Standard Operating Procedures for Meteorological Monitoring

Air Quality Division

Department of Environmental Conservation

<u>September 2009</u>

The Alaska Department of Environmental Conservation Division of Air Quality wants to thank the State of Washington, Department of Ecology for providing a template for this Standard of Operating Procedures. The main body of text was taken from the DOE's SOP, dated August 2000 and altered and amended to fit the State of Alaska's needs.

State of Alaska
Department of Environmental Conservation
Air Quality Division – Air Monitoring & Quality Assurance

STANDARD OPERATING PROCEDURES FOR METEOROLOGICAL MONITORING

Prepared by: Cindy Dettmer-Shea

September 2009

____ Date: ____________
Barbara Trost, Air Quality Program Manager

____ Date: ____________
Dan Fremgen, Quality Assurance Coordinator

Table of Contents

List of Figures

1.0 Introduction

The use of on-site meteorological data to support air quality impact analysis has grown rapidly over the past decade. It is generally recognized that valid on-site data provide a more accurate characterization of the meteorological conditions affecting the transport and dispersion of pollutants emitted by a source, than data from a distant location. As a result of the shift toward on-site data it is essential that such data be representative of atmospheric dispersion conditions in the area of interest.

This document describes the guidelines for installing and operating meteorological monitoring sites in accordance with the EPA guidance document, Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD). Topics covered include: site selection, site installation, calibration standards, calibration, quality control, maintenance, quality assurance, data recording and data quality assessment. The purpose of this document is to provide information and guidance to the meteorologist as well as the non-meteorologist as to the proper operational aspects of a quality run meteorological station. In addition, this document will provide the minimum requirements for meteorological data collection to support air quality impact analysis performed for programs administered by the Washington State Department of Ecology Air Quality Program. All heights referenced in this document are measured from the tower base.

2.0 Site Selection

The primary objective when siting a meteorological monitoring station is to site the instruments away from the influence of obstructions such as buildings and trees and in a location that is representative of the atmosphere in the area of interest. A secondary consideration is accessibility and security, however these considerations should not be allowed to compromise the quality of the data.

2.1 Wind Measurements

Wind measurements are typically taken over open, level terrain at a height of 10 meters. This height can change however, depending on the requirements of the monitoring program and/or the height of the source emission point. Open terrain is defined as an area where the obstruction(s), man-made or natural, is 10 times the height of the obstruction away from the monitoring tower.

In general, the siting of meteorological towers on top of buildings should be avoided. However, if the wind instruments are to be mounted on the roof of a building, due to the lack of open space, the measurements should be taken high enough to ensure that no adverse effects are created by the building wake. In general this height above the roof is 1.5 times the height or width of the building (whichever is less). Additional information on siting monitoring stations near major structures can be obtained in the Guideline for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations) - Revised EPA 450/4-80-023R. All site characteristics must be documented on the site installation form shown in Figure 2-1 upon completion of the installation. Photographs of the site must also be provided.

2.2 Temperature Measurements

Temperature measurements should be taken at a height of approximately 2 meters, and vertical temperature difference measured between 2 meters and 10 meters. The sensor(s) should be located over an open, level area at least 10 meters in diameter. The temperature sensors must be protected from thermal radiation by mounting the sensors in aspirated radiation shields. All temperature measurements should be taken over a level plot of ground at least 10 meters in diameter. Ground cover should be short grass, preferably non-irrigated, or natural earth.

Temperature sensors should be mounted at least 4 times the height of any obstructions away from that obstruction, and at least 30 meters away from large paved areas. Other siting situations to be avoided include: large industrial heat sources, rooftops, sheltered hollows, high vegetation, shaded areas, swamps, and areas where standing water can accumulate. Measurements should also not be made near ridges, steep slopes or valleys unless those areas are of specific interest. Measurements taken close to bodies of water should also be avoided due to the large temperature variations.

2.3 Meteorological Towers

Towers should be located over an open level area. Attention should be taken when choosing a site to ensure that the site is representative of the area under study, while at the same time is free from obstructions that might affect the measurements.

Towers should preferably be of the open lattice variety. Regardless of the type, the tower should be rugged enough to withstand substantial wind and adverse weather conditions. Folding and collapsible towers are preferable provided that they are rugged enough to keep the instrumentation properly oriented.

Wind instruments should be mounted above the top of the tower on a boom or mast. If a crossarm is employed in the mounting of the wind instruments, the crossarm should be mounted perpendicular to the prevailing wind flow and at least one tower diameter above the top of the tower structure. This will ensure that the measurements taken are not affected by the wind sensor bodies or the tower itself.

2.4 Station Siting

When choosing a meteorological monitoring site it is important to have the monitoring purpose clearly defined. This will enable the personnel performing the station siting to evaluate and choose the site that best defines the purpose. In most cases the purpose of the monitoring is to provide PSD quality meteorological data to be used for computer modeling in support of an existing air quality concern and/or as part of a PSD application requirement.

Prior to the selection of a site, a written proposal to the Washington Air Monitoring Workgroup (WAMWG) is required. If the proposal is approved the Repair and Calibration Unit will provide direction, guidance, and technical assistance to the requesting party. For additional information on siting procedures, refer to the Washington State Department of Ecology "Air Monitoring Site Selection and Installation Procedures", October 1994.

Once a site is selected, the site must be completely documented on the site installation form shown in Figure 2-1. Photographs of the site must also be included. All site documentation must be submitted to the Data Management Section of the Department of Ecology. A copy should also be returned to the Quality Assurance Unit as soon as possible, upon completion of the installation.

Figure 2-1

SITE INSTALLATION DOCUMENTATION

AIRS SITE # | 5 | 3 | - | | | | | | | |

LOCATION:

Site Name: ____

Address: ____

City (if inside city limits): ____________________ County:______________________

Location of probe (if different than address): ____________________________________

UTMs: [ ][ ] Zone [ ][ ][ ][ ][ ][ ] X-Coordinate [ ][ ][ ][ ][ ][ ][ ] Y-Coordinate

[ ][ ][ ][ ] Site Elev. [ ][ ] FT or M [ ][ ] Sta. Type

INSTRUMENT INFORMATION:

PARAMETER	MANUFACTURER	MODEL	PROBE HT. (FT)	PROBE LENGTH (FT)

GENERAL INFORMATION:

Distance from nearest road: ____________________ Ft.
Type of roadway: _____________________________ Local Street, Highway, Through Street, etc.

Draw a picture or attach a map of site (minimum one-block radius). Identify all surrounding thoroughfares, traffic patterns, arterials, etc.

↑
|
|
|
N

Installed By: ______________________________________ Date: ________________________

Rev. 7/2000

INSTRUCTIONS

(It would be advantageous to take this form along at the time of the site installation.)

This form should be filled out at the time a site is installed and forwarded to Telemetry personnel in Olympia within five working days of the installation.

1. Complete all areas. Attach all forms for a given site together.

2. Send original to telemetry personnel in Olympia (make and keep a copy for reference purposes).

3. Final distribution will be made by telemetry personnel in Olympia when all areas have been filled in.

3.0 Site Installation

Upon procurement and receipt of the meteorological instrumentation, but prior to installation, a complete acceptance testing program will be performed by the Repair and Calibration Unit to verify the operation status of the sensors. This acceptance test should include, but is not limited to: physical examination of all sensors, cables, and connectors, a wind speed sensor calibration, a wind direction sensor calibration, and a temperature sensor calibration. Document the acceptance test in the logbook that will be used at the station. Bring any problems encountered during the acceptance test to the attention of the vendor as soon as possible to avoid delays in the monitoring project. Additional information on acceptance testing can be found in the EPA document On-Site Meteorological Program Guidance for Regulatory Modeling Applications EPA-450/4-87-013 as well as the EPA Quality Assurance Handbook for Air Pollution Measurement Systems EPA-600/4-82-060. Revised August 1989.

Once the site has been selected and the station has been established, equipment and supplies are required for the measurement of the meteorological parameters. The station must contain at a minimum the following.

- meteorological sensors, cables, and manuals
- tower with mounting mast
- power supply (11-24 VDC)
- data acquisition system
- strip chart recorder
- room temperature sensor (sheltered site)
- station logbook
- spare parts, and
- supplies and expendables

Install the meteorological monitoring instruments according to the manufacturers' instruction manual. The information contained in the manual includes instructions on:

- installation of the equipment
- calibration
- operation
- preventative maintenance
- troubleshooting

4.0 Calibration

The calibration procedures described in this section will be used to assess the performance and validate the data from meteorological networks.

The procedures written in this document have been developed for the R.M. Young meteorological monitoring system. However, many of the procedures that are used are also applicable to other instrument systems. It is recommended that the reader refer to the instrument manual for specific instructions on calibration.

The calibration procedure should be performed immediately upon installation of the system, on a quarterly basis thereafter, and at the end of the monitoring project (no earlier than 30 days prior to the end of the monitoring period).

Use the Meteorological Quality Control (QC) check worksheet shown in Figure 4-2 to document the results and identify corrective actions taken. Once the calibration has been performed, ensure that the worksheet is complete and submit a copy to the Quality Assurance Unit.

4.1 Wind Direction Orientation

During the station installation the sensor will be aligned to true north (magnetic north +/- declination) using the solar azimuth observation procedure in the Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV, Meteorological Measurements, Section 4.2.4.3.2.2. Once the vane alignment rod has been aligned using the solar noon observation procedure:

1. Identify a distant landmark and bearing using a transit or from the site diagram. Set up the transit in line with the sensor's vane alignment rod, at a location where the distant landmark can be seen and at least 60 feet from the tower.

2. Sight the distant landmark with the transit telescope and lock in the known bearing on the transit horizontal circle. Without moving the transit tripod or horizontal circle, turn the transit telescope, sight down the sensor's vane alignment rod and read the bearing from the horizontal circle. This is the sensors actual bearing. Record this value on the QC worksheet.

3. If the difference between the sensor's actual bearing and true north (360^{o}) is greater then 2^{o} take corrective action by adjusting the sensor's orientation ring. Record this remedial action on the QC Worksheet and in the station log book.

4.2 Wind Speed Threshold Check

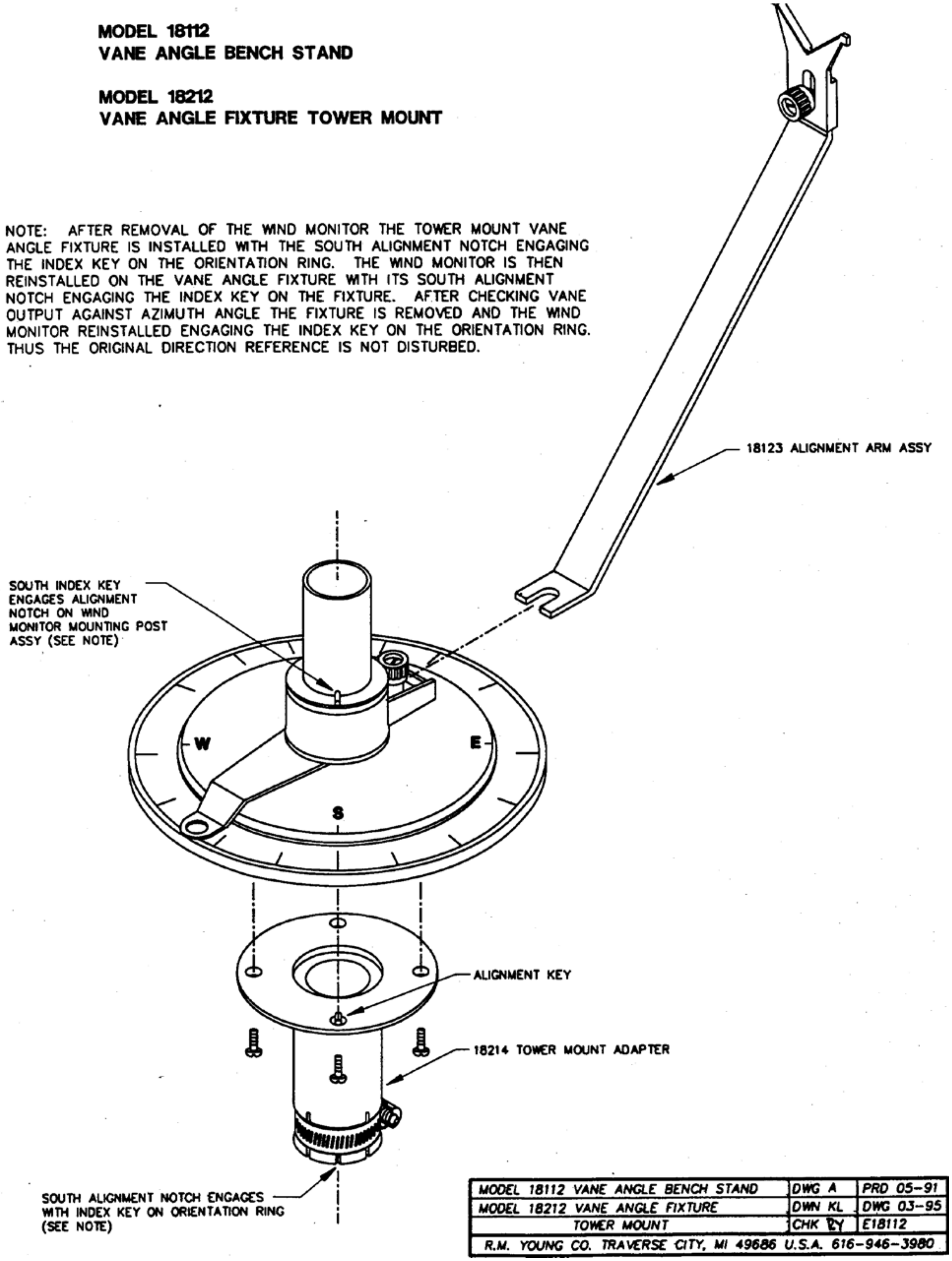
1. Disable the data logger, lower the tower and disconnect the wiring from the wind sensor. Verify that the orientation ring is tight. This will ensure that the wind sensor will be reinstalled in the proper orientation. Remove the wind sensor from the tower and mount it on the vane angle bench stand (Figure 4-1). Verify that the vane angle bench stand is level and is not binding when rotated.

2. Remove the propeller and install the propeller torque disk. Verify that the disk is in balance with the anemometer assembly. Set the orientation of the screw holes to a variety of positions (at least six) and verify that the disk does not turn when released. Add balancing weight (tape or rotate the disk on the shaft to achieve equilibrium).

3. Install the 0.1 gram black nylon screw weight on the left side of the anemometer torque disk 1 centimeter from the center as seen looking at the disk from the front. Set the line of screw holes horizontal. This imposes a 0.1 gram-centimeter torque in the direction the wind would turn the propeller.

   If the disk moves five degrees or more this is the starting torque. If it does not, increase the torque by moving the weight further from the center or adding more weight to the anemometer torque disk

Figure 4-1


MODEL 18112
VANE ANGLE BENCH STAND
MODEL 18212
VANE ANGLE FIXTURE TOWER MOUNT
NOTE: AFTER REMOVAL OF THE WIND MONITOR THE TOWER MOUNT VANE ANGLE FIXTURE IS INSTALLED WITH THE SOUTH ALIGNMENT NOTCH ENGAGING THE INDEX KEY ON THE ORIENTATION RING. THE WIND MONITOR IS THEN REINSTALLED ON THE VANE ANGLE FIXTURE WITH ITS SOUTH ALIGNMENT NOTCH ENGAGING THE INDEX KEY ON THE FIXTURE. AFTER CHECKING VANE OUTPUT AGAINST AZIMUTH ANGLE THE FIXTURE IS REMOVED AND THE WIND MONITOR REINSTALLED ENGAGING THE INDEX KEY ON THE ORIENTATION RING. THUS THE ORIGINAL DIRECTION REFERENCE IS NOT DISTURBED.
18123 ALIGNMENT ARM ASSY
SOUTH INDEX KEY ENGAGES ALIGNMENT NOTCH ON WIND MONITOR MOUNTING POST ASSY (SEE NOTE)
W
E
S
ALIGNMENT KEY
18214 TOWER MOUNT ADAPTER
SOUTH ALIGNMENT NOTCH ENGAGES WITH INDEX KEY ON ORIENTATION RING (SEE NOTE)
MODEL 18112 VANE ANGLE BENCH STAND
DWG A
PRD 05-91
MODEL 18212 VANE ANGLE FIXTURE
DWN KL
DWG 03-95
TOWER MOUNT
E18112
R.M. YOUNG CO. TRAVERSE CITY, MI 49686 U.S.A. 616-946-3980

until the torque is found. During the test, rotate the sensor and check the torque both to the left and right of center. During the test, rotate the disk both to the left and right of center. This tests the torque on both sides of the centerline. If necessary use the 1.0 gram stainless steel screw weight. Record the gram-centimeter starting torque on the QC Worksheet and in the logbook.

To calculate the threshold speed (meters/sec) divide the gram centimeter starting torque by the propeller k constant (3.8 for R.M. Young carbon filter propeller) and take the square root of the result.

4. If the starting threshold is greater than 1 gram-centimeter (0.5 meters/sec) take corrective action by replacing the anemometer bearing assembly. Record this remedial action on the QC Worksheet and in the logbook.

4.3 Wind Direction Threshold Check

1. With the wind sensor still mounted on the level vane angle bench stand, but prior to the torque test, ensure that there is no air movement in the room by moving the vane to a variety of positions and noting any movement. Adjust the vane location if necessary.

2. Mount the vane torque gauge as shown in Figure 4-3.

3. Slowly apply steady force at the end of the leaf spring until the vane begins to move in a clockwise direction. Test the vane through 360^o and note the maximum reading in grams. Repeat the test in the counterclockwise direction.

   To calculate the threshold speed (meters/sec) divide the gram-centimeter starting torque by the wind vane constant K (37 for the R.M. Young wind monitor) and take the square root of the result.

   Select Torque value for type of instrument to be checked and desired maximum threshold from table. Preset stop on leaf spring to this torque value (force in grams x 10 cm distance from center of rotation). Install gauge on mounting bracket with tip of leaf spring 10 cm from centerline (CL) of instrument as shown. With instrument mounted on level surface with no air movement apply steady pressure at end of leaf spring. Vane should rotate through 360 degrees without exceeding preset torque value. Free rotation indicates good bearing/transducer condition. Excess torque indicates need for service.

4. If the starting torque is greater than 12 gram-centimeters (0.57 meters per second) take corrective action by replacing both sets of bearings in the direction vane assembly. Record this remedial action on the QC Worksheet and in the station logbook.

4.4 Wind Speed Accuracy Test

1. Connect an alternate cable from the wind monitor to the data logger. Refer to Figure 4-4 for wiring connections.

2. Mount the selectable speed calibration unit to the wind monitor and attach the coupling to the anemometer shaft.

3. Through the data logger menu, switch the display to "raw voltages". Speed in miles per hour is equal to the displayed voltage reading for wind speed divided by 2.237 and multiplied by 100. Record this value for zero revolutions.

4. Set the calibration unit speed to 600 revolutions per minute counter-clockwise (06 on the digital switch). To calculate the simulated wind speed in meters/second divide the revolutions per minute by 60 seconds per minute and multiply by the propeller pitch of 0.294 meters per second.

   To convert meters per second to miles per hour, multiply by 2.237.

   Six hundred revolutions per minute results in a simulated wind speed of 3.07 meters per second or 6.87 miles per hour. Allow the wind speed calibrator to run until the reading becomes stable. Record this simulated wind speed and the indicated wind speed from the voltmeter on the QC worksheet.

5. Set the calibration unit speed to 1200 revolutions per minute counter-clockwise (12 on the digital switch). This simulates a wind speed of 6.14 meters per second or 13.74 miles per hour. Record this simulated wind speed and the indicated wind speed from the voltmeter on the QC Worksheet.

6. Set the calibration unit speed to 2400 revolutions per minute counter-clockwise (24 on the digital switch). This simulates a wind speed of 12.28 meters per second or 27.48 miles per hour. Record this simulated wind speed and indicated speed from the voltmeter on the QC Worksheet.

7. Take corrective action if the indicated readings are not within 0.2 meters per second (0.50 miles per hour) of the simulated wind speed. The corrective action may include sending the sensor to back to the Repair and Calibration Unit. Record this remedial action on the QC Worksheet and in the station logbook.

8. Remove the calibration unit and reinstall the propeller with the smooth side and letter markings facing forward (into the wind).

4.5 Wind Direction Accuracy Check

1. Install the vane holding arm on the vane angle bench stand. Tighten the v-shaped holder in a two point contact position with the vane boom. Don't over tighten the v-shaped holder or the boom will bind when rotated.

2. Through the data logger menu, switch the display to "raw voltages". To calculate a bearing from the voltmeter reading, divide the voltage reading by 5 and multiply by 540^o.

3. Move the indicator to the following positions in sequence and record the output readings, from the data logger, for each position on the QC Worksheet and in the logbook.

005^o	030^o	060^o	090^o	120^o	150^o	180^o	210^o	240^o
270^o	300^o	330^o	350^o	370^o	390^o	420^o	450^o	480^o
510^o	538^o	450^o	370^o	270^o	180^o	090^o	005^o	

4. Subtract the azimuth reading, calculated from the data output, from the indicated position and record the value for each of the 26 positions.

5. A difference between the actual and indicated direction equal to or greater than 3^o requires corrective action. Record any remedial action taken in the QC Worksheet and in the station logbook.

6. Remove the sensor from the vane angle bench stand and install on the tower mast.

FIGURE 4-2

Q.C. AUDIT REPORT

Station:______________________ Date:____________

Station #:_____________________ Time:____________

Operator:______________________

Visual Inspection

☐ Vane ☐ Propeller ☐ Tower

MEASUREMENTS	TOLERANCE		AS IS			AFTER SERVICING	
Bearing Torque *(threshold)*							
Wind Speed	1 gm – cm						
Azimuth	12 gm – cm						
Wind Direction Orientation Check			Bearing	Diff.		Degrees	Diff.
	± 2.0°						
Wind Speed Translator Output			MPH	Diff.		MPH	Diff.
0 rpm	± 0.5 mph						
600 rpm	± 0.83 mph						
1200 rpm	± 1.16 mph						
2400 rpm	± 1.82 mph						
Wind Direction Translator Output			**Degrees**	**Diff.**		**Degrees**	**Diff.**
90 deg	± 3.0°						
180 deg	± 3.0°						
270 deg	± 3.0°						
370 deg	± 3.0°						
538 deg	± 3.0°						
Temperature			**Degrees**	**Diff.**		**Degrees**	**Diff.**
Water Bath	± 0.50° C						
Ice Bath	± 0.50° C						
Delta T			**Degrees**	**Diff.**		**Degrees**	**Diff.**
Water Bath	± 0.10°C						
Ice Bath	± 0.10° C						

Action Taken:______________________ Date:______________________

By:______________________

Meteorological Quality Control Check Report

Station:___________________________________ Date:___________________________________
Station #:_________________________________ Time:___________________________________
Operator:__________________________________ Personnel:_______________________________
Purpose of Check: ☐ Quarter ☐ Other____

Wind Sensor Model # :_____________________ Wind Translator Serial #:_________________
Wind Sensor Serial #: _____________________ Wind Translator Air #: __________________
Propeller Serial #: _______________________ Temp. Translator Serial #:________________
Temp Sensor Model #:______________________ Temp. Translator Air #: _________________

As Found Orientation Check

Distant Object Bearing:____
Actual Vane Alignment Rod Bearing:____
Difference From True North:____(± 2 degrees max)
Comments:____

Wind Speed Threshold Check

Starting Torque:____ g – cm (1 g-cm maximum)
Actual Vane Alignment Rod Bearing:____

Wind Direction Threshold Check

Starting Torque Clockwise:_____________________________________ g – cm (12 g-cm maximum)
Starting Torque Counter Clockwise:____________________________ g – cm (12 g-cm maximum)
Comments:____

Wind Speed Accuracy Test

RPM/Speed	DAS Reading	Indicated Speed	Difference
	Volts	MPH	
0/0 mph			
600/6.87 mph			
1200/13.74 mph			
2400/27/48 mph			

(maximum error 0.5 mph ± 5% of the desired wind speed.)

Comments:____

Wind Direction Accuracy Check

Actual Direction	DAS Output		Indicated Direction		Difference (± 3° max)	
	Pre	Post	Pre	Post	Pre	Post
005						
030						
060						
090						
120						
150						
180						
210						
240						
270						
300						
330						
350						
370						
390						
420						
450						
480						
510						
538						
450						
370						
270						
180						
090						
005						

Comment: ____

Temperature Accuracy Check

Test Method	ASTM Reading	DAS Reading (Volts)	Indicated DAS Reading	Difference (± 0.5° C Max)
Water Bath				
Ice Bath				

Comments: ____

Delta Temperature Accuracy Check

Test Method	ASTM Reading	DAS Reading Volts	Indicated Delta T Reading	Difference (± 0.1° C Max)
Water Bath				
Ice Bath				

Comments: ____

Calibration Equipment

Description	Model Number	Serial Number
Thermometer		
Thermometer		
Torque Wheel		
Torque Gauge		
Speed Motor		
Transit		

Auditor: ____________________________________ Date: ________________________________

Net Radiometer Accuracy Check

Normal	Inverted	Difference

	Constant	Response	Result
Field			
Backup			
Field			
Backup			
Field			

(Max ± 5% between average for field and backup)

Comments: ____

Figure 4-3

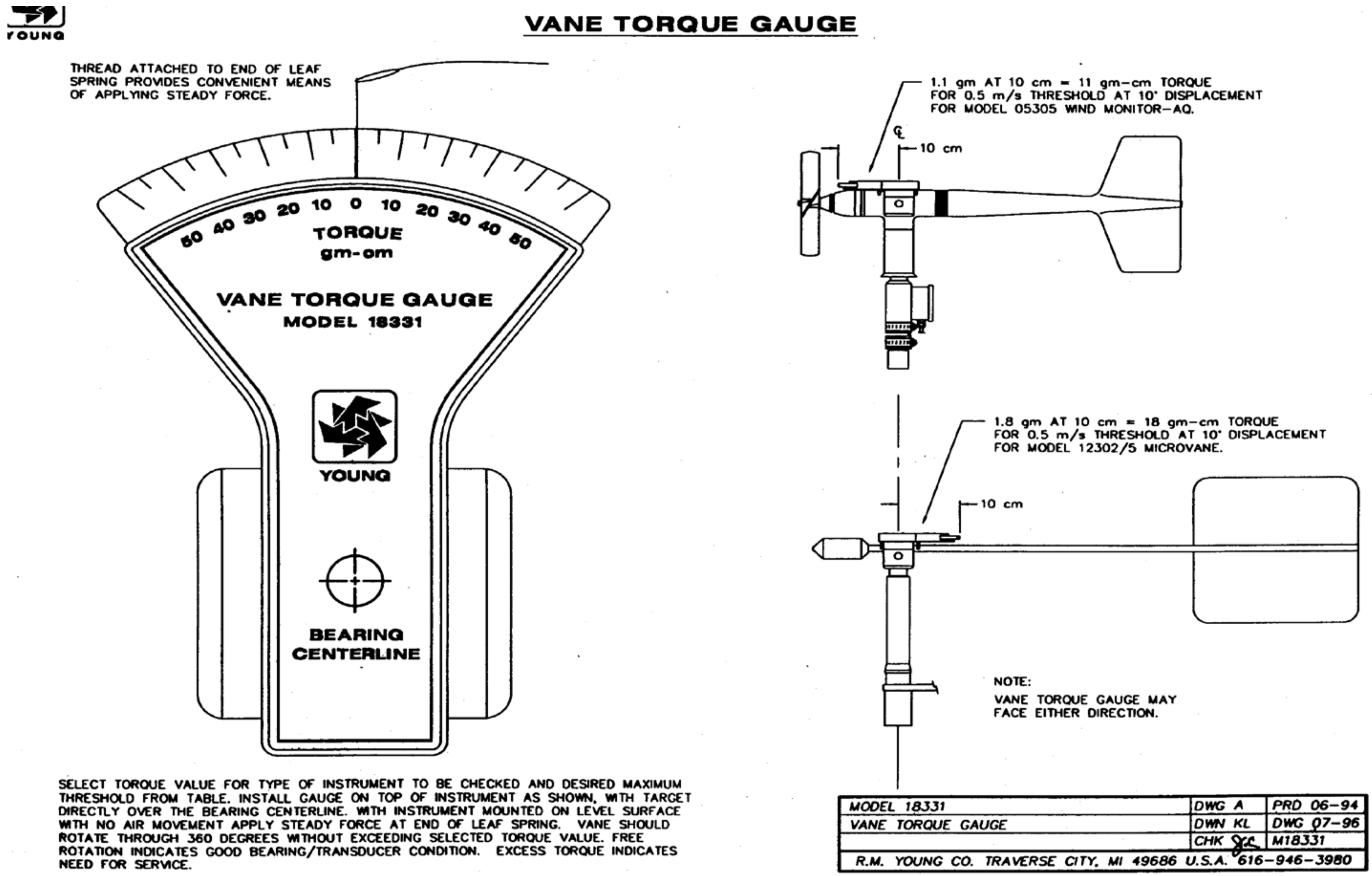
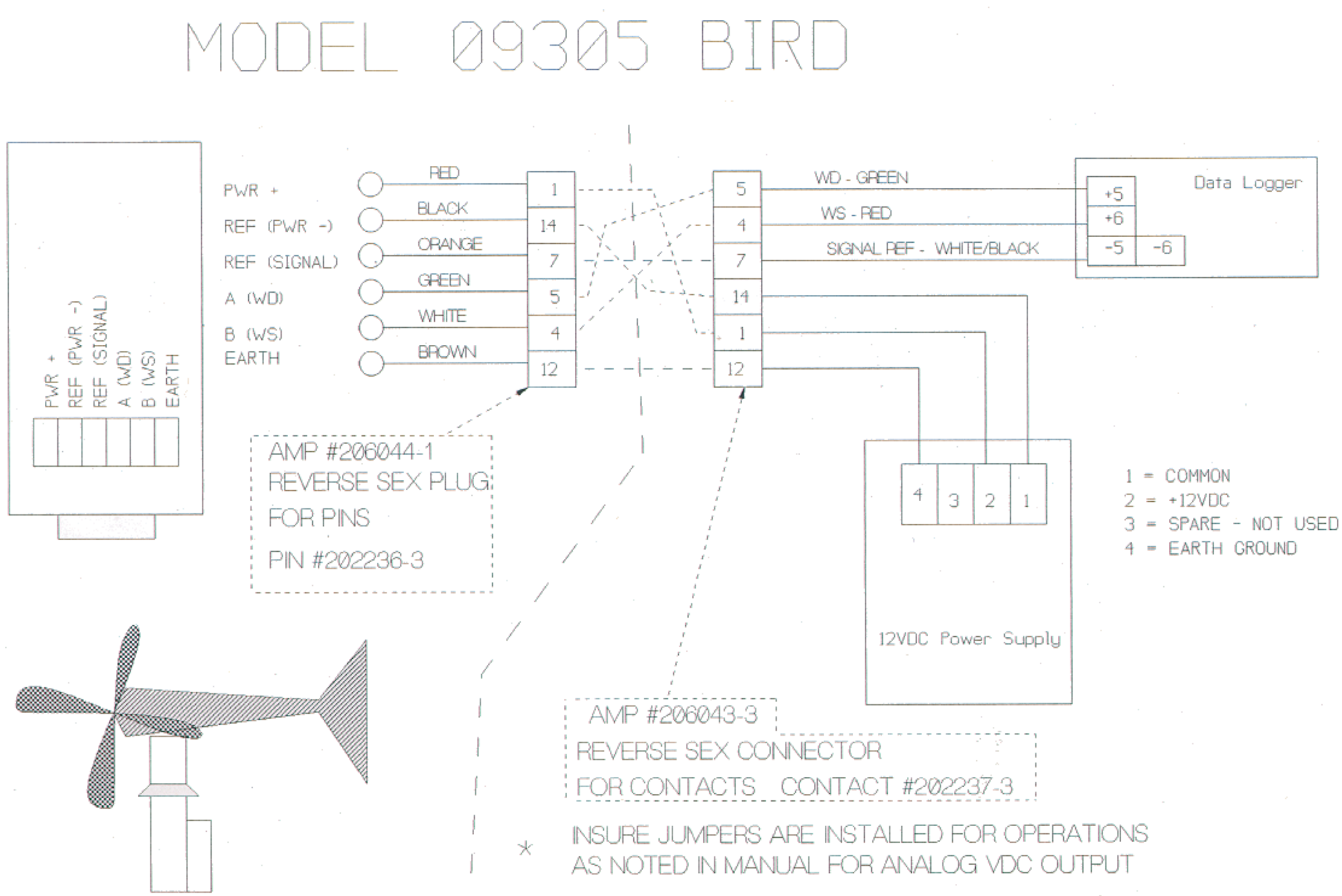

YOUNG
VANE TORQUE GAUGE
THREAD ATTACHED TO END OF LEAF SPRING PROVIDES CONVENIENT MEANS OF APPLYING STEADY FORCE.
50 40 30 20 10 0 10 20 30 40 50
TORQUE gm-cm
VANE TORQUE GAUGE
MODEL 18331
YOUNG
BEARING CENTERLINE
1.1 gm AT 10 cm = 11 gm-cm TORQUE FOR 0.5 m/s THRESHOLD AT 10° DISPLACEMENT FOR MODEL 05305 WIND MONITOR-AQ.
10 cm
1.8 gm AT 10 cm = 18 gm-cm TORQUE FOR 0.5 m/s THRESHOLD AT 10° DISPLACEMENT FOR MODEL 12302/5 MICROVANE.
10 cm
NOTE:
VANE TORQUE GAUGE MAY FACE EITHER DIRECTION.
SELECT TORQUE VALUE FOR TYPE OF INSTRUMENT TO BE CHECKED AND DESIRED MAXIMUM THRESHOLD FROM TABLE. INSTALL GAUGE ON TOP OF INSTRUMENT AS SHOWN, WITH TARGET DIRECTLY OVER THE BEARING CENTERLINE. WITH INSTRUMENT MOUNTED ON LEVEL SURFACE WITH NO AIR MOVEMENT APPLY STEADY FORCE AT END OF LEAF SPRING. VANE SHOULD ROTATE THROUGH 360 DEGREES WITHOUT EXCEEDING SELECTED TORQUE VALUE. FREE ROTATION INDICATES GOOD BEARING/TRANSDUCER CONDITION. EXCESS TORQUE INDICATES NEED FOR SERVICE.
MODEL 18331
VANE TORQUE GAUGE
DWG A
DWN KL
CHK
PRD 06-94
DWG 07-96
M18331
R.M. YOUNG CO. TRAVERSE CITY, MI 49686 U.S.A. 616-946-3980

Figure 4-4


MODEL 09305 BIRD
PWR +
REF (PWR -)
REF (SIGNAL)
A (WD)
B (WS)
EARTH
RED
BLACK
ORANGE
GREEN
WHITE
BROWN
1
14
7
5
4
12
WD - GREEN
WS - RED
SIGNAL REF - WHITE/BLACK
Data Logger
+5
+6
-5
-6
AMP #206044-1
REVERSE SEX PLUG
FOR PINS
PIN #202236-3
12VDC Power Supply
1 = COMMON
2 = +12VDC
3 = SPARE - NOT USED
4 = EARTH GROUND
AMP #206043-3
REVERSE SEX CONNECTOR
FOR CONTACTS CONTACT #202237-3
* INSURE JUMPERS ARE INSTALLED FOR OPERATIONS
AS NOTED IN MANUAL FOR ANALOG VDC OUTPUT

4.6 Temperature Accuracy Check

1. Ideal conditions for a temperature check are those that have a minimum solar impact (i.e., nighttime, overcast, moderate wind etc.). Through the data logger menu, switch the display to “raw voltages”. To calculate temperature from the voltmeter reading, multiply by 100 and subtract 50.

2. Disconnect the temperature probe from the radiation shield and place both the probe and the appropriate NIST traceable thermometer in a bath of crushed ice and stir. While stirring continuously at a steady pace, ensure that both the temperature sensor and the thermometer are at the same level in the bath.

3. When the readings from both the instrument and the thermometer are steady, record both readings on the QC Worksheet and in the station logbook.

4. Verify that the reading matches with that of the strip chart and the data logger. Note the reading on the strip chart.

5. Place both the probe and the appropriate thermometer in a bath of luke warm water and stir.

6. When the readings from both the instrument and the thermometer are steady, record both readings.

7. For both tests subtract the thermometer reading from the sensor reading. If the difference exceeds +/- 0.5^{o} Celsius, take remedial action. Record any remedial action taken on the QC Worksheet and in the station logbook.

8. Return the temperature probe to the radiation shield.

4.7 Delta Temperature Accuracy Check

1. Remove the temperature sensors from their shields.

2. Disconnect the site signal cables from the translator and reconnect the test signal cables to the appropriate terminals on the translator and the thermocouple. Refer to the electrical diagram for correct connections.

3. Through the data logger menu, switch the display to “raw voltages”. To calculate delta T from the voltmeter reading multiply by 10 and subtract 3.

4. Immerse the two thermistors together in a bath of crushed ice and stir constantly.

5. After equilibrium has been reached, record the delta T from the voltmeter along with the bath temperature determined independently with the ASTM thermometer onto the QC Worksheet and in the station logbook.

6. Repeat steps 4 and 5 in luke warm water.

7. If the delta T value is greater than +/- 0.10^{o} Celsius, take corrective action. Record any remedial action on the QC Worksheet and in the station logbook.

8. Prior to placing the thermistors back in their radiation shields, ensure that the shields are clean (white). Clean with a damp cloth if necessary.

9. Return the thermocouple to their respective radiation shields and reconnect the cables.

5.0 Maintenance

With the advent of sealed bearings and instrument housings that are impervious to corrosion, instrument failure has declined dramatically. These improvements however, should be combined with a routine Quality Control and maintenance program to properly protect the system from failure.

With a properly administered Quality Control program, the only component likely to need replacement due to normal wear is the precision bearings. It is recommended that the wind speed bearings be replaced on a semi-annual basis. Refer to your instrument specific manual for proper instructions on the replacement of these parts as well as any other maintenance activities.

6.0 Quality Assurance

6.1 Performance Audits

During each calendar year, utilizing the procedures in section 4.0, 100% of the operating meteorological monitoring stations will be audited and an audit report will be generated.

6.2 System Audits

The Systems audit is an on-site review and inspection of the entire meteorological monitoring program to assess its compliance with established regulations governing the collection, analysis, validation, and reporting of meteorological data. A systems audit will be performed annually.

7.0 Data Recording, Validating and Reporting

Refer to "State of Washington Department of Ecology, Automated Method Data Documentation and Validation Procedures," December 1993, document. This document describes the procedures for handling, recording and validating air monitoring data. All data will be reviewed and certified by the Quality Assurance Coordinator prior to being reported or used to make decisions concerning air quality, air pollution abatement or control.

8.0 Data Quality Assessment

For each calendar quarter and year, the Quality Assurance unit will prepare data completeness reports. The completeness of the data will be determined for each meteorological parameter and expressed as a percentage. Percent valid data will be a gauge of the amount of valid data obtained compared to the amount expected under ideal conditions (24 hours per day, 365 days per year).

9.0 References

1. "On-Site Meteorological Program Guidance for Regulatory Modeling Applications" EPA-450/4-87-013. June 1987.

2. "Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD)" EPA-450/4-87-007. May 1987.

3. "Quality Assurance Handbook for Air Pollution Measurement Systems" EPA-600/R-94/038d. Revised March, 1995.

4. Washington State Department of Ecology "Air Monitoring Quality Assurance Plan", February 1999

5. Washington State Department of Ecology "Automated Method Data Documentation and Validation Procedures", December 1993.

6. Washington State Department of Ecology "Air Monitoring Site Selection and Installation Procedures", October 1994.

10.0 Forms

This section contains blank forms. Please make copies as needed retaining the originals within the document.

SITE INSTALLATION DOCUMENTATION

AIRS SITE # | 5 | 3 | - | | | | | | | |

LOCATION:

Site Name: ____

Address: ____

City (if inside city limits): ____________________ County: ______________________

Location of probe (if different than address): ______________________________

UTMs:

Zone	X-Coordinate	Y-Coordinate

Site Elev.	FT or M	Sta. Type

INSTRUMENT INFORMATION:

PARAMETER	MANUFACTURER	MODEL	PROBE HT. (FT)	PROBE LENGTH (FT)

GENERAL INFORMATION:

Distance from nearest road: ____________________ Ft.
Type of roadway: ______________________________ Local Street, Highway, Through Street, etc.

Draw a picture or attach a map of site (minimum one-block radius). Identify all surrounding thoroughfares, traffic patterns, arterials, etc.

↑
|
|
|
N

Installed By: ______________________________ Date: ____________________

Rev. 7/2000

INSTRUCTIONS

(It would be advantageous to take this form along at the time of the site installation.)

This form should be filled out at the time a site is installed and forwarded to Telemetry personnel in Olympia within five working days of the installation.

1. Complete all areas. If more than one parameter is being monitored at a single site, complete a form for each parameter through the instrument portion. Attach all forms for a given site together.

2. Send original to telemetry personnel in Olympia (make and keep a copy for reference purposes).

4. Final distribution will be made by telemetry personnel in Olympia when all areas have been filled in.

Q.C. AUDIT REPORT

Station:____ Date:________________

Station #:______________________________________ Time:________________

Operator:_______________________________________

Visual Inspection

☐ Vane ☐ Propeller ☐ Tower

MEASUREMENTS	TOLERANCE		AS IS			AFTER SERVICING	
Bearing Torque *(threshold)*							
Wind Speed	1 gm – cm						
Azimuth	12 gm – cm						
Wind Direction Orientation Check			Bearing	Diff.		Degrees	Diff.
	± 2.0°						
Wind Speed Translator Output			MPH	Diff.		MPH	Diff.
0 rpm	± 0.5 mph						
600 rpm	± 0.83 mph						
1200 rpm	± 1.16 mph						
2400 rpm	± 1.82 mph						
Wind Direction Translator Output			**Degrees**	**Diff.**		**Degrees**	**Diff.**
90 deg	± 3.0°						
180 deg	± 3.0°						
270 deg	± 3.0°						
370 deg	± 3.0°						
538 deg	± 3.0°						
Temperature			**Degrees**	**Diff.**		**Degrees**	**Diff.**
Water Bath	± 0.50° C						
Ice Bath	± 0.50° C						
Delta T			**Degrees**	**Diff.**		**Degrees**	**Diff.**
Water Bath	± 0.10°C						
Ice Bath	± 0.10° C						

Action Taken:____ Date:________________________________

By:____

Meteorological Quality Control Check Report

Station:______________________________ Date:______________________________
Station #:_____________________________ Time:______________________________
Operator:_____________________________ Personnel:__________________________
Purpose of Check: ☐ Quarter ☐ Other__________________________________

Wind Sensor Model # :___________________ Wind Translator Serial #:________________
Wind Sensor Serial #: ___________________ Wind Translator Air #: ________________
Propeller Serial #: ___________________ Temp. Translator Serial #:_______________
Temp Sensor Model #:___________________ Temp. Translator Air #: ________________

As Found Orientation Check

Distant Object Bearing:____
Actual Vane Alignment Rod Bearing:___________________________________
Difference From True North:____(± 2 degrees max)
Comments:____

Wind Speed Threshold Check

Starting Torque:_______________________________________ g – cm (1 g-cm maximum)
Actual Vane Alignment Rod Bearing:____

Wind Direction Threshold Check

Starting Torque Clockwise:_______________________________ g – cm (12 g-cm maximum)
Starting Torque Counter Clockwise:_________________________ g – cm (12 g-cm maximum)
Comments:____

Wind Speed Accuracy Test

RPM/Speed	DAS Reading	Indicated Speed	Difference
	Volts	MPH	
0/0 mph			
600/6.87 mph			
1200/13.74 mph			
2400/27/48 mph			

(maximum error 0.5 mph ± 5% of the desired wind speed.)

Comments:____

Wind Direction Accuracy Check

Actual Direction	DAS Output		Indicated Direction		Difference (± 3° max)	
	Pre	Post	Pre	Post	Pre	Post
005						
030						
060						
090						
120						
150						
180						
210						
240						
270						
300						
330						
350						
370						
390						
420						
450						
480						
510						
538						
450						
370						
270						
180						
090						
005						

Comment: ____

Temperature Accuracy Check

Test Method	ASTM Reading	DAS Reading (Volts)	Indicated DAS Reading	Difference (± 0.5° C Max)
Water Bath				
Ice Bath				

Comments: ____

Delta Temperature Accuracy Check

Test Method	ASTM Reading	DAS Reading Volts	Indicated Delta T Reading	Difference (± 0.1° C Max)
Water Bath				
Ice Bath				

Comments: ____

Calibration Equipment

Description	Model Number	Serial Number
Thermometer		
Thermometer		
Torque Wheel		
Torque Gauge		
Speed Motor		
Transit		

Auditor: ______________________________________ Date: ___________________________________

Net Radiometer Accuracy Check

Normal	Inverted	Difference

	Constant	Response	Result
Field			
Backup			
Field			
Backup			
Field			

(Max ± 5% between average for field and backup)

Comments: ____