STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES
FOR
AIR QUALITY MONITORING

APPENDIX V

METEOROLOGICAL PARAMETER PROCEDURES
FOR
WIND DIRECTION SENSORS

MONITORING AND LABORATORY DIVISION

SEPTEMBER 1995

TABLE OF CONTENTS

APPENDIX V

METEOROLOGICAL PARAMETER PROCEDURES
FOR
WIND DIRECTION SENSORS

TABLE OF CONTENTS (cont.)

APPENDIX V

METEOROLOGICAL PARAMETER PROCEDURES
FOR
WIND DIRECTION SENSORS

APPENDIX V

**METEOROLOGICAL PARAMETER PROCEDURES
FOR
WIND DIRECTION SENSORS**

FIGURES

STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES
FOR
AIR QUALITY MONITORING

APPENDIX V.1

STATION OPERATOR'S PROCEDURES
FOR
WIND DIRECTION SENSORS

MONITORING AND LABORATORY DIVISION

SEPTEMBER 1995

V.1.0 GENERAL INFORMATION

V.1.0.1 THEORY OF OPERATION

Wind direction sensors provide information on the azimuth angle from which the wind is blowing. A tail assembly is positioned on a vertical shaft. When the wind blows, it will apply a force to the tail assembly, and the tail assembly will turn the shaft seeking a position of minimum force. The shaft is supported by low friction precision grade bearings and is connected to a low torque potentiometer. The potentiometer will yield a voltage output proportional to the wind direction. The relationship of shape, size, and distance from the axis of rotation of the tail assembly to the bearings and potentiometer torque requirements control the starting threshold. The proper orientation of the sensor to TRUE NORTH, efficient operation of bearing assemblies, and correct potentiometer function are factors which can effect the quality of wind direction data. Thus, calibration of the wind direction sensor is necessary every six months to assure the correct function of the components. There are many commercially available wind direction sensors on the market. The two primary systems used by the California Air Resources Board (CARB) are manufactured by Met One Instruments and R.M. Young Company. These Standard Operating Procedures (SOP's) will only discuss the Met One 020 Wind Direction Sensor (Figure V.1.0.1) and the R.M. Young 05305 Wind Monitor-AQ (Air Quality) (Figure V.1.0.2). However, these procedures can serve as a guide for other systems which measure wind direction.

V.1.0.2 SYSTEM DESCRIPTION

1. Met One 020 Wind Direction Sensor

   a. The Met One 020 Wind Direction Sensor uses a light-weight, air-foil vane and microtorque potentiometer to produce an analog voltage output proportional to wind direction. An internal heater maintains the sensor interior at a positive pressure, which provides positive aspiration through the bearings and contributes to extended bearing life. This sensor is used in conjunction with the 184 Crossarm Assembly, the Met One 1190 Translator Module, and the Met One A1157-XX sensor cable (XX is cable length in feet).

NOTE: A1157-XX sensor cables can be retrofitted with a CARB standardized meteorological sensor interconnect and cable (Figure V.1.0.3 and Figure V.1.0.4).

b. The Met One 1190 Translator Module converts the output of the Met One 020 Wind Direction Sensor into an expanded 0-540 degree output. This scale expansion greatly reduces the 0/360 degree crossover problem. In typical use, the translator module provides +12 volts direct current (VDC) for sensor power. The sensor's internal heater requires a separate source of 12 volts. There are built-in zero and half-scale test switches and input and output test points in the front of the translator module. Two analog output signals are available from the output of the translator module.

2. R.M. Young 05305 Wind Monitor-AQ

a. The R.M. Young 05305 Wind Monitor-AQ measures horizontal wind speed and direction. The main housing, nose cone, propeller, and other internal parts are constructed of injection molded ultraviolet stabilized plastic. The tail section is constructed of thermoformed expanded polystyrene. The nose cone assembly threads directly into the main housing contracting an o-ring seal. Both the propeller and vertical shafts use stainless steel precision grade ball bearings. Propeller shaft bearings have shields to help exclude contamination and moisture.

b. The vane position is transmitted by a 10 kilohm precision conductive plastic potentiometer which requires a regulated excitation voltage. With a constant voltage applied to the potentiometer, the output signal is an analog voltage directly proportional to azimuth angle.

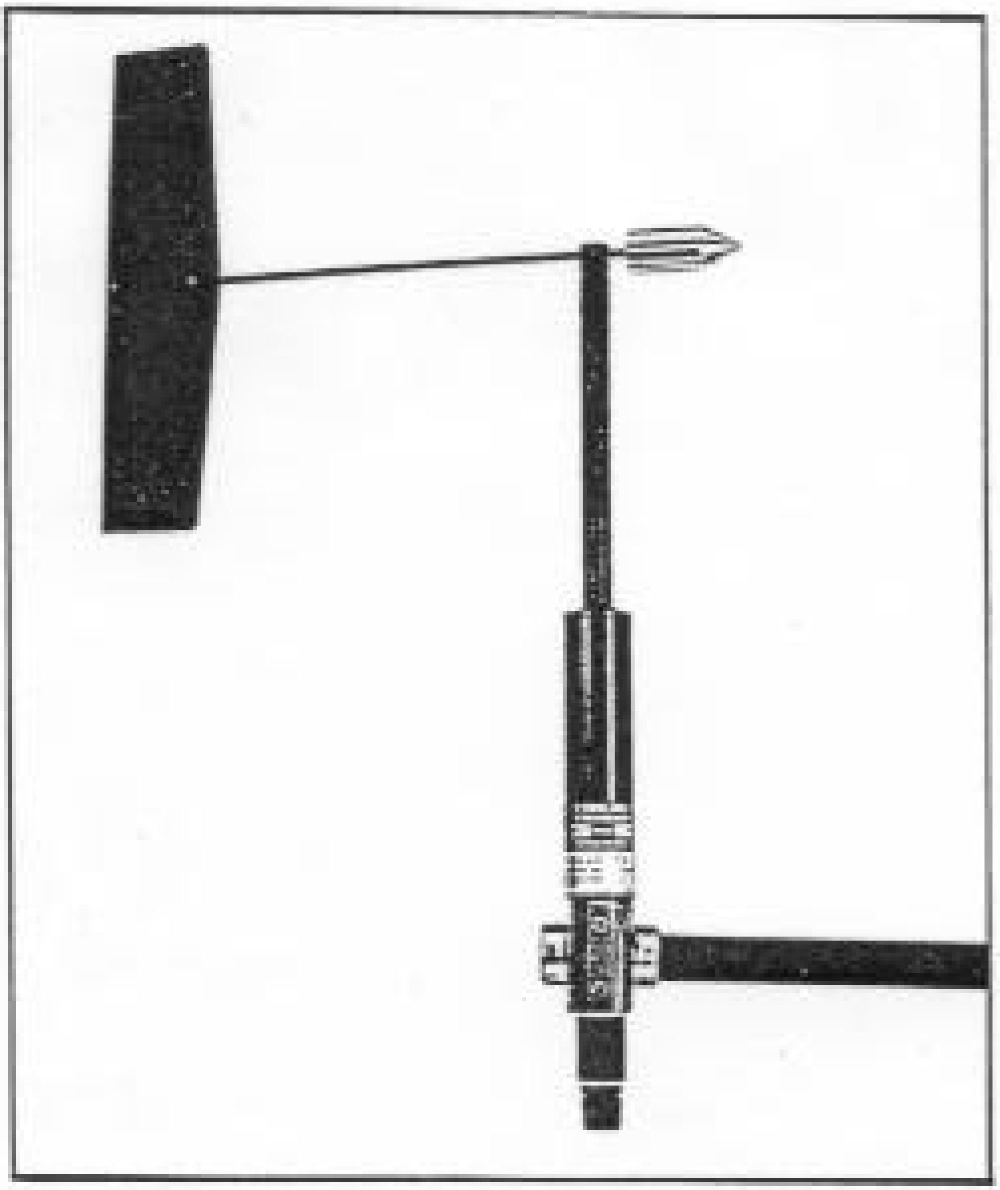

Figure V.1.0.1
Met One 020 Wind Direction Sensor

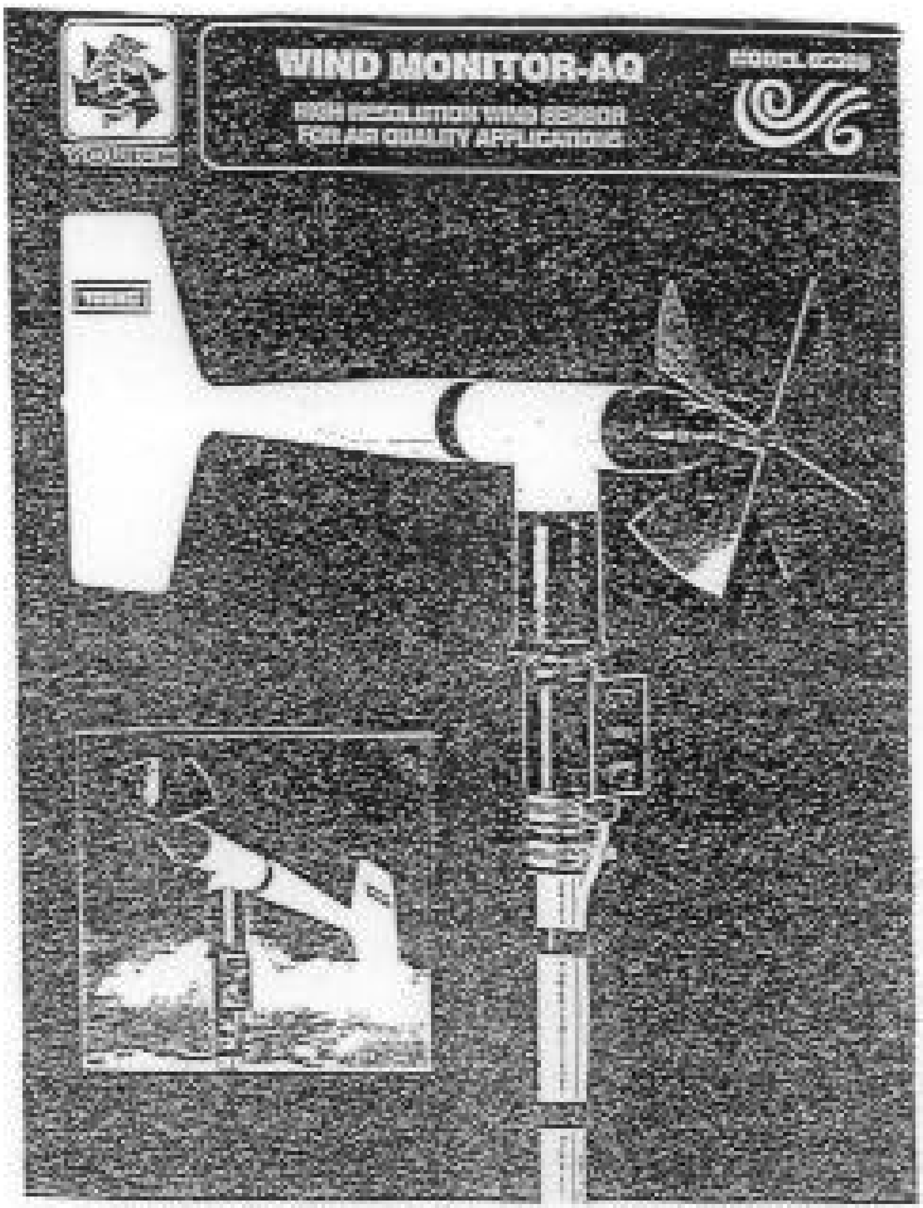

Figure V.1.0.2
R.M. young 05305 Wind Monitor-AQ

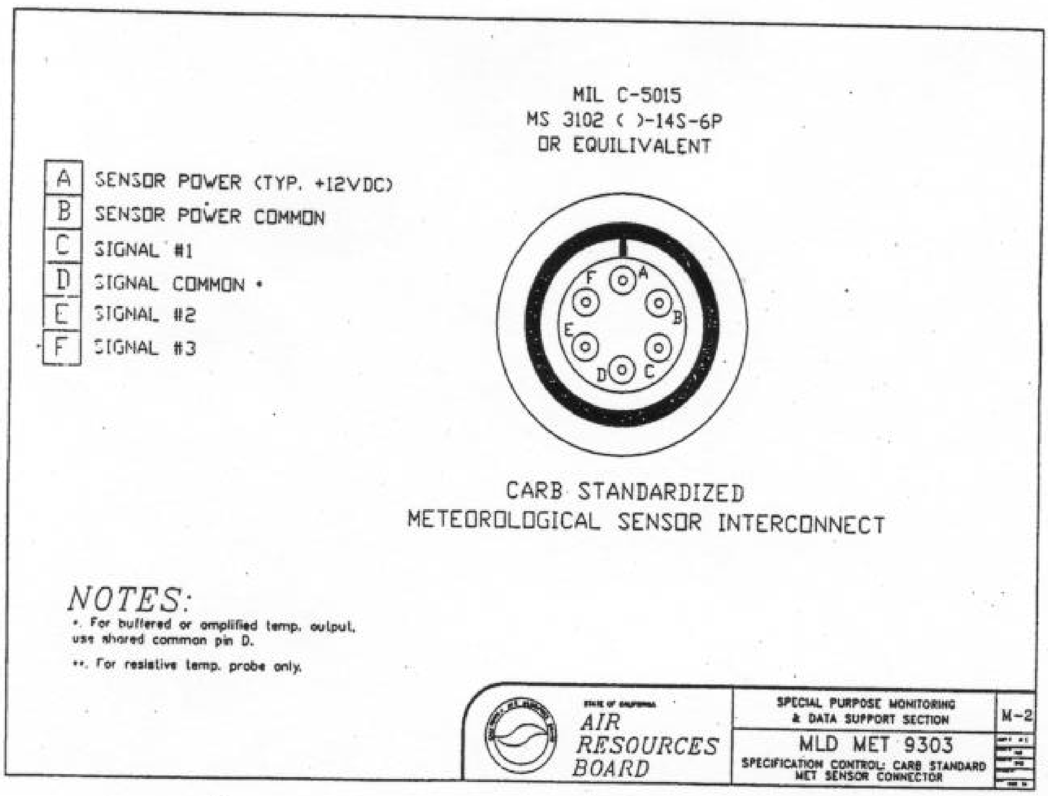

Figure V.1.0.3
CARB Standardized Meteorological Sensor Interconnect

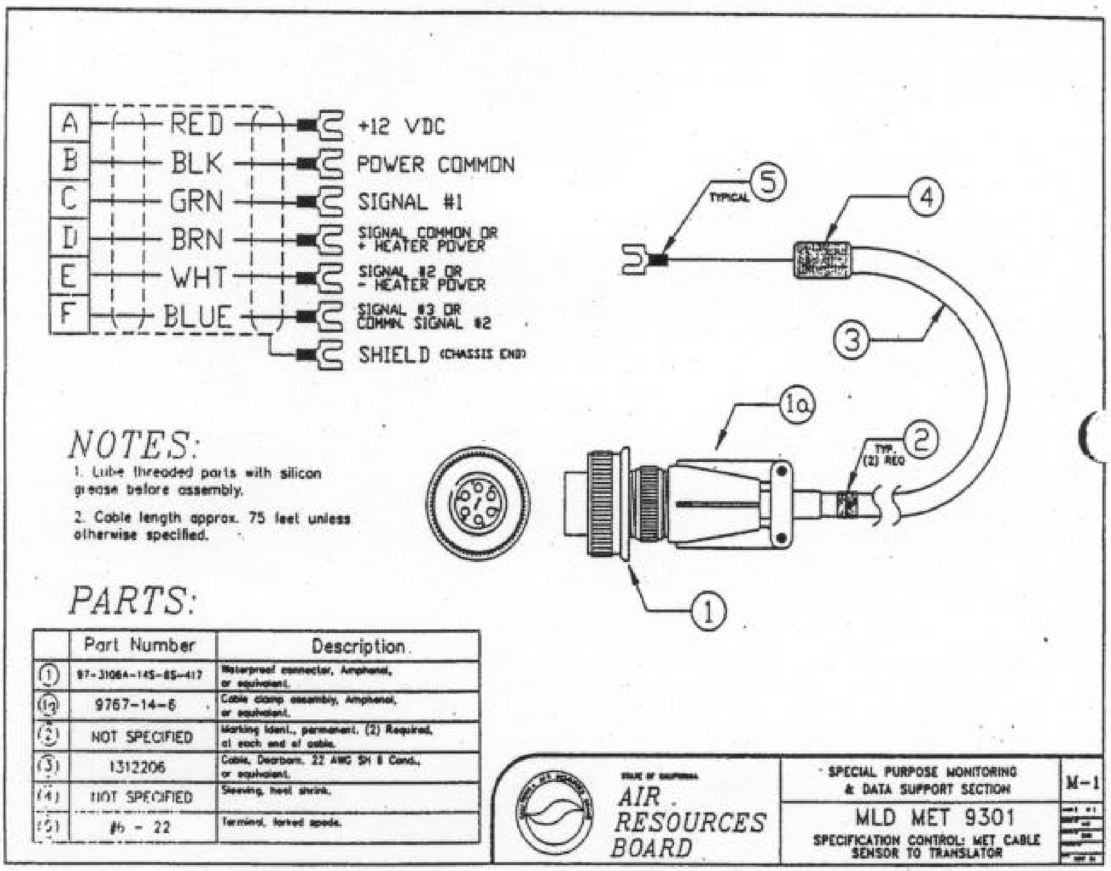

Figure V.1.0.4
CARB Meteorological Sensor Cable

V.1.1 INSTALLATION PROCEDURES

V.1.1.1 PHYSICAL INSPECTIONS

Upon receiving the wind direction systems, unpack and check for any signs of shipping damage.

V.1.1.2 INITIAL SET-UP/INSTALLATION

Proper operation of any meteorological instrument is directly related to siting of the equipment. An ideal installation is one where the operator can safely access the sensor, perform tests adjacent to the electronics and recorder, and re-install the sensor, alone, within one hour. Station operators should read the CARB Air Monitoring Quality Assurance Standard Operating Procedures for Air Quality Monitoring, Volume II Section 2.0.8 (Siting Requirements for Meteorological Equipment); the Environmental Protection Agency (U.S. EPA), Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV; and U.S. EPA Prevention of Significant Deterioration (PSD) guidelines to get a more detailed description of siting requirements. The CARB Air Monitoring Quality Assurance Standard Operating Procedures for Air Quality Monitoring, Volume II, will be referred to as the CARB SOP for Air Quality Monitoring, Volume II, for the rest of this document.

NOTE: To obtain specific information regarding the installation of wind direction sensors, read the sensor operating manual. Also, best results are achieved if two people perform the installation. Be sure to have silicon grease, electrical tape, and ultra violet stabilized zip ties with you.

1. Met One 020 Wind Direction Sensor Installation

   a. Carefully mount the vane assembly onto the transmitter by supporting the rotating hub with one hand while fitting the vane assembly onto the hub with the other hand. The vane assembly is keyed to fit the hub. Tighten the set screw.

   b. Check to see that the vane assembly rotates freely and the sensor is vertical.

c. Install the sensor into the end of the crossarm assembly. The orientation notch on the sensor should be aligned with the crossarm assembly; when the crossarm is aligned, per Section V.1.1.3, the orientation notch should be facing south.

d. Connect the Met One A1157-XX cable to the keyed sensor receptacle and tape it to the mounting arm.

e. Connect the leads of the Met One A1157-XX cable to the appropriate points on the Met One 1190 translator module.

f. Check the datalogger reading and verify that it agrees with the direction the sensor is indicating.

2. R.M. Young 05305 Wind Monitor-AQ Installation

a. Place the orientation pointer on the mounting post. Assure that enough space is left above the pointer so that the sensor is firmly mounted and seats on the orientation pointer clamp.

b. Align the orientation pointer to True North using a compass. The compass should be mounted on a non-magnetic tripod when performing this alignment. Refer to CARB SOP for Air Quality Monitoring, Volume II, Section V.1.1.3 on the alignment procedures.

c. Place the wind sensor on the mounting post and tighten the clamp. Ensure that the junction box faces South. Connect the R.M. Young cable to the junction box on the R.M. Young wind sensor base. Secure the sensor cables to the tower.

d. Connect the leads of the cable to the appropriate points on the R.M. Young translator module.

e. Check the datalogger reading and verify that it agrees with the direction that the sensor is indicating.

V.1.1.3 WIND DIRECTION SENSOR ALIGNMENT

The wind direction sensor index should be oriented with respect to True North. Prior to installation, the station operator should be familiar with the site magnetic declination and operation of a surveying compass. PSD standards require that the sensors be aligned to ≤2 degrees with respect to sensor mount (≤5 degrees absolute error for the installed system.)

NOTE: The compass reading can be affected by magnetic materials such as watches, belt buckles, knives, etc. All magnetic materials must be kept away from the compass when readings are taken.

Wind direction sensors should be oriented as follows:

1. Adjust the compass for proper site magnetic declination. Attach the ball and socket head to the tripod and attach the compass to the socket, secure with clamp.

2. Position the tripod where you can get a clear and safe view of the sensor. **The best position is usually to the South of the mast, in line with the mast, approximately 10 to 30 meters from mast looking North.**

3. Open the mirror to about a 45 degree angle and set the front site perpendicular to the case. Level the compass by using the circular bubble level. The compass is correctly sighted on the sensor when the operator, while looking into mirror, sees the black center line of the mirror bisecting both the front site and the crossarm or orientation vane. Check the bubble in the circular level to confirm that it is still level. The North seeking end of the needle should be pointing to 0 degrees ± .5 degree. If the correct declination is used and the compass is properly sited, the crossarm or alignment vane should be aligned to True North. To confirm that the sensor is properly aligned, it is helpful to view the mast from the opposite side (180 degrees) of the orientation direction.

4. The use of an orientation pointer may make alignment of sensors to True North easier. If this is done, the pointer may appear parallel to the black bisecting centerline in the mirror.

5. Alignment of sensors is best done by two people, one person to orient the sensor and one person to read the compass.

V.1.2 ROUTINE SERVICE CHECKS

V.1.2.1 GENERAL INFORMATION

Perform the following checks on wind direction sensors at the intervals specified in the service schedule. The checks may be performed more frequently, but should be performed at least at the specified intervals. Document all results and maintenance on the Monthly Quality Control Maintenance Checksheet (Figure V.1.2.1).

V.1.2.2 DAILY CHECKS*

1. Review datalogger data for correct operation of the wind direction sensor.

2. Data editing for wind direction data must be in accordance with the CARB SOP for Air Quality Monitoring, Volume II, Section 2.0.2.8 (Specific Criteria for Data Validity).

3. Perform a visual inspection of the wind direction sensor to assure that the sensor vane assembly is not damaged and operating properly.

* or each day the operator services the station.

V.1.2.3 BIWEEKLY CHECKS

1. Perform a visual inspection of the wind direction sensor to ensure that the sensor vane assembly is not damaged. Record the estimated wind direction to the nearest cardinal wind direction.

2. Visually inspect the orientation pointer or crossarm to see if it is oriented to True North.

3. Review the data. Check for excessive zero and span drifts, non-charateristic traces, or blank spaces on the Data Summary Reports.

4. Perform the zero and half scale translator card checks (Met One only).

5. Record the datalogger engineering and voltage readings on the Monthly Quality Control Maintenance Checksheet. Instantaneous wind direction readings will fluctuate on the datalogger, so station operators should watch the output for 15 -20 seconds and estimate the average. The datalogger estimated average should be in the same quadrant as the visual direction estimate.

V.1.2.4 MONTHLY CHECKS

Complete and submit Monthly Quality Control Maintenance Checksheet to your supervisor.

CALIFORNIA AIR RESOURCES BOARD
MONTHLY QUALITY CONTROL MAINTENANCE CHECK SHEET
METEOROLOGICAL INSTRUMENTATION

Location: ______________________ Month/Year: ______________________

Station Number: ______________________ Technician: ______________________

	RESULTANT WIND SPEED			
	TRANSLATOR CHECK (Knots)		DATALOGGER	
DATE	Zero	Full	Knots	Volts

RESULTANT WIND DIRECTION				
TRANSLATOR CHECK (Deg.)		DATALOGGER		VISUAL CHECK
Zero	Half	Deg.	Volts	

	OUTSIDE TEMPERATURE				
	TRANSLATOR CHECK (C)		DATALOGGER		REFERENCE
DATE	Zero	Full	°C	Volts	°C

INSIDE TEMPERATURE			
DATALOGGER		CHART	REFERENCE
°C	Volts	°C	°C

	PERCENT RELATIVE HUMIDITY					
	TRANSLATOR CHECK (%RH)		CHART	REFERENCE RH SENSOR	DATALOGGER	
DATE	Zero	Full	%RH	%RH	%RH	Volts

SOLAR RADIATION			
TRANSLATOR CHECK (W/m2)		DATALOGGER	
Zero	Full	W/m^2	Volts

MLD-111 1 of 2 (8/95)

Figure V.1.2.1
Monthly Quality Control Maintenance Checksheet

OPERATOR INSTRUCTIONS:

1. Daily Checks: Review datalogger and strip charts.
2. Bi-Weekly Checks: Record datalogger and strip chart readings.
   Record translator check readings (MET ONE ONLY).
   RWS: Visually inspect sensor cups or propeller for damage.
   RWD: Visually inspect wind vane for damage and record estimated wind direction (N, SW, NE, etc.). Verify mast orientation (Relative to True North).
   RH: Check station sensor versus reference %RH sensor.
   OTEMP/RH: Radiation shield fan operating.
   O/ITEMP: Check station sensor(s) versus reference temp. sensor.
   SOL. RAD: Radiation sensor not shaded.

3. Monthly Checks: Complete monthly maintenance check sheet.
   SOL. RAD: Clean radiation sensor element.

4. Semi-Annual Checks: Calibration (Last Cal. Date:________________)

5. As needed checks: Inspect and lubricate sensor cable connections with silicon based grease. Clean radiation shield housing.

NOTE: Resultant Wind Speed (RWS) and Resultant Wind Direction (RWD) datalogger readings will fluctuate, so operator should watch output for 15 - 20 seconds and record the average reading in the space provided. This value should be approximately ± 5 knots (RWS) and ± 30 degrees (RWD) of visual estimates.

Generally, %RH exceeds 70% during nighttime and early morning hours. Considering that the instruments are generally most accurate between 20% and 80% of their range. QC checks should be made sometime during the day when %RH is below 60%. If the difference between station RH sensor and the reference RH sensor (6T-L Hygroskop or Pyschro-dyne) is greater than 10% RH, then a problem may exist and the operator should troubleshoot to correct the problem. Station sensor filter cover may be excessively dirty.

DATE	COMMENTS OR MAINTENANCE PERFORMED

MLD-111 2 of 2 (8/95) Reviewed by: ________________ Date: ____________

Figure V.1.2.1 (cont.)
Monthly Quality Control Maintenance Checksheet

V.1.3 DETAILED MAINTENANCE PROCEDURES

The Met One 020 and R.M Young 05305 wind direction sensors are designed to provide years of service. They are constructed of non-corrosive materials and require little maintenance. The only components likely to need replacement due to normal wear are the precision ball bearings and the wind direction potentiometer. Refer to the sensor operating manual for detailed instructions.

1. Inspect and lubricate the sensor cable connections with silicon-based grease as necessary.

2. Record any maintenance, malfunctions, repairs, and actions taken to prevent recurrence of malfunctions on the Monthly Quality Control Maintenance Checksheet.

V.1.4 TROUBLESHOOTING

V.1.4.1 GENERAL INFORMATION

Before starting any troubleshooting procedure, refer to the sensor operating manual for specific information pertaining to troubleshooting. Record malfunctions, repairs, and actions taken to prevent recurrence of any malfunction on the Monthly Quality Control Maintenance Checksheet (Figure V.1.2.1).

NOTE: Wind directions in the same quadrant for long periods of time (for example: 18 hours), may indicate a problem with bearings.

V.1.4.2 TROUBLESHOOTING

Troubleshooting should attempt to isolate the source of the malfunction and reduce maintenance time. The following should be checked if a problem exists:

1. Visually inspect sensor.
    a. Check for signs of damage.
    b. Verify that the vane assembly is turning freely.
2. Check for loss of voltage supply.
3. Check for proper operation of the sensor bearings. Bad bearings may affect the starting threshold.
4. Verify that the cable connections are secure.
5. Measure the outputs from the wind direction sensor and/or translator using the voltmeter.
6. Verify proper datalogger initialization.

STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES
FOR
AIR QUALITY MONITORING

APPENDIX V.2

ACCEPTANCE TEST PROCEDURES
FOR
WIND DIRECTION SENSORS

MONITORING AND LABORATORY DIVISION

SEPTEMBER 1995

V.2.0 ACCEPTANCE TEST PROCEDURES

V.2.0.1 GENERAL INFORMATION

Before beginning acceptance testing of the wind direction system, read the sensor operating manual thoroughly. Initiate an Acceptance Test Log (Figure V.2.0.1) and an Acceptance Test "Mini" Report (Figure V.2.0.2). Record the dates of the individual tests, problems, contacts with the manufacturer, and all other pertinent information on the Acceptance Test Log.

V.2.0.2 PHYSICAL INSPECTION

Unpack the wind direction system and check for physical damage. Verify that the system is complete and includes all options and parts required by the purchase order.

V.2.0.3 OPERATIONAL CHECKS

Operational checks should assure that the wind direction sensors meet or exceed performance specifications stated by the vendor. Verify that the wind direction sensors meet Prevention of Significant Deterioration (PSD) Standards for wind direction: **STARTING THRESHOLD $\leq$0.5 meters/second and ACCURACY $\leq$ 3 degrees with respect to sensor mount.** Perform the following operational checks using a voltmeter, oscilloscope, and/or datalogger and record the results on the Acceptance Test "Mini" Report. Tests must be run in the range normally used in field operations.

1. Translator Test - Connect a recorder or voltmeter to the output of the translator. In accordance with sensor operating manual, verify that the translator correctly converts voltage to degrees. Verify proper operation of zero and half scale switches (Met One only).

2. Linearity - Verify translator voltage outputs are linear $\pm$1 percent across the full scale at a minimum of five points. Enter the results on the Acceptance Test "Mini" Report linearity chart.

3. Starting Threshold Speed (Torque) Test - in accordance with the sensor operating manual, determine the starting threshold speed in meters/second (m/s). Use the formula below to calculate torque or starting threshold speed.

Torque: T=K*(U)
Where: T=Torque U=Starting Threshold Speed (m/s)
K=Constant for Aerodynamic Shape

Refer to the sensor operating manual or contact the manufacturer for the "K" value. The wind speed (U) at starting threshold should meet vendor specifications and be less than 0.5 meters/second (1.12 mph) to meet PSD Standards.

4. Range Test - Verify that the wind direction sensor operates over the full scale as stated in the vendors specifications.

5. Accuracy - Verify that the wind direction sensor accuracy meets or exceeds the vendors specifications.

Make _________ Model _________ Serial _________

ACCEPTANCE TEST LOG

Date	Action

2/94

Figure V.2.0.1
Acceptance Test Log

ACCEPTANCE TEST "MINI" REPORT

Make ________________ Model ________________ Date ________________

Serial ________________ CARB # ______________ By __________________

Reviewed ______________

	Pass	Fail	Comments
I. Physical Inspection			
A. Shipping damage			
B. Electrical wiring			
C. Completeness			
II. Operational Test			
A. Translator			
B. Linearity			
C. Starting Threshold			
D. Range			
E. Accuracy			
III. Special Test			
IV. Maintenance Performed			

LINEARITY FULL SCALE ______________

Figure V.2.0.2
Acceptance Test “Mini Report”

%FS	True Voltage	Indicated Voltage	Diff. True-Ind.	Comments
o				
.25				
.50				
.75				
1.00				

Abs. Value Average Difference ______________________

Average Diff. True - Ind. must be less than 1% of Full Scale (.01V)

Linear Regression Slope ___________ Intercept _________ Correlation ___________

Figure V.2.0.2 (cont.)
Acceptance Test "Mini Report"

STATE OF CALIFORNIA

AIR RESOURCES BOARD

AIR MONITORING QUALITY ASSURANCE

VOLUME II

STANDARD OPERATING PROCEDURES
FOR
AIR QUALITY MONITORING

APPENDIX V.3

CALIBRATION PROCEDURES
FOR
WIND DIRECTION SENSORS

MONITORING AND LABORATORY DIVISION

SEPTEMBER 1995

V.3.0 OVERVIEW

V.3.0.1 THEORY

Wind direction sensors should be calibrated every six months, or more frequently in corrosive environments. Calibrations consist of system and component accuracy checks. System accuracy checks test the system as a whole and verifies that the sensor mount is accurate with respect to True North. Component accuracy checks test for errors within the system. These tests consist of a starting torque test, as well as an accuracy test with respect to a known standard.

Normally, sensors are only removed from the mast when they are undergoing maintenance and repairs or being calibrated. Therefore, sensors should be found in the same condition as when they were last placed on the mast. Before beginning the calibration, document the following "AS-IS" conditions of the sensor in the comments section of the Wind Direction Calibration Datasheet (Figure V.3.1.1).

1. Site Declination
2. Vane or Crossarm Orientations (Relative to True North)
3. Datalogger Output (Sensor held to True North, if possible)
4. Sensor Condition
5. "AS-IS" Azimuth (Computed from 1, 2 & 3)
6. Translator Card full/half and zero scale (Met One only)

This "AS-IS" condition will provide information to verify data validity between calibration periods. An "AS-IS" Wind Direction Calibration Datasheet is completed when an "AS-IS" calibration is performed. If a repair is made or the sensor is changed, a "FINAL" calibration form would also be completed.

V.3.0.2 CALIBRATION EQUIPMENT

1. Met One 020 Wind Direction Sensor

    a. Met One 040 Degree Wheel and Pointer

    b. Compass with tripod (for sensor orientation)

c. R.M. Young 18310 Cup-Wheel Torque Disc with Slotted Center with 1.0 and 0.1 gram screws or Torque Watch

d. Wind Direction Calibration Datasheet (Figure V.3.1.1)

2. R.M. Young 05305 Wind Monitor-AQ

a. R.M. Young 18112 Vane Angle Bench Stand (degree fixture)

b. Compass with tripod (for instrument orientation)

c. R.M. Young 21145 Torque Gauge

d. Wind Direction Calibration Datasheet (Figure V.3.1.1)

V.3.1 CALIBRATION PROCEDURES

V.3.1.1 GENERAL INFORMATION

The wind direction calibration must be completed before starting the wind speed calibrations. To calibrate the sensors accurately as possible, be observant of problems which could effect sensor operation, such as dirty components, and loose, worn, or broken parts. Correct and document any problems noted on the Wind Direction Calibration Datasheet. If a sensor should fail any of the following calibration procedures, try to complete the other procedures before performing repairs or sensor replacement.

V.3.1.2 STARTING TORQUE TEST

The starting threshold of the wind direction sensor is influenced by the design of the vane assembly. Wind direction sensors should have a starting threshold speed of less than 0.5 m/s. The sensors were originally built to meet this standard, and if the maximum gram-centimeter (gm-cm) torque listed in each sensors's appropriate section is exceeded, the sensor should be replaced.

NOTE: The datalogger wind direction channel should be disabled. Set the datalogger to "REPEAT READ" the wind direction channel. The sensors should be removed from the tower to perform the torque test and placed in an area free of drafts (van or station), because the sensors are very sensitive to air movement.

1. Met One 020 Sensor

    a. Remove the vane assembly and attach the modified R.M. Young torque disc with slotted center or torque watch. Place the sensor in a horizontal position (flat on table), parallel to the floor.

    b. There are two types of weights provided with the disc, black nylon screws (0.1 gram) and stainless steel screws (1.0 gram). The screws can be combined at different radii to provide a total torque.

    c. Orient the disc such that the holes are parallel to the floor. Screw a stainless steel screw in the forth hole from the center. This equals

4.0 gram-centimeters (gm-cm). The disc should rotate when released. If the disc does not rotate, increase torque by adding additional weight at different radii.

d. When the disc begins to rotate, turn the disc to at least four additional starting points in both clockwise and counterclockwise directions. This checks the operation of the bearings a complete 360 degrees.

e. Record the highest torque value measured on the Wind Direction Calibration Datasheet.

f. The starting torque should be less than 9.5 gm-cm. If the starting torque is greater than 9.5 gm-cm, replace the sensor.

g. If the sensor is replaced, repeat steps a through f.

2. R.M. Young 05305 Wind Monitor-AQ

a. Remove sensor propeller and secure the sensor in the R.M. Young 18112 Vane Angle Bench Stand. Assure that the indentation on the bottom of the sensor fits over the nipple on the vane angle bench stand.

b. Install the vane torque gauge in its mounting bracket and then install the mounting bracket over the top of the sensor. The vane torque gauge leaf spring should be six centimeters forward of the sensor centerline and point towards the front of sensor. The molding line on the sensor is approximately at six centimeters. A bubble level can be placed on the the base of the Vane Angle Bench Stand to verify that it is level. If needed, level the Vane Angle Bench Stand.

c. Using your finger, slowly apply gentle horizontal pressure against the leaf spring.

d. Measure the gram-centimeter torque needed to start the sensor moving at a minimum of 4 directions (000, 090, 180, 270 on vane angle bench stand). Verify that the vane turns smoothly for 360 degrees in both clockwise and counterclockwise directions.

e. Record the highest torque value measured on the Wind Direction calibration Datasheet. If the highest torque value is greater than 12 gram-centimeters (2 grams on the gauge scale), replace the sensor.

V.3.1.3 WIND DIRECTION ACCURACY

The accuracy calibration is performed to determine if the sensor output is correct at a minimum of five known direction orientations. The datalogger should be programmed with the correct slope and intercept values to offset any internal system errors. If the sensor output has an error of more than three degrees at any degree setting, verification of correct translator operation or replacement of the sensor will be required. Set the datalogger to "REPEAT READ" the wind direction channel, prior to performing the accuracy check.

1. Met One 020 Wind Direction Sensor

   a. Remove the wind direction vane assembly from the sensor. Slide the degree wheel over the sensor with the numbered side facing towards the top of the sensor. Align the 180 degree mark on the degree wheel to the scribed mark that is on the outside of the sensor shaft. Tighten screw to hold the degree wheel in place.

   b. Install the pointer of the degree wheel on the shaft where the wind vane assembly was removed. Assure that the pointer is close enough to the degree fixture to accurately read the degree values.

   c. Rotate the pointer to the following degree settings on the degree wheel: 005, 090, 180, 270, 355, 450, and 535. Record the datalogger display on the Wind Direction Calibration Datasheet for each point.

   d. If there is more than a three degree difference between the datalogger and the degree wheel, calibrate the 1190 Translator Module. If the translator module cannot be calibrated properly, replace the translator board and repeat step c. If readings are still more than three degrees off at any degree setting, replace the sensor. Return the removed translator board and the sensor to the CARB's Air Quality Monitoring-North and Operations Support Section.

e. Remove the Met One 040 Degree wheel and pointer. Reinstall the vane assembly on the sensor shaft.

f. Position the sensor back on the mast (Section V.1.1.2).

2. R.M. Young 05305 Wind Monitor-AQ

a. Secure the sensor in the R.M. Young 18112 vane angle bench stand. Assure that the indentation on the bottom of the sensor fits over the nipple on the vane angle bench stand. Install the R.M. Young alignment arm firmly onto the vane angle bench stand to support the tail of the vane assembly.

b. Rotate the pointer on the vane angle bench stand to the following degree settings on the degree wheel: 005, 090, 180, 270, 355. Record the datalogger display on the Wind Direction Calibration Datasheet for each point.

c. If there is more than a three degree difference between the datalogger and the degree wheel readings, return the sensor and the translator to the CARB's Air Quality Monitoring-North and Operations Support Section for repair.

d. Remove the alignment arm and the vane angle bench stand from the sensor.

e. Position the sensor back on the mast (Section V.1.1.2).

CALIFORNIA AIR RESOURCES BOARD
WIND DIRECTION CALIBRATION DATA SHEET

DATE ____________ CALIBRATION: AS IS |____| FINAL |____|
SITE: Name ________________ Number __________ Last Cal. Date ______

INSTRUMENT DESCRIPTION:

Manufacturer ____________ Model __________ Serial __________
Reporting Units __________ Range __________ Sensor Height ______

CALIBRATION EQUIPMENT:
Brunton Transit Serial ____________ Torque Disc Serial __________
Torque Guage Serial ____________ Degree Fixture Serial ________

"AS IS" CONDITION:
Declination of site _____° East
Vane or Crossarm Alignment (Relative to TRUE NORTH) ______________
Datalogger Output (Sensor vane aligned with crossarm) ______________
Sensor Condition ______________________________
AS-FOUND Azimuth computed from above measurements ______________

CALIBRATION:

Starting Torque (gm-cms) __________ (Met One ≤9.5 and R.M. Young ≤11.0)
Direction Accuracy: Difference TRUE - LOGGER less than 3.0 Degrees

TRUE Degrees	Datalogger Degrees	Difference TRUE - ESC
005		
090		
180		
270		
355		
450		
535		

	Volt	Degrees
Zero Scale	______	______
Half Scale	______	______
	o	o

450 and 535 readings for Met One 0 - 540 potentiometer sensors.

RWD Linear Regress: Slope=______ Intercept=______ Correlation=______

AS LEFT CONDITION:
Datalogger Output (Sensor vane aligned with crossarm) ______________
Vane or Crossarm Alignment (Relative to TRUE NORTH) ______________
AS-LEFT Azimuth computed from above measurements ______________

Comments: ____

Calibrated by ________________ Checked by ________________

MLD-129 (08/07/95)

Figure V.3.1.1
Wind Direction Calibration Datasheet

CALIFORNIA AIR RESOURCES BOARD
CALIBRATION REPORT

TO: Michael Spears, Manager
Special Purpose Monitoring & Data Support

LOG NUMBER: N/A
CALIBRATION DATE: 05/10/95
REPORT DATE: 05/16/95

FROM: Reginald Smith
Air Pollution Specialist

IDENTIFICATION

Instrument: Met One Wind Direction	Site Name: Jackson
Model Number: 020	Site Number: 03-614
Property Number: N/A	Site: ARB
Serial Number: 2445-A	Location: 201 Clinton Road Ste 109
Previous Calibration Log Number: N/A	Instrument Property of: ARB
Elevation: 1800 ft Site Temperature: 17 °C	Barometric Pressure: N/A mm Hg

CALIBRATION STANDARDS

Standard	I.D. Number	Certification Date	Certified Value Or Factor
Brunton F-3008 Pocket Transit (compass)	5080694093	Factory	N.A.
Modified R.M. Young Torque Disc	SPM2	Factory	N.A.
Met One Direction Fixture Model 040	SPM1	Factory	N.A.

CALIBRATION RESULTS

Component		Wind Direction		
Instrument Range, degrees		0 to 540		
AS-IS Azimuth in Relation to True North, degrees		006 East		
FINAL Azimuth in Relation to True North, degrees		+/- 1 West		
AS-IS Starting Torque, gm-cms		05		
FINAL Starting Torque, gm-cms		05		
AS-IS Avg. Direction Difference, degrees		1.20		
FINAL Direction Difference, degrees		N/A		
Best Fit Linear Regression	Slope	0.9944		
	Intercept	1.4919		
	Correlation	0.9999		

Comments:

Calibrated By RWS/DXB Checked By ____________

MLD-25 (11/90)

Figure V.3.1.2
Sample Calibration Report

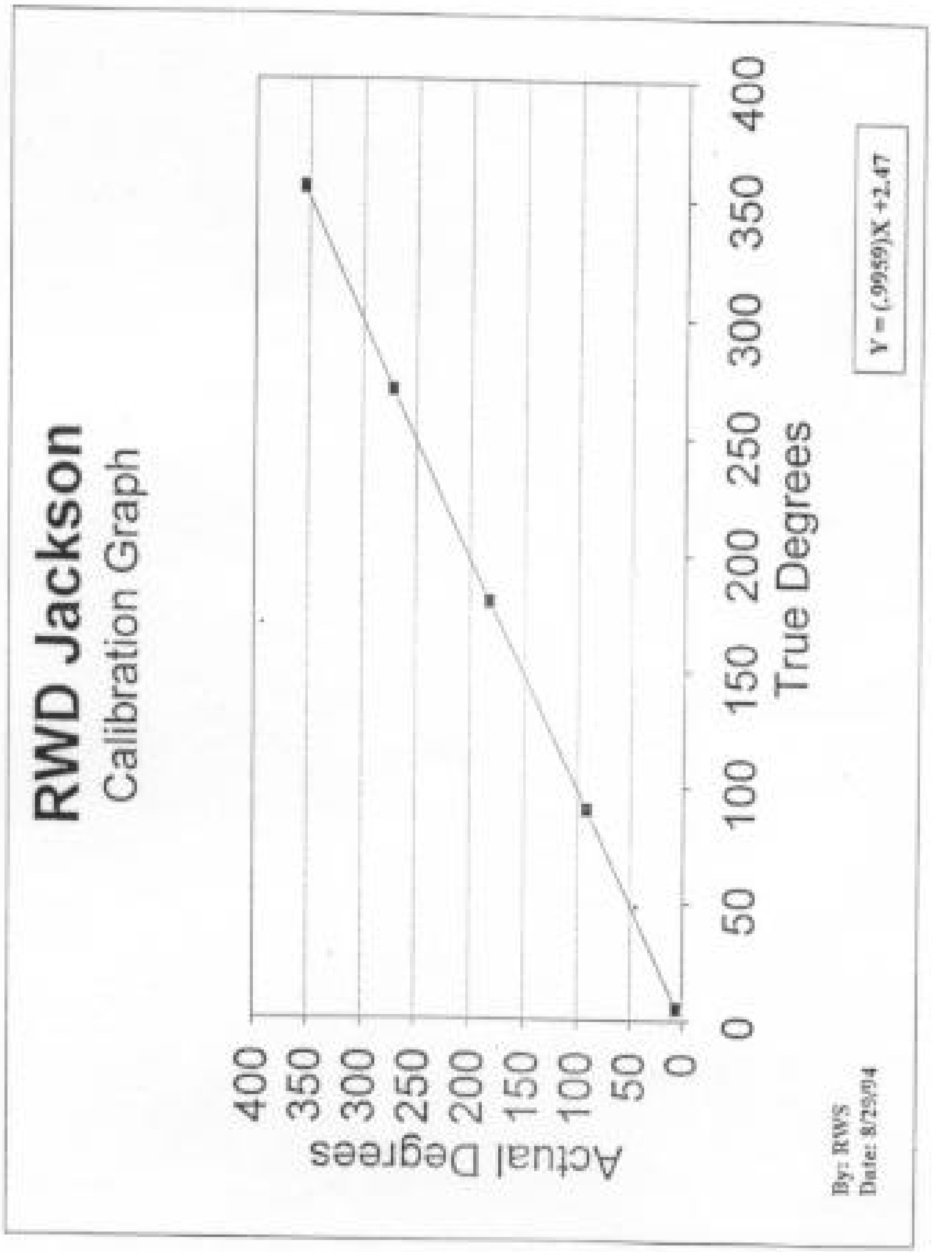

Figure V.3.1.3
Sample Calibration Graph