Sensor
4. Model 020C Wind Direction Sensor

Note: minor components are not specified but included by reference.

The ECB is responsible for ensuring that all components are compatible with the meteorological measurement devices. The ECB is responsible for the performance of complete system evaluation prior to the field installation and that the system is fully functional at the completion of the installation. On an ongoing basis as needed the ECB provides equipment and instrumentation maintenance and operational support to maximize the collection of the highest quality ambient air pollution data possible in accordance with accepted and approved procedures.

The **Quality Assurance Handbook for Air Pollution Measurement Systems Vol. IV: Meteorological Measurements Version 2.0 (Final)**, is designed to provide clear and concise information and guidance to the State/Local/Tribal (SLT) air pollution control agencies that operate meteorological monitoring equipment and systems. Recently, the new monitoring rule was published, which establishes the requirements for meteorological monitoring in support of National Core (NCORE) network for items such as ambient temperature, relative humidity,

wind speed and wind direction. Other requirement items such as barometric pressure, solar radiation, uv radiation, precipitation and upper-air meteorology will not be discussed in this document.

2.12.1.1 Meteorological Monitoring Equipment

Selection and Procurement

The Electronics and Calibration Branch (ECB) of the Ambient Monitoring Section of the Division of Air Quality (DAQ) is responsible for the evaluation and procurement of ambient pollution monitoring equipment; installation of monitoring instrumentation, samplers, and support equipment; evaluation of the on-going performance of all state operated air pollution sampling and monitoring systems; and scheduled and unscheduled system maintenance. The ECB maintains a sufficient inventory of monitoring system instrumentation, support equipment, and replacement parts to minimize the loss of ambient air monitoring data for all ambient air monitoring equipment of the Ambient Monitoring Section.

The ECB is also responsible for procuring and maintaining dedicated traceable standards for the certification of all calibrators and the independent accuracy auditing of ambient air quality monitoring systems. These standards provide a direct link to established national standards and are the foundation for the collection of the highest quality ambient air pollution data possible in accordance with current procedures and existing Federal Regulations and Guidelines. The accuracy audits performed by ECB provide an ongoing evaluation of monitoring equipment performance and site operator adherence to approved operating procedures. The ECB maintains permanent records on all standards used in the calibration and auditing of all instrumentation and sampling equipment used in support of DAQ monitoring activities.

The ECB maintains permanent records for each meteorological site used to monitor ambient air quality in the state of NC. Each significant component of the meteorological monitoring system (wind direction indicators, wind speed indicators, thermometers, and relative humidity sensors) is assigned a dedicated unique (data logger) logbook. These logbook records include the complete repair records for the site instrumentation. These permanent records are updated continuously.

The ECB is also responsible for evaluating, developing, and recommending changes in equipment and operating parameters to improve the quality of data collected and procedures used in the collection of the data.

All original records (records documenting observations, i.e. calibration and audit logbook) must be legible, complete, dated, and signed by the operator and retained as part of the permanent instrument calibration record. The operator's signature on the calibration logbook form certifies

that the calibration has been performed in accordance with this QA/SOP and that the information contained on the form is accurate. All records will be reviewed and verified by the ECB Supervisor and audited by Raleigh Central Office.

2.12.1.1.1 Model 010C Wind Speed Sensor

The wind speed sensor uses a three-cup anemometer assembly and solid-optical link with a 40-slot chopper disk to produce a pulse output frequency proportional to the wind speed. An internal heater reduces moisture to extend bearing life. This sensor is usually used in conjunction with the 191 Cross arm Assembly. The sensor cable is connected directly to the data logger. The following table summarizes the performance and electrical specifications:

PERFORMANCE CHARACTERISTICS	
Maximum Operating Range	0-125 mph or 0-60 meters/sec
Starting speed	0.6 mph or 0.27 meters/sec
Calibrated range	0-100 mph or 0-50 meters/sec
Accuracy	1% or 0.15 mph
Temperature range	-50°C to +85°C
Response	Distance constant less than 5 feet of flow*
* The distance traveled by a sharp wind gust for the anemometer to reach 63% of the new wind speed value.	
ELECTRICAL CHARACTERISTICS	
Power requirements	12 VDC at 10 mA
Output signal	11-volt pulse
Output impedance	100 ohms maximum
Heater Power Requirement	12 VDC at 350 mA
Maximum cable length	300 feet

Installation

- a) Mount the cup assembly and secure with the allen-head setscrew and check to see that the cup assembly rotates freely.
- b) Install the sensor in the end of the Model 191 Mounting Arm (the end without the bushing).
- c) Tighten the locking setscrews. **Do not over tighten**. Apply a small amount of silicone grease to the setscrews to prevent freezing in corrosive environments.
- d) Connect the cable assembly to the keyed sensor receptacle and attach it to the mounting arm. (Refer to Met One operations manual, 010C Wind Speed Sensor Fig. 2-1).
- e) Connect the six wires on the cable from the 2 meter and 10 meter wind speed sensors to the ESC data logger. (Refer to Met One operations manual, Connections section drawing SID-1019 and SID-1021).
- f) Weather sensors are sensitive to direct or nearby lightning strikes. A well-grounded metal rod or frame should be placed above the sensor installation. In addition, the shield on the signal cable leading to the translator must be connected to a good earth ground at the translator end and the cable route should not be vulnerable to lightning.

Operational Check

- a) Spinning the anemometer cup assembly will produce output pulses (40 pulses per revolution). To verify sensor output, monitor this signal with the translator module, data logger or an oscilloscope. Spinning the anemometer hub without the cup assembly mounted and allowing it to coast to a stop will give a good indication of the threshold performance; a jerky or sudden stop indicates damaged bearings, bent drive shaft or obstruction in the light chopper.
- b) Inspect the cup assembly for loose cup arms or other damage. The cup assembly cannot change calibration unless a mechanical part has come loose or has been broken. If a cup arm is loose or broken, the calibration of the sensor may be affected.
- c) Check the internal heater operation by sliding the sensor cover down and touching the housing behind the printed circuit board. The housing should feel warmer than the adjoining metal parts. The sensor has a built-in heater that is designed to provide a raise in the internal temperature, providing a small positive pressure. This heater requires an external 12V (@500ma) power supply.

Maintenance, 6-12 Month Interval

- a) At the cross arm assembly, disconnect the quick disconnect plug from the sensor (leave the cable secured to the cross arm) and remove the sensor from the cross arm assembly.
 - b) Loosen the setscrew holding the cup assembly. Support the rotating hub of the sensor with one hand and pull the anemometer cup assembly free.
 - c) Visually inspect the anemometer cups for cracks and breaks, and make sure each arm is securely attached to the cup assembly hub.
 - d) Slide the sensor cover down to expose the light chopper disc assembly, light source and the detector and circuit board. Inspect the interior of the sensor for any signs of corrosion and dust buildup. Inspect the light-chopper for cracks and make sure all slots are free of corrosion. Inspect the signal conditioning module for cracks and corrosion around the soldered connections. Repair or replace any bad components.
 - e) Apply a small amount of silicone lubricant (Dow Corning DC-33 or equivalent) to the sensor o-rings. Slide the cover up over the sensor and remove any excess lubricant.
 - f) A moisture vent is located on the base of the sensor; make sure this vent is clear.
 - g) Reinstall the sensor and verify proper operation and sensor output per Section 2.12.1.1.1
- Operational Check**

Maintenance, 12-24 Month Interval

- a) Recommend complete overhaul of sensor. This maintenance may be provided by the factory or in-house. Section "b)" provides instructions for maintenance of the wind speed sensor.
- b) **Maintenance**
The following procedures require a relatively clean, dry work area, a source of 12 VDC power at approximately 20 mA, and an oscilloscope (DC to 10 KHz minimum range required). The following sections assume the sensor has already been removed from the tower and the cup assembly removed. Also, the appendix contains a list of parts for this sensor.
- c) **Sensor Bearing Replacement (Refer to Met One operations manual 010C Wind Speed Sensor, Section, 4.4 and Table 4.2)**

Disassemble the sensor and remove the old bearings by the following steps:

1. Slide the sensor cover (16) down to expose the light chopper assembly (11).
2. Loosen both special setscrews on the shaft of the light chopper assembly (11)
3. Support the light chopper assembly (10) with one hand and slowly pull the rotating hub/shaft assembly (2) out of the assembly (8).
4. Remove the shield (4) and slinger (5) from the column (8).
5. Remove the light-chopper assembly (10) from the sensor housing, being careful not to damage the slots located between the light chopper holder and the lower bearing.
6. Insert the lower end of the rotating hub/shaft assembly into the upper bearing, cock it slightly to one side and push out the lower bearing.
7. Insert a right-angle type of tool, such as an Allen wrench, into the upper bearing: cock it slightly to one side and remove the bearing.
8. Clean dirt from the bearing using a cotton swab and alcohol.

Install the new bearings and assemble the sensor as follows:

1. Install the new upper and lower bearings in the column (8). Bearings should slide easily into the bearing bores.
2. Install the slinger and shield (4,5) on the column assembly. Replace the damaged or corroded parts with new parts.
3. Insert the rotating hub shaft (2) into the column assembly (8) through the shield (4), slinger and upper bearing, until it starts to protrude through the lower bearing.
4. Support the light-chopper assembly (10) with one hand and slowly push the rotating hub shaft into it until the shaft almost bottoms.
5. Tighten both special setscrews on the light-chopper assembly, but do not over tighten as the setscrews will damage the shaft.
6. Rotate the sensor hub assembly (2) to ensure it turns freely and the end play is about 0.005.
7. Hold the sensor vertically and make sure the light-chopper assembly (10) is not contacting the detector assembly (12).
8. Apply small amount of silicone lubricant (Dow Corning DC-33 or equivalent) to the sensor O-rings and slide the cover (16) up over the sensor and remove any excess lubricant.

d) C1200 Circuit Board Assembly Replacement (Refer to Met One operations manual 010C Wind Speed Sensor, Section 4.5, Table 4.2 and Drawing 1202)

1. Slide the sensor cover (16) down to expose the light-chopper disc assembly (10), detector assembly (12) and the circuit board (18).
2. Remove the two screws (17) holding the circuit board assembly (18) and lift the circuit board away from the sensor housing.

3. Note the colors of each wire and unsolder the three wires to the detector assembly from the circuit board and the three wires from the connector (19).
 4. Install new circuit board assembly by reversing the above steps and following the wire color code.
- e) Detector Assembly Replacement (Refer to Met One operations manual 010C Wind Speed Sensor, Section 4.6, Table 4.2 and Drawing 1202)
1. Slide the sensor cover (16) down to expose the light-chopper disc assembly (10), detector assembly (12) and the circuit board (18).
 2. Remove the two screws (17) holding the circuit board assembly (18) and lift the circuit board away from the sensor housing.
 3. Note the color of each wire and unsolder the three wires to the detector assembly from the circuit board (18).
 4. Remove the two screws (20) holding the detector assembly (12) and remove the assembly.
 5. Install the new detector assembly and re-assemble by reversing the above steps and following the wire color coding.
- f) Integrated Amplifier Replacement (Refer to Met One operations manual 010C Wind Speed Sensor, Section 4.6, Table 4.2 and Drawing 1202)
1. Slide the sensor cover (16) down to expose the light-chopper disc assembly (10), detector assembly (12) and the circuit board (18).
 2. Carefully pry the amplifier (23) from its socket on the circuit board noting Pin 1 orientation.
 3. Install replacement integrated amplifier by reversing the above steps, being sure Pin 1 is properly oriented.

Model 010C Wind Speed Sensor Troubleshooting Chart

Symptom	Probable Cause	Solution
No wind Speed output	Loss of supply voltage	Check translator +12V supply & connecting cables
	Faulty integrated amplifier	Replace IC amplifier
	Faulty diodes D1, D2	Replace circuit board
	Faulty detector	Replace detector
No wind speed output below 2-5 mph	Bad bearings	Replace bearings
	Faulty detector	Replace detector
Wind speed signal drops out as speed increases	Faulty detector	Faulty detector

2.12.1.1.1a Wind Speed Calibrations

Calibration Frequencies

Calibrations are required on the wind speed sensor at site startups, sensor repairs or adjustments that will affect the response or data. Also calibrations are required after any unacceptable QA audit. Bi-annual wind speed calibrations are required at all NCore stations. The audit and calibrations can be performed together using different standards and different electronic technicians. This reduces the collection of invalid data, sensor down time and assistance from site operators.

Wind Speed Calibrations Devices

The wind speed calibration device is a Model 053 Wind Speed Calibrator. It consist of a variable speed motor, a electronic control and display module, a sensor clamp assembly to mount the motor and couplings to connect the motor to the shaft. The wind speed calibrator produces known revolutions per minute (RPM) of shaft speed to the wind speed sensor. The shaft speed in RPM's is used to calculate the wind speed in meters per second.

The wind speed starting torque device is a Model 050 Torque Gauge. It consists of a balance wheel and precision counter weights. The gauge is traceable to NIST MIL-STD-45662A specifications.

Calibration Procedure

- a) The calibration begins by removing the wind speed anemometer cup assembly from the sensor. The wind speed calibrator motor drive is then positioned on the sensor to spin the wind speed sensor's shaft. Care must be exercised to properly align the wind speed calibrator motor drive directly over the shaft. This will prevent any strain to the calibrator motor or the shaft. The coupling from the calibrator motor drive to the shaft should be centered. Connect the calibrator motor drive cable to the electronic control module. The calibrator is now ready to begin the calibration.
- b) The calibration speeds to calibrate a Met One 010C wind speed sensor are 0.0, 100, 200, 400 and 800 RPM. The 0.0 RPM is produced with the control module turned off. The upscale points are generated with the control module turned on and the direction switch is set on clockwise rotation. The push wheel switches are toggled to produce the desired reading on the 4 digit LCD starting with the lowest setting first. The motor and control module should stabilize within a one-minute period to the input setting. If the readout is not within +/- 1 RPM on the control module LCD stop the audit and investigate problem. Problem is usually improper alignment of motor drive or weak control module batteries. Once the control module LCD is stable, view the data logger wind speed value. If data logger wind speed reading is stable at this point record the value. Adjust the push wheel switch for the next point and repeat measurement process. Continue the calibration until all points are generated and the wind speed response is recorded from the data logger.
- c) Turn off the control module power, disassemble the motor drive and remove the sensor clamp assembly. Remove the sensor cable from the wind speed sensor and remove the sensor from the cross arm mount.
- d) Install the 050-torque balance wheel on the wind speed sensor shaft to verify the starting torque. Screw a black nylon screw into the 2 cm position of the balance wheel. Lay the sensor in a horizontal position and hold the balance wheel level. Release the balance wheel and watch for a downward deflection caused by the nylon screw. Rotate the wind speed sensor 90 degrees and level balance wheel. Release the balance wheel and watch for the deflection caused by the nylon screw. Repeat measurements until the sensor is tested at four evenly spaced points around the sensor's shaft. If there is no downward deflections at any test points the counter weight must be increased by 0.1 gm-cm until there is downward movement. Do not exceed 0.4 gm-cm counterweight since starting torque specifications have been exceeded. Record the highest value tested.

- e) Reinstall the wind speed sensor to the cross arm mount and reconnect the signal cable. Install the anemometer cups to the wind speed sensor. The wind speed calibration is now complete.

- f) Calculate the calibration input values from the formula given below and found on the field calibration form (**Figure 1**). The calibration is considered acceptable if each wind speed value is within +/- 0.5 meters per second from the calibration input value. The audited sensor starting torque threshold is acceptable if all measured points are less than 0.2 grams per centimeter. If any measurements do not meet the acceptable specifications for a wind speed calibration the sensor must be evaluated by the technician. The technician will examine the sensor, make necessary repairs and recalibrate the sensor. The calibration data and recommendations will be included a calibration report.

$$\text{Calibration Input Wind Speed m/sec} = \left(\frac{\text{LCD RPM}}{37.522569} \right) + 0.27$$

Figure 1 Wind Speed Cal/Audit

Wind Speed: Calibration ____ Audit ____

Site _____	Date _____
Start Time _____	Stop Time _____
Sensor Model _____	Sensor SN _____
Torque Gauge _____	Device SN _____
Calibration Device _____	Device SN _____

RPM	Input Speed (m/sec)	Data logger speed (m/sec)	Difference
0.0			
100.0			
200.0			
400.0			
800.0			

Measured Sensor Torque _____ gms/cm Specifications _____

$$\text{Calibration Wind Speed meters / second} = \left(\frac{\text{LCD RPM}}{37.522569} \right) + 0.27$$

Difference = Data logger speed - input speed

Acceptable: Yes ____ No ____ Auditor _____

Each single point measurement must be within ±0.25m/s ≤5m/s; 5% >2m/s not to exceed 2.5m/s of input value for calibration to be acceptable

2.12.1.1.2 Model 020C Wind Direction Sensor

The wind direction sensor uses a lightweight airfoil vane and a micro torque potentiometer to produce an analog output proportional to the wind direction. An internal heater reduces moisture for extended bearing life. The sensor is used in conjunction with the 191 Cross arm Assembly. This sensor is connected to the data logger using the 2465 sensor cable. The following table summarizes the performance and electrical specifications:

PERFORMANCE CHARACTERISTICS	
Azimuth	Electrical 0 – 356° Mechanical 0 – 360°
Threshold	0.6 mph
Linearity	± 0.5% of full scale
Accuracy	± 2°
Damping Ratio	0.4 - 0.6
Delay Distance	less than 3 feet
Temperature range	-50°C to +85°C
ELECTRICAL CHARACTERISTICS	
Input Power (+VRef)	5VDC (max) with 5 mA current limiting
Output	Varying resistance 0-10k ohms
Maximum line length	1500 feet
Heater power requirement	12VDC at 350 mA

Installation

- a) Install the vane assembly on the sensor (note the locator pin fits into the slot in the vane assembly hub) and tighten the setscrew. Do not over tighten. (Refer to Met One operations manual 020C Wind Direction Sensor, Section 2.1, Table 4-3, Fig. 2-1, and Drawing 2465).
- b) Check to see if the vane assembly rotates freely.
- c) Ensure the vane assembly is properly balanced and the balance counterweight is tight.

- d) Install the sensor in the Model 191 Mounting Arm with the keyed bushing. The orientation screw on the stem of the wind direction sensor will fit into the hole on the mounting bushing.
- e) The aluminum fitting has two recessed setscrews that may require tightening to further secure the sensor. Over-tightening these screws may strip out the head, making it virtually impossible to remove. Apply a small amount of silicone grease to prevent freezing in corrosive environments.
- f) Connect the cable assembly to the keyed sensor receptacle and attach it to the mounting arm.
- g) Model 020C Wind Direction Sensor Alignment (Refer to Met One operations manual 020C Wind Direction Sensor, Section 2-2, Table 4-3, Fig. 2-1 and Drawing 2465). The orientation pin located on the stem of the sensor is to be oriented so it points true south. This means that the wind direction orientation must account for the difference between magnetic and true north.
- h) Tape the sensor hub and column together so the notches on each part are exactly aligned.
- i) Loosen the two setscrews in the aluminum fitting so the sensor and mounting bushing may be rotated.
- j) Rotate the sensor so the vane (counter-weight end) points directly south. A transit located directly south or north will facilitate the alignment process. Merely rotate the sensor until the vane (counter weight and sensor column) point south.
- k) Tighten the two setscrews in the aluminum fitting and remove the orientation device. Apply a small amount of silicone grease to the screws to prevent freezing in the aluminum fitting. The sensor may now be removed and re-installed at any time without requiring orientation.
- l) Connect the five wires on the cable from the 2 meter and 10 meter wind direction sensors to the ESC data logger.(Refer to Met One operations manual 020C Connections Section, SID-1020 and SID-1022).
- m) Weather sensors are sensitive to direct or nearby lightning strikes. A well-grounded metal rod or frame should be placed above the sensor installation. In addition, the shield on the signal cable leading to the translator must be connected to a good earth ground at the translator end and the cable route should not be vulnerable to lightning.

Operational Checkout

- a) With the sensor connected to the input, any movement of the vane in a clockwise direction (as seen from above) will result in a positive voltage output. Movement of the sensor's output will progress up-scale until it reaches + Vref, then the output voltage will drop to 0 volts. Continued clockwise rotation will again bring the module's output voltage to +Vref and the action can be repeated. When the notch on the hub and the column of the sensor are exactly aligned, the output signal will correspond to 180° or 50% of Vref.
- b) Check the internal heater operation by sliding the sensor cover up and touching the housing. The housing should feel warmer than the adjoining metals parts.

Maintenance, 6-12 Month Interval

- a) At the cross arm assembly, disconnect the quick disconnect connector from the sensor (leave the cable secured to the cross arm). Remove the sensor from the cross arm assembly bushing. (Refer to Met One operations manual 021C Wind Direction Sensor, Section 4.2, Table 4-3, Fig. 2-1, and Drawing 2465).
- b) Support the rotating hub of the sensor with one hand and pull the vane assembly free.
- c) Visually inspect the wind vane assembly to ensure the wind vane and counterweight are securely attached to the wind vane rod, and the setscrew in the rotating hub holds the rod in place.
- d) Carefully slide the sensor cover down to expose the potentiometer assembly. Inspect the interior of the sensor for any signs of corrosion. Also, inspect the potentiometer for loose wires, cracks and corrosion.
- e) Inspect the shaft coupler for proper position. Make sure the marks on the rotating hub and the column assembly are aligned and all four special setscrews are tight.

NOTE: Any time the coupler assembly is moved in relation to the shaft, the potentiometer alignment must be performed.
- f) Rotate the sensor hub assembly to make sure it turns freely and the sensor bearings are not damaged. If rotation is not free, inspect the bearings and replace if necessary.
- g) Check to ensure the potentiometer assembly is rigid in its holder.
- h) Check the sensor O-rings for cracks. Replace as necessary. Apply a small amount of silicone lubricant (Dow Corning DC-33 or equivalent) to the sensor O-rings seals. Slide

the cover over the sensor and wipe off any excess lubricant.

- i) Support the rotating hub of the sensor with one hand and mount the wind vane assembly on the hub. The wind vane assembly is keyed to fit the pin on the hub. Make sure the moisture vent located on the base of the sensor is unobstructed.
- j) Re-install the sensor and verify proper operations per Section 2.12.1.1.2 **Installation and Operational Checkout**.

Maintenance, 12-24 Month Interval

- a) Replace sensor bearings

Maintenance, 24-36 Month Interval

- a) Recommend complete overhaul of the sensor. This maintenance may be provided by the factory or done in-house. Section "b)" provides instructions for maintenance of the wind direction sensor.
- b) **Maintenance**
The following procedure requires a relatively clean, dry work area, a source of 5V DC power at approximately 5 mA, and a digital voltmeter. The following sections assume the sensor has already been removed from the tower and the vane assembly removed. (Refer to Met One operations manual 021C Wind Direction Sensor, Section 4.1, 4.2, 4.3, 4.4, Table 4-3, Figure 2-1, and Drawing 2465).
- c) **Sensor Bearing Replacement.**
 - 1. Slide the sensor cover (14) down to expose the horizontal potentiometer assembly (9).
 - 2. Make sure the two lower special setscrews on the drive coupler (15) next to the potentiometer are tight. Loosen the two upper special setscrews.
NOTE: Any time the coupler assembly is moved in relation to the shaft, the alignment must be performed.
 - 3. Slowly pull the rotating hub shaft assembly (2.7) from the column.
 - 4. Remove the shield (4) and slinger (5) from the column.
 - 5. Insert a right-angle type of tool, such as an allen wrench, into the bearing cocking it slightly to one side and remove the bearing (5). Clean any dirt from the bearing

bores using a cotton swab and alcohol.

6. Install a new upper bearing in the column assembly. The bearing should slide easily into the bearing bore.

CAUTION: Do not lubricate Bearing. Do not force.

7. Install the slinger (5) and the shield (4) on the column assembly. If the parts are damaged or corroded, they should be replaced.
8. Insert the rotating hub shaft assembly (2,7) into the column assembly through the shield (4), slinger (5) and the bearing (6).
9. Support the drive coupler (15) with one hand and slowly push the rotating hub shaft (2,7) until the shaft bottoms.
10. Recalibrate the sensor.
11. Replace the vane assembly and place back on tower.

d) Potentiometer replacement (Refer to Met One operations manual 020C Wind Direction Sensor, Section 4.2, 4.4, 4.6, Table 4-3, Figure 2-1, and Drawing 2465).

1. Carefully slide the sensor cover (14) down to expose the horizontal potentiometer assembly (9). Unsolder these wires to the potentiometer (note color code for re-installation).
2. Loosen the two lower setscrews closest to the potentiometer in the drive coupler (15).
3. Using a pencil, mark the approximate position of the right-hand potentiometer terminal on the pot support.
4. Loosen the two setscrews on the potentiometer adapter and remove the potentiometer.
5. Install the new potentiometer. Tighten the potentiometer into the adapter using the two screws. Tighten 3 turns after finger tight.
6. Re-calibrate the sensor.
7. Replace the vane assembly and install on the tower.

Model 020C Wind Direction Sensor Troubleshooting Chart

SYMPTOM	PROBABLE CAUSE	SOLUTION
No wind direction output	Loss of supply voltage	Check supply cables
	Faulty potentiometer	Replace potentiometer
No change in wind direction output below 2-5 mph	Bad bearings	Replace bearings

2.12.1.1.2a Wind Direction Calibration

Calibration Frequencies

Calibrations are required on the wind direction sensor at site startup and after sensor repairs or adjustments that will affect the data. Also calibrations will be required after any unacceptable Q.A. audit. Bi-annual wind direction calibrations are required at all NCore stations. The audit and calibrations can be performed together using different standards and different electronic technicians. This helps in reducing invalid data collection, down data logger channels for sensor calibrations and audits.

Wind Direction Calibration Devices

A wind direction calibration device used is a Model 040 wind direction calibrator. The device is a directional wheel marked from 0.0 degrees to 360 degrees and is mounted on the wind direction sensor body near the hub. A pointer arm is then attached to the wind direction sensor’s hub. The pointer is used to read the calibration direction from the directional wheel.

The wind direction starting torque device is a Model 050 Torque Gauge. It consists of a balance wheel and precision counter weights. The gauge is traceable to NIST MIL-STD-45662A specifications.

A surveyor’s transit can be used to calibrate the wind direction. It will be used to set the reference hubs at 180 degrees from the wind direction sensor. The transit sighting scope will be set to a known direction by using the compass and adjusting for the magnetic declination of the site.

A wind direction calibration device is a model 042 telescopic sight orientation device. The telescopic sighting scope is used to align the 191 cross arm locking hub. The wind direction sensor when mounted into the locking hub will be oriented to 180 degrees. A reference hub of 180 degrees from the wind direction sensor must be established before the scope can be used.

Calibration Procedure

- a) The calibration begins by finding the direction of the wind direction sensor. A transit can be used approximately 100 feet from the met tower. To avoid possible errors in the calibration secure the transit tripod firmly in the ground to prevent movement of the transit when observing the wind vane. Check and double check the transit bubble levels and horizontal scales for correct adjustments. The transit horizontal direction scales are set to true North with the compass needle set on magnetic North for the site location. The magnetic declination for the site can be obtained from a USGS office or the nearest airport. The transit compass can be read to within 0.5 degrees using a magnifier lens. With the transit referenced to true North, release the upper direction scale and sight the wind direction vane in the transit sighting scope cross hairs. The wind vane is taped to fix the vane's position once the vane is centered horizontally in the sighting scope's cross hairs. The wind direction sensor's direction value is then read from the data logger and recorded as found direction. The calibration direction is read from the transit horizontal direction scale. The reading must be corrected by adding 180 degrees if the scale reading is less than 180 degrees or subtracting 180 degrees if the scale reading is more than 180 degrees. The correction is done to correct for the reverse shooting of the wind direction vane from the transit.
- b) To calibrate the direction, a reference hub must be located 180 degrees from the wind direction sensor. The transit is used to establish this point and mark it with a stake. With the transit set to true north and the wind direction sensor located 180 degrees from the transit the reference hub point is found. The reference hub stake is set in the vertical cross hairs of the transit telescopic sight. The wind direction sensor must be in the same vertical line of the cross hairs. If not the transit is moved in an arc from the sensor until all the above conditions are satisfied. The reference hub has now been established. If the reference hub is found disturbed it must be reestablished with the transit before it can be used for calibrations.
- c) Disconnect the wind direction sensor cable from the sensor. Remove wind vane from the sensor and then remove the sensor from the cross arm hub. Insert the 042 sighting scope into the 191 cross arm hub and secure with the locking screw to the hub. The hub setscrews are loosened so the hub can be rotated. The hub is rotated until the vertical cross hairs of the sighting scope are in line with the reference hub. The cross arm hub is then locked with the hub setscrews. Recheck the alignment with the reference hub and readjust the cross arm hub if needed. When the cross hub is referenced to the reference hub the scope is removed from the cross arm hub. The wind direction sensor is inserted into the cross arm hub and set with the sensor setscrew. The wind direction sensor is now oriented to 180 degrees. The signal cable is connected to the wind direction sensor. The sensor's hub and stem alignment marks are then taped together so the sensor direction is

set to 180 degrees. Observe the data logger and record the wind direction reading as the system calibration.

- d) The wind direction vane and the signal cable are then disconnected from the wind direction sensor. The sensor is then removed from the cross arm hub. The Model 040 wind direction calibrator is then set up on the sensor and the signal cable is reconnected. The wind direction sensor's hub is rotated until the wind direction response is reading 180 degrees +/- 2.0 degrees on the data logger. The hub position is then taped fixed. The directional wheel is then set to the pointer to read 180 degrees on the directional wheel. The wind direction calibrator is now setup to perform the wind direction sensor calibration. The data logger wind direction value is read and recorded for the calibration input direction of 180 degrees. The tape is then removed from the hub. The hub can now be turned using the calibrator pointer to the other calibration points of 270, 360, 10, 90 and 180 degrees located on the directional wheel. All values are read from the data logger and recorded. After all points are performed the calibrator is removed and the signal cable disconnected.
- e) Install the 050-torque balance wheel on the wind direction sensor shaft to verify the starting torque. Screw a stainless steel screw into the 4 cm and the 2 cm position of the balance wheel. Screw a black nylon screw into the 5 cm position of the balance wheel. Lay the sensor in a horizontal position and hold the balance wheel level. Release the balance wheel and watch for a downward deflection caused by the screws. Rotate the wind direction sensor 90 degrees and level the balance wheel. Release the balance wheel and watch for the deflection caused by the screws. Repeat the measurements until the sensor is tested at four evenly spaced points around the sensor's shaft. If there are no downward deflections at any test points the counter weight must be increased by 0.5 gm/cm until there is downward movement. Do not exceed 9.0gm/cm counterweight since starting torque specifications have been exceeded. Record the highest value tested
- f) Reinstall the wind direction sensor to the cross arm mount and reconnect the signal cable. Install the wind vane to the wind direction sensor. The wind direction calibration is now complete.
- g) All wind direction calibration values are recorded on the field audit form (**Figure 2**). The system direction calibration performed with the transit or 042 sighting scope is acceptable if the wind direction response is within +/- 5.0 degrees from the transit's direction or +/- 5.0 degrees of the reference hub. The wind direction sensor calibration is considered acceptable if each wind direction value is within +/- 3.0 degrees from the calibration input value. The sensor starting torque threshold is acceptable if all measured points are less than 6.5 grams per centimeter. If any measurements do not meet the acceptable specifications for a wind speed calibration the sensor must be evaluated by the technician.

The electronics technician will examine the sensor, make necessary repairs and recalibrate the sensor. The calibration data and recommendations will be included in an audit report.

Figure 2 Wind Direction Cal / Audit

Wind Direction: Calibration ____ Audit ____

Site _____	Date _____
Start Time _____	Stop Time _____
Sensor Model _____	Sensor SN _____
Torque Gauge _____	Device SN _____
Calibration Device _____	Device SN _____
Transit _____	Device SN _____

System Calibration Direction _____ Degrees System Value _____ Degrees

Wind Direction Sensor Calibration

Input Direction (Deg)	Data logger Direction (Deg)	Difference

Measured Sensor Torque _____ gms/cm Specifications <6.5 gms/cm

Acceptable: Yes___ No___ Auditor _____

The system calibration must be within +/- 5.0 degrees of calibration direction for the calibration to be acceptable

Each single point sensor calibration measurements must be within +/- 3.0 degrees of input value for the calibration to be acceptable

2.12.1.1.3 Model 062 Temperature Sensor

The temperature sensor is a precision thermistor temperature instrument. The sensor produces a resistance change inversely proportional to the temperature. For the most accurate air temperature measurements, the sensor is mounted in the Model 327C Aspirated Radiation Shield which minimizes errors caused by solar and terrestrial radiation heating. The Model 327C Aspirated Radiation Shield includes a blower aspirated, shielded enclosure integrated into the support arm. The Model 062 temperature sensor is surrounded by a cylindrical shield with a high surface-to-mass ratio. The inner shield is fabricated from 0.003 inch stainless steel. Surrounding the inner shield is a second cylindrical shield manufactured from 0.062 inch aluminum. This outer shield is of a different material than the inner shield to reduce the effect of secondary radiation and also serves to provide mechanical protection for the assembly. A third shielding element, umbrella shaped, is included for further reduction of solar radiation error. An intake baffle shields the temperature sensor from reflected radiation and ensures the air sample is drawn into the aspirator with minimum vertical disturbance. The blower is mounted at the opposite end of the mounting arm. The aspirator uses a small fan blower, driven by a totally enclosed synchronous motor. The motor has a lifetime-lubricated bearing and there are no brushes requiring maintenance.

TEMPERATURE SENSOR SPECIFICATIONS	
Maximum Range	-50° to +50°C
Linearity	□0.15 ° C
Accuracy	□0.1 ° C
Time constant	10 seconds
ASPIRATED RADIATION SHIELD SPECIFICATIONS	
Shielding	Under test radiation intensity of 1.56 gm-calories/cm ² radiation errors less than 0.1 ° C
Aspiration Rate	6 M/S
Air Flow Switch	4 M/S
Aspirator Motor Power	115V AC, 0.25A
Operating Range	-40 ° C to +65 ° C

Installation

- a) Assemble the retaining bracket for the temperature sensor to mount on the mounting butts located in the neck of the shield assembly. Mount the temperature sensor to the supplied clip assembly. (Refer to Met One operations manual, 327C Aspirated Radiation Shields, Section 2.0, 4.2, 4.3, Table 4-3, Fig. 2, Figure 5a, Figure 6, Figure 7, Figure 8, Connection Section SID-1018, SID-1023, SID-2008).

CAUTION: Lower tip of the sensor must not fall lower than 3-5 inches from under side of the umbrella shield. If the sensor tip falls below this point, remount. Failure to do so may result in temperature reading errors exceeding specifications during periods of maximum solar radiation.

- b) Connect the temperature sensor wire leads and thread through the air duct assembly. The shield assembly utilizes a bayonet style mounting with a single retaining screw.
- c) Mount the motor assembly to the air duct assembly ensuring the exhaust port of the motor assembly faces down.
- d) Mount the shield with the aspirator blower on one side of the tower and the sensor cavity balanced on the other side. Use U-bolts to secure the shield to the tower.
- e) The leads from the temperature sensor run through the inside of the duct assembly and out the rubber grommet on the bottom side of the duct to the ESC data logger. Connect the radiation shield temperature sensors (2 M and 10 M) to the ESC data logger. (Refer to Met One operations manual Connection Section SID-1018).
- f) The radiation shield motor power connections are made by utilizing the supplied junction box. Make all required wiring connections. (Refer to Met One operations manual, 327C Aspirated Radiation Shields, Figure 5a, Connection Section SID-1023, SID-2008). The blower switch is shown in the no air flow state. That is, the normally open contacts are open and the normally closed contacts are closed. When the proper air flow is reached, the switch changes state and the normally open contacts (pins 6 and 7 or colors blue and orange) close. The contacts will close at an air flow of about 4 m/sec and normal air flow is about 6 m/sec.

2.12.1.1.3a Ambient Temperature and Delta Temperature Measurement Calibration

The sensor is tested for calibration conformity at the factory. Field calibration may be verified by testing and comparison with a known standard. It is not possible to make alterations to the sensor's calibration, as it is fixed.

Temperature Verification Devices

- a) The temperature verification device is a ETI Model 3101 Dry Well. The dry well is traceable to NIST specifications.
- b) A verification device can be mercury in glass thermometer. The audit thermometer must have scale divisions of 0.1 degrees Celsius and be NIST traceable.

Calibration Procedure

- a) The calibration of ambient temperature sensors and delta temperature must be done very carefully to avoid errors that can be introduced in the testing method. The testing method is measuring the temperatures of 0° C (32° F), 20° C (68° F), and 40° C (104° F). The probes must be allowed to equilibrate to the different temperature settings before the readings are taken.
- b) To perform the calibrations, the thermistor probes must be removed from their aspirated radiation shields. First remove the shield from the support arm and removing the thermistor probe from the mounting plate. The signal cable is then fed through the support arm until the thermistor probes can be submersed into the temperature dry well.
- c) The calibration begins with the thermistor probes submersed in the ETI Dry Well. Configure the dry well to measure (0° C, 32 ° F). Let the thermistor probes stabilize for about 30 minutes. Read and record the RTD temperature (**Figure 3**) of the LCD display in degrees Fahrenheit. Record at the same time the temperature of the thermistor probes and the delta temperature from the data logger.
- d) Configure the dry well to measure (20° C, 68 ° F). Let the thermistor probes stabilize for about 30 minutes. Read and record the RTD temperature (**Figure 3**) of the LCD display in degrees Fahrenheit. Record at the same time the temperature of the thermistor probes and the delta temperature from the data logger.
- e) Configure the dry well to measure (40° C, 108 ° F). Let the thermistor probes stabilize for about 30 minutes. Read and record the RTD temperature (**Figure 3**) of the LCD display in degrees Fahrenheit. Record at the same time the temperature of the thermistor probes and the delta temperature from the data logger.
- f) Remove the thermistor probes from the dry well. Reinstall the sensors to the mounting plate in the aspirated shield by carefully pulling signal cable back through the support arm until probe can be attached. Attach the aspirated radiation shield to the support arm and secure with the setscrew. The temperature sensors are now ready to go back on line.
- g) Record all data logger and readings for the verification on the calibration form (**Figure 3**). Perform calculations given below and on the form to determine the verification accuracy of the temperature sensors and delta temperature.

Calculations

ETI dry well temperature - sensor temperature data logger = temperature difference

10 meter sensor - 2 meter sensor = sensors = delta difference

Delta temperature data logger – sensors = delta difference = delta temperature difference

Figure 3 Ambient / Delta Temperature Cal/Audit

Ambient Temperature and Delta Temperature: Calibration ____ Audit ____

Site _____	Date _____
Start Time _____	Stop Time _____
Sensor Model 2 meters _____	Sensor SN _____
Sensor Model 10 Meters _____	Sensor SN _____
Calibration Device (ETI 3101) _____	Device SN _____

Input Tests Points >	0°C (32 °F)	20°C (68 °F)	40°C (104 °F)	Differential baths negative delta temperature	Differential baths positive delta temperature
RTD sensor temperature (degrees C)				na	na
2 meter level data logger temperature (degrees C)					
2 meter difference temperature (degrees C)				na	na
RTD sensor temperature (degrees C)				na	na
10 meter level temperature data logger (degrees C)					
10 meter difference temperature (degrees C)				na	na
Delta temperature data logger (degrees C)					
Sensors delta difference 10 meter - 2 meter					
Delta Temperature difference (Delta temp- sensors difference)					

Specification Temperature Verification Test Accuracy = ±0.5 °C Between RTD and sensors

Acceptable: Yes ____ No ____ Auditor _____

Maintenance, Annually

- a) Inspect the aspirated radiation shield screen over the intake baffle to remove insects and any other objects that can interfere with the operation of the motor. The screen can be cleaned with a brush and soap and water.
- b) Remove the fan assembly by removing the screws attaching it to the blower mount. Brush or blow off any accumulation of dust. Replace housing and return to service.

WARNING: Ensure the power is off before servicing. Failure to do so will result in exposure to severe electrical shock.

- c) The motor bearings are permanently lubricated and do not require normal maintenance. Bearing lubrication should be performed only by personnel familiar with motor maintenance. Lubrication is not recommended as a standard preventive maintenance measure.

Calibration Frequencies

Calibrations are required on the temperature sensors at site startup and after sensor repairs or adjustments that will affect the data. Also calibrations will be required after any unacceptable QA audit. Bi-annual temperature calibrations are required at all NCore stations. The audit and calibrations can be performed together using different devices and different electronic technicians. This helps in reducing invalid data collection, down data logger channels for sensor calibrations and audits.

2.12.1.1.4 Model 083C Relative Humidity Sensor

The Model 083C relative humidity sensor is an extremely accurate and sensitive relative humidity sensor, which responds to the full range of humidity. Response is linear with small hysteresis and negligible temperature dependence. The sensor is housed in the Model 5980 Radiation Shield. This radiation shield is naturally aspirated solar radiation shield constructed of aluminum plates to reflect solar energy.

MODEL 083C RELATIVE HUMIDITY SENSOR SPECIFICATIONS	
Sensing Element	Thin film capacitor
Range	0 - 100 % RH
Temperature Range	-20°F to +50°C
Response Time	15 seconds at 68°F 90% of final RH value
Accuracy	Better than $\pm 3\%$ between 10% and 90% RH
Hysteresis	For 0% to 100% to 0% excursion less than $\pm 1\%$
Temperature Coefficient	$\pm 0.04\%$ per 1°C
Output	0 - 1V at full scale (standard)
Input Power	12V DC $\pm 2V$, 12 ma

Installation

- a) Since the sensor comes mounted to the radiation shield, mount the radiation shield unit on a: O vertical pipe using the supplied U-bolts. (Refer to Met One operations manual, 083C Relative Humidity Sensor Section 2.0, Drawing 1873 and Connection Section SID-1015).
- b) Make the wiring connections to the ESC data logger.

Operational Checkout

- a) To verify correct wiring and as a rough test of the sensor operation, blowing on the sensor will cause the relative humidity to increase.
- b) The relative humidity sensor has been calibrated at the factory and will not change unless the sensor is damaged. To check for proper operation the output values can be compared against a local weather station. Exact correlation is not to be expected due to atmospheric and geographical variations.

Maintenance, 6-12 months

The instrument should operate for extended period of time with minimum amount of care and maintenance. (Refer to Met One operations manual 083C Relative Humidity Sensor, Section 4.0,

Drawing 1840 and 1842.

- a) Switch off the power before servicing the unit. Unscrew the sensor and clean the element by blowing on the sensor chip.

CAUTION: Do not use compressed air.
Do not touch the sensor chip with bare hands.
Do not use detergents or water.

Replacement of the Sensor Element

- a) Disconnect the power and unscrew the filter.
- b) Un-solder the old chip and solder a new one in its place.

CAUTION: The sensor chip is very delicate. Do not touch the chip with bare hands. Handle the chip only by gripping its lead with pliers. When soldering, hold the lead with the pliers to prevent the heat from soldering operation from damaging the chip. Do not bump the chip when reinstalling the protective grid.

- c) After replacement of the of the sensor element, calibrate the sensor.

2.12.1.1.4a Relative Humidity Calibration

The calibration method is based on the constant water vapor pressure over a saturated salt solution and constant temperature. Chemicals used for the calibration are lithium chloride (LiCl), sodium chloride (NaCl), and potassium sulfate (K₂SO₄). The salt solutions create a humidity of approximately 13%, 75%, and the latter approximately 97% at 68°F (20°C). All of these chemicals are available from local suppliers. To guarantee accurate calibration, the salts must be of high purity. The Model 510070 Relative Humidity Calibrator is used to calibrate the relative humidity probe. Use the Vaisala HMK 11/15 Humidity Calibrator and Operating Manual to perform all humidity calibrations. **Calibration solutions will be kept separate from the audit solutions by using separate lot/batch numbers and recorded on the Relative Humidity Calibration/Audit form.**

Relative Humidity Calibration Device

- a) The humidity audit device is a Vaisala model HMK 11/15 Relative Humidity Calibrator. The calibrator is a sealed case with two bottles of salt solutions and a thermometer. The salt solutions are prepared following directions given in the HMK 11/15 operating manual. These salt solutions generate a known relative humidity in the air space above the solution. This relative humidity value is given in a table for the temperature of the solution. The thermometer measures the temperatures of the solutions. The salt solutions

are prepared in a laboratory following the procedure given the HMK operating manual.

The salt solutions are placed into the sealed case immediately after they are prepared. Carefully install all salt solution bottle plugs to seal the salt solutions to prevent contamination. Let the calibrator stand for 24 hours to let the temperatures of the solutions stabilize. The calibrator must always be stored in a room that is between 10 and 50 degrees Celsius.

Relative Humidity Calibration Procedure

- a) The calibration of the relative humidity sensors must be done very carefully to avoid errors that can be introduced in the audit method. The calibrator must be handled carefully to prevent the solutions from spilling and damage to the sealed case. The calibrator must be kept between 10 and 50 degrees Celsius once the salt solutions are inserted. The calibrator must be allowed to stabilize to within +/- 1.0 degree C. of the ambient temperature at the site. A difference of 1 degree C can produce errors of 3 to 6 % relative humidity at the high point. The calibrator may require shielding from the sun and wind to prevent sudden temperature changes. The relative humidity sensor probe must be handled carefully to prevent damage to the exposed sensor element chip after the probe filter is removed. The exposed sensor element chip can be damaged or become contaminated by foreign matter.

- b) To set up for the relative humidity calibration the calibrator must be allowed to stabilize to the site ambient temperature. The site ambient temperature must be between 10 and 50 degrees C to perform the calibration. Remove the relative humidity sensor probe from the radiation shield. Place the calibrator in a position so the relative humidity sensor probe can be inserted into the calibrator. Remove the sensor probe filter to expose the sensing element chip on the relative humidity probe. Remove the sealing plug on the lithium chloride bottle that will allow the sensor probe to be inserted down inside the salt solution bottle. Let the probe and the calibrator stabilize for 30 minutes. Read the calibrator thermometer and record the reading. Read the relative humidity value for the calibrator temperature from the calibration table found on the calibrator case. Record this value as the relative humidity calibration input. Read and record the data logger value for relative humidity. The sensor probe is then removed from the lithium chloride solution bottle. The sealing plug is then reinserted to the lithium chloride bottle. Remove the sealing plug on the calcium nitrate bottle that will allow the sensor probe to be inserted down inside the salt solution bottle. Let the probe and the calibrator stabilize for 30 minutes. Read the calibrator thermometer and record the reading. Read the relative humidity value for the calibrator temperature from the calibration table found on the calibrator case. Record this value (**Figure 4**) as the relative humidity calibration input. Read and record the data logger value for relative humidity. Repeat the procedure for the sodium chloride and potassium sulfate solutions. If any reading is out of calibration

specifications, adjustment is required. Go to section "c)" and continue with calibration.

If all calibration readings are within calibration specifications, no sensor adjustments are required. The sensor probe is then removed from the last solution bottle. The sealing plug is then reinserted to the bottle. The sensor probe filter is then reinstalled on the sensor probe.

- c) To adjust the relative humidity sensor the cover is removed to expose the circuit board. The low end is adjusted with resistor R15 when the relative humidity probe inserted in the lithium chloride bottle. The high end is adjusted with R18 when the relative humidity probe is inserted in the sodium sulfate bottle. The sensor probe must be allowed to stabilize to the solutions before any adjustments are made. Very small adjustments on the resistors will produce large changes in the sensor response. After adjustments are made, the other level must be checked and adjusted if needed. Continue with the calibration until no adjustments are needed at the low and high points. The adjustments will require a lot of time to insure the sensor is stable so patience must be exercised. The sensor probe is then removed from the sodium sulfate solution bottle. The sealing plug is then reinserted to the sodium sulfate bottle. The sensor probe cover and filter are reinstalled on the sensor probe. (Refer to Met One operations manual 083C Relative Humidity Sensor, Section 4.0, Drawing 1840 and 1842.
- d) The calibration is now completed. Reinstall the sensor probe to the radiation shield. The relative humidity calibrator must be stored in a room that meets storage requirements.

Calculations

Calibration Difference = Data logger relative humidity reading - Calibration relative humidity

Greenspan's Calibration Table

° C	LiCl	NaCl	K ₂ SO ₄
0	11.23±0.54	75.5±0.3	98.8±1.1
5	11.26±0.47	75.7±0.3	98.5±0.9
10	11.29±0.41	75.7±0.2	98.2±0.8
15	11.30±0.35	75.6±0.2	97.9±0.6
20	11.31±0.31	75.5±0.1	97.6±0.5
25	11.30±0.27	75.3±0.1	97.3±0.5
30	11.28±0.24	75.1±0.1	97.0±0.4
35	11.25±0.22	74.9±0.1	96.7±0.4
40	11.21±0.21	74.7±0.1	96.4±0.4
45	11.16±0.21	74.5±0.2	96.1±0.4
50	11.10±0.22	74.4±0.2	95.8±0.5

The numbers on the right in each column indicate the uncertainty of the reference humidity of the salt in that temperature.

- 1) Greenspan, L.: journal of Research of the National Bureau of Standards – A physics and Chemistry Vol. 81A, No. 1 January-February, pp. 89-95

Calibration Frequencies

Calibrations are required on the relative humidity sensor at site startup and after sensor repairs or adjustments that will affect the data. Also calibrations will be required after any unacceptable Q.A. audit. Bi-annual relative humidity calibrations are required at all NCore stations. The audit and calibrations can be performed together using different solutions and different electronic technicians. This helps in reducing invalid data collection, down data logger channels for sensor calibrations and audits.

Figure 4 Relative Humidity Cal / Audit

Relative Humidity: Calibration ____ Audit ____

Site _____	Date _____
Start Time _____	Stop Time _____
Sensor Model _____	Sensor SN _____
Calibration Device _____	Device SN _____

Calibration Input Relative Humidity	Calibrator Temperature (Degrees C)	Input Value (From Table)	Data logger Relative Humidity Readings	Calibration Difference
Lithium Chloride				
Sodium Chloride				
Sodium Sulfate				
After Adjustments				
Lithium Chloride				
Sodium Chloride				
Sodium Sulfate				

Calibration Difference = Data logger relative humidity reading - Audit relative humidity

Each calibration point measurement must be with $\pm 7\%$ relative humidity of the calibration input for the calibration to be acceptable.

Acceptable: Yes ____ No ____ Auditor _____

2.12.1.2 Data Logger Channel Procedures

- a) Disable channels on data loggers if channels are up. While disabled, values are collected but flagged as invalid data.
1. Disable channels
 - {ESC} to Home Menu on PDL
 - Select: "C" Configuration Menu
 - Select: "D" Configure Data Channels
 - Select: "M" "Disable/Mark Channel Offline"
 - Use arrow key to select "RH", <ENTER>
 - Highlight "RH" then press, <ENTER>
 2. Enable Channels
 - {ESC} to Home Menu on PDL
 - Select: "C" Configuration Menu
 - Select: "D" Configure Data Channels
 - Select: "E" "Enable/Mark Channel Online"
 - Use arrow key to select "RH", <ENTER>
 - Highlight "RH" then press, <ENTER>

Setting computer and PDL time/date.

The times for the PDL and computer must be EASTERN STANDARD TIME

Sources for getting the correct time:

1. Call the ECB and ask for the NIST time.
2. Call the NIST Colorado time @ (303) 499-7111 (long distance).
3. Correct time loaded into cell phone.
4. Correct time website, <http://nist.time.gov/>

Check the computer time and date at the lower right hand corner of the computer screen. If the time and date are not correct; click "START" button, control panel, date/time or right click computer time on taskbar, select "Adjust Date/Time", type in changes and select "OK".

PDL time and date:

- Double click "Shortcut to Splitscreen"
- Open PDL
- Highlight PDL and type 2 letter data logger site code and AQM, (e.g.) "GR AQM" (located on front of data logger, may have to hit {ESC} a couple of times before typing)
- Select: "L" Login
- Type password: XXXXXXXXXXXX (not case sensitive), this brings up Home Menu
- Select: "C" configuration menu
- Select: "S" configure System Parameters
- Highlight "Logger Time"

- Type in correct time in the format of: **HH:MM:SS**
- **{ESC}{ESC}{ESC}**

Setting Data Logger Time

The times for the data logger must be EASTERN STANDARD TIME

- Access data logger and log in, this gives the main menu
- Select "C", configuration
- Select "S" configure system
- Scroll down to "TIME" and edit the time to correct value, <ENTER>
- ESC back to the main menu and log out

Up the PDL channel: Go to the Home Menu (by pressing **{ESC}** several times if needed), Press "L" and <ENTER> the code when it asks for the password and press <ENTER>.

- **{ESC}** to Home Menu on PDL
- Select: "C" Configuration Menu
- Select: "D" Configure Data Channels
- Select: "E" "Enable/Mark Channel Online"
- Use arrow key to select parameter, <ENTER>
- Highlight "RH" then press, <ENTER>

2.12.1.3 Site Visits

Whenever the ECB technicians visit a site, they will:

1. Document the date, time and reason for the visit in the site logbook.
2. Check that the site building temperature is between 20° C and 30° C.
3. Check that the building is secure. Vandalism is reported to the ECB Supervisor.
4. Check that all monitoring systems are operating within normal ranges (unless the reason for the visit is site start-up).
5. Down any channels for equipment being repaired, replaced, or audited during the repair, replacement, or audit.
6. Up any channels after equipment is repaired, replaced, or audited.

2.12.1.4 Accuracy Audits

The frequency for performing meteorology accuracy audits will be according to the NCore Meteorological Calibration and Accuracy Table (**Table 1**).

a) Meteorology System Audit

The meteorology system audit is performed to insure the meteorological instrumentation is being operated and calibrated to QA specifications. The audit provides information about sensor calibration status, sensor malfunctions, repairs that may be needed and improvements to the QA plan. The audit is a valuable tool in determining the data quality of the different meteorological parameters that are

measured. The audit information is recorded on the field audit forms and the equipment logbook. The date, start and stop times are logged so the database will not include values associated with the audit.

When the audit values are more than the parameter(s) criteria, call the ECB Supervisor and inform the Chief of the situation and print out a copy of the last autocal. The ECB Supervisor will investigate suspicious audits to determine if there is a problem and if so, where the problem is and how to solve the problem.

If the problem is with the ECB equipment, the ECB generally fixes the audit equipment and repeats the audit. If the problem is with the site equipment, the ECB takes appropriate action to either repair or replace the site equipment. If the problem is a major site operation problem, the ECB supervisor informs the Projects and Procedures Supervisor.

- b) **Interagency Testing**
No interagency testing devices are known to be available from EPA. When such devices become available NCDAQ will participate in interagency testing.

2.12.1.5 Data Acquisition

- a) When the data logger has been shown to be polling acceptable data, the data will be automatically collected by the Data Management and Statistical Services Branch (DMSSB) computer using polling routines. The actions required by the ECB staff are to report reasons for missing data: identify invalid data and identify data to be changed by DMSSB. The actions are to be recorded on the problem log sheet meteorological site forms for documentation purposes.

Data Editing

- a) All periods of missing or invalid data must be accounted for. Documentation identifying the reasons for missing or invalid data is the meteorology system checkout list.
- b) Any valid data identified by the data logger as "invalid" data (by flags) must be verified with proper documentation stating why data is valid. This documentation should state actions required correcting the problem and why data flags were set by the data logger.
- c) The data must be exported into a spreadsheet or a database program on the PC. The data is exported with a start date and end date for the file. The data files are created monthly for each site. Monthly data files can be edited using the data base software. The edited data must have documentation to support any editing changes made to the database.

- d) The database is edited first to satisfy the documentation generated from site operations or any questionable data. Once all editing is done the database is screened. The screening process involves comparing the data to expected values or range of values. The screening criterion is given in **Exhibit A**. The screening is performed manually or by macros using a PC. All data that does not pass the screening criteria must be examined to determine if the data is acceptable. The data that is determined unacceptable can be deleted from the database or marked questionable. A documentation record must be created to log deleted data and questionable data. This record provides information about gaps in the data base and quality of the database.
- e) The data now can be transferred to AQS according to procedures. Notify the Data Base Administrator to update when the screening file is ready.
- f) Review the quarterly data reports from AQS, make changes as needed. When data in AQS is complete and correct, prepare the quarterly data submittal letter for the signature of the Ambient Monitoring Chief.

Table 1 Database Screening Criteria

Wind Speed	Wind speed less than 0 m/sec or greater than 25 m/sec, does not vary more than 0.1 m/sec for 3 consecutive hours
Wind Direction	Wind direction less than 0 degrees or more than 360 degrees, does not vary more than 1 degree for 3 consecutive hours
Temperature	Does not vary more than 0.5 degrees C for 12 consecutive hours, more than 5.0 degrees C change from previous hour
Relative Humidity	Does not vary more than $\pm 7\%$ RH

Table 2 NCore Meteorological Calibration and Accuracy Criteria

Measurement	Verification/Calibration			Accuracy		
	Type	Acceptance Criteria	Frequency	Type	Acceptance Criteria	Frequency
Ambient Temperature	3 pt. Water Bath with NIST traceable thermistor or thermometer	± 0.5 °C	Semi-Annually	3 pt. Water Bath with NIST traceable thermistor or thermometer	± 0.5 °C	Annually
Relative Humidity	NIST-traceable Psychrometer or standards solution	$\pm 7\%$ RH	Semi-Annually	NIST-traceable Psychrometer or standards solution	$\pm 7\%$ RH	Annually
Wind Speed	NIST-traceable Synchronous Motor, CTS method ^a	$\pm 0.25\text{m/s} \leq 5\text{m/s}$; 5% > 2m/s not to exceed 2.5m/s	Semi-Annually	NIST-traceable Synchronous Motor	$\pm 0.25\text{m/s} \leq 5\text{m/s}$; 5% > 2m/s not to exceed 2.5m/s	Annually
Wind Direction	Solar Noon, GPS Magnetic Compass, CTS method ^a	± 5 degrees; includes orientation error	Semi-Annually	Solar Noon, GPS or Magnetic Compass	± 5 degrees; Includes orientation error	Annually

^a This method is described in detail in Section 2.72 – 2.74 of the **Quality Assurance Handbook for Air Pollution Measurement Systems Vol. IV: Meteorological Measurements Version 2.0 (Final)**.