South Coast Air Quality Management District
Science and Technology Advancement

Monitoring and Analysis Division
Atmospheric Measurements Branch
Operations Section

STANDARD OPERATING PROCEDURE

FOR
Operation of
METEOROLOGICAL SYSTEMS

SOP00070
Version 1.0
JANUARY 07, 2010

PREPARATION, REVIEWS AND APPROVALS

Standard Operating Procedure for Meteorological Systems

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REVISION HISTORY

Standard Operating Procedure for Meteorological Systems

Version	Date
1.0	January 07, 2010

REVISION CHANGES FROM PREVIOUS VERSION

Standard Operating Procedure for Meteorological Systems

Section	Revisions
N/A	- N/A

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1.0 GENERAL INFORMATION

1.1 Purpose:

The purpose of this Standard Operating Procedure (SOP) is to provide a set of written instructions that document routine maintenance and operation procedures for measurement of Wind Speed and Direction, Barometric Pressure, UV Radiation, Solar Radiation, Relative Humidity and Ambient Temperature.

1.2 General Description and Principle of Operation

Ultrasonic Anemometer:

The Gill ultrasonic anemometer unit has no customer serviceable parts and requires no calibration or maintenance. *Do NOT remove black "rubber" transducer caps*. Gill products are in continuous development and therefore specifications may be subject to change and design improvements without prior notice. The Gill model 1172N wind sensor is a very robust, lightweight unit with no moving parts, outputting wind speed and direction. The units of wind speed, output rate and formats are all user selectable.

Figure 1 Met One Ultrasonic anemometer

R.M. Young Anemometer/Climatronics 101283-G2:

The Model 05305VP/101283-G2 Wind Monitor-AQ is a high resolution wind sensor designed specifically for air quality applications. It combines simple, corrosion-resistant construction with low threshold, fast response and excellent fidelity. The Wind Monitor-AQ meets the requirements of the following regulatory agencies: U.S. Environmental Protection Agency-Ambient Monitoring Guidelines for Prevention of Significant Deterioration (PSD). Wind speed is sensed by a lightweight, carbon fiber thermoplastic (CFT), helicoid propeller. Propeller rotation produces an AC sine wave voltage signal with frequency directly proportional to wind speed. Slip rings and brushes are not used. The instrument body is UV stabilized plastic with stainless steel and anodized aluminum fittings. Precision grade, stainless steel ball bearings are used throughout. Transient protection and cable terminations are located in a convenient junction box. The instrument mounts on standard 1" pipe. The wind direction sensor is a lightweight vane with performance characteristics that assure excellent fidelity in fluctuating wind conditions. Vane position is sensed by a precision potentiometer. Output is a DC voltage directly proportional to vane angle.

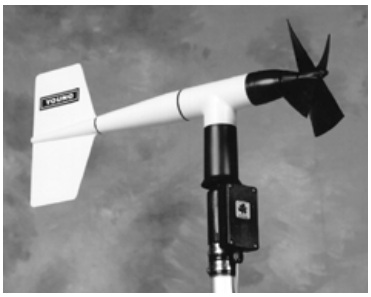

Figure 2 RM Young 5305VP/ Climatronics 101283-G2 Anemometer

Barometric Pressure:

Barometric Pressure Sensors convert absolute atmospheric pressure into a linear, proportional voltage, which may be used in any meteorological program. The Met One Model 090D are inherently stable devices that do not require periodic service or routine recalibration.

Figure 3 Met One 092 Barometer

The enclosure houses a solid state pressure transducer.

UV Radiation:

The Eppley model 31722 Total Ultraviolet Radiometer is a rugged, relatively simple detector for the measurement of solar UV radiation. Ease of operation combined with performance accuracy comparable with pyranometers intended for the recording of the total short-wave radiation (0.295 to 0.385 µm) make this instrument an attractive instrument for UV measurement. This instrument utilizes a hermetically sealed selenium barrier-layer cell which is protected by a quartz window. It is operated at low light levels and under conditions of minimum electrical current drain, in order to ensure a high degree of performance stability over lengthy periods of exposure. A specially designed Teflon diffuser not only reduces the radiant flux to acceptable levels but also provides close adherence to the Lambert cosine law. An encapsulated narrow bandpass (interference) filter limits the spectral response of the photocell to the wavelength interval 0.295 to 0.385 µm, with negligible secondary transmission

Figure 4 Eppley Model 31722 UVR

Solar Radiation:

A CMP6 series pyranometer is a high quality radiometer designed for measuring short-wave irradiance on a plane surface (radiant flux, W/m2) which results from the sum of direct solar radiation and the diffuse radiation incident from the hemisphere above the instrument. Solar energy is a significant element in large-scale atmospheric motion, and as a result, it has an important place in meteorology. It is directly related to atmospheric stability, and is used in determining stability classes for pollution studies.

Figure 5 Kipp and Zonen CMP6

Relative Humidity / Ambient Temperature:

The Met One Model 083E sensor probe represents sensitivity, accuracy, linearity and stability not encountered with conventional relative humidity sensors. It is extremely well suited for meteorological, industrial, laboratory and other demanding applications. The Model 083D Relative Humidity Sensor is based upon the capacitance change of a polymer thin film capacitor. A one-micron thick dielectric polymer layer absorbs water molecules through a thin metal electrode and causes capacitance change proportional to relative humidity. The thin polymer layer reacts very fast, and therefore, the response time is very short; less than five seconds to 90% of the final value of relative humidity. The sensor responds to the full range from 0-100% relative humidity. Its response is essentially linear, with small hysteresis, and negligible temperature dependence

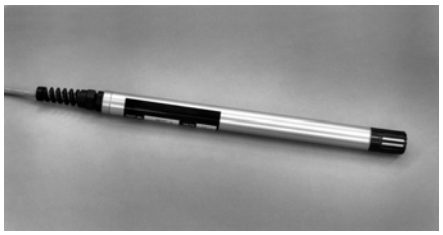

Figure 6 Met One 083E RH/T Sensor

Indoor Temperature:

Met One Instrument model TI-064-2 sensor is a precision, extended range thermistor device that is used for the accurate measurement of ambient air temperature. It is particularly well suited for field applications, as it exhibits very high resistance sensitivity. The solid state multi-element thermistor produces a relatively large resistance change per degree of temperature change, allowing the use of normal signal voltages without self-heating of the sensor. When used with signal conditioning modules, the resultant output is a precise analog voltage.

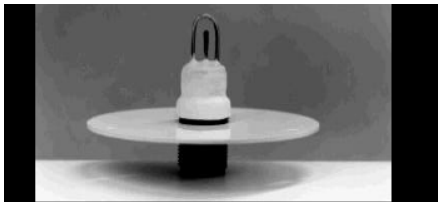

Figure 7 Met One TI-064 Indoor Temperature

2.0 SITING AND INSTALLATION

2.1 Physical Inspection

Check the contents of the shipment for completeness and note whether any damage has occurred during transport; if the contents are incomplete, the manufacturer should be notified in order to facilitate the repair or replacement of the instrument.

2.2 Initial setup and installation

Proper operation of any meteorological sensor is directly related to the siting of the sensor. An ideal location is one is where the operator can safely access the sensor, perform necessary maintenance, and easily remove and reinstall the sensor. Station operators should familiarize themselves with EPA publication EPA-454/B-08-002, "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume IV: Meteorological Measurements Version 2.0 (Final)." (http://www.epa.gov/ttn/amtic/files/ambient/met/Volume%20IV_Meteorological_Measurements.pdf). Specifications for installation of meteorological sensors are summarized in Table 1. The role of the operator is to assure the installation of equipment meets these standards.

Gill Ultrasonic Anemometer:

Do NOT remove the black "rubber" transducer caps. Take care not to knock the four Transducer arms. All the time the 1172N is not in its final location, it should be protected from damage by keeping it in the original packaging as long as possible, treating it as a delicate instrument. Warranty is void if the unit case is removed. The 1172N requires no calibration or adjustment whatsoever. Always check the installation to ensure the 1172N is not affected by other equipment operating locally, which may not conform to current standards e.g. radio/radar transmitters. Ensure the product is correctly grounded in accordance with this manual. Use cables supplied by Gill; where the cables are cut and re-connected (junction boxes, plugs and sockets) the cable screen integrity must be maintained, to prevent the EMC performance being compromised. Avoid turbulence caused by surrounding structures that will affect the accuracy of the 1172N such as trees, masts and buildings. The standard exposure of wind instruments over level open terrain is 10m above the ground. Assure all connections are secure and tight with no loose wires.

R.M. Young Anemometer:

Locate wind sensor away from obstructions such as trees and buildings. As a general rule of thumb there should be a horizontal distance of at least ten times the height of the obstruction between the anemometer and the obstruction. If it is necessary to mount the sensor on a roof or building the height of the sensor above the roof should be at least 1.5 times the height of the building. Assure all connections are secure and tight with no loose wires.

Barometric Pressure:

The location of a barometer should be carefully considered in order for the equipment to accurately measure atmospheric pressure. A barometer should be placed in a location

- That has uniform, constant temperature
- That has good general lighting but is shielded from direct sunshine
- That is away from drafts and heaters
- Where it will have a solid, vertical mounting
- Where it will be protected against rough handling

Assure all connections are secure and tight with no loose wires.

UV Radiation/Solar Radiation:

The site selected for an upward-looking UV Radiation or Solar Radiation sensor should be free from any obstruction above the plane of the sensor and should allow easy access for cleaning and maintaining the instrument. It should be located so that shadows will not be cast on the device and away from light-colored walls or other objects likely to reflect sunlight. A flat roof is usually a good choice; but if such a site is not possible, a rigid stand with a horizontal surface some distance from buildings or other obstructions should be used. A site survey of the angular elevation above the plane of the radiometer surface should be made through 360 degrees.

Relative Humidity / Ambient Temperature:

Relative humidity/Ambient Temperature sensors should be mounted over a plot of open level ground at least 9 m in diameter. The ground surface should be covered with non-irrigated or un-watered short grass or, in areas where grass does not grow, natural earth. The surface must not be concrete or asphalt or oil-soaked. The standard height for climatological purposes is 1.25 m to 2 m above obstructions, but required heights may frequently be different in air quality studies.

Indoor Temperature

The indoor temperature sensor should be mounted within the station shelter in an area that is not located over any surface or area which can affect the ambient temperature (such as air conditioning vents).

3.0 ROUTINE SERVICING

3.1 General information

Perform the following checks on meteorological sensors at the intervals specified in the service schedule. The checks may be preformed more frequently but should be preformed at least at the prescribed intervals. Be sure to document all results of maintenance and downtime on the monthly maintenance sheet and downtime log. The Downtime Log, Monthly Maintenance sheet are included as attachments. A summary of maintenance intervals are in Table 2.

3.2 Daily Maintenance

All Instruments

On a daily basis the operator should review sensor data collected from the previous day for all sites by viewing data remotely or by Chessell stripchart. Data should be compared to the previous day's weather for consistency with weather pattern. For example, on a sunny day, the UV and temperature should be higher and on rainy days, the % humidity should be highs are pressure slightly lower. The operator should familiarize himself with the normal diurnal pattern for each instrument. If patterns appear incorrect, the operator should investigate further.

3.3 Weekly Maintenance

All Instruments

On the maintenance sheet, record code for current weather as defined on the maintenance sheet. Record the current readings from the Chessell stripchart recorder and data logger in the appropriate columns on the maintenance sheet. Perform a visual inspection of the sensor to ensure that it is not damaged. Review the Chessell stripchart data for the preceding week to ensure that data appears to follow normal diurnal patters and check appropriate box to indicate whether traces are normal on maintenance sheet.
*on the day that the operator services the station

3.4 Monthly Maintenance

All Instruments

Lower and raise the elevator mechanism and lubricate plastic guides with silicone spray if necessary and record on maintenance sheet. Inspect the Solar radiation sensor to assure the desiccant is colored orange. If desiccant is transparent note on the maintenance sheet and report to repair personnel to either be replaced or rejuvenated. Clean the solar radiation and Ultraviolet radiation sensors with de-ionized water and visually inspect the sensors to be sure they are level, if necessary obtain a leveling device to confirm horizontal alignment. Using a cover which blocks sunlight, cover both UVR and SR sensors to verify zero of each sensor. One this is complete check the appropriate box on the maintenance sheet and record values.
*on the day that the operator services the station

3.5 Annual Maintenance

All Instruments

Assure that the Repair group has cleaned and lubricated the elevator mechanism; Verified Temperature sensors are within specification using an NIST traceable thermometer; Relative Humidity sensors have been verified to be within specification, and anemometer has been calibrated. Annual maintenance can be verified by reviewing documentation in logbook. If the preceding has not been completed please report to appropriate personnel.

4.0 CHAIN OF CUSTODY

4.1 Downtime Log

Complete and submit to the Senior AQIS for review. The downtime log indicates periods of time when meteorological instruments were not collecting valid data due to instrument malfunction, maintenance, repair or calibration. Please record the pollutant or parameter, the event (reason for lack of data), beginning data and ending date in the

appropriate columns. Once the issue has been resolved please document the resolution in the comment section.

4.2 Maintenance sheets

Complete and submit the Monthly Maintenance sheet to the Senior AQIS for review. Once reviewed, The Senior AQIS submits the maintenance sheet to Data Validation for review.

5.0 TROUBLESHOOTING

5.1 Basic Troubleshooting

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 maintenance sheet.

- Visually inspect the sensor in question and look for signs of damage.
- Verify proper orientation of sensor, that it is level and not obstructed.
- Check for loss of voltage supply.
- Verify that cable connections to sensor and data logger are secure.
- Measure the outputs from the sensor, using a voltmeter.
- Verify proper data logger initialization.

Measurement	Distance from Obstruction	Distance Above Ground	Recommended Group Cover	Comments
Wind Speed/Direction	10x the height of the obstruction	10 meters	Grass or gravel	The standard exposure of the wind instruments over level, open terrain is 10 meters above ground
Temperature/Dew Point	1.5x the tower diameter	1.25 to 2 meters	Non-irrigated or un-watered short grass, or natural earth	The surface should not be concrete or asphalt or oil-soaked. Reflection from these surfaces may affect the performance of the sensor.
Vertical Temperature Difference	1.5x the tower diameter	2 meters and 10 meters	Non-irrigated or un-watered short grass, or natural earth	The surface should not be concrete or asphalt or oil-soaked. Reflection from these surfaces may affect the performance of the sensor.
Solar Radiation	2 meters	2 to 10 meters	No requirements	Sensor should be free from obstructions above the plane of the sensor. It should be located so that shadows will not cast on the device.
Barometric pressure	1meter	1 to 10 meters	No requirements	The location should have uniform, constant temperature, shielded from the sun, away from drafts or heaters
Precipitation	2x to 4x the obstruction height	30 cm, minimum	Natural vegetation or gravel	Asphalt or concrete should be avoided to avoid splashing the gage. The gage should be high enough to avoid it being covered by snow.

Table 1 Siting and Exposure for Meteorological Sensors

Table 2 Maintenance Summary Schedule

Interval	Maintenance	Responsibility
Daily	Review sensor data collected from the previous day for all sites by viewing data remotely or by stripchart. Data should be compared to the previous day's weather for consistency with weather pattern.	Station Operator
Weekly	Record the code for current weather during station visit along with observed readings from the stripchart and data logger on the Monthly Maintenance Sheet. Visually inspect sensors for alignment and cleanliness. Review the preceeding week's chart, notify Senior AQIS if values are not as expected.	Station Operator
Monthly	Check elevator mechanism for operation, lubricate as nescessary. Clean and check zero on UV, and SR sensors, record zero value on maintenace sheet. Inspect SR dessicant.	Station Operator
Annual	Clean and lubricate the elevator mechanism; Verify temperature sensors are within specification using an NIST traceable thermometer; Verify Relative Humidity sensors are within specification; calibrate anemometer	Repair/Calibration Technician

APPENDIX A

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
MONTHLY DOWNTIME LOG

Location:_____ Month/Year: _____

Reviewed by:_____ Technician: _____

Page : _____ of _____

Pollutant	Event	Date & Time		COMMENTS
		From	To	

ollutant: Ozone, CO, NO2, SO2, Continuous PM2.5, PM10, or Meteorological

ent : Calibration, Repair, Operations Maintenance or Instrument failure

Date and Time: The time the event began or data became suspect.

Comments: Please note thoroughly, specific data related to event and resolution

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APPENDIX B

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
QUALITY CONTROL MAINTENANCE CHECKSHEET
METEOROLOGICAL SYSTEM

Location _____ Month/Year_____

Station No._____ Specialist _____

Property No._____ Reviewed by/Date_____

Circle System Type(s): Met One Ultrasonic RM Young

Weather Codes	
A.	Clear and calm
B.	Clear and windy
C.	Overcast and calm
D.	Overcast and windy
E.	Fog G. Snow
F.	Rain H. Other

WEEKLY CHECKS: Operations Group

1. Record code for current weather. If reporting H for other, explain in comments section.
2. Record current readings from chart (Chessell) and telemetry (datalogger).
3. Visually check sensors for alignment.
4. Check all of the preceding week's chart (Chessell) values. Notify Senior AQIS if any chart traces are not as expected.

Date	Weather Code	WIND SPEED (mph)		WIND DIR. (°)		TEMPERATURE (°F)		RH (%)		TRACES NORMAL?
		Chart	Telem	Chart	Telem	Chart	Telem	Chart	Telem	
										Yes ☐ No ☐
										Yes ☐ No ☐
										Yes ☐ No ☐
										Yes ☐ No ☐
										Yes ☐ No ☐
										Yes ☐ No ☐

MONTHLY CHECKS: Operations Group Date Performed: _____

1. Lower and raise elevator and lubricate plastic guides with silicone spray. Done: Yes ☐ No ☐
2. Clean and zero ultraviolet radiation sensor. Zero value = _____
4. Clean and zero solar radiation sensor zero. Zero value = _____
5. Clean aspirator for RH/T sensor. Done: Yes ☐ No ☐

ANNUAL SERVICE: Support Group

1. Clean and lubricate elevator mechanism.
2. Verify temperatures using NIST traceable thermometer, ± 2°F
3. Clean and calibrate RH sensor.
4. Verify wind sensor dimensions.
5. Clean all sensors.

Date	Comments or Maintenance Performed

Annual Service Date:_____ Annual Service Due Date:_____

REFERENCES

1. **USEPA Quality Assurance Handbook for Air Pollution Measurement Systems Volume IV: Meteorological Measurements Version 2.0 (Final) EPA-454/B-08-002 March 2008**
2. **RM Young MODEL 05103 WIND MONITOR NOVEMBER 2001 MANUAL PN 05103-90**
3. **Kipp and Zonen CMP series pyranometer Instrument Manual, Manual revision 0806, www.kippzonen.com downloaded 1/22/2010**