Section 1.0 Title and Approval Sheet

Quality Assurance Project Plan for Meteorological Monitoring State of Connecticut Department of Environmental Protection

EPA policy requires that all work performed by or on behalf of EPA involving the collection of environmental data shall be implemented in accordance with an Agency-approved Quality Assurance Project Plan (QAPP). A Quality Assurance Project Plan is a document that describes the technical and quality control activities of a project. It is written as a guideline for ensuring that the results of the project are of the highest quality.

This Quality Assurance Project Plan (QAPP) outlines how the Connecticut Department of Environmental Protection (CTDEP) Bureau of Air Management, 79 Elm Street, Hartford, Connecticut 06106, conducts Meteorological Sampling. CTDEP measures the following Meteorological Parameters: Barometric Pressure, Precipitation, Relative Humidity/Dew Point, Solar Radiation, Temperature, Wind Direction, and Wind Speed.

CTDEP is required to measure Barometric Pressure, Precipitation, Relative Humidity/Dew Point, Solar Radiation, Temperature, Wind Direction, and Wind Speed data at their PAM sites.

CTDEP is required to measure Relative Humidity/Dew Point, Temperature, Wind Direction, and Wind Speed data at their NCORE sites.

Although CTDEP is not required to measure meteorological data for their SLAMS sites, various meteorological parameters are measured at these sites.

Presently, CTDEP's Attainment Planning Stationary Source Group does not use meteorological data from CTDEP air monitoring sites for the primary data sets for New Source Review Modeling.

Quality Assurance Project Plan for Meteorological Monitoring State of Connecticut Department of Environmental Protection

Names, titles and signatures of approving officials

	Signature	Approval Date
Field Operations Supervisor (Planning & Standards/Field Operations & Monitoring): Dennis Demchak Supervising Engineer, CTDEP		10/26/10
Meteorological Program Coordinator (Planning & Standards/Field Operations& Monitoring /Audits): Michael L. Labickas Air Pollution Control Engineer 3, CTDEP	Michael L. Labickas	10/26/10
EPA Regional Project Officer: Paul Bryan New England Regional Laboratory USEPA-Region1		
Quality Assurance Chemist: Richard Siscanaw New England Regional Laboratory USEPA-R1		

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Section 3.0 Distribution List

The following table identifies all CTDEP personnel involved in the acquisition of meteorological data. All personnel, on this list, will receive an electronic copy of the approved QAPP as well as future revisions.

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Table 3.1
CTDEP Meteorological Sampling QAPP Distribution List

Section 4 Project/Task Organization

A Commissioner heads the Connecticut Department of Environmental Protection (CTDEP). The Commissioner serves at the discretion of the governor. CTDEP is organized into six Bureaus. The six Bureaus are Air Management, Water Protection & Land Use, Materials Management & Compliance Assurance, Outdoor Recreation, Natural Resources, and Financial & Support Services. A Bureau Chief reporting directly to the Commissioner administers each Bureau.

The Bureau of Air Management consists of three main Divisions: Planning & Standards (P&S), Engineering & Enforcement (E&E) and Radiation (Rad). A Director manages each Division and reports to the Bureau Chief. Figure 4.1 charts the management portion of the organization and is subject to change.

Engineers, analysts, technicians, specialists, and aides within a division report to a Supervising Engineer or Analyst, who reports to an Assistant Director, who in turn reports to the Division Director.

The Meteorological Sampling program resides within the P&S division. The P&S Division is based at CTDEP's main office at 79 Elm Street, Hartford, CT 06106. The P&S Division's Field Operations Monitoring and Data Groups are located at CTDEP's Field Operation's Facility (DEP Lab) 9 Windsor Avenue, Windsor, CT 06095.

The Field Operations Monitoring Group is responsible for purchasing, installing, auditing, operating, and maintaining the analyzers, samplers, data acquisition systems, and meteorological instrumentation for the air monitoring network. The Data Group is responsible for acceptance testing, calibration, and the quality assurance, verification, validation, and submittal of meteorological data to EPA.

Section 4.1.0 EPA's Roles and Responsibilities

The Environmental Protection Agency Office of Air Quality Planning and Standards (OAQPS) is authorized by the Clean Air Act (CAA) to protect and enhance the quality of the nation's air resources. Standards for air pollutants are set by the OAQPS to protect the public's health and welfare. This includes evaluation of potential air pollutants and establishment of national standards for those deemed harmful to the public's health or welfare. Compliance with standards is managed by the OAQPS by cooperation of the Regional Offices and state agencies. The management tools include regulations established for source emission controls and State Implementation Plans (SIPs). OAQPS maintains the national database for air quality measurements, pollutant emissions and control. OAQPS also tracks national air quality trends, approves the criteria gas methods and operates the National Performance Audit Program (NPAP).

The Monitoring and Quality Assurance Group (MQAG) of the OAQPS's Emissions Monitoring and Analysis Group is responsible for oversight of Ambient Air Quality Monitoring Networks. Their influence on state agencies is through the establishment and support of Regional Offices.

Section 4.1.1 EPA Regional Personnel

The Quality Assurance Chemist, EPA Regional Office, Region 1, North Chelmsford, Massachusetts (New England Regional Labs) is responsible for review and approval of CTDEP's Meteorological Monitoring QAPP . Presently, EPA Region 1 does not conduct any performance audits on CTDEP's meteorological instrumentation. EPA Region 1 Personnel conduct an annual network review and also perform a technical system audit every 3 years.

Section 4.2.0 CTDEP Personnel and Responsibilities

Dennis Demchak, a Supervising Air Pollution Control Engineer, within the Field Monitoring Operations Section, oversees the Audit Group, Operations Group, and Network/Implementation/Preventative Measures Group. The Supervisor also acts as a contact with EPA and other interested parties and organizations concerning air pollutant and meteorological data and provides joint coordination with the Supervising Air Pollution Control Analyst, of the Data Section, for overall planning, project direction and project management.

Peter Babich, a Supervising Air Pollution Control Analyst, within the Data Section, oversees the Data Analysis/Validation Group, QA/QC Group, and PAMS/Toxics Group. The Supervisor also acts as a contact with EPA and other interested parties and organizations concerning air pollutant and meteorological data and provides joint coordination with the Supervising Air Pollution Control Engineer, of the Field Monitoring Operations Section, for overall planning, project direction and project management.

Michael Labickas, an Air Pollution Control Engineer 3, within the Audit Group, is the Meteorological Program Coordinator and is responsible for writing the Meteorological Program's SOP's and Meteorological Program's QAPP. He oversees the Audit Group and also performs data review for Criteria Pollutants and Meteorological Instrumentation.

Robert Salls, a Data Equipment Technician, within the Audit Group, performs in-house criteria pollutant and meteorological instrumentation audits and performs data review of the meteorological instrumentation. Assists in writing Audit SOP's for Criteria Pollutants.

Michael Murphy, an Air Pollution Control Engineer 2 and Mark Labonte, an Air Pollution Control Technician, both within the QA/QC Group, conduct Criteria Pollutant and meteorological instrumentation calibrations and perform data review of the meteorological instrumentation.

Mark Demko, an Air Pollution Control Engineer 3 within the QA/QC Group, oversees the Air Pollution Control Engineer 2 and Air Pollution Control Technician, both within the QA/QC Group. He also performs data review and certifications for the Criteria Pollutants.

Reid Matusek, an Air Pollution Control Engineer 3, within the QA/QC Group, provides QA support functions for the network, prepares Standard Operating Procedures (SOP's) and Quality Assurance Project Plans (QAPP's), performs certifications, calibrations and data assurance and acts as a contact with EPA.

Adam Augustine, Paul Gauvin, and William Sowik, all Air Pollution Control Technicians, and Tom Conroy, an Environmental Compliance Specialist 3, within the Operations Group, are responsible for the daily operation, checks, and field preventive maintenance of the analyzers, samplers, data acquisition systems, and meteorological instrumentation for the air monitoring network.

Trevor DePass and Joe Kowalczyk, both Data Equipment Technicians, within the Operations Group, oversee the Air Pollution Control Technicians and Environmental Compliance Specialist 3, both within the Operations Group. They fill in for field personnel, when they are sick or on vacation.

Section 4.2.0 CTDEP Personnel and Responsibilities

Randy Semagin, an Environmental Analyst 2, within the Data Validation/Analysis Group, reviews, verifies, validates, generates final meteorological data reports for AQS and the SLAMS report submittal, and corresponds with EPA on data analysis issues. Assists with writing data related sections of SOP's and QAPP's.

Pierre Menard and Dean Tully, both Data Equipment Technicians, within the Network Implementation/ Preventative Measures Group are responsible for the maintenance and repair of criteria pollutant, meteorological instrumentation, and data acquisition systems.

Michelle Chafee, Data Equipment Technician, within the Data/PAMS/Toxics Group, consolidates the meteorological field and QA data sheets, reviews and validates the data, and then submits data to AQS. She is also involved in the review and AQS submittal process for PAMS data.

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Bureau of Air Management
Office of the Bureau Chief
DEP43500-16200

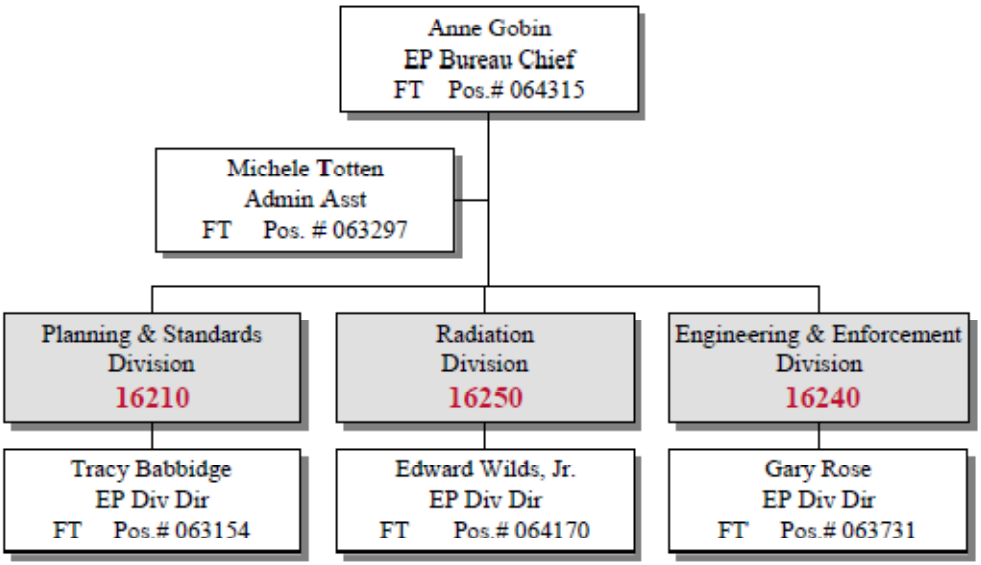

Figure 4.1
Organization Chart
Bureau of Air Management
Office of the Bureau Chief

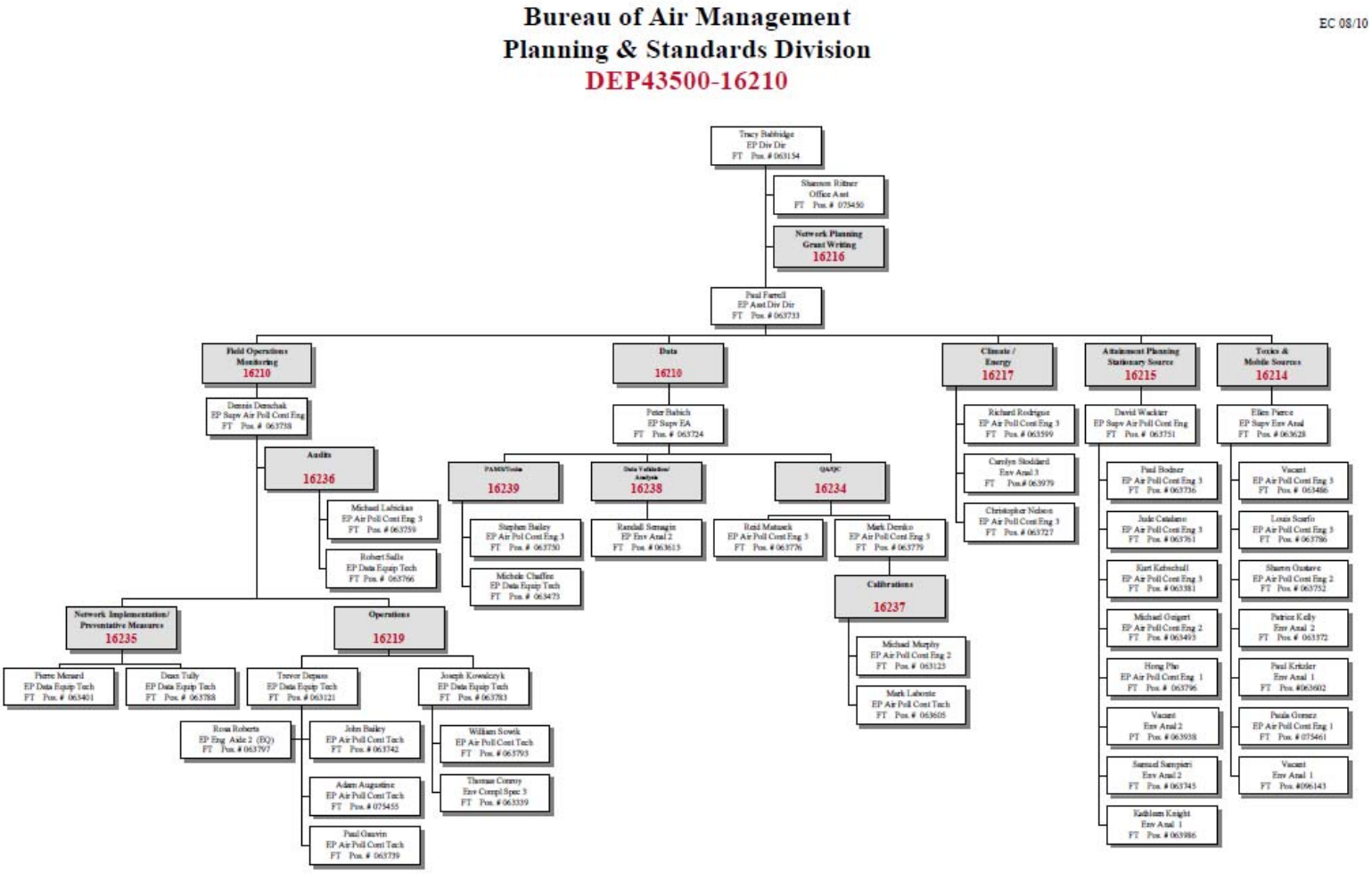

Figure 4.2
Organization Chart
Bureau of Air Management
Planning and Standards Division

Section 5 Background

The Connecticut Department of Environmental Protection (DEP), Bureau of Air Management, Ambient Air Monitoring Group monitors air quality to protect public health and the environment. The monitoring of air quality data is crucial to determine compliance with the Federal EPA primary and secondary air quality standards and to evaluate how well pollution control and abatement strategies are working to clean the air.

The criteria pollutants measured in the ambient air monitoring network are: ozone (O_3), particulate matter, nitrogen dioxide (NO_2), sulfur dioxide (SO_2) and carbon monoxide (CO). The DEP has also monitored for toxic pollutants and metals including volatile organic compounds, aldehydes, polycyclic aromatic hydrocarbons, lead, mercury and dioxin. Determining the amount of air pollution through monitoring is essential to effective control of air pollution. Today, the CT DEP has 26 permanent pollutant monitoring stations.

Air monitoring began in Connecticut in the 1950's, when CT DEP started to monitor for total suspended particulate. In the 1970's, CT DEP installed its first computerized network and started daily pollution forecasting with the Pollution Standards Index. In the 1980's, CT DEP instituted the ambient dioxin monitoring program which monitored around each municipal waste combustor operated by the Connecticut Resources Recovery Authority. In 1992, CT DEP established the Photochemical Assessment Monitoring Stations (PAMS) network and by 1995 had the capability of monitoring over 100 toxic pollutants.

Over the last 20 years, monitored levels of the criteria pollutants have decreased significantly due to various control measures implemented by CT DEP and the Environmental Protection Agency (EPA). However, even with the decline in monitored levels of all these pollutants, more progress remains to be made.

CTDEP is required to measure Barometric Pressure, Precipitation, Relative Humidity/Dew Point, Solar Radiation, Temperature, Wind Direction, and Wind Speed data at their PAM sites.

CTDEP is required to measure Relative Humidity/Dew Point, Temperature, Wind Direction, and Wind Speed data at their NCORE sites.

Although CTDEP is not required to measure meteorological data for their SLAMS sites, various meteorological parameters are measured at these sites.

Section 6 Project/Task Description

It is important to determine the type of meteorological instrumentation required to meet the needs of the organization collecting the data. States are required to have certain meteorological instrumentation at designated sites. PAMS and NCore sites are required to have specific meteorological instrumentation at their sites, but SLAM sites do not. Meteorological data are collected by onsite personal computers and transmitted to a central data storage facility at the DEP Lab Facility in Windsor, CT. This data are used to forecast weather and for air pollution modeling purposes.

Barometric pressure data is used to forecast weather. Decreasing barometric pressure is an indicator of stormy, wet, and windy weather whereas rising barometric pressure is an indicator of dry and calm weather.

Precipitation refers to all liquid or solid water particles that fall from the earth's atmosphere. This occurs when the atmosphere becomes so saturated with water vapor, that water condenses and drops to the earth's surface.

Relative humidity is a ratio of the amount of moisture in the air at a given temperature to the amount of moisture the air is capable of holding at that temperature. Dew point indicates the amount of moisture in the air. Dew point is the temperature at which air becomes saturated and produces dew.

Solar radiation data is used to determine atmospheric stability for calculating various surface layer parameters, in dispersion modeling for estimating convective (daytime) mixing heights, and for modeling photochemical reactions.

Temperature is a measurement of how warm or cold an object or environment is, with reference to a standard scale. CTDEP measures the temperature within the shelters, that house air and meteorological instrumentation, as well as ambient temperature.

Wind direction and wind speed are important tools for weather forecasting and determining the sources of air pollutants.

Section 6.1 Purchasing

Once it has been determined as to which instrumentation is needed, the process of researching and purchasing can begin. EPA Guidance Handbooks, measurement quality objectives, manufacturer literature, compatibility with data acquisition systems being used, discussion with vendors and other users, and initial and operating costs are some of the most important factors in determining what to purchase. In addition to the meteorological instrumentation, performance standards to conduct the quality assurance requirements need to be researched and purchased.

Section 6.2 Acceptance Testing

Once this task is accomplished, the process of acceptance testing can begin. The QA/QC Group is responsible for this activity. This should be performed shortly after the purchased instrumentation has been delivered. The type and length of testing will be determined by the type of instrumentation being analyzed. It is critical that the purchased instrumentation be compared to NIST traceable instrumentation or standards to assure that the manufacturer specifications and Measurement Quality Objectives are achieved.

Section 6.3 Installation

When the instrument has successfully completed its acceptance test and the results properly documented, it is ready for installation at the monitoring site. CTDEP personnel, performing the installation, need to be familiar with the siting criteria for each meteorological parameter to ensure the proper placement for obtaining the most accurate data possible. Siting criteria from EPA Guidance Handbooks and manufacture literature is utilized to accomplish this task (see Table 6.1).

Section 6.4 Calibrations

Once instrumentation is properly sited, it can be calibrated. This is accomplished by comparison to a NIST traceable standard or comparison to a similar instrument that is designated strictly for calibration purposes and that has NIST traceability. CTDEP personnel, who perform the calibrations, must not be the specialist, technician or engineer who conducts the routine service or analysis.

Calibrations are required to be performed on all meteorological instrumentation upon installation or relocation, upon operation interruption of more than 84 hours, if it exhibits unusual or abnormal behavior, following repair or replacement, and at a minimum of once every 6 months. The standards and equipment used for calibrations must be different from the standards used for audits. Records of all calibrations, along with documents certifying standards traceability and accuracy are kept at the DEP Lab Facility in Windsor, Ct. A status board is kept listing the calibration and calibration due dates for all air monitoring and meteorological instrumentation. A logbook is kept listing the calibration dates and calibration due dates of standards used to perform the calibrations.

Section 6.5 Operation Checks

Once successfully calibrated, the routine performance of operational checks, preventive and corrective maintenance and quality control checks begin. CTDEP field personnel are required to visit their sites a minimum of once per week. Visual observations

Section 6.6 Performance Audits

Performance audits are required to be performed on all meteorological instrumentation at a minimum of once every 12 months. Results of these audits are used to assess the accuracy of the meteorological instrumentation. CTDEP personnel, who perform the performance audits, must not be the specialist, technician or engineer who conducts the routine service or analysis. The standards and equipment used for audits must be different from the standards used for calibrations. Records of all Performance Audits, along with documents certifying standards traceability and accuracy are kept at the DEP Lab Facility in Windsor, Ct. A logbook is kept listing the audit dates for all air monitoring and meteorological instrumentation. A logbook is kept listing the calibration dates and calibration due dates of standards used to perform the audits. If there are any issues identified during a performance audit, a corrective action report will be filled out and submitted to the Supervisor of Data or Supervisor of Field Operations/Monitoring.

Section 6.7 Data Review, Verification, and Validation

Meteorological data are collected by onsite personal computers and transmitted to a central data storage facility at the DEP Lab Facility in Windsor, CT. The Data Group utilizes real time minute and hourly average data for verification and validation. CTDEP personnel review the transmitted data every morning and report any problems to the appropriate group.

Site check sheets are changed monthly and brought in for review by the QA/QC Group. In addition, calibration reports are submitted to the QA/QC Group for review. The monthly check sheets and calibration reports are filed, by site, in a designated cabinet. The Data Group has access to the reviewed sheets and reports for verification and validation. Performance Audit Check Sheets are submitted to the Data Group on a quarterly basis. Once data review, verification, and validation is completed, meteorological data is submitted to EPA.

CTDEP Siting and Exposure Criteria for Meteorological Sensors

Measurement	Distance from obstacles	Distance above ground	Recommended Ground Cover	Comments
Temperature Dew Point	1.5 times the tower diameter	1.25 - 2 meters	Non-irrigated or un-watered short grass Or natural earth	The surface should not be concrete, asphalt, or oil soaked. Reflection from these surfaces may affect the performance of the sensor.
Wind Speed Wind Direction	10 times the height of the obstruction	10 meters	Grass or Gravel	The standard exposure of wind instruments over level, open terrain is 10 meters above ground
Solar Radiation	2 meters	2 - 10 meters	No requirements	The sensor should be away from obstructions above its plane. It should be placed in an area free from shadows.
Precipitation	2 to 4 times the height of the obstruction	30 cm, minimum	Natural vegetation or gravel	Asphalt or concrete should be avoided to prevent splashing the rain gauge. The rain gauge should be high enough to avoid being covered by snow.
Barometric Pressure	1 meter	1 - 10 meters	No requirements	The sensor should be shielded from the sun and away from drafts or heaters. It should also be in an area with minimal temperature fluctuation.

Table 6.1
CTDEP Siting and Exposure Criteria for Meteorological Sensors

Section 7 Quality Objectives and Criteria

Organizations must ensure that data collected for the characterization of environmental processes and conditions are of the appropriate type and quality for their intended use and which environmental technologies are designed, constructed, and operated according to defined expectations. EPA Order 5360.1 A2 requires that all EPA organizations (and organization with extramural agreements with EPA) follow a systematic planning process to develop acceptance or performance criteria for the collection, evaluation, or use of environmental data.

Section 7.1.0 Data Quality Objectives

Data quality objectives are qualitative and quantitative statements that clarify The monitoring objectives, define appropriate data to collect, and specify tolerable levels of error for the monitoring program. These statements are derived from OAQPS's DQO process that is based upon the requirements of the decision makers. The objective is to control precision and bias in order to reduce the probability of errors in the decision making process.

Data quality objectives for the CTDEP Meteorological Network are obtaining data that is accurate, precise, representative of the area, reproducible, and defensible in a court of law.

Section 7.2.0 Measurement Quality Objectives

Once DQO's are identified, measurement indicators must be determined to see if the DQOs are being met. CTDEP collects data to support federally mandated programs like PAMS and NCore and CTDEP's SLAM sites. EPA identifies the following objectives in their recommended MQO tables:

1. Measurement – Type of parameter needed to be collected
2. Method – Recommended; however, other methods are available and newer technologies will be developed. For regulatory programs, any alternative methods that are employed must meet these minimum requirements or recommendations.
3. Reporting Units – Mandatory for regulatory programs (PAMS, PSD, and NCore); for non-regulatory programs, they are recommended only.
4. Recommended Operating Range(s) – Typically employed but are not required.
5. Detection Limits – Required for regulatory programs (PAMS, PSD, and NCore); the detection limit levels are mandatory. For non-regulatory programs, they are recommended only.
6. Minimum Sample Frequency – Recommended.
7. Raw Data Collection Frequency – Recommended.
8. Completeness – Required for regulatory programs (PAMS, PSD, and NCore); the levels of completeness are mandatory. For non-regulatory programs, they are recommended only.
9. Calibration – Recommended methods. Other methods may be employed; however, the levels of accuracy of other methods must meet the acceptance criteria.
10. Accuracy – Required for regulatory programs (PAMS, PSD, and NCore); the levels of accuracy are mandatory. For non-regulatory programs, they are recommended only.
11. Representativeness – Recommended.

CTDEP's MQO's are listed in a table format, based on the designation given to that monitoring site. The table defines the measurement requirements, frequency, corrective action and acceptance criteria necessary to meet the DQO's.

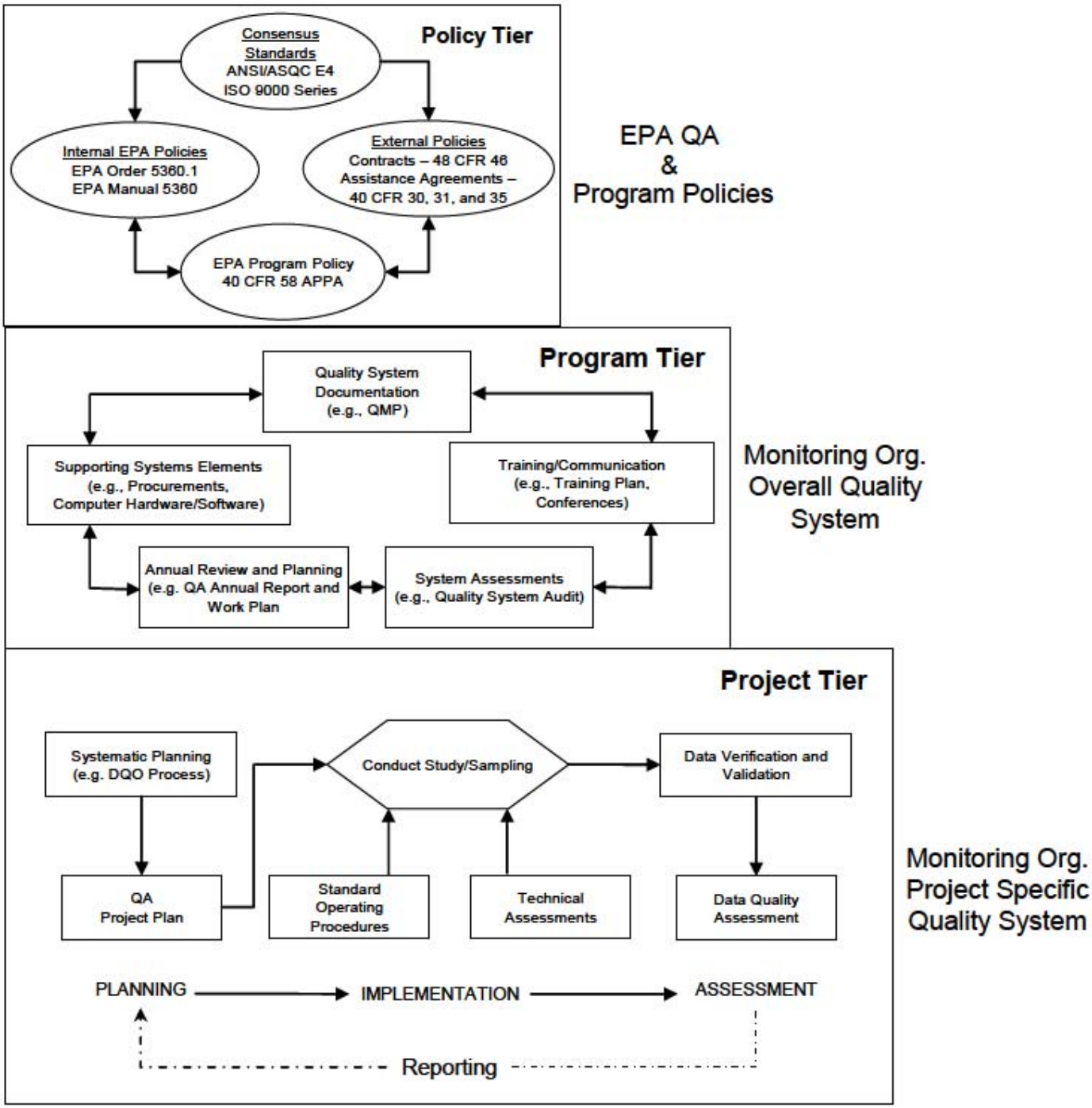

Figure 7.1
DQO Flow Chart

CTDEP Meteorological MQO's for PAM Sites

Measurement	Method	Reporting Units	Operating Range	Resolution	Minimum Sample Frequency	Raw Data Collection Frequency	Completeness
Ambient Temperature	Thermistor	^{o}C	-30 - 50 ^{o}C	0.1	Hourly	1 minute	75%
Relative Humidity	Relative Humidity Sensor	%	0 -100 %	0.5% RH	Hourly	1 minute	75%
Dew Point	Relative Humidity Sensor	^{o}C	-40 to 60 ^{o}C	0.1	Hourly	1 minute	75%
Barometric Pressure	Barometric Pressure Sensor	mb	600-1100 mb	0.1	Hourly	1 minute	75%
Wind Speed	Cup	m/s	0.0 - 65.0 m/s	0.1	Hourly	1 minute	75%
	Sonic Anemometer	m/s	0.0 - 50.0 m/s	0.1	Hourly	1 minute	75%
Wind Direction	Vane	Degrees	0 - 360 Degrees	1.0 Degree	Hourly	1 minute	75%
	Sonic Anemometer	Degrees	0 -360 Degrees	1.0 Degree	Hourly	1 minute	75%
Solar Radiation	Pyranometer	Watts/ m^2	0 - 1200 Watts/ m^2	$\pm$ 1W/m^2	Hourly	1 minute	75%
Precipitation	Tipping Bucket Gauge	inches	0.01 inch per tip	NA	Hourly	1 minute	75%

Table 7.1
CTDEP Meteorological MQO's for PAM Sites

CTDEP Meteorological MQO's for NCore Sites

Measurement	Method	Reporting Units	Operating Range	Resolution	Minimum Sample Frequency	Raw Data Collection Frequency	Completeness
Ambient Temperature	Thermistor	^{o}C	-30 to 50 ^{o}C	0.1 ^{o}C	Hourly	1 minute	75%
Relative Humidity	Relative Humidity Sensor	%	0-100 %	0.5% RH	Hourly	1 minute	75%
Dew Point	Relative Humidity Sensor	^{o}C	-40 to 60 ^{o}C	0.1	Hourly	1 minute	75%
Wind Speed	Cup	m/s	0.5 -50.0 m/s	0.1 m/s	Hourly	1 minute	75%
	Sonic Anemometer	m/s	0.5 -50.0 m/s	0.1 m/s	Hourly	1 minute	75%
Wind Direction	Vane	Degrees	0 - 360 Degrees	1.0 Degree	Hourly	1 minute	75%
	Sonic Anemometer	Degrees	0 -360 Degrees	1.0 Degree	Hourly	1 minute	75%
Optional							
Solar Radiation	Pyranometer	Watts/ m^2	0 -1200 Watts/ m^2	10	Hourly	1 minute	75%
Precipitation	Tipping Bucket	inches	0.01 inch per tip	NA	Hourly	1 minute	75%
Barometric Pressure	Barometric Pressure Sensor	mb	600-1100 mb	0.5	Hourly	1 minute	75%

Table 7.2
CTDEP Meteorological MQO's for NCore Sites

CTDEP Meteorological MQO's for Non NCore Sites

Measurement	Method	Reporting Units	Operating Range	Resolution	Minimum Sample Frequency	Raw Data Collection Frequency	Completeness
Ambient Temperature	Thermistor	^{o}C	-30 - 50 ^{o}C	0.1 ^{o}C	Hourly	1 minute	75%
Relative Humidity	Relative Humidity Sensor	%	0-100 %	0.5% RH	Hourly	1 minute	75%
Dew Point	Relative Humidity Sensor	^{o}C	-40 to 60 ^{o}C	0.1	Hourly	1 minute	75%
Wind Speed	Cup	m/s	0.5 - 50.0 m/s	0.1 m/s	Hourly	1 minute	75%
	Sonic Anemometer	m/s	0.5 - 50.0 m/s	0.1 m/s	Hourly	1 minute	75%
Wind Direction	Vane	Degrees	0 - 360 Degrees	1.0 Degree	Hourly	1 minute	75%
	Sonic Anemometer	Degrees	0 - 360 Degrees	1.0 Degree	Hourly	1 minute	75%
Optional							
Solar Radiation	Pyranometer	Watts/ m^2	0 - 1200 Watts/ m^2	10	Hourly	1 minute	75%
Precipitation	Tipping Bucket	inches	0.01 inch per tip	NA	Hourly	1 minute	75%
Barometric Pressure	Barometric Pressure Sensor	mb	600-1100 mb	0.5	Hourly	1 minute	75%

Table 7.3
CTDEP Meteorological MQO's for Non NCore Sites

CTDEP Meteorological MQO's for PSD Sites

Measurement	Method	Reporting Units	Operating Range	Resolution	Minimum Sample Frequency	Raw Data Collection Frequency	Completeness
Ambient Temperature	Thermistor	^{o}C	-30 to 50 ^{o}C	0.1	Hourly	1 minute	90%
Relative Humidity	Relative Humidity Sensor	%	0-100 %	0.5% RH	Hourly	1 minute	90%
Dew Point	Relative Humidity Sensor	^{o}C	-40 to 60 ^{o}C	0.1	Hourly	1 minute	90%
Barometric Pressure	Barometric Pressure Sensor	mb	600-1100 mb	0.5	Hourly	1 minute	90%
Wind Speed	Cup	m/s	0.5 - 50.0 m/s	0.1 m/s	Hourly	1 minute	90%
	Sonic Anemometer	m/s	0.5 - 50.0 m/s	0.1 m/s	Hourly	1 minute	90%
Wind Direction	Vane	Degrees	0 - 360 Degrees	1.0 Degree	Hourly	1 minute	90%
	Sonic Anemometer	Degrees	0 - 360 Degrees	1.0 Degree	Hourly	1 minute	90%
Solar Radiation	Pyranometer	Watts/ m^2	0 -1300 Watts/ m^2	10	Hourly	1 minute	90%
Precipitation	Tipping Bucket	inches	0.01 inch per tip	NA	Hourly	1 minute	90%

Table 7.4
CTDEP Meteorological MQO's for PSD Sites

CTDEP Meteorological MQO's for Modeling Application

Measurement	Method	Reporting Units	Operating Range	Resolution	Minimum Sample Frequency	Raw Data Collection Frequency	Completeness
Ambient Temperature	Thermistor	^{o}C	-40 to 60 ^{o}C	0.1	Hourly	1 minute	90%
Relative Humidity	Relative Humidity Sensor	%	0-100 %	0.5% RH	Hourly	1 minute	90%
Dew Point	Relative Humidity Sensor	^{o}C	-40 to 60 ^{o}C	0.1	Hourly	1 minute	90%
Barometric Pressure	Barometric Pressure Sensor	mb	600-1100 mb	0.5	Hourly	1 minute	90%
Wind Speed	Cup or Sonic Anemometer	m/s	0.5 -50.0 m/s	0.25	Hourly	1 minute	90%
Wind Direction	Vane or Sonic Anemometer	Degrees	0 -360 Degrees	0.5	Hourly	1 minute	90%
Solar Radiation	Pyranometer	Watts/ m^2	0 -1300 Watts/ m^2	10	Hourly	1 minute	90%
Precipitation	Tipping Bucket	inches	0.01 inch per tip	NA	Hourly	1 minute	90%

Table 7.5
CTDEP Meteorological MQO's for Modeling Application

CTDEP Calibration and Accuracy Criteria for PAM Sites

	Calibration				Accuracy			
Measurement	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**
Ambient Temperature	**3 point water bath with NIST traceable thermistor or thermometer**	**± 0.7°C**	**± 1.0°C**	**Semi-Annually**	**3 point water bath withNIST traceable thermistor or thermometer**	**± 0.7°C**	**± 1.0°C**	**Annually**
Relative Humidity	**NIST traceable Hygrometer or RH standard solutions**	**± 7%**	**± 10%**	**Semi-Annually**	**NIST traceable Hygrometer or RH standard solutions**	**± 7%**	**± 10%**	**Annually**
Dew Point Temperature	**NIST traceable Hygrometer**	**± 1.0°C**	**± 1.5°C**	**Semi-Annually**	**NIST traceable Hygrometer**	**± 1.0°C**	**± 1.5°C**	**Annually**
Barometric Pressure	**NIST traceable BP sensor**	**± 7 mb**	**± 10 mb**	**Semi-Annually**	**NIST traceable BP sensor**	**± 7 mb**	**± 10 mb**	**Annually**
Wind Speed (Cup) (F460 system)	**NIST traceable synchronous motor or NIST traceable sonic anemometer**	**± 0.2 m/s + 5%**	**± 0.2 m/s + 5%**	**Semi-Annually**	**NIST traceable synchronous motor or NIST traceable sonic anemometer**	**± 0.2 m/s + 5%**	**± 0.2 m/s + 5%**	**Annually**
Wind Direction (Vane) (F460 system)	**NIST traceable test fixture or NIST traceable sonic anemometer**	**± 5° Crossarm alignment ±5°**	**± 10° Crossarm alignment ±5°**	**Semi-Annually**	**NIST traceable test fixture or NIST traceable sonic anemometer**	**± 5° Crossarm alignment ±5°**	**± 10 ° Crossarm alignment ±5°**	**Annually**
Wind Speed (Cup) (F460 system)	**NIST traceable Torque Watch**	**Starting Threshold ≤ 0.5 m/s**	**Starting Threshold ≤ 0.5 m/s**	**Semi-Annually**	**NIST traceable Torque Watch**	**Starting Threshold ≤ 0.5 m/s**	**Starting Threshold ≤ 0.5 m/s**	**Annually**
Wind Direction (Vane) (F460 system)	**NIST traceable Torque Watch**	**Starting Threshold ≤ 0.5 m/s**	**Starting Threshold ≤ 0.5 m/s**	**Semi-Annually**	**NIST traceable Torque Watch**	**Starting Threshold ≤ 0.5 m/s**	**Starting Threshold ≤ 0.5 m/s**	**Annually**
Wind Speed (sonic anemometer)	**NIST traceable sonic anemometer**	**±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s**	**±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s**	**Semi-Annually**	**NIST traceable sonic anemometer**	**±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s**	**±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s**	**Annually**
Wind Direction (sonic anemometer)	**NIST traceable sonic anemometer**	**± 7° Crossarm alignment ±5°**	**± 10° Crossarm alignment ±5°**	**Semi-Annually**	**NIST traceable sonic anemometer**	**± 7° Crossarm alignment ±5°**	**± 10° Crossarm alignment ±5°**	**Annually**
Solar Radiation	**NIST traceable pyranometer**	**± 5% of mean observed interval**	**± 5% of mean observed interval**	**Semi-Annually**	**NIST traceable pyranometer**	**± 5% of mean observed interval**	**± 5% of mean observed interval**	**Annually**
Precipitation	**Seperatory funnel and graduated cylinder**	**± 7% of input volume**	**± 10% of input volume**	**Semi-Annually**	**Seperatory funnel and graduated cylinder**	**± 7% of input volume**	**± 10% of input volume**	**Annually**

Table 7.6
CTDEP Calibration and Accuracy Criteria for PAM Sites

CTDEP Calibration and Accuracy Criteria for NCore Sites

	Calibration				Accuracy			
Measurement	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**
Ambient Temperature	3 point water bath with NIST traceable thermistor or thermometer	± 0.7°C	± 1.0°C	Semi-Annually	3 point water bath with NIST traceable thermistor or thermometer	± 0.7°C	± 1.0°C	Annually
Relative Humidity	NIST traceable Hygrometer or RH standard solutions	± 7%	± 10%	Semi-Annually	NIST traceable Hygrometer or RH standard solutions	± 7%	± 10%	Annually
Dew Point Temperature	NIST traceable Hygrometer	± 1.0°C	± 1.5°C	Semi-Annually	NIST traceable Hygrometer	± 1.0°C	± 1.5°C	Annually
Wind Speed (Cup) (F460 system)	NIST traceable synchronous motor or NIST traceable sonic anemometer	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	Semi-Annually	NIST traceable synchronous motor or NIST traceable sonic anemometer	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	Annually
Wind Direction (Vane) (F460 system)	NIST traceable test fixture or NIST traceable sonic anemometer	± 5 ° Crossarm alignment ±5°	± 10 ° Crossarm alignment ±5°	Semi-Annually	NIST traceable test fixture or NIST traceable sonic anemometer	± 5 ° Crossarm alignment ±5°	± 10 ° Crossarm alignment ±5°	Annually
Wind Speed (Cup) (F460 system)	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Semi-Annually	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Annually
Wind Direction (Vane) (F460 system)	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Semi-Annually	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Annually
Wind Speed (sonic anemometer)	NIST traceable sonic anemometer	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	Semi-Annually	NIST traceable sonic anemometer	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	Annually
Wind Direction (sonic anemometer)	NIST traceable sonic anemometer	± 7° Crossarm alignment ±5°	± 10° Crossarm alignment ±5°	Semi-Annually	NIST traceable sonic anemometer	± 7° Crossarm alignment ±5°	± 10° Crossarm alignment ±5°	Annually
Optional								
Solar Radiation	NIST traceable pyranometer	± 5% of mean observed interval	± 5% of mean observed interval	Semi-Annually	NIST traceable pyranometer	± 5% of mean observed interval	± 5% of mean observed interval	Annually
Precipitation	Seperatory funnel and graduated cylinder	± 7% of input volume	± 10% of input volume	Semi-Annually	Separatory funnel and graduated cylinder	± 7% of input volume	± 10% of input volume	Annually
Barometric Pressure	NIST traceable BP sensor	± 7 mb	± 10 mb	Semi-Annually	NIST traceable BP sensor	± 7 mb	± 10 mb	Annually

Table 7.7
CTDEP Calibration and Accuracy Criteria for NCore Sites

CTDEP Calibration and Accuracy Criteria for Non NCore Sites

	Calibration				Accuracy			
Measurement	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**
Ambient Temperature	3 point water bath with NIST traceable thermistor or thermometer	± 0.7°C	± 1.0°C	Semi-Annually	3 point water bath with NIST traceable thermistor or thermometer	± 0.7°C	± 1.0°C	Annually
Relative Humidity	NIST traceable Hygrometer or RH standard solutions	± 7%	± 10%	Semi-Annually	NIST traceable Hygrometer or RH standard solutions	± 7%	± 10%	Annually
Dew Point Temperature	NIST traceable Hygrometer	± 1.0°C	± 1.5°C	Semi-Annually	NIST traceable Hygrometer	± 1.0°C	± 1.5°C	Annually
Wind Speed (Cup) (F460 system)	NIST traceable synchronous motor or NIST traceable sonic anemometer	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	Semi-Annually	NIST traceable synchronous motor or NIST traceable sonic anemometer	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	Annually
Wind Direction (Vane) (F460 system)	NIST traceable test fixture or NIST traceable sonic anemometer	± 5 ° Crossarm alignment ±5°	± 10 ° Crossarm alignment ±5°	Semi-Annually	NIST traceable test fixture or NIST traceable sonic anemometer	± 5 ° Crossarm alignment ±5°	± 10 ° Crossarm alignment ±5°	Annually
Wind Speed (Cup) (F460 system)	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Semi-Annually	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Annually
Wind Direction (Vane) (F460 system)	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Semi-Annually	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Annually
Wind Speed (sonic anemometer)	NIST traceable sonic anemometer	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	Semi-Annually	NIST traceable sonic anemometer	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	Annually
Wind Direction (sonic anemometer)	NIST traceable sonic anemometer	± 7° Crossarm alignment ±5°	± 10° Crossarm alignment ±5°	Semi-Annually	NIST traceable sonic anemometer	± 7° Crossarm alignment ±5°	± 10° Crossarm alignment ±5°	Annually
Optional								
Solar Radiation	NIST traceable pyranometer	± 5% of mean observed interval	± 5% of mean observed interval	Semi-Annually	NIST traceable pyranometer	± 5% of mean observed interval	± 5% of mean observed interval	Annually
Precipitation	Seperatory funnel and graduated cylinder	± 7% of input volume	± 10% of input volume	Semi-Annually	Separatory funnel and graduated cylinder	± 7% of input volume	± 10% of input volume	Annually
Barometric Pressure	NIST traceable BP sensor	± 7 mb	± 10 mb	Semi-Annually	NIST traceable BP sensor	± 7 mb	± 10 mb	Annually

Table 7.8
CTDEP Calibration and Accuracy Criteria for Non NCore Sites

CTDEP Calibration and Accuracy Criteria for PSD Sites

	Calibration				Accuracy			
Measurement	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**
Ambient Temperature	3 point water bath with NIST traceable thermistor or thermometer	± 0.7°C	± 1.0°C	Quarterly	3 point water bath with NIST traceable thermistor or thermometer	± 0.7°C	± 1.0°C	Quarterly
Relative Humidity	NIST traceable Hygrometer or standard solutions	± 7%	± 10%	Quarterly	NIST traceable Hygrometer or standard solutions	± 7%	± 10%	Quarterly
Dew Point	NIST traceable Hygrometer	± 1.0°C	± 1.5°C	Quarterly	NIST traceable Hygrometer	± 1.0°C	± 1.5°C	Quarterly
Wind Speed (Cup) (F460 system)	NIST traceable synchronous motor or NIST traceable sonic anemometer	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	Quarterly	NIST traceable synchronous motor or NIST traceable sonic anemometer	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	Quarterly
Wind Direction (Vane) (F460 system)	NIST traceable test fixture or NIST traceable sonic anemometer	± 5 ° Crossarm alignment ±5°	± 10 ° Crossarm alignment ±5°	Quarterly	NIST traceable test fixture or NIST traceable sonic anemometer	± 5 ° Crossarm alignment ≤ ±5°	± 10 ° Crossarm alignment ≤ ±5°	Quarterly
Wind Speed (Cup) (F460 system)	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Quarterly	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Quarterly
Wind Direction (Vane) (F460 system)	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Quarterly	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Quarterly
Wind Speed (sonic anemometer)	NIST traceable sonic anemometer	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	Quarterly	NIST traceable sonic anemometer	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	Quarterly
Wind Direction (sonic anemometer)	NIST traceable sonic anemometer	± 7° Crossarm alignment ±5°	± 10° Crossarm alignment ±5°	Quarterly	NIST traceable sonic anemometer	± 7° Crossarm alignment ±5°	± 10° Crossarm alignment ±5°	Quarterly
Solar Radiation	NIST traceable pyranometer	± 5% of mean observed interval	± 5% of mean observed interval	Quarterly	NIST traceable pyranometer	± 5% of mean observed interval	± 5% of mean observed interval	Quarterly
Precipitation	Separatory funnel and graduated cylinder	± 7% of input volume	± 10% of input volume	Quarterly	Separatory funnel and graduated cylinder	± 7% of input volume	± 10% of input volume	Quarterly
Barometric Pressure	NIST traceable barometric pressure sensor	± 7 mb	± 10 mb	Quarterly	NIST traceable barometric pressure sensor	± 7 mb	± 10 mb	Quarterly

Table 7.9
CTDEP Calibration and Accuracy Criteria for PSD Sites

CTDEP Calibration and Accuracy Criteria for Modeling Application

	Calibration				Accuracy			
Measurement	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**
Ambient Temperature	3 point water bath with NIST traceable thermistor or thermometer	± 0.7°C	± 1.0°C	Semi-Annually	3 point water bath with NIST traceable thermistor or thermometer	± 0.7°C	± 1.0°C	Annually
Relative Humidity	NIST traceable Hygrometer or RH standard solutions	± 7%	± 10%	Semi-Annually	NIST traceable Hygrometer or RH standard solutions	± 7%	± 10%	Annually
Dew Point Temperature	NIST traceable Hygrometer	± 1.0°C	± 1.5°C	Semi-Annually	NIST traceable Hygrometer	± 1.0°C	± 1.5°C	Annually
Wind Speed (Cup) (F460 system)	NIST traceable synchronous motor or NIST traceable sonic anemometer	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	Semi-Annually	NIST traceable synchronous motor or NIST traceable sonic anemometer	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	Annually
Wind Direction (Vane) (F460 system)	NIST traceable test fixture or NIST traceable sonic anemometer	± 5 ° Crossarm alignment ≤ ±5°	± 10 ° Crossarm alignment ≤ ±5°	Semi-Annually	NIST traceable test fixture or NIST traceable sonic anemometer	± 5 ° Crossarm alignment ≤ ±5°	± 10 ° Crossarm alignment ≤ ±5°	Annually
Wind Speed (Cup) (F460 system)	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Semi-Annually	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Annually
Wind Direction (Vane) (F460 system)	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Semi-Annually	NIST traceable	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Annually
Wind Speed (sonic anemometer)	NIST traceable sonic anemometer	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	Semi-Annually	NIST traceable sonic anemometer	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	Annually
Wind Direction (sonic anemometer)	NIST traceable sonic anemometer	± 7° Crossarm alignment ±5°	± 10° Crossarm alignment ±5°	Semi-Annually	NIST traceable sonic anemometer	± 7° Crossarm alignment ±5°	± 10° Crossarm alignment ±5°	Annually
Optional								
Solar Radiation	NIST traceable pyranometer	± 5% of mean observed interval	± 5% of mean observed interval	Semi-Annually	NIST traceable pyranometer	± 5% of mean observed interval	± 5% of mean observed interval	Annually
Precipitation	Seperatory funnel and graduated cylinder	± 7% of input volume	± 10% of input volume	Semi-Annually	Separatory funnel and graduated cylinder	± 7% of input volume	± 10% of input volume	Annually
Barometric Pressure	NIST traceable BP sensor	± 7 mb	± 10 mb	Semi-Annually	NIST traceable BP sensor	± 7 mb	± 10 mb	Annually

Table 7.10
CTDEP Calibration and Accuracy Criteria for Modeling Application

Section 8 Staff Training/Certifications

CTDEP personnel working with meteorological instrumentation will receive training from experienced staff members and if available, from vendor sponsored training courses. CTDEP personal associated with CTDEP's Meteorological Network are required to read CTDEP's Meteorological Monitoring QAPP, CTDEP SOP's for Meteorological Instrumentation, and instrumentation operating manuals provided by the manufacturer. Additional training is available from USEPA Guidance Documents, Handbooks, Videos, Websites (AMTIC), and Air Pollution Training Institute courses. The Supervising Engineer of the Field Operations Monitoring Section and the Supervising Environmental Analyst of the Data Section are responsible for assuring that personal, within their sections, are properly trained to perform the required meteorological instrumentation tasks.

Personnel Training Log

TYPE OF TRAINING	DATE OF TRAINING	PERSONNEL RECEIVING TRAINING	SUPERVISOR SIGN-OFF	LOCATION OF RECORDS AND CERTIFICATES*

***** If records or certificates do not exist, document this

Table 8.1
Personnel Training Log

Section 9 Documentation and Records

For CTDEP's Ambient Air Monitoring and Meteorological Programs, there are number of documents and records that need to be retained. A document, from a records management perspective, is a volume that contains information that describes, defines, specifies, reports, certifies, or provides data or results pertaining to environmental programs. As defined in the Federal Records Act of 1950 and the Paperwork Reduction Act of 1995 (now 44 U.S.C. 3101-3107), records are: "...books, papers, maps, photographs, machine readable materials, or other documentary materials, regardless of physical form or characteristics, made or received by an agency of the United States Government under Federal Law or in connection with the transaction of public business and preserved or appropriate for preservation by that agency or its legitimate successor as evidence of the organization, functions, policies, decisions, procedures, operations, or other activities of the Government or because of the informational value of data in them..."

All personnel, on the Meteorological Monitoring QAPP distribution list, will receive an electronic copy of the approved QAPP as well as future revisions. In addition, they will receive a hard copy of the Meteorological Monitoring SOP's.

Proper documentation and record keeping are important tools used to ensure that the data obtained from CTDEP's air monitoring and meteorological sites are of the highest quality. CTDEP personnel follow written SOP's that contain specific forms designed to record required information. This information consists of: calibration and audit results, instrumentation, ambient conditions during sampling, maintenance activities and performance checks with date and time each is performed. Specific analyzer and sampler operating parameters are documented, as well as repair or replacement events. Field operators are to include observations of conditions or events at or near the sampling site that may have influenced sampling. This information is also entered at that sites data acquisition system as an electronic memo. Visitors to the site are required to fill out a Visitor's logbook, recording the date and times of the visit in addition to the purpose of the visit.

Additionally, calibration and audit traceability logbooks and paperwork are kept on file in the QA Lab at the CTDEP's Air Lab. The Maintenance Group will keep analyzer and sampler acceptance test and maintenance logbooks on file in the Maintenance Lab of the CTDEP's Air Lab.

CTDEP Meteorological records will be filed in a designated cabinet at the CTDEP Field Operations Facility in Windsor, CT. The QA/QC Group will maintain their own meteorological site files, containing the monthly meteorological site check sheets and calibration sheets. The Audit Group will maintain their own meteorological site files, containing performance audit sheets.

A number of data forms, (monthly check sheet, performance audit check sheet, calibration sheet) require data to be entered by hand. All hardcopy information will be filled out in indelible ink. Corrections will be made by inserting one line through the incorrect entry, initialing and dating this correction, and placing the correct entry alongside the incorrect entry.

CTDEP's requires ambient air quality and meteorological data records to be stored for an approved retention period. CTDEP has a Records Retention Schedule Worksheet describing what needs to be retained and for how long. Records are stored at the CTDEP Office, CTDEP Laboratory, the State Record Center or an approved off-site location.

Acceptance Testing Log
for Meteorological Instrumentation

Type of Instrumention	Date Received	Date(s) of Acceptance Testing	Type of Testing	Date of Acceptance	Responsible Party Sign-off

Figure 9.1
Acceptance Testing Log for Meteorological Instrumentation

Personnel Training Log

TYPE OF TRAINING	DATE OF TRAINING	PERSONNEL RECEIVING TRAINING	SUPERVISOR SIGN-OFF	LOCATION OF RECORDS AND CERTIFICATES*

***** If records or certificates do not exist, document this

Table 9.1
Personnel Training Log

Visitor Log-in Sheet

Date & time entered (EST)	Initials	Reason for visit	Time left (EST)

Figure 9.3
Visitor Log-in Sheet

Weekly Operations Check Sheet
Meteorological Instrumentation

Page _____of

Town/ Site _____ Month/Year _____

Day of Month / Time (EST)	/	/	/	/	/	/	/
Operator							
Ambient Conditions (e.g.: Clear, Cloudy, Rain, Fog, Windy, etc.)							
Review data back to last visit							
Perform Remaining Operational Checks							
Temp Probes	Always ensure Temp probes are not in contact with any surfaces & are clean.						
Inside Temp Location/Clean	/	/	/	/	/	/	/
Outside Temp Location/Clean	/	/	/	/	/	/	/
Solar Radiation D.L./Obs	/	/	/	/	/	/	/
Dome Clean & Clear							
Precipitation D.L.(60-min avg)/Obs	/	/	/	/	/	/	/
Heater ON @ temp < 4.4°C							
Indicate observed wind speed as Calm (C) Breezy (B), or Windy (W)							
Wind Speed D.L./Obs	/	/	/	/	/	/	/
Cups Operational							
Wind Direction D.L./Obs	/	/	/	/	/	/	/
Vane Operational							
Data Rejection: Enter Reason Under Comments. Start date EST							
End date EST							
End Time EST							
COMMENTS → → → → → → → Perform any necessary corrective/preventative maintenance. Clearly document any problem and the corrective action taken in the Comment Section to the right. Also record audits & calibrations performed. Use the Data Rejection section to document probe/sensor failure, freeze-ups, etc.							

Monthly performance checks: compare ambient sensors to tetraCal sensors, all checks are to be done on the same day

Last performance check date			New performance check date		
Solar Radiation Silica Gel % discolored		Precip Gauge Level?	Y N	Precip Funnel Clean?	Y N
tetraCal S.N.	Sensor\System	D.L.	tetraCal	Specification	w/in spec
	Inside Temp			w/in +/- 0.7°C	Y N
tetraCal Cert due date	Outside Temp			w/in +/- 0.7°C	Y N
	Barometric Pressure			w/in +/- 7 mb	Y N

forms\METCHECK.OPS rev. 9/30/2010

Figure 9.4
Weekly Operations Check Sheet: Meteorological Instrumentation

Visitor Check Sheet

Visitors initials														
Date														
D.L. / P.C. (ESC 8816)														
Check for messages														
Channels taken out of Maintenance (OPS) or Enabled (QA)														
Icons minimized, PC anywhere WAITING														
Phone handset properly positioned														
Modem ON														
TE Model 42C NO/NO_X & TE Model 175 Gas Dilution Calibrator														
DIP switch 6 ON														
LED REMOTE displayed														
Site cylinder main valve **CLOSED**														
Compressor Drained														
Sample line properly connected														
TE Model 43CTL SO_2 & TE Model 145 Permeation Calibrator														
LED SAMPLE displayed														
Auto cal rotameter in NORMAL														
Auto cal mode switch in REMOTE														
Sample & auto cal lines properly connected														
TE Model 48i-TLE CO														
LED SAMPLE displayed														
Sample & auto cal lines properly connected														
Site cylinder main valve **CLOSED**														
TE Model 49C O_3														
LED SAMPLE & REMOTE displayed														
Sample & auto cal lines properly connected														
Auto cal pump unobstructed & OFF														
Met One Model BAM-1020 particulates														
Main menu status ON														
Climatronics														
Temperature translator in OPERATE														
Wind translator in OPERATE														
Dew point translator in OPERATE														
Barometric pressure translator in OPERATE														
TE Model 5020 SPA/SPC SO_4														
Analyzer date correct														
Analyzer time synchronized with D.L. time														
Analyzer cycle starting on the quarter hour														
Sunset Labs Real Time OCEC														
Running														
Site														
Check heater location and controls														
Check air conditioner louvers and controls														
Check that all sample lines are in manifold and properly insulated														
Lights out														

Town _____ Site _____ ID _____ Month/Year _____

Comments:

Lock door with **506** lock.....**HAVE YOUR KEYS ?** forms\visitor check.ops rev. 6/28/2007

Figure 9.5
Visitor Check Sheet

Semi-Annual Meteorological Parameters Calibration Sheet

side 1 of 2

Town		Site		N-Core	PAMS	non N-Core
QA Officer			Date/Time			

Cal Devices	MFG/Model	S.N.	Last Cert Date
Temp Probe			
Compass	Suunto / KB-14		N/A
WS Cal	R.M. Young Co. / 18803		
WD Cal	Climatronics / 101984		
WS Torque Watch	Waters / 366-3M		
WD Torque Watch	Waters / 366-2M		

Site Devices	MFG/Model	Serial or DEP #	Range
UIM	Climatronics		N/A
Inside T probe			-30 to +50°C
Outside T probe			-30 to +50°C
WS Sensor			
WD Sensor			

Temp	Standard	I.T. resp	Difference	w/in 1°C	Standard	O.T. resp	Difference	w/in 1°C
Ice				PASS/FAIL				PASS/FAIL
Ambient				PASS/FAIL				PASS/FAIL
Warm				PASS/FAIL				PASS/FAIL

Met Tower

Cross-Arm Orientation	°	Site Specific Magnetic Declination		°	E or W
Wind Tower w/in 5° of Declination?		YES	NO	EAST	WEST

WS	RPM	Response (m/s)	Spec	w/in spec	WS Torque Starting Threshold (μ)	Report μ as m/s
	0	0	0.25 +/-	PASS/FAIL	Torque (gm-cm)	μ = (torque/1.4)$^{1/2}$
	200	4.9	4.5 - 5.4	PASS/FAIL		
	1000	23.4	22.0 - 24.8	PASS/FAIL	Spec ≤ 0.35 gm-cm	
	1700	40.2	38.0 - 42.4	PASS/FAIL	PASS/FAIL	
If WS Sensor replaced New SN:	0	0	0.25 +/-	PASS/FAIL	Torque (gm-cm)	μ = (torque/1.4)$^{1/2}$
	200	4.9	4.5 - 4.5	PASS/FAIL		
	1000	23.4	22.0 - 24.8	PASS/FAIL	Spec ≤ 0.35 gm-cm	
	1700	40.2	38.0 - 42.4	PASS/FAIL	PASS/FAIL	

WD	As Is	° set point	° Response	Difference	w/declination w/in 5°?	WD Torque Starting Threshold (μ)	Report μ as m/s
0 (360)°		0 (360)			PASS/FAIL	Torque (gm-cm)	μ = (torque/30)$^{1/2}$
w/in 5°	PASS/FAIL	90			PASS/FAIL		
180°		180			PASS/FAIL	Spec ≤ 7.5 gm-cm	
w/in 5°	PASS/FAIL	270			PASS/FAIL	PASS	
If WD Sensor replaced New SN:		0 (360)			PASS/FAIL	Torque (gm-cm)	μ = (torque/30)$^{1/2}$
		90			PASS/FAIL		
		180			PASS/FAIL	Spec ≤ 7.5 gm-cm	
		270			PASS/FAIL	PASS	

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Figure 9.6A
Semi-Annual Meteorological Parameter Calibration Sheet
(Page 1)

Semi-Annual Meteorological Parameters Calibration Sheet

side 2 of 2

Town		Site		N-Core	PAMS	non N-Core
QA Officer			Date/Time			

Cal Devices Standards	MFG/Model	S.N.	Last Cert Date
SR			
BP			
Rain Gauge			
DMM			

Site Devices	MFG/Model	Serial or DEP #	Range
SR	Kipp & Zonen / CMP6		0 to 1600 W/m^2
BP			
Rain Gauge			
RH			
Line Voltage			

SR (W/m^2)	Standard	SR response	Hour of day	Standard	SR response	% Diff	% Diff	w/in 10%
Desiccant	Color/Clear	Color/	Day1/					
Zero			Day2/					PASS/FAIL

Comments:

BP (mb)	Hour of day	Standard	BP response	difference	difference w/in 10mb
single point					

Rain (ml) mfg.	Volume (ml)	Gauge resp	difference from Volume	%D	w/in 10% D
					PASS/FAIL
If outside T < 4.5°C (40°F), is heater functioning?					YES/NO

RH (%)	Hour of day	Standard	RH response	% D	w/in 10% D
single point					PASS/FAIL

DP (°C)	Hour of day	Standard	DP response	difference	w/in +/- 1.5°C
single point		+/- 0.3%			PASS/FAIL

LV (VAC)	Time of day	Standard	LV reading	difference	w/in +/- 5 VAC
single point					PASS/FAIL

Data Review			Cal Date		Previous Cal	
Date/time	Date/time	Correction	Null Code	Parameter & Comments		

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Figure 9.6B
Semi-Annual Meteorological Parameter Calibration Sheet
(Page 2)

Barometric Pressure Line /Voltage Performance Audit

Barometric Pressure

Town/Site_____ Date/Time_____ _____EST

Type of Site (Circle one): NCore PAMS SLAMS (non-Ncore)

Climatronics UIM DEP # _____ PC Manufacturer/DEP# _____

Site Barometric Pressure Sensor Mfr/SN _____ Range 600 to 1100 mb

Audit Device Mfr/SN _____ Date of Last Cert. _____

Date of Last Calibration _____ Auditor _____

Site Barometric Pressure (mb)	Audit Barometric Pressure (mb)	Within 10 mb (Yes/No)	Audit Pass or Fail (Yes/No)

****

Line Voltage

Town/Site_____ Date/Time_____EST

Type of Site (Circle one): NCore PAMS SLAMS (non-Ncore)

Voltmeter Mfr/SN _____ Date of Last Cert. _____

Auditor _____

Site Line Voltage (Volts)	Audit Line Voltage (Volts)	Site Line Voltage Within +/- 5 Volts	Site Line Voltage Within 105 to 125 Volts	Audit Pass or Fail

****

Comments:

Reviewed by: _____

Figure 9.7
Barometric Pressure/Line Voltage Performance Audit Sheet

Precipitation Performance Audit Sheet

Town/Site _____ Date/Time _____EST

Type of Site (Circle one): NCore PAMS SLAMS (non-Ncore)

Rain Gauge Mfr/Model/SN _____

Audit Rain Gauge Mfr/Model/SN _____ _____

Climatronics UIM DEP # _____ Auditor _____

****

Observations

Screen and Funnel Clean Yes No

Bubble Level of Rain Gauge Okay Yes No

Heater Element Functional (if Ambient Temperature below 4.4^{o}C) Yes No NA

If any of the above questions are answered "No", explain under Comments

****

Conversions

Number of Measured Tips ____Tips

Met One Rain Gauge: Each tip is Equal to 8.24 ml

All Weather Rain Gauge: Each tip is Equal to 8.6834 ml

Measured Volume = Number of tips x _____ml = _____ml

Actual Volume (Met One Rain Gauge) = 206 ml

Actual Volume (All Weather Rain Gauge) = 217 ml

****

Measured Volume (ml)	Actual Volume (ml)	Difference (ml)	Within +/- 10% of Input Volume	Audit Pass or Fail

****

Comments:

Reviewed by: _____

Figure 9.8
Precipitation Performance Audit Sheet

Relative Humidity Performance Audit

Town/Site_____ Date/Time_____

Type of Site (Circle one): NCore PAMS SLAMS (non-Ncore)

Starting Ambient Temperature _____°C Ending Ambient Temperature _____°C

Site Relative Humidity Probe Mfr/Model/SN **Rotronic / MP601A/**_____

Date of Last Calibration _____ Relative Humidity Range **_0 to 100.0 % RH_**

Climatronics UIM DEP SN _____ PC Manufacturer/SN _____

Calibration Device/Portable Humidity Chamber Mfr/SN **Rotronic / EM25 / 119959**____

Start/ End Equilibration Time _____ ___**EST** Auditor _____

****

Humidity Standard	Lot/Serial Number	Uncertainty at 23°C (+/- 2 °C)
35%		+/- 0.5% RH
80%		+/- 1.2% RH
10%		+/- 0.3% RH

Humidity Standard % RH	DRDAS Response % RH	Difference % RH	Pass/Fail Within +/- 10% RH
35%			
80%			
10%			

Reviewed by _____

Figure 9.9
Relative Humidity Performance Audit Sheet

Dew Point Performance Audit

Town/Site_____ Date/Time_____

Type of Site (Circle one): NCore PAMS SLAMS (non-Ncore)

Site RH Probe Mfr/SN _____ Date of Last Calibration _____

Audit Standard Mfr/SN _____ Date of Last Certification _____

Climatronics UIM DEP SN _____ PC Manufacturer/SN _____

****

Dew Point Readings

Time (EST)	10 seconds	20 seconds	30 seconds	40 seconds	50 seconds	60 seconds	1 minute average	DRDAS 1 minute
Ten minute average:								

Audit 10 minute average	DRDAS 10 minute average	°C Difference

°C Difference Within +/- 1.5°C ? Yes No Audit: Pass Fail

Reviewed by _____

Figure 9.10
Dew Point Performance Audit Sheet

Solar Radiation Performance Audit

Town/Site _____ **Date/Time** _____ **EST**

Type of Site (Circle one): NCore PAMS SLAMS (non-Ncore) Auditor _____

Site Solar Radiation Sensor Mfr/Model/SN Kipp & Zonen / CMP 6/_____

Audit Solar Radiation Sensor Mfr/Model/SN Kipp & Zonen / CMP 6/_____

Solar Radiation Range 0 to 1600 W/m^2 **Climatronics UIM DEP #** _____

Site Solar Radiation Sensor Zero Check _____ **Pass Fail**

Audit Solar Radiation Sensor Zero Check: _____ **Pass Fail**

****

Time (EST)	Site Pyranometer Response W/m^2	Audit Pyranometer Response W/m^2	Within +/- 5%
000			
100			
200			
300			
400			
500			
600			
700			
800			
900			
1000			
1100			
1200			
1300			
1400			
1500			
1600			
1700			
1800			
1900			
2000			
2100			
2200			
2300			
2400			
Daily Total			

Daily Total Within 5%? Yes No Audit: Pass Fail

****

Comments:

Reviewed by: _____

Figure 9.11
Solar Radiation Performance Audit Sheet

Site Temperature Performance Audit Sheet

Town/Site_____ Date/Time_____EST

Type of Site (Circle one): NCore PAMS SLAMS (non-Ncore)

Climatronics UIM DEP # _____ PC Manufacturer/DEP# _____

Inside Site Temp Probe Mfr/SN _____ Range -30.0 °C to 50 °C

Outside Site Temp Probe Mfr/SN _____ Range -30.0 °C to 50 °C

Audit Temp Probe Mfr/SN _____ Date of Last Cert._____

Date of Last Calibration _____ Auditor _____

****

Inside Temperature Audit

Test Environment	Audit Temperature °C	DRDAS Response °C	Difference °C	Pass/Fail Within +/- 1.0 °C
Ice Slurry Bath (~ 0°C)				
Ambient Temp Water Bath				
Warm Water Bath (~ 40°C)				

****

Outside Temperature Audit

Test Environment	Audit Temperature °C	DRDAS Response °C	Difference °C	Pass/Fail Within +/- 1.0 °C
Ice Slurry Bath (~ 0°C)				
Ambient Temp Water Bath				
Warm Water Bath (~ 40°C)				

Reviewed by _____

Figure 9.12
Site Temperature Performance Audit Sheet

Wind Speed & Wind Direction Performance Audit
(F460 Wind System)

(page 1 of 2)

Town/Site_____ Date/Time_____

WS Sensor Mfr. /SN Climatronics/ _____ WD Sensor Mfr. /SN Climatronics/ _____

Climatronics UIM DEP # _____ PC Manufacturer/SN _____

WS Calibrator Mfr/Model/SN R.M. Young Company / 18802/ CA03036 Date of Last Cert _____

WD Calibrator Mfr/Model/SN Climatronics / 101984 / 162 Date of Last Cert _____

WS Torque Watch Mfr/Model/SN Waters Mfg. / 366-3M / 5073 Date of Last Cert _____

WD Torque Watch Mfr/Model/SN Waters Mfg. / 366-2M / 5074 Date of Last Cert _____

Compass Mfr/Model/SN Suunto / KB-14 / 524673 Auditor R D Salls

****

Wind Tower Cross-arm Orientation

Magnetic Declination _____ º Wind Tower Cross-arm Orientation _____ º

Difference _____ º Orientation within +/- 5 º of Magnetic Declination Yes No Audit: Pass Fail

****

Wind Speed Audit

Audit Wind Speed rpm	Audit Wind Speed m/s	Wind Speed Response m/s	CTDEP Spec. (+/- 0.2m/s +5%)	Audit: Pass/Fail
0	0.0		+ 0.25	
200	4.9		4.5 to 5.4	
1000	23.4		22.0 to 24.8	
1700	40.2		38.0 to 42.4	

****

Wind Speed Starting Threshold

Torque (T) _____ gm-cm Wind Speed Aerodynamic Constant (K) __1.4__

Starting Threshold (u) = (T / K) ½ _____ = (_____/__1.4__)½

Starting Threshold ≤ 0.5 m/s Yes No Audit: Pass Fail

****

Comments:

Reviewed _____

Figure 9.13A
Wind Speed & Wind Direction Performance Audit Sheet: F460 Wind System
(Page 1)

Wind Speed & Wind Direction Performance Audit
(F460 Wind System)
(page 2 of 2)

Town/Site_____ Date/Time _____

Wind Direction Audit

degrees	As Left (from last cal)	As Is	Within 5 ^{o}	Audit: Pass /Fail
180°				
360°				

Audit Wind Direction (Degrees)	Wind Sensor Response (Degrees)	Degree Difference	CTDEP Spec. Within +/- 10°	Audit: Pass /Fail
0				
90				
180				
270				

****

Wind Direction Starting Threshold

Torque (T) _____ gm-cm Wind Direction Aerodynamic Constant (K) _30_

Starting Threshold (u) = (T / K) ^{½} _____ = (_____/__30__)^{½}

Starting Threshold $\leq$ 0.5 m/s Yes No Audit: Pass Fail

****

Comments:

Reviewed _____

Figure 9.13B
Wind Speed & Wind Direction Performance Audit Sheet: F460 Wind System
(Page 2)

Sonic Anemometer Performance Audit

Town/Site_____ Date/Time_____EST

Type of Site (Circle one): NCore PAMS SLAMS (non-Ncore)

Climatronics UIM DEP # _____ PC Manufacturer/DEP# _____

Sonic Anemometer Mfr/SN Met One/_____ WS Range 0-50m/s WD Range 0-360°

Audit CTS Mfr/SN Met One/_____ Date of Last Cert. _____

Audit Starting Date _____ Audit Ending Date _____ Auditor _____

****

Zero Test: Readings between 0.0 to 0.1 m/s Yes No Zero Test: Pass Fail

****

Span Test

Wind Speed			Wind Direction		
Blocked Axis	Expected Response	Actual Response	Blocked Axis	Expected Response	Actual Response
North - South	100 m/s		North - South	10°	
East - West	100 m/s		East - West	160°	
Both	100 m/s		Both	170°	

Span Test: Pass Fail

****

Side by Side 24 hour Audit

Wind Speed						Wind Direction					
Hour	Site Sensor m/s	Audit Sensor m/s	Hour	Site Sensor m/s	Audit Sensor m/s	Hour	Site Sensor degrees	Audit Sensor degrees	Hour	Site Sensor degrees	Audit Sensor degrees
100			1300			100			1300		
200			1400			200			1400		
300			1500			300			1500		
400			1600			400			1600		
500			1700			500			1700		
600			1800			600			1800		
700			1900			700			1900		
800			2000			800			2000		
900			2100			900			2100		
1000			2200			1000			2200		
1100			2300			1100			2300		
1200			2400			1200			2400		

Wind Speed Spec: +/- 0.5 m/s ≤ 11.3 m/s + 5% > 11.3 m/s Wind Direction Spec: ± 10°

Wind Speed Side by Side Audit: Pass Fail Wind Direction Side by Side Audit: Pass Fail

Reviewed by _____

Figure 9.14
Sonic Anemometer Performance Audit Sheet

Corrective Action Report

Date of Report _____ **Town/Site** _____ **Site Tech**_____

Problem identified from: (circle one)

Daily Report **Daily Check Report**

Performance Audit **Procedure Audit**

Calibration **Operation's Check**

Other _____

Affected Equipment: (circle one)

CO **SO_2** **NO_2** **NO_y** **O_3** **Sulfate**

$PM_{2.5}$ FRM **PM_{10}FRM** **$PM_{2.5}$ BAM** **PM_{10}BAM** **$PM_{2.5}$ FDMS**

Aetholometer **Nepholometer** **BC/UVC** **OCEC** **STN** **Improve**

Ins Temp **Outs Temp** **WS** **WD** **BP** **RH** **Precipitation** **SR**

VOC's **Carbonyls** **Dioxin** **Lead**

Problem:

_____
_____
_____
_____
_____
_____
_____

Date corrective action report given to supervisor _____

Date correction action assigned _____

Date correction action completed _____

Person(s) performing corrective action _____

Type of Corrective Action taken

_____
_____
_____
_____
_____
_____
_____
_____

Figure 9.15
Corrective Action Report

Records Retention Schedule Worksheet

		Approved Retention Period		
Item #	**Record Series Title**	**Office**	**Off-site**	**Total**
1	**Ambient Air Quality and Meteorological Parameters:** A computer database which is used to determinde CT's compliance with National Ambient Air Quality Standards (NAAQS), to determine pollution trends and effectiveness of the DEP. The pollutants measured include criteria pollutants (particulates, ozone, carbon monoxide, sulfir dioxide and nitrogen dioxide) , Photochemical Assement Monitoring System pollutants (Volitile organic carbons and carbonyls) and toxics (dioxins). The meteorological pararmeters measured are wind speed, wind direction, temperture, dew point, rain fall, pressure and solar radiation.	Permanent	N/A	Permanent Archival
2	**Environmental System Corporation (ESC) Database:** This record series replces the SAS Database of April 1996. It contains raw data electronically collected from all monitoring sites from around CT. This includes the raw data of the air quality and meteorological parameters described aove as 1 hour averages and kept in PC "Poll1" in Windsor lab and the PC "Poll2" at DEP Headquaters located a 75 Elm Street. The records also include the instruments environmetal parameters such as voltage, calibrator temperature, room temperature periods of one minute averages.	5 years	N/A	5 years
3	**Monitoring and Meteorological Instrumentation Operation Check Sheets:** This record series contains written documentation of the performance of monitoring and meteorological equipment. The sheets are a part of the DEP's quality assurance plan to ensure that the instruments continue to operate effectively. These records are filed in the field operations monitoring files, and includes taper element oscillating microbalance (TEOM) checks, bio-aerosol mass spectrometry (BAMS) checks TEOM calibrations, BAM calibrations, METONE SASS calibrations and Internal data from instruments.	5 years	N/A	5 years
4	**Preventative Maintenance Check Sheet:** This series is a written record of periodic maintenance (visual inspections, lubrication etc.) preformed at the monitoring site to insure a minimum of instrument downtime and/or rejection due to environmental and peripheral equipment problems. This includes Maintenance and PR log books.	5 years	N/A	5 years
5	**Site Files:** This record series includes information about both active and inactive air quality monitoring sites. Information such as site name, location, environment within 1 mile radius, sampling probe locations, topography and chronological changes to the site . these files are stored in P&S files and operations monitoring units.	Permanent	N/A	Permanent Archival
6	**Data Review Form:** This record series contains the results of monthly visual review of air monitoring instrumentation outputs to reveal any abonormalities. This is a part of the DEP quality assurance procedures used to ensure data received fom monitoring instruments is accuralty reported Ambient air Quality and Meteorological Parameters files.	5 years	N/A	5 years
7	**Air Quality Calibration Data Sheet:** This record series is a written record of a DEP quality assurance procedure that compares preforemance of an air monitoring instrument to the National Institute of Standards and Technology (NIST) in order to determine the instruments accuracy. Any adjustments needed to align the instruments with NIST preformance and then preformed. These records contain the results which determine whether data should be kept, modified or rejected.	5 years	N/A	5 years
8	**Performance Audit Report:** This record series documents air monitoring instrument accuaracy by comparison to NIST. These comparisons are preformed by independent DEP staff (staff other than those who condust the tests for #7 records). The results of the audit are used to assess accuracy of the data reported, assess accuracy of the instrument network data (all instruments measuring same pollutant) and integrity of all qulaity control procedures used by DEP air monitoring.	5 years	N/A	5 years
9	**Data Logger Calibration:** This record series is an equipment calibration which is used to bridge the gap between the Calibration Data Sheet(#7) and the ESC Database (#2) The data logger stores hourly averages from the instrument until it is retrieved by polling computer for storage into ESC database.	5 years	N/A	5 years
10	**Meteorlogical Instruments and Line Voltage Monitor Calibration:** This record series documents calibration of meteorological and environmental instrumentation. This procedure insures that data inputed into the data logger is with in accepted specifications.	5 years	N/A	5 years
11	**Field Instrument Standards Records:** This record series contains documentation for creation of standards used to calibrate air monitoring field instruments which measure air quality. It includes the documentation of calibration of transfer instruments as well as the settings and corresponding output levels of the working standards used in the field.	5 years	N/A	5 years
12	**Monitoring Instrumentation Analog Charts:** This record series contains a continuous visual display of air pollutant concentrations or meteorological parameters. It is used as a backup system to #2. Because it is a continuous analog display it is also used for data validation.	5 years	N/A	5 years
13	**Record Calibration:** The recorder is the instrument that generates the analog charts in #12. The calibration certifies the performance of this instrument.	5 years	N/A	5 years

Table 9.1A
Records Retention Schedule Worksheet
(Page 1)

Records Retention Schedule Worksheet

		Approved Retention Period		
	Record Series Title	**Office**	**Off-site**	**Total**
14	**Clean Room Records:** This record series contains all documentation of the condition and maintenance of the clean room/weigh room. These records were formally housed with the Department of Public Health and the Environmental Research Institute and have been moved to the CT DEP's air monitoring unit with the development of an in-house particulate matter (PM) weigh room/clean room. These records included documentation on room humidity, temperature, pressure, scale calibrations, parts log, a general log, problem log, archival log and room sign-in log.	5 years	N/A	5 years
15	**Particulate Records:** This record series inlcuded the documentation of the PM2.5 and PM10 filters. This includes PM2.5 and PM10 filter record sheets, PM2.5 and PM10 filters, filter data logs (Id, weights, air flow, temperature ect.) and weighing logs.	5 years	N/A	5 years
16	**Photochemical Assessment Monitoring System (PAMS) Procedural Records:** This record series is a collection of written reports on the procedures for data collection, handling and archiving (ie Quality Assurance Program Plans (QAPPS) and Standard Operating Procedures (SOPs).	5 years	N/A	5 years
17	**PAMS Data Records:** This record series contains PAMS data in raw and converted formats as well as any written field records. This data is used for the determination of compliance, pollution trends and correlations with ozone production. Records include, electronic and hard copy site logs, site check sheets, RST & TXO files, chromatographs, VOC data files, excel files, PAMS AIRS summary data, SITEtot.tot files, SITEair.air files, instrument log books, etc.	5 years	N/A	5 years
18	**PAMS Calibration Records:** This record series is in accordance with the DEP's quality assurance plan and is designed to ensure accurate and precise data (of above #17). These records include calibration cylinder tracking, calibration certifications, Air Quality System (AQS) reports of calibrations, etc.	5 years	N/A	5 years
19	**Quality Assurance Documents:** This record series contains the documents created with the calibration data and created with the purpose of ensuring accurate and precise data so that it may be certified. Included are the SOPs, calibration reports, supplemental data sheets, instrument operational check sheets, special study documentation, acceptance testing documentation, etc.	5 years	N/A	5 years
20	**Data Validation and Reporting;** This record series is the documentation that is associated with the AQS reports and data certification. The documentation included is pollutant data review sheets, meteorological data review sheets, AQS submittal reports, quaterly accuracy and precision review reports, etc.	5 years	N/A	5 years

Table 9.1B
Records Retention Schedule Worksheet
(Page 2)

Section 10 Sampling Design

Air pollutant monitoring siting criteria have been set forth in 40 CFR, Parts 53 and 58 (Reference 6). CTDEP's monitoring sites have been located in accordance with these guidelines. CTDEP will strive to find new or alternative sites if the need arises.

Section 10.1 Demography

Connecticut is a small, coastal state situated in southern New England midway between the metropolitan areas of New York City and Boston. Although located in the densely populated Northeast, over 60% of the State's land area is forested, mostly with mixed hardwood species. The State's population, as estimated by the 2000 census, is 3,405,565 persons. The vast majority of citizens inhabit either the narrow coastal plain fronting Long Island Sound or the broad, Central Valley carved prehistorically by the Connecticut River.

Bridgeport, on the western third of Long Island Sound, is the largest city and perhaps the most industrialized. Bridgeport sits astride the intersection of Interstate highways 95 and Connecticut state highway Route 8. Secondary metal smelting and casting were prevalent but are now declining in importance. These industries have been replaced largely by the manufacturing of electrical and industrial instruments, appliances and accessories.

New Haven, near the central portion of the coast, is the second largest city and home to Yale University. The city is intersected by Interstate highways 91 and 95. Significant quantities of petroleum products are imported for redistribution via pipeline and surface transport. New Haven manufactures a wide range of consumer goods and wire-related products.

Hartford, located in the north-central portion of the state, is the state Capitol and third largest city. A leader in the insurance and underwriting trades, Hartford sits astride the intersection of Interstate highways 91 and 84. Since the late 19th century the area was noted for its machined metal products ranging from Colt firearms to jet engines.

Stamford, the fourth most populous city, has become known as a financial center. It has also been considered one of the largest business centers in the United States. Precision manufacturing also maintains a significant presence in Stamford.

Waterbury, the fifth largest city, once known as the Brass City for manufacturing of copper and brass products, it is now diverse in its business scope.

The Groton-New London area is known for submarine, surface vessel and pharmaceutical production.

Other industrial or high activity areas include the Norwich-Ledyard area which attracts 30,000 vehicles per day due to two gambling casinos operated by Native Americans on sovereign tribal properties.

Figure 10.1
CTDEP Air Monitoring Sites

Monitoring Site Information

Below is a table with a list of all monitoring sites currently operated by the State of Connecticut. The following pages list detailed information for each monitoring site. The monitoring sites are listed in alphabetical order by site name.

Site Information Table

Town	Site	PM2.5 FRM	PM2.5 FRM colo	PM2.5 FDMS	PM2.5 BAM	PM2.5 Nephelometer	PM-Coarse FDMS	PM10 FRM (lo-vol)	PM10 FRM colo	PM10 BAM	STN	IMPROVE	Continuous OC/EC	Continuous Sulfate	BC/UVC	Ozone	SO2	CO	NOx	NOy	Lead (Pb)	VOCs (PAMS)	Carbonyls (PAMS)	Cont. PAH	Mercury	Dioxins	Wind Speed	Wind Direction	Temperature	Dew Point / Rel. Humidity	Rain Fall	Barometric Pressure	Solar Radiation
Bridgeport	Edison School																XT																
Bridgeport	Roosevelt School	1/3		X	P			1/6										XT											X				
Cornwall	Mohawk Mountain	1/3		P	X	X	P	P		P		X	X	X	X	X	T	PT	P	PT	P						X	X	X	X	X	X	X
Danbury	Western Connecticut State University	1/3			X											X											X	X	X		X		
East Hartford	High Street	1/3			X																						X	X					
East Hartford	McAuliffe Park	1/1		X	P			1/6							X	X	T	XT	X			X	X				X	X	X	X			X
Greenwich	Point Park															X											X	X	X		X		
Groton	Fort Griswold				X											X													X				
Hartford	Brainard Field																									X							
Hartford	Morgan Street Courthouse																	XT															
Madison	Hammonasset State Park															X											X	X	X				
Mansfield	DOT																										X	X	X				
Middletown	Connecticut Valley Hospital															X											X	X	X		X	X	
New Haven	Agricultural Center	1/3																															
New Haven	Criscuolo Park	1/1	1/6	X	X		X	1/6	1/6	X	X		X	X	X	X	T	T	X	T	X	X		X	X		X	X	X	X	X	X	X
New Haven	State Street	1/3																															
New Haven	Woodward Avenue Fire House	1/3																															
Norwalk	Health Department	1/3						1/6																									
Norwich	Norwich Courthouse	1/1 1/3																															
Stafford	Shenipsit State Forest															X											X	X	X				
Stratford	Stratford Lighthouse															X													X				
Thomaston	Waste Water Treatment Plant	1/3		X	P								X	X	X		T	T	X					X			X	X	X	X		X	
Waterbury	Meadow & Bank Street	1/3	1/6		X			1/6	1/6																		X	X	X		X		
Westport	Sherwood Island State Park	1/1 1/3						1/6								X	T	T	X			X					X	X	X	X			X

X=Existing, P =Planned, = Planned to Terminate, T=Trace, 1/1=Everyday sampling, 1/3=1-in-3 day sampling; 1/6=1-in-6 day sampling

Table 10.1
CTDEP Air Monitoring Site Information

Section 11 Sampling Methods

EPA has not identified a Reference Method for Meteorological instrumentation in the same manner as they have done for the criteria pollutants. USEPA produced the Quality Assurance Handbook for Air Pollution Measurement Systems, Vol IV: Meteorological Measurements to provide guidance for State/Local/Tribal (SLT) air pollution agencies staff that operate meteorological equipment.

Standard operating procedures (SOP's) for each meteorological parameter are written to describe the work that is required to be performed by air monitoring personnel. Adhering to the SOP's will result in data that is accurate, precise, representative of the are being monitored, reproducible and defensible in a court of law.

Section 11.1 Barometric Pressure

Barometric or atmospheric pressure is the pressure caused by the weight of air above any given area on the earth. Altitude and temperature affect barometric pressure. Barometric pressure is low at high altitudes because there is less air pushing down onto the earth. Barometric pressure decreases as temperature rises. This is due to the air being less dense at higher temperatures.

A barometer is an instrument used to monitor barometric pressure. This information can be used to forecast weather. Decreasing barometric pressure is an indicator of stormy, wet, and windy weather whereas rising barometric pressure is an indicator of dry and calm weather.

CTDEP uses the Setra Model 276 Barometric Pressure Transducer to collect barometric pressure data. The transducer consists of a Setraceram™ sensing element and Setra's custom Application Specific Integrated Circuit. These features will allow for long-term stability and high accuracy.

Many of the Setra Model 276 Barometric Pressure Sensors come pre-mounted on back of the Climatronics UIM. Barometric Pressure Sensors not located on the UIM, will be mounted in a secure area, away from drafts and heat. When the barometer is mounted inside a shelter, it is recommended to use a static head that will couple the barometer to the atmosphere.

Section 11.2 Precipitation

Precipitation refers to all liquid or solid water particles that fall from the earth's atmosphere. This occurs when the atmosphere becomes so saturated with water vapor, that water condenses and drops to the earth's surface. Precipitation comes in many different forms such as rain, snow, sleet, and hail. Small amounts of dew, frost, and rime may also be included in the total amount of precipitation collected by a rain gauge.

CTDEP is in the process of replacing all of the All Weather 8" Rain Gauges in their meteorological network with Met One 8" Rain Gauges. The only significant difference between the rain gauges is the volume of water it takes to tip the tipping bucket.

Precipitation enters the gauge through a collection funnel and flows into one of two tipping buckets inside. When one bucket fills, its weight tips the next bucket into position. This activates a reed switch and a signal is sent to the data logger for counting. Each tip indicates 0.01 inch of rainfall. The measured water is drained out the base of the gauge. The precipitation gauge is equipped with electrical heaters. The heating elements are thermostatically controlled ($4.4^{o}C/40^{o}F$) to melt and measure the water content of snow and frozen rain, but avoid evaporative loss. Two-mesh screens cover the collection funnel to keep insects, leaves and other foreign material from clogging and entering the gauge.

Section 11.3 Relative Humidity

Relative humidity is a ratio of the amount of moisture in the air at a given temperature to the amount of moisture the air is capable of holding at that temperature. CTDEP presently monitors relative humidity at 5 sites using Rotronic MP601A humidity probes.

The MP 601A is an OEM humidity probe designed for use in meteorological systems. The MP601A can operate within -40°C and +60°C. Operating the MP601A outside of the temperature limits may result in inaccurate measurements and can permanently damage the unit. The MP601A can operate within 0 and 100 % RH. Direct condensation does not damage the sensor. However, the humidity sensor will not provide correct readings as long as condensation is present. The MP601A can be used over long periods of time without any maintenance or recalibration.

Use of a HYGROMER C94 humidity sensor, in the MP601A, results in exceptional resistance to contaminants. The HYGROMER C94 sensor maintains its accuracy over the full range of humidity, even at conditions close to condensation. Separate power and signal grounds permit use of a long length of cable without loss of signal accuracy.

The humidity sensor requires a compensation for the effect of temperature on the humidity output signal in order to provide accurate measurements over a wide range of temperature conditions. Compensation is required because the dielectric characteristics of both the water molecule and the hygroscopic polymer used in the sensor vary with temperature. The MP 601A is equipped with an NTC temperature sensor, located next to the humidity sensor, which is used exclusively for the purpose of compensating the humidity sensor. This sensor should not be used for measuring temperature since it would not provide sufficient accuracy. Compensation is automatically done by the electronic circuit of the MP601A, based on the data provided by the NTC sensor.

Section 11.4 Solar Radiation

A pyranometer is an instrument used for the measurement of global or diffuse solar radiation. Solar radiation is described in units of energy flux, usually wW/m2. CTDEP uses the Kipp & Zonen CMP 6 pyranometer (see Figure 640.1 & 640.2) for measuring solar radiation. This instrument fully complies with all ISO-9060 specification criteria thus qualifying it as first-class pyranometer instrument, as defined by the World Meteorological Organization. It is designed for measuring short wave irradiance on a plane surface (radiant flux, W/m^2) which results from the sum of direct solar radiation and diffuse radiation incident from the hemisphere above the instrument.

The Kipp & Zonen CMP 6 pyranometer features a sixty-four junction (connected in series) thermocouple sensing element. The sensing element is coated with a highly stable carbon based inorganic coating, which delivers excellent spectral absorption and long-term stability characteristics. The detector is housed under two concentric glass domes which are 2 mm thick. The glass is specially formulated to transmit solar radiation over a wide range of wavelengths. Because pyranometers measure solar radiation from the sky, it is imperative that monitoring sites have a 360º view of the horizon, without significant obstacles. Corrections can be made for some obstructions but, the clearer the horizon is, the more accurate measurements will be.

Section 11.5 Temperature

Temperature is a measurement of how warm or cold an object or environment is, with reference to a standard scale. Climatronics' temperature sensors are accurate, durable, and linear over a wide range, can be provided with NIST traceable calibration, and are well matched for high accuracy delta temperature applications. The operating range is set -30º to +50º C

The temperature sensors encase a thermistor bead in a stainless steel sheath. This casing, combined with Climatronics' temperature shield, gives the thermistor bead protection from solar radiation, precipitation, and corrosive, airborne particles. Such configurations transfer heat as rapidly as possible, yielding a typical time constant of 3.6 seconds. When direct exposure of the thermistor to the media being measured is permissible, our Fast Response Sensor reduces the time constant to aminimal 0.6 seconds.

CTDEP measures the temperature within the shelters, that house air and meteorological instrumentation, as well as ambient temperature

Section 11.6 Wind Speed/Wind Direction

Wind direction and wind speed are important tools for weather forecasting and determining the sources of air pollutants.

A rotating cup assembly, mounted on top of a sensor, is used to measure wind speed. It consists of 3 aluminum cups attached to the end of 3 aluminum stems. The cups turn whenever there is wind movement. How fast the cups turn, determine what the wind speed is.

An interrupted light beam transducer is used to convert the rate of the cup rotation to an electrical signal suitable for measurement. This transducer consists of a slotted disk, photo emitter, and photo detector. The cup assembly rotates the slotted disk, creating a pulse each time the light passes through the slot, which is measured by the photo detector.

A wind vane, mounted on top of a sensor, is used to measure wind direction. It consists of a pointer and tail attached to a horizontal shaft. The vane is also made from light weight materials in order to achieve a low starting threshold. Wind direction is measured in degrees clockwise from true north. The lightweight tail moves whenever there is wind movement and the pointer will indicate the direction the wind is blowing from. The transducer used to measure wind direction is a 540° potentiometer. Voltage across the potentiometer is measured and this voltage varies directly with the wind direction.

In addition, CTDEP has one heated sonic anemometer, the MetOne Instruments Model 50.5 Wind sensor. It is a solid-state ultrasonic instrument capable of measuring wind speed and wind direction in the U and V axes. Sonic pulses are generated at the transducers and are received by opposing transducers. Mathematics derived for these sonic pulses provide a wind velocity measurement in each of the corresponding axes. The wind sensor uses a microprocessor-based, digital electronic measurement system to control the sample rate and compute the wind speed and wind direction

The heater is activated at 38°F and will keep the arms ice-free at temperatures down to -20°F. This sensor has no moving parts, which allows accurate measurements of wind speed and wind direction with zero maintenance. The sonic anemometer operates on the principal that the speed of the wind affects the time it takes for sound to travel from one point to a second point. If the sound is traveling in the direction of the wind then the transit time is decreased. If the sound is traveling in a direction opposite the wind, then the transit time is increased.

Section 12 Sample Handling and Custody

Since there is no physical sample being handled or collected for analysis, sample handling and custody requirements are not needed.

Section 13 Analytical Methods

No analytical methods are utilized for the monitoring, calibration, and auditing of meteorological instrumentation.

Section 14 Quality Control

Quality Control is the overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that the stated requirements established meet the needs of the user. These activities are used to ensure that measurement uncertainty is maintained within acceptance criteria for the attainment of the DQO.

To assure the quality of data from air and meteorological monitoring measurements, two distinct and important interrelated tasks must be performed.

The first is implementation of various QA activities including procedures, developing DQOs and MQO's, assigning roles and responsibilities, conducting oversight and reviews, and implementing corrective actions. This has been addressed in previous sections.

The second task is implementation of various QC procedures including performance audits, calibrations, and weekly checks.

Section 14.1 Performance Audits

Performance audits are required to be performed on all meteorological instrumentation at a minimum of once every 12 months. Results of these audits are used to assess the accuracy of the meteorological instrumentation. CTDEP personnel, who perform the performance audits, must not be the specialist, technician or engineer who conducts the routine service or analysis. The standards and equipment used for audits must be different from the standards used for calibrations. Records of all Performance Audits, along with documents certifying standards traceability and accuracy are kept at the DEP Lab Facility in Windsor, Ct. A logbook is kept listing the audit dates for all air monitoring and meteorological instrumentation. A logbook is kept listing the calibration dates and calibration due dates of standards used to perform the audits. If there are any issues identified during a performance audit, a corrective action report will be filled out and submitted to the Supervisor of Data or Supervisor of Field Operations/Monitoring.

Section 14.2 Calibrations

Once instrumentation is properly sited, it can be calibrated. This is accomplished by comparison to a NIST traceable standard or comparison to a similar instrument that is designated strictly for calibration purposes and that has NIST traceability. CTDEP personnel, who perform the calibrations, must not be the specialist, technician or engineer who conducts the routine service or analysis.

Calibrations are required to be performed on all meteorological instrumentation upon installation or relocation, upon operation interruption of more than 84 hours, if it exhibits unusual or abnormal behavior, following repair or replacement, and at a minimum of once every 6 months. The standards and equipment used for calibrations must be different from the standards used for audits. Records of all calibrations, along with documents certifying standards traceability and accuracy are kept at the DEP Lab Facility in Windsor, Ct. A status board is kept listing the calibration and calibration due dates for all air monitoring and meteorological instrumentation. A logbook is kept listing the calibration dates and calibration due dates of standards used to perform the calibrations.

Section 14.3 Weekly Checks

Once successfully calibrated, the routine performance of operational checks, preventive and corrective maintenance and quality control checks begin. CTDEP field personnel are required to visit their sites a minimum of once per week. Visual observations, in addition to monthly performance checks are performed. Any observation or response that is suspicious is reported to the Head of Operations so corrective action can take place.

CTDEP's MQO's are listed in a table format, based on the designation given to that monitoring site. The table defines the measurement requirements, frequency, corrective action and acceptance criteria necessary to meet the DQO's.

CTDEP Meteorological MQO's for PAM Sites

Measurement	Method	Reporting Units	Operating Range	Resolution	Minimum Sample Frequency	Raw Data Collection Frequency	Completeness
Ambient Temperature	Thermistor	^oC	-30 – 50 ^oC	0.1	Hourly	1 minute	75%
Relative Humidity	Relative Humidity Sensor	%	0 -100 %	0.5% RH	Hourly	1 minute	75%
Dew Point	Relative Humidity Sensor	^oC	-40 to 60 ^oC	0.1	Hourly	1 minute	75%
Barometric Pressure	Barometric Pressure Sensor	mb	600-1100 mb	0.1	Hourly	1 minute	75%
Wind Speed	Cup	m/s	0.0 – 65.0 m/s	0.1	Hourly	1 minute	75%
	Sonic Anemometer	m/s	0.0 – 50.0 m/s	0.1	Hourly	1 minute	75%
Wind Direction	Vane	Degrees	0 – 360 Degrees	1.0 Degree	Hourly	1 minute	75%
	Sonic Anemometer	Degrees	0 -360 Degrees	1.0 Degree	Hourly	1 minute	75%
Solar Radiation	Pyranometer	Watts/ m^2	0 – 1200 Watts/ m^2	$\pm$ 1W/m^2	Hourly	1 minute	75%
Precipitation	Tipping Bucket Gauge	inches	0.01 inch per tip	NA	Hourly	1 minute	75%

Table 14.1
CTDEP Meteorological MQO's for PAM Sites

CTDEP Meteorological MQO's for Ncore Sites

Measurement	Method	Reporting Units	Operating Range	Resolution	Minimum Sample Frequency	Raw Data Collection Frequency	Completeness
Ambient Temperature	Thermistor	^oC	-30 to 50 ^oC	0.1 ^oC	Hourly	1 minute	75%
Relative Humidity	Relative Humidity Sensor	%	0-100 %	0.5% RH	Hourly	1 minute	75%
Dew Point	Relative Humidity Sensor	^oC	-40 to 60 ^oC	0.1	Hourly	1 minute	75%
Wind Speed	Cup	m/s	0.5 -50.0 m/s	0.1 m/s	Hourly	1 minute	75%
	Sonic Anemometer	m/s	0.5 -50.0 m/s	0.1 m/s	Hourly	1 minute	75%
Wind Direction	Vane	Degrees	0 – 360 Degrees	1.0 Degree	Hourly	1 minute	75%
	Sonic Anemometer	Degrees	0 -360 Degrees	1.0 Degree	Hourly	1 minute	75%
Optional							
Solar Radiation	Pyranometer	Watts/ m^2	0 -1200 Watts/ m^2	10	Hourly	1 minute	75%
Precipitation	Tipping Bucket	inches	0.01 inch per tip	NA	Hourly	1 minute	75%
Barometric Pressure	Barometric Pressure Sensor	mb	600-1100 hPa	0.5	Hourly	1 minute	75%

Table 14.2
CTDEP Meteorological MQO's for Ncore Sites

CTDEP Meteorological MQO's for Non Ncore Sites

Measurement	Method	Reporting Units	Operating Range	Resolution	Minimum Sample Frequency	Raw Data Collection Frequency	Completeness
Ambient Temperature	Thermistor	^oC	-30 – 50 ^oC	0.1 ^oC	Hourly	1 minute	75%
Relative Humidity	Relative Humidity Sensor	%	0-100 %	0.5% RH	Hourly	1 minute	75%
Dew Point	Relative Humidity Sensor	^oC	-40 to 60 ^oC	0.1	Hourly	1 minute	75%
Wind Speed	Cup	m/s	0.5 – 50.0 m/s	0.1 m/s	Hourly	1 minute	75%
	Sonic Anemometer	m/s	0.5 – 50.0 m/s	0.1 m/s	Hourly	1 minute	75%
Wind Direction	Vane	Degrees	0 – 360 Degrees	1.0 Degree	Hourly	1 minute	75%
	Sonic Anemometer	Degrees	0 – 360 Degrees	1.0 Degree	Hourly	1 minute	75%
Optional							
Solar Radiation	Pyranometer	Watts/ m^2	0 – 1200 Watts/ m^2	10	Hourly	1 minute	75%
Precipitation	Tipping Bucket	inches	0.01 inch per tip	NA	Hourly	1 minute	75%
Barometric Pressure	Barometric Pressure Sensor	mb	600-1100 mb	0.5	Hourly	1 minute	75%

Table 14.3
CTDEP Meteorological MQO's for Non Ncore Sites

CTDEP Meteorological MQO's for PSD Sites

Measurement	Method	Reporting Units	Operating Range	Resolution	Minimum Sample Frequency	Raw Data Collection Frequency	Completeness
Ambient Temperature	Thermistor	^oC	-30 to 50 ^oC	0.1	Hourly	1 minute	90%
Relative Humidity	Relative Humidity Sensor	%	0-100 %	0.5% RH	Hourly	1 minute	90%
Dew Point	Relative Humidity Sensor	^oC	-40 to 60 ^oC	0.1	Hourly	1 minute	90%
Barometric Pressure	Barometric Pressure Sensor	mb	600-1100 mb	0.5	Hourly	1 minute	90%
Wind Speed	Cup	m/s	0.5 – 50.0 m/s	0.1 m/s	Hourly	1 minute	90%
	Sonic Anemometer	m/s	0.5 – 50.0 m/s	0.1 m/s	Hourly	1 minute	90%
Wind Direction	Vane	Degrees	0 – 360 Degrees	1.0 Degree	Hourly	1 minute	90%
	Sonic Anemometer	Degrees	0 – 360 Degrees	1.0 Degree	Hourly	1 minute	90%
Solar Radiation	Pyranometer	Watts/ m^2	0 -1300 Watts/ m^2	10	Hourly	1 minute	90%
Precipitation	Tipping Bucket	inches	0.01 inch per tip	NA	Hourly	1 minute	90%

Table 14.4
CTDEP Meteorological MQO's for PSD Sites

CTDEP Meteorological MQO's for Modeling Application

Measurement	Method	Reporting Units	Operating Range	Resolution	Minimum Sample Frequency	Raw Data Collection Frequency	Completeness
Ambient Temperature	Thermistor	^{o}C	-40 to 60 ^{o}C	0.1	Hourly	1 minute	90%
Relative Humidity	Relative Humidity Sensor	%	0-100 %	0.5% RH	Hourly	1 minute	90%
Dew Point	Relative Humidity Sensor	^{o}C	-40 to 60 ^{o}C	0.1	Hourly	1 minute	90%
Barometric Pressure	Barometric Pressure Sensor	mb	600-1100 mb	0.5	Hourly	1 minute	90%
Wind Speed	Cup or Sonic Anemometer	m/s	0.5 -50.0 m/s	0.25	Hourly	1 minute	90%
Wind Direction	Vane or Sonic Anemometer	Degrees	0 -360 Degrees	0.5	Hourly	1 minute	90%
Solar Radiation	Pyranometer	Watts/ m^2	0 -1300 Watts/ m^2	10	Hourly	1 minute	90%
Precipitation	Tipping Bucket	inches	0.01 inch per tip	NA	Hourly	1 minute	90%

Table 14.5
CTDEP Meteorological MQO's for Modeling Application

CTDEP Calibration and Accuracy Criteria for PAM Sites

	Calibration				Accuracy			
Measurement	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**
Ambient Temperature	3 point water bath with NIST traceable thermistor or thermometer	± 0.7°C	± 1.0°C	Semi-Annually	3 point water bath withNIST traceable thermistor or thermometer	± 0.7°C	± 1.0°C	Annually
Relative Humidity	NIST traceable Hygrometer or RH standard solutions	± 7%	± 10%	Semi-Annually	NIST traceable Hygrometer or RH standard solutions	± 7%	± 10%	Annually
Dew Point Temperature	NIST traceable Hygrometer	± 1.0°C	± 1.5°C	Semi-Annually	NIST traceable Hygrometer	± 1.0°C	± 1.5°C	Annually
Barometric Pressure	NIST traceable BP sensor	± 7 mb	± 10 mb	Semi-Annually	NIST traceable BP sensor	± 7 mb	± 10 mb	Annually
Wind Speed (Cup) (F460 system)	NIST traceable synchronous motor or NIST traceable sonic anemometer	± 0.2 m/s + 5%	± 0.2 m/s + 5%	Semi-Annually	NIST traceable synchronous motor or NIST traceable sonic anemometer	± 0.2 m/s + 5%	± 0.2 m/s + 5%	Annually
Wind Direction (Vane) (F460 system)	NIST traceable test fixture or NIST traceable sonic anemometer	± 5° Crossarm alignment ±5°	± 10° Crossarm alignment ±5°	Semi-Annually	NIST traceable test fixture or NIST traceable sonic anemometer	± 5° Crossarm alignment ±5°	± 10 ° Crossarm alignment ±5°	Annually
Wind Speed (Cup) (F460 system)	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Semi-Annually	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Annually
Wind Direction (Vane) (F460 system)	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Semi-Annually	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Annually
Wind Speed (sonic anemometer)	NIST traceable sonic anemometer	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	Semi-Annually	NIST traceable sonic anemometer	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	Annually
Wind Direction (sonic anemometer)	NIST traceable sonic anemometer	± 7° Crossarm alignment ±5°	± 10° Crossarm alignment ±5°	Semi-Annually	NIST traceable sonic anemometer	± 7° Crossarm alignment ±5°	± 10° Crossarm alignment ±5°	Annually
Solar Radiation	NIST traceable pyranometer	± 5% of mean observed interval	± 5% of mean observed interval	Semi-Annually	NIST traceable pyranometer	± 5% of mean observed interval	± 5% of mean observed interval	Annually
Precipitation	Seperatory funnel and graduated cylinder	± 7% of input volume	± 10% of input volume	Semi-Annually	Seperatory funnel and graduated cylinder	± 7% of input volume	± 10% of input volume	Annually

Table 14.6
CTDEP Calibration and Accuracy Criteria for PAM Sites

CTDEP Calibration and Accuracy Criteria for Ncore Sites

	Calibration				Accuracy			
Measurement	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**
Ambient Temperature	3 point water bath with NIST traceable thermistor or thermometer	± 0.7°C	± 1.0°C	Semi-Annually	3 point water bath with NIST traceable thermistor or thermometer	± 0.7°C	± 1.0°C	Annually
Relative Humidity	NIST traceable Hygrometer or RH standard solutions	± 7%	± 10%	Semi-Annually	NIST traceable Hygrometer or RH standard solutions	± 7%	± 10%	Annually
Dew Point Temperature	NIST traceable Hygrometer	± 1.0°C	± 1.5°C	Semi-Annually	NIST traceable Hygrometer	± 1.0°C	± 1.5°C	Annually
Wind Speed (Cup) (F460 system)	NIST traceable synchronous motor or NIST traceable sonic anemometer	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	Semi-Annually	NIST traceable synchronous motor or NIST traceable sonic anemometer	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	Annually
Wind Direction (Vane) (F460 system)	NIST traceable test fixture or NIST traceable sonic anemometer	± 5 ° Crossarm alignment ±5°	± 10 ° Crossarm alignment ±5°	Semi-Annually	NIST traceable test fixture or NIST traceable sonic anemometer	± 5 ° Crossarm alignment ±5°	± 10 ° Crossarm alignment ±5°	Annually
Wind Speed (Cup) (F460 system)	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Semi-Annually	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Annually
Wind Direction (Vane) (F460 system)	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Semi-Annually	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Annually
Wind Speed (sonic anemometer)	NIST traceable sonic anemometer	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	Semi-Annually	NIST traceable sonic anemometer	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	Annually
Wind Direction (sonic anemometer)	NIST traceable sonic anemometer	± 7° Crossarm alignment ±5°	± 10° Crossarm alignment ±5°	Semi-Annually	NIST traceable sonic anemometer	± 7° Crossarm alignment ±5°	± 10° Crossarm alignment ±5°	Annually
Optional								
Solar Radiation	NIST traceable pyranometer	± 5% of mean observed interval	± 5% of mean observed interval	Semi-Annually	NIST traceable pyranometer	± 5% of mean observed interval	± 5% of mean observed interval	Annually
Precipitation	Seperatory funnel and graduated cylinder	± 7% of input volume	± 10% of input volume	Semi-Annually	Separatory funnel and graduated cylinder	± 7% of input volume	± 10% of input volume	Annually
Barometric Pressure	NIST traceable BP sensor	± 7 mb	± 10 mb	Semi-Annually	NIST traceable BP sensor	± 7 mb	± 10 mb	Annually

Table 14.7
CTDEP Calibration and Accuracy Criteria for Ncore Sites

CTDEP Calibration and Accuracy Criteria for Non Ncore Sites

	Calibration				Accuracy			
Measurement	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**
Ambient Temperature	3 point water bath with NIST traceable thermistor or thermometer	± 0.7°C	± 1.0°C	Semi-Annually	3 point water bath with NIST traceable thermistor or thermometer	± 0.7°C	± 1.0°C	Annually
Relative Humidity	NIST traceable Hygrometer or RH standard solutions	± 7%	± 10%	Semi-Annually	NIST traceable Hygrometer or RH standard solutions	± 7%	± 10%	Annually
Dew Point Temperature	NIST traceable Hygrometer	± 1.0°C	± 1.5°C	Semi-Annually	NIST traceable Hygrometer	± 1.0°C	± 1.5°C	Annually
Wind Speed (Cup) (F460 system)	NIST traceable synchronous motor or NIST traceable sonic anemometer	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	Semi-Annually	NIST traceable synchronous motor or NIST traceable sonic anemometer	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	Annually
Wind Direction (Vane) (F460 system)	NIST traceable test fixture or NIST traceable sonic anemometer	± 5 ° Crossarm alignment ±5°	± 10 ° Crossarm alignment ±5°	Semi-Annually	NIST traceable test fixture or NIST traceable sonic anemometer	± 5 ° Crossarm alignment ±5°	± 10 ° Crossarm alignment ±5°	Annually
Wind Speed (Cup) (F460 system)	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Semi-Annually	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Annually
Wind Direction (Vane) (F460 system)	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Semi-Annually	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Annually
Wind Speed (sonic anemometer)	NIST traceable sonic anemometer	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	Semi-Annually	NIST traceable sonic anemometer	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	Annually
Wind Direction (sonic anemometer)	NIST traceable sonic anemometer	± 7° Crossarm alignment ±5°	± 10° Crossarm alignment ±5°	Semi-Annually	NIST traceable sonic anemometer	± 7° Crossarm alignment ±5°	± 10° Crossarm alignment ±5°	Annually
Optional								
Solar Radiation	NIST traceable pyranometer	± 5% of mean observed interval	± 5% of mean observed interval	Semi-Annually	NIST traceable pyranometer	± 5% of mean observed interval	± 5% of mean observed interval	Annually
Precipitation	Seperatory funnel and graduated cylinder	± 7% of input volume	± 10% of input volume	Semi-Annually	Separatory funnel and graduated cylinder	± 7% of input volume	± 10% of input volume	Annually
Barometric Pressure	NIST traceable BP sensor	± 7 mb	± 10 mb	Semi-Annually	NIST traceable BP sensor	± 7 mb	± 10 mb	Annually

Table 14.8
CTDEP Calibration and Accuracy Criteria for Non Ncore Sites

CTDEP Calibration and Accuracy Criteria for PSD Sites

	Calibration				Accuracy			
Measurement	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**
Ambient Temperature	3 point water bath with NIST traceable thermistor or thermometer	± 0.7°C	± 1.0°C	Quarterly	3 point water bath with NIST traceable thermistor or thermometer	± 0.7°C	± 1.0°C	Quarterly
Relative Humidity	NIST traceable Hygrometer or standard solutions	± 7%	± 10%	Quarterly	NIST traceable Hygrometer or standard solutions	± 7%	± 10%	Quarterly
Dew Point	NIST traceable Hygrometer	± 1.0°C	± 1.5°C	Quarterly	NIST traceable Hygrometer	± 1.0°C	± 1.5°C	Quarterly
Wind Speed (Cup) (F460 system)	NIST traceable synchronous motor or NIST traceable sonic anemometer	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	Quarterly	NIST traceable synchronous motor or NIST traceable sonic anemometer	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	Quarterly
Wind Direction (Vane) (F460 system)	NIST traceable test fixture or NIST traceable sonic anemometer	± 5 ° Crossarm alignment ±5°	± 10 ° Crossarm alignment ±5°	Quarterly	NIST traceable test fixture or NIST traceable sonic anemometer	± 5 ° Crossarm alignment ±5°	± 10 ° Crossarm alignment ±5°	Quarterly
Wind Speed (Cup) (F460 system)	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Quarterly	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Quarterly
Wind Direction (Vane) (F460 system)	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Quarterly	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Quarterly
Wind Speed (sonic anemometer)	NIST traceable sonic anemometer	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	Quarterly	NIST traceable sonic anemometer	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	Quarterly
Wind Direction (sonic anemometer)	NIST traceable sonic anemometer	± 7° Crossarm alignment ±5°	± 10° Crossarm alignment ±5°	Quarterly	NIST traceable sonic anemometer	± 7° Crossarm alignment ±5°	± 10° Crossarm alignment ±5°	Quarterly
Solar Radiation	NIST traceable pyranometer	± 5% of mean observed interval	± 5% of mean observed interval	Quarterly	NIST traceable pyranometer	± 5% of mean observed interval	± 5% of mean observed interval	Quarterly
Precipitation	Separatory funnel and graduated cylinder	± 7% of input volume	± 10% of input volume	Quarterly	Separatory funnel and graduated cylinder	± 7% of input volume	± 10% of input volume	Quarterly
Barometric Pressure	NIST traceable barometric pressure sensor	± 7 mb	± 10 mb	Quarterly	NIST traceable barometric pressure sensor	± 7 mb	± 10 mb	Quarterly

Table 14.9
CTDEP Calibration and Accuracy Criteria for PSD Sites

CTDEP Calibration and Accuracy Criteria for Modeling Application

	Calibration				Accuracy			
Measurement	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**
Ambient Temperature	3 point water bath with NIST traceable thermistor or thermometer	± 0.7°C	± 1.0°C	Semi-Annually	3 point water bath with NIST traceable thermistor or thermometer	± 0.7°C	± 1.0°C	Annually
Relative Humidity	NIST traceable Hygrometer or RH standard solutions	± 7%	± 10%	Semi-Annually	NIST traceable Hygrometer or RH standard solutions	± 7%	± 10%	Annually
Dew Point Temperature	NIST traceable Hygrometer	± 1.0°C	± 1.5°C	Semi-Annually	NIST traceable Hygrometer	± 1.0°C	± 1.5°C	Annually
Wind Speed (Cup) (F460 system)	NIST traceable synchronous motor or NIST traceable sonic anemometer	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	Semi-Annually	NIST traceable synchronous motor or NIST traceable sonic anemometer	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	± 0.25 m/s <+ 5% 5%> 2m/s not to exceed ± 0.25 m/s	Annually
Wind Direction (Vane) (F460 system)	NIST traceable test fixture or NIST traceable sonic anemometer	± 5 ° Crossarm alignment ≤ ±5°	± 10 ° Crossarm alignment ≤ ±5°	Semi-Annually	NIST traceable test fixture or NIST traceable sonic anemometer	± 5 ° Crossarm alignment ≤ ±5°	± 10 ° Crossarm alignment ≤ ±5°	Annually
Wind Speed (Cup) (F460 system)	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Semi-Annually	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Annually
Wind Direction (Vane) (F460 system)	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Semi-Annually	NIST traceable Torque Watch	Starting Threshold ≤ 0.5 m/s	Starting Threshold ≤ 0.5 m/s	Annually
Wind Speed (sonic anemometer)	NIST traceable sonic anemometer	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	Semi-Annually	NIST traceable sonic anemometer	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s	Annually
Wind Direction (sonic anemometer)	NIST traceable sonic anemometer	± 7° Crossarm alignment ±5°	± 10° Crossarm alignment ±5°	Semi-Annually	NIST traceable sonic anemometer	± 7° Crossarm alignment ±5°	± 10° Crossarm alignment ±5°	Annually
Optional								
Solar Radiation	NIST traceable pyranometer	± 5% of mean observed interval	± 5% of mean observed interval	Semi-Annually	NIST traceable pyranometer	± 5% of mean observed interval	± 5% of mean observed interval	Annually
Precipitation	Seperatory funnel and graduated cylinder	± 7% of input volume	± 10% of input volume	Semi-Annually	Separatory funnel and graduated cylinder	± 7% of input volume	± 10% of input volume	Annually
Barometric Pressure	NIST traceable BP sensor	± 7 mb	± 10 mb	Semi-Annually	NIST traceable BP sensor	± 7 mb	± 10 mb	Annually

Table 14.10
CTDEP Calibration and Accuracy Criteria for Modeling Application

Barometric Pressure Line /Voltage Performance Audit

Barometric Pressure

Town/Site_____ Date/Time_____EST

Type of Site (Circle one): Ncore PAMS SLAMS (non-Ncore)

Climatronics UIM DEP # _____ PC Manufacturer/DEP# _____

Site Barometric Pressure Sensor Mfr/SN _____ Range 600 to 1100 mb

Audit Device Mfr/SN _____ Date of Last Cert. _____

Date of Last Calibration _____ Auditor _____

Site Barometric Pressure (mb)	Audit Barometric Pressure (mb)	Within 10 mb (Yes/No)	Audit Pass or Fail (Yes/No)

Line Voltage

Town/Site_____ Date/Time_____EST

Type of Site (Circle one): Ncore PAMS SLAMS (non-Ncore)

Voltmeter Mfr/SN _____ Date of Last Cert. _____

Auditor _____

Site Line Voltage (Volts)	Audit Line Voltage (Volts)	Site Line Voltage Within +/- 5 Volts	Site Line Voltage Within 105 to 125 Volts	Audit Pass or Fail

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Comments:

Reviewed by: _____

Figure 14.1
Barometric Pressure/Line Voltage Performance Audit Sheet

Precipitation Performance Audit Sheet

Town/Site _____ Date/Time _____EST

Type of Site (Circle one): Ncore PAMS SLAMS (non-Ncore)

Rain Gauge Mfr/Model/SN _____

Audit Rain Gauge Mfr/Model/SN _____ _____

Climatronics UIM DEP # _____ Auditor _____

****

Observations

Screen and Funnel Clean Yes No

Bubble Level of Rain Gauge Okay Yes No

Heater Element Functional (if Ambient Temperature below 4.4^{o}C) Yes No NA

If any of the above questions are answered "No", explain under Comments

Conversions

Number of Measured Tips ____Tips

Met One Rain Gauge: Each tip is Equal to 8.24 ml

All Weather Rain Gauge: Each tip is Equal to 8.6834 ml

Measured Volume = Number of tips x _____ml = _____ml

Actual Volume (Met One Rain Gauge) = 206 ml

Actual Volume (All Weather Rain Gauge) = 217 ml

Measured Volume (ml)	Actual Volume (ml)	Difference (ml)	Within +/- 10% of Input Volume	Audit Pass or Fail

****

Comments:

Reviewed by: _____

Figure 14.2
Precipitation Performance Audit Sheet

Relative Humidity Performance Audit

Town/Site_____ Date/Time_____

Type of Site (Circle one): Ncore PAMS SLAMS (non-Ncore)

Starting Ambient Temperature _____°C Ending Ambient Temperature _____°C

Site Relative Humidity Probe Mfr/Model/SN **Rotronic / MP601A/**_____

Date of Last Calibration _____ Relative Humidity Range **_0 to 100.0 % RH_**

Climatronics UIM DEP SN _____ PC Manufacturer/SN _____

Calibration Device/Portable Humidity Chamber Mfr/SN **Rotronic / EM25 / 119959**____

Start/ End Equilibration Time _____**EST** Auditor _____

Humidity Standard	Lot/Serial Number	Uncertainty at 23°C (+/- 2 °C)
35%		+/- 0.5% RH
80%		+/- 1.2% RH
10%		+/- 0.3% RH

Humidity Standard % RH	DRDAS Response % RH	Difference % RH	Pass/Fail Within +/- 10% RH
35%			
80%			
10%			

Reviewed by _____

Figure 14.3
Relative Humidity Performance Audit Sheet

Dew Point Performance Audit

Town/Site_____ Date/Time_____

Type of Site (Circle one): Ncore PAMS SLAMS (non-Ncore)

Site RH Probe Mfr/SN _____ Date of Last Calibration _____

Audit Standard Mfr/SN _____ Date of Last Certification _____

Climatronics UIM DEP SN _____ PC Manufacturer/SN _____

Dew Point Readings

Time (EST)	10 seconds	20 seconds	30 seconds	40 seconds	50 seconds	60 seconds	1 minute average	DRDAS 1 minute
						Ten minute average:		

Audit 10 minute average	DRDAS 10 minute average	°C Difference

°C Difference Within +/- 1.5°C ? Yes No Audit: Pass Fail

Reviewed by _____

Figure 14.4
Dew Point Performance Audit Sheet

Solar Radiation Performance Audit

Town/Site _____ **Date/Time** _____ **EST**

Type of Site (Circle one): Ncore PAMS SLAMS (non-Ncore) Auditor _____

Site Solar Radiation Sensor Mfr/Model/SN Kipp & Zonen / CMP 6/_____

Audit Solar Radiation Sensor Mfr/Model/SN Kipp & Zonen / CMP 6/_____

Solar Radiation Range 0 to 1600 W/m^2 **Climatronics UIM DEP #** _____

Site Solar Radiation Sensor Zero Check _____ **Pass Fail**

Audit Solar Radiation Sensor Zero Check: _____ **Pass Fail**

****

Time (EST)	Site Pyranometer Response W/m^2	Audit Pyranometer Response W/m^2	Within +/- 5%
000			
100			
200			
300			
400			
500			
600			
700			
800			
900			
1000			
1100			
1200			
1300			
1400			
1500			
1600			
1700			
1800			
1900			
2000			
2100			
2200			
2300			
2400			
Daily Total			

Daily Total Within 5% of mean observed interval? Yes No Audit: Pass Fail

****

Comments:

Reviewed by: _____

Figure 14.5
Solar Radiation Performance Audit Sheet

Site Temperature Performance Audit Sheet

Town/Site_____ Date/Time_____EST

Type of Site (Circle one): Ncore PAMS SLAMS (non-Ncore)

Climatronics UIM DEP # _____ PC Manufacturer/DEP# _____

Inside Site Temp Probe Mfr/SN _____ Range -30.0 °C to 50 °C

Outside Site Temp Probe Mfr/SN _____ Range -30.0 °C to 50 °C

Audit Temp Probe Mfr/SN _____ Date of Last Cert._____

Date of Last Calibration _____ Auditor _____

Inside Temperature Audit

Test Environment	Audit Temperature °C	DRDAS Response °C	Difference °C	Pass/Fail Within +/- 1.0 °C
Ice Slurry Bath (~ 0°C)				
Ambient Temp Water Bath				
Warm Water Bath (~ 40°C)				

Outside Temperature Audit

Test Environment	Audit Temperature °C	DRDAS Response °C	Difference °C	Pass/Fail Within +/- 1.0 °C
Ice Slurry Bath (~ 0°C)				
Ambient Temp Water Bath				
Warm Water Bath (~ 40°C)				

Reviewed by _____

Figure 14.6
Site Temperature Performance Audit Sheet

Wind Speed & Wind Direction Performance Audit
(F460 Wind System)

(page 1 of 2)

Town/Site_____ Date/Time_____

WS Sensor Mfr. /SN Climatronics/ _____ WD Sensor Mfr. /SN Climatronics/ _____

Climatronics UIM DEP # _____ PC Manufacturer/SN _____

WS Calibrator Mfr/Model/SN R.M. Young Company / 18802/ CA03036 Date of Last Cert _____

WD Calibrator Mfr/Model/SN Climatronics / 101984 / 162 Date of Last Cert _____

WS Torque Watch Mfr/Model/SN Waters Mfg. / 366-3M / 5073 Date of Last Cert _____

WD Torque Watch Mfr/Model/SN Waters Mfg. / 366-2M / 5074 Date of Last Cert _____

Compass Mfr/Model/SN Suunto / KB-14 / 524673 Auditor R D Salls

---

Wind Tower Cross-arm Orientation

Magnetic Declination _____ º Wind Tower Cross-arm Orientation _____ º

Difference _____ º Orientation within +/- 5 º of Magnetic Declination Yes No Audit: Pass Fail

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Wind Speed Audit

Audit Wind Speed rpm	Audit Wind Speed m/s	Wind Speed Response m/s	CTDEP Spec. (+/- 0.2m/s +5%)	Audit: Pass/Fail
0	0.0		+ 0.25	
200	4.9		4.5 to 5.4	
1000	23.4		22.0 to 24.8	
1700	40.2		38.0 to 42.4	

Wind Speed Starting Threshold

Torque (T) _____ gm-cm Wind Speed Aerodynamic Constant (K) __1.4__

Starting Threshold (u) = $(T / K)^{½}$ _____ = (_____/__1.4__)^{½}

Starting Threshold ≤ 0.5 m/s Yes No Audit: Pass Fail

Comments:

Reviewed _____

Figure 14.7A
Wind Speed & Wind Direction Performance Audit Sheet: F460 Wind System
(Page 1)

Wind Speed & Wind Direction Performance Audit
(F460 Wind System)
(page 2 of 2)

Town/Site_____ Date/Time _____

Wind Direction Audit

degrees	As Left (from last cal)	As Is	Within 5 ^{o}	Audit: Pass /Fail
180°				
360°				

Audit Wind Direction (Degrees)	**Wind Sensor Response (Degrees)**	**Degree Difference**	**CTDEP Spec. Within +/- 10°**	**Audit: Pass /Fail**
0				
90				
180				
270				

Wind Direction Starting Threshold

Torque (T) _____ gm-cm **Wind Direction Aerodynamic Constant (K) _30_**

Starting Threshold (u) = (T / K) ^{½} _____ = (_____/__30__)^{½}

Starting Threshold ≤ 0.5 m/s Yes No Audit: Pass Fail

Comments:

Reviewed _____

Figure 14.7B
Wind Speed & Wind Direction Performance Audit Sheet: F460 Wind System
(Page 2)

Sonic Anemometer Performance Audit

Town/Site_____ Date/Time_____EST

Type of Site (Circle one): Ncore PAMS SLAMS (non-Ncore)

Climatronics UIM DEP # _____ PC Manufacturer/DEP# _____

Sonic Anemometer Mfr/SN Met One/_____ WS Range 0-50m/s WD Range 0-360°

Audit CTS Mfr/SN Met One/_____ Date of Last Cert. _____

Audit Starting Date _____ Audit Ending Date _____ Auditor _____

Zero Test: Readings between 0.0 to 0.1 m/s ? Yes No Zero Test: Pass Fail

Span Test

Wind Speed			Wind Direction		
Blocked Axis	Expected Response	Actual Response	Blocked Axis	Expected Response	Actual Response
North – South	100 m/s		North – South	10°	
East – West	100 m/s		East – West	160°	
Both	100 m/s		Both	170°	

Span Test: Pass Fail

Side by Side 24 hour Audit

Wind Speed						Wind Direction					
Hour	Site Sensor m/s	Audit Sensor m/s	Hour	Site Sensor m/s	Audit Sensor m/s	Hour	Site Sensor degrees	Audit Sensor degrees	Hour	Site Sensor degrees	Audit Sensor degrees
100			1300			100			1300		
200			1400			200			1400		
300			1500			300			1500		
400			1600			400			1600		
500			1700			500			1700		
600			1800			600			1800		
700			1900			700			1900		
800			2000			800			2000		
900			2100			900			2100		
1000			2200			1000			2200		
1100			2300			1100			2300		
1200			2400			1200			2400		

Wind Speed Spec: +/- 0.5 m/s ≤ 11.3 m/s + 5% > 11.3 m/s Wind Direction Spec: ± 10°

Wind Speed Side by Side Audit: Pass Fail Wind Direction Side by Side Audit: Pass Fail

Reviewed by _____

Figure 14.8
Sonic Anemometer Performance Audit Sheet

Semi-Annual Meteorological Parameters Calibration Sheet

side 1 of 2

Town		Site		N-Core	PAMS	non N-Core
QA Officer			Date/Time			

Cal Devices	MFG/Model	S.N.	Last Cert Date
Temp Probe			
Compass	Suunto / KB-14		N/A
WS Cal	R.M. Young Co. / 18803		
WD Cal	Climatronics / 101984		
WS Torque Watch	Waters / 366-3M		
WD Torque Watch	Waters / 366-2M		

Site Devices	MFG/Model	Serial or DEP #	Range
UIM	Climatronics		N/A
Inside T probe			-30 to +50°C
Outside T probe			-30 to +50°C
WS Sensor			
WD Sensor			

Temp	Standard	I.T. resp	Difference	w/in 1°C	Standard	O.T. resp	Difference	w/in 1°C
Ice				PASS/FAIL				PASS/FAIL
Ambient				PASS/FAIL				PASS/FAIL
Warm				PASS/FAIL				PASS/FAIL

Met Tower

Cross-Arm Orientation	°	Site Specific Magnetic Declination			°	E or W
Wind Tower w/in 5° of Declination?		YES	NO	EAST	WEST	

WS	RPM	Response (m/s)	Spec	w/in spec	WS Torque Starting Threshold (μ)	Report μ as m/s
	0	0	0.25 +/-	PASS/FAIL	Torque (gm-cm)	μ = (torque/1.4)$^{1/2}$
	200	4.9	4.5 - 5.4	PASS/FAIL		
	1000	23.4	22.0 - 24.8	PASS/FAIL	Spec ≤ 0.35 gm-cm	
	1700	40.2	38.0 - 42.4	PASS/FAIL	PASS/FAIL	
If WS Sensor replaced New SN:	0	0	0.25 +/-	PASS/FAIL	Torque (gm-cm)	μ = (torque/1.4)$^{1/2}$
	200	4.9	4.5 - 4.5	PASS/FAIL		
	1000	23.4	22.0 - 24.8	PASS/FAIL	Spec ≤ 0.35 gm-cm	
	1700	40.2	38.0 - 42.4	PASS/FAIL	PASS/FAIL	

WD	As Is	° set point	° Response	Difference	w/declination w/in 5°?	WD Torque Starting Threshold (μ)	Report μ as m/s
0 (360)°		0 (360)			PASS/FAIL	Torque (gm-cm)	μ = (torque/30)$^{1/2}$
w/in 5°	PASS/FAIL	90			PASS/FAIL		
180°		180			PASS/FAIL	Spec ≤ 7.5 gm-cm	
w/in 5°	PASS/FAIL	270			PASS/FAIL	PASS	
If WD Sensor replaced New SN:		0 (360)			PASS/FAIL	Torque (gm-cm)	μ = (torque/30)$^{1/2}$
		90			PASS/FAIL		
		180			PASS/FAIL	Spec ≤ 7.5 gm-cm	
		270			PASS/FAIL	PASS	

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Figure 14.9A
Semi-Annual Meteorological Parameter Calibration Sheet
(Page 1)

Semi-Annual Meteorological Parameters Calibration Sheet

side 2 of 2

Town		Site		N-Core	PAMS	non N-Core
QA Officer			Date/Time			

Cal Devices Standards	MFG/Model	S.N.	Last Cert Date
SR			
BP			
Rain Gauge			
DMM			

Site Devices	MFG/Model	Serial or DEP #	Range
SR	Kipp & Zonen / CMP6		0 to 1600 W/m^2
BP			
Rain Gauge			
RH			
Line Voltage			

SR (W/m^2)	Standard	SR response	Hour of day	Standard	SR response	% Diff	% Diff	w/in 10%
Desiccant	Color/Clear	Color/	Day1/					
Zero			Day2/					PASS/FAIL

BP (mb)	Hour of day	Standard	BP response	difference	difference w/in 10mb
single point					

Rain (ml) mfg.	Volume (ml)	Gauge resp	difference from Volume	%D	w/in 10% D
					PASS/FAIL
If outside T < 4.5°C (40°F), is heater functioning?					YES/NO

RH (%)	Hour of day	Standard	RH response	% D	w/in 10% D
single point					PASS/FAIL

DP (°C)	Hour of day	Standard	DP response	difference	w/in +/- 1.5°C
single point		+/- 0.3%			PASS/FAIL

LV (VAC)	Time of day	Standard	LV reading	difference	w/in +/- 5 VAC
single point					PASS/FAIL

Comments:

Data Review			Cal Date		Previous Cal	
Date/time	Date/time	Correction	Null Code	Parameter & Comments		

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Figure 14.9B
Semi-Annual Meteorological Parameter Calibration Sheet
(Page 2)

Weekly Operations Check Sheet
Meteorological Instrumentation

Page _____of

Town/ Site _____ Month/Year _____

Day of Month / Time (EST)	/	/	/	/	/	/	/
Operator							
Ambient Conditions (e.g.: Clear, Cloudy, Rain, Fog, Windy, etc.)							
Review data back to last visit							
Perform Remaining Operational Checks							
Temp Probes	Always ensure Temp probes are not in contact with any surfaces & are clean.						
Inside Temp Location/Clean	/	/	/	/	/	/	/
Outside Temp Location/Clean	/	/	/	/	/	/	/
Solar Radiation D.L./Obs	/	/	/	/	/	/	/
Dome Clean & Clear							
Precipitation D.L.(60-min avg)/Obs	/	/	/	/	/	/	/
Heater ON @ temp < 4.4°C							
Indicate observed wind speed as Calm © Breezy (B), or Windy (W)							
Wind Speed D.L./Obs	/	/	/	/	/	/	/
Cups Operational							
Wind Direction D.L./Obs	/	/	/	/	/	/	/
Vane Operational							
Data Rejection: Enter Reason Under Comments. Start date / EST							
End date / EST							
End Time EST							
COMMENTS → → → → → → → Perform any necessary corrective/preventative maintenance. Clearly document any problem and the corrective action taken in the Comment Section to the right. Also record audits & calibrations performed. Use the Data Rejection section to document probe/sensor failure, freeze-ups, etc.							

Monthly performance checks: compare ambient sensors to tetraCal sensors, all checks are to be done on the same day

Last performance check date			New performance check date		
Solar Radiation Silica Gel % discolored		Precip Gauge Level?	Y N	Precip Funnel Clean?	Y N
tetraCal S.N.	Sensor\System	D.L.	tetraCal	Specification	w/in spec
	Inside Temp			w/in +/- 0.7°C	Y N
tetraCal Cert due date	Outside Temp			w/in +/- 0.7°C	Y N
	Barometric Pressure			w/in +/- 7 mb	Y N

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Figure 14.10
Weekly Operations Check Sheet: Meteorological Instrumentation

Corrective Action Report

Date of Report _____ **Town/Site** _____ **Site Tech**_____

Problem identified from: (circle one)

Daily Report **Daily Check Report**

Performance Audit **Procedure Audit**

Calibration **Operation's Check**

Other _____

Affected Equipment: (circle one)

CO **SO_2** **NO_2** **NO_y** **O_3** **Sulfate**

$PM_{2.5}$ FRM **PM_{10}FRM** **$PM_{2.5}$ BAM** **PM_{10}BAM** **$PM_{2.5}$ FDMS**

Aetholometer **Nepholometer** **BC/UVC** **OCEC** **STN** **Improve**

Ins Temp **Outs Temp** **WS** **WD** **BP** **RH** **Precipitation** **SR**

VOC's **Carbonyls** **Dioxin** **Lead**

Problem:

_____
_____
_____
_____
_____
_____
_____

Date corrective action report given to supervisor _____

Date correction action assigned _____

Date correction action completed _____

Person(s) performing corrective action _____

Type of Corrective Action taken

_____
_____
_____
_____
_____
_____
_____
_____

Figure 14.11
Corrective Action Report

Section 15 Instrument /Equipment Testing, Inspection, and Maintenance

All newly required instrumentation undergoes inspection and acceptance testing prior to it being released to CTDEP's monitoring sites. This should be performed shortly after the purchased instrumentation has been delivered. The QA/QC Group is responsible for this activity.

Instruments are carefully removed inspected for visible damage. Any problems are documented and the manufacturer notified. The manufacture will determine whether the instrument can be repaired or replaced. If the inspection reveals no visual damage, acceptance testing can begin.

The type and length of acceptance testing is determined by the type of instrumentation being analyzed. It is critical that the purchased instrumentation be compared to NIST traceable instrumentation or standards to assure that the manufacturer specifications and acceptance criteria of the Measurement Quality Objectives are achieved. The manufacturer will be notified of any instrumentation failing CTDEP's acceptance test. When an instrument has successfully completed its acceptance test and the results properly documented, it is ready for installation at the monitoring site.

Scheduled maintenance is critical to minimizing data loss due to instrumentation failure. Properly maintaining the instrumentation will also ensure that the life span of that unit is achieved. Maintenance is usually performed according to manufacturer recommendations. All maintenance will be documented on appropriate paperwork. The site technicians are responsible for routine site maintenance and field repair. All other site maintenance and repair will be performed by field or laboratory data equipment technicians.

Audit and QA personnel are responsible for audit and calibration instrumentation maintenance and ensuring that all NIST traceability standards are certified accordingly. This includes sending out instrumentation to the manufacturer for yearly re-certifications. Repairs will be performed by the Network Implementation/ Preventative Measures Group or instrument manufacturer.

It is the responsibility of the Network Implementation/ Preventative Measures Group to ensure that there is an adequate supply of components/spare parts available, in the event of instrumentation malfunction or breakdown.

Many of the instruments used for meteorological monitoring are sensors that require replacements parts. The instruments either work or do not work. As a result, there is minimal preventive maintenance. Weekly observation and monthly comparison checks are performed by the site technicians to ensure that meteorological instrumentation are adhering to the required tasks in the SOP's. All observation/DL and monthly performance checks, calibration, audit, and preventive maintenance is documented on the Weekly Operations Check Sheet for Meteorological Instrumentation.

Section 15.1 Barometric Pressure

Performance Check – Monthly
Calibration – every 6 months
Audit – every 12 months

Section 15.2 **Precipitation**

Comparison Check/ Heater Check – Weekly
Level Check/Funnel Check – Monthly
Calibration – every 6 months
Audit – every 12 months

Section 15.3 **Relative Humidity/DewPoint**

Dust filter cleaning - every 6 months (at time of calibration)
Cleaning should be done without removing the filter from the probe. Gently wipe the filter with a solution of water and mild soap. If this does not remove most of the stains, replace the dust filter.
Calibration – every 6 months
Audit – every 12 months

Section 15.4 **Relative Humidity/DewPoint**

Comparison Check – Weekly
Silica Gel check – Monthly
Inspection and replacement of gel when it turns completely transparent.
Calibration – every 6 months
Audit – every 12 months

Section 15.5 **Inside & Outside Temperature**

Comparison Check/ Location Check/Clean Check – Weekly
Performance Check – Monthly
Calibration – every 6 months
Audit – every 12 months

Section 15.6 **Wind Speed & Wind Direction**

Comparison Check/ Cup and Vane Operational Check – Weekly
Level Check/Funnel Check – Monthly
Calibration – every 6 months
Audit – every 12 months
Bearings/potentiometers replaced when outside action/acceptance MQO's

Acceptance Testing Log for Meteorological Instrumentation

Type of Instrumention	Date Received	Date(s) of Acceptance Testing	Type of Testing	Date of Acceptance	Responsible Party Sign-off

Figure 15.1
Acceptance Testing Log for Meteorological Instrumentation

Section 16 Instrument /Equipment Calibration and Frequency

Calibration is the most critical quality assurance task for ensuring that all meteorological data collected is traceable to the highest standard available. The monitoring organization is then able to assess the data from the calibration to see if all the data and measurement quality objectives are met. Proper and complete documentation of the calibration is essential for maintaining the proper paper trail for data validation.

Although USEPA recommends various frequencies for calibrations based on the type of site it is, CTDEP personnel will perform meteorological calibrations on a semi-annual basis. A meteorological calibration schedule, listing sites with meteorological instrumentation, calibration dates, and calibration due dates, is posted on a bulletin board and is updated as required.

	Meteorological Instrumentation Calibration			
Instrument	**Type**	**Corrective Action Criteria**	**Acceptance Criteria**	**Frequency**
Ambient Temperature	**3 point water bath with NIST traceable thermistor or thermometer**	**± 0.7°C**	**± 1.0°C**	**Semi-Annually**
Relative Humidity	**NIST traceable Hygrometer or RH standard solutions**	**± 7%**	**± 10%**	**Semi-Annually**
Dew Point Temperature	**NIST traceable Hygrometer**	**± 1.0°C**	**± 1.5°C**	**Semi-Annually**
Wind Speed (F460 system)	**NIST traceable synchronous motor or NIST traceable sonic anemometer**	**± 0.25 m/s <+ 5%**	**± 0.25 m/s <+ 5%**	**Semi-Annually**
Wind Speed (Sonic Anemometer)	**NIST traceable sonic anemometer**	**±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s**	**±0.5 m/s ≤ 11.3 m/s ±5% ≥ 11.3. m/s**	**Semi-Annually**
Wind Direction (F460 system)	**NIST traceable test fixture or NIST traceable sonic anemometer**	**± 5° Crossarm alignment ±5°**	**± 10° Crossarm alignment ±5°**	**Semi-Annually**
Wind Direction (Sonic Anemometer)	**NIST traceable sonic anemometer**	**± 7° Crossarm alignment ±5°**	**± 10° Crossarm alignment ±5°**	**Semi-Annually**
Wind Direction (F460 system)	**NIST traceable torque watch**	**Starting Threshold ≤ 0.5 m/s**	**Starting Threshold ≤ 0.5 m/s**	**Semi-Annually**
Wind Direction (Sonic Anemometer)	**NIST traceable torque watch**	**Starting Threshold ≤ 0.5 m/s**	**Starting Threshold ≤ 0.5 m/s**	**Semi-Annually**
Solar Radiation	**NIST traceable pyranometer**	**± 5% of mean observed interval**	**± 5% of mean observed interval**	**Semi-Annually**
Precipitation	**Seperatory funnel and graduated cylinder**	**± 10% of input volume**	**± 10% of input volume**	**Semi-Annually**
Barometric Pressure	**NIST traceable BP sensor**	**± 7 mb**	**± 10 mb**	**Semi-Annually**

Table 16.1
CTDEP Meteorological Instrumentation Calibration Frequency

Section 17 Inspection/Acceptance for Supplies and Consumables

The majority of instrumentation used for meteorological monitoring either works or it doesn't. If meteorological instrument data is suspicious, fails an audit or calibration, it is replaced with another instrument. Supplies mostly consist of spare instrumentation. It is the responsibility of the Network Implementation/ Preventative Measures Group to ensure that there is replacement instrumentation, spare parts, and consumables.

Section 17.1 Barometric Pressure

The transducer works or it doesn't. Replace with a new transducer.

Section 17.2 Precipitation

The rain gauge works or it doesn't. Replace with new/refurbished rain gauge.
Spare parts – Switches, heaters.

Section 17.3 Relative Humidity

The RH sensor works or it doesn't. Replace with a new RH sensor.

Section 17.4 Solar Radiation

The pyranometer works or it doesn't. Replace with new pyranometer.
Consumables - Silica gel packets to replace "spent" silica gel.

Section 17.5 Temperature

The temperature sensor works or it doesn't. Replace with a new temperature sensor.

Section 17.6 Wind Speed/Wind Direction

F460 wind sensors – Replace with new/refurbished sensor
Spare parts - Bearings, cross arm cups, potentiometers, vanes.
Sonic anemometer - The anemometer works or it doesn't. Replace with a new sonic anemometer.

Section 18 Non-direct Measurements

All data monitored, validated and reported as indicated under the Meteorological QAPP, is obtained directly within this project. However, on a case by case basis, some external data may be obtained and utilized to assist in the validation process to corroborated specific values.

During validation of meteorological data, outlying values are specifically investigated by:

1. Checking compliance with operational checks, calibrations and audits.
2. Checking finer resolution data for physical plausibility.

Although other internal data is most often used for comparison in temporal or spatial analyses, occasionally data from outside the CTDEP network are used. Information and data from used for validation from outside sources include the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) and National Climate Data Center (NCDC). Both meteorological data measurements and satellite imagery may be used.

Section 19 Data Management

For meteorological monitoring, minute and hour average concentrations are computed and stored on the data logger PCs at each site. The data is managed on the PCs using Envitech's Enview for Windows (Enview FW) or Enview Ultimate (Ultimate) software. Further details are described in part .8 (data) of CTDEP's Meteorological Monitoring SOP.

At hourly intervals, the Central Polling Server (CPS) at CTDEP's Air Lab downloads minute and hour data from the site data loggers by DSL/AirCard/T1. Data files are uploaded to an SQL Server from which the QA Group accesses the data using their workstation PCs (QA PCs) for data validation. Validation consists of checking data completeness, calibration and quality control field data sheets, data and status flags automatically generated by the data logger. Gaps in hourly data will be filled (fill-ins) using raw minute-average data, if available, obtained from the site PCs.

On a quarterly basis, after completion of validation, which includes data correction, the Data Group performs data verification, which includes a review of the initial QA validation, as well as statistical reviews to identify outliers, data gaps and anomalous data. Minute time base data obtained from the site PCs or Central Polling Server may be used to investigate suspect hourly data periods or to recalculate valid hourly averages. The validated data is then exported from the DR DAS Reporter program as text files in "Re-engineered AIRS" format (i.e. one line per record, "pipe"-delimited format).

After completion of data verification, data group personnel perform the quarterly precision and accuracy (P&A) evaluation. Precision (calibration) and accuracy (audit) data is entered into a MS Access database, which generates precision and accuracy reports with statistical summaries. Precision checks or accuracy audits that do not conform to the limits specified in the MQO tables, found in Section 7, are referred to QA groups for secondary review. As a result of this review, potential systematic issues may be identified and addressed by Field Operations. At this time, meteorological P&A data is not reported to EPA, but such reporting may be required in the future for NCORE or SLAMS sites.

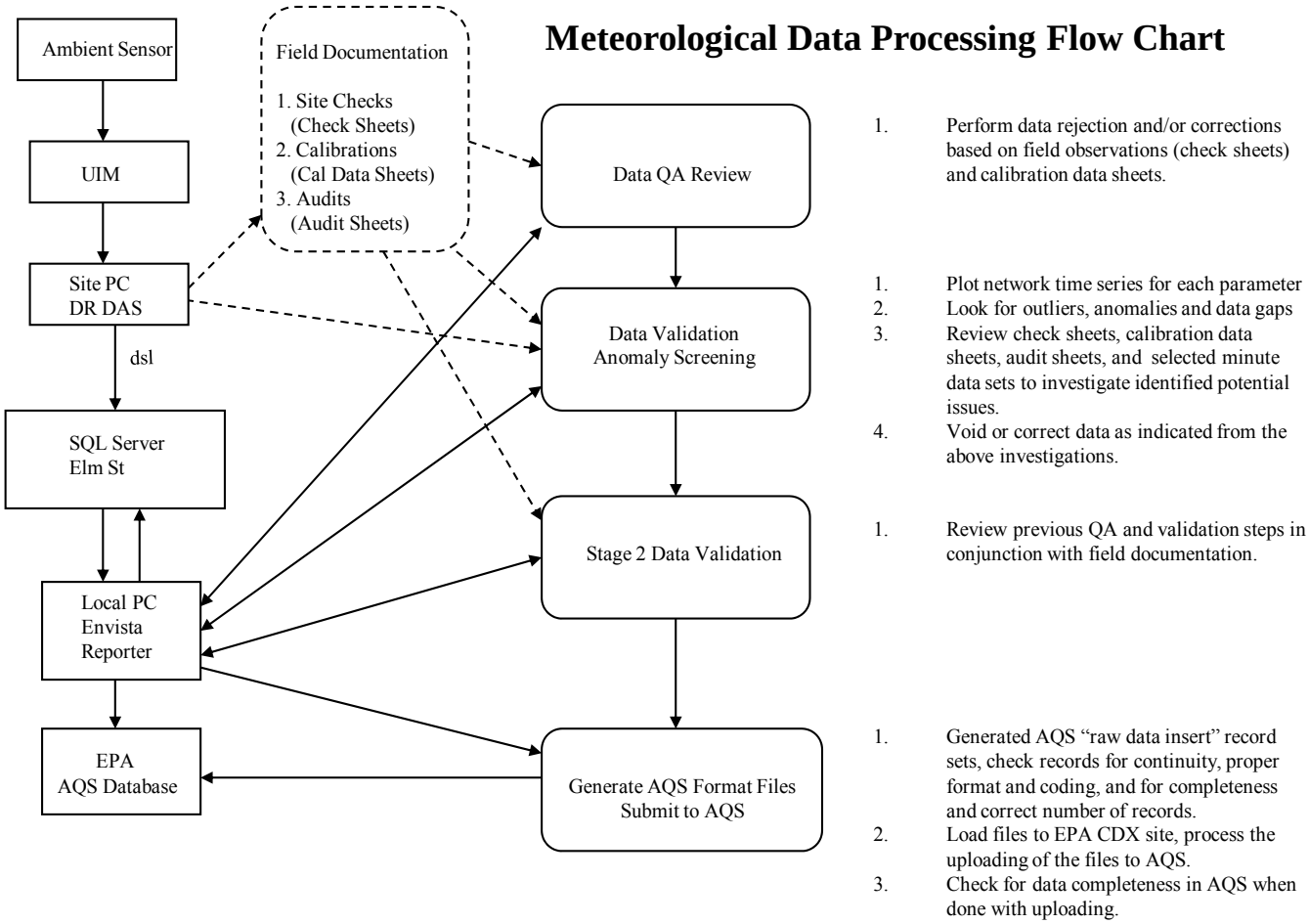

Figure 19.1
Meteorological Data Processing Flow Chart

Section 20 Assessment and Response Actions

An assessment is defined as an evaluation process used to measure the performance or effectiveness of the quality system and various measurement phases of the data operation. The results of assessments indicate whether the Quality Control efforts are adequate or need to be improved. Documentation of all Quality Assurance and Quality Control efforts implemented during the data collection, analysis, and reporting phases are important to data users and decision makers, who can then consider the impact of these control efforts on the data quality.

Data assessment occurs on several levels from initial field and site conditions and instrumentation operational parameters, to final QA review of the entire data set. SOP's have been developed to ensure that meteorological instrumentation are operated, calibrated, audited, and maintained properly. Weekly observation checks, bi-yearly calibrations and yearly audits are performed and verified to assess data accuracy. Daily Reports are electronically sent every morning to designated CTDEP personnel identifying problems or concerns at air and meteorological monitoring sites. CTDEP personnel are then sent to that site to investigate, troubleshoot, repair, or replace instrumentation. Proper documentation is entered on appropriate paperwork to facilitate the data validation process.

CTDEP undertakes an annual network review in conjunction with EPA Region 1. The annual network review report takes into consideration the State of Connecticut's air monitoring and meteorological network and proposed changes. The proposed changes may be directed by EPA's Regional Office for SLAMS, EPA's National Office for NAMS, or by the State for other monitoring sites. Changes may relate to, but not be limited to funding resources, upcoming regulations, changes in agency needs or progress toward attainment.

All of the above assessments occur as scheduled in the various parts of the SOPs they relate to. Additionally, assessments may occur more frequently as required by unusual results, malfunctions, failed remote communications, etc.

Section 21 Reports to Management

Detailed written and electronic records are maintained to assist in data validation and assessment.

Site operators maintain field records and report any significant events to their immediate supervisor. Supervisors provide reports to Management through regularly scheduled staff meetings involving the various Groups within Air Management.

Data that appears suspect undergoes additional quality assurance checks. Generally when results are questioned, particularly through audits, the data undergoes a full review as indicated or required. The results of the review are reported to the QA/Data and Field Operations supervisors. Corrective action, if needed, is undertaken through corrective action reports completed by QA/Data or Operations personnel, and filed with the supervisor in charge of the aspect requiring action (i.e.: Operations for an equipment or technician issue, QA/Data for a calibration issue). Corrective actions will be taken in a timely fashion to prevent or minimize data loss.

Section 21.1 Frequency, Content and Distribution

The field data sheets provide records of field preventive maintenance, performance checks, installation and removal dates and/or times and any comments or observations by the technician servicing the site. In addition, electronic logbook entries denoting site checks and any related issues affecting data or operations serve as back-up to the weekly field data check sheets. Calibration and audit field reports are submitted for internal review, and any issues are brought to the attention of the Data and/or Operations supervisor(s) through corrective action forms.

Section 21.2 Quarterly Data Reports

Quarterly ambient meteorological data reports are to be submitted to the EPA Region 1 Air Program Chief within 90-days of the end of each reporting period. The details for preparing this report can be found in part .8 (data) of CTDEP's meteorological data SOPs.

Section 21.3 Precision and Accuracy Report

A Data Quality Assessment Report or Precision and Accuracy Report (P&A report) is prepared and reviewed each calendar before that quarter's data is reported to EPA. The P&A report is filed electronically to the EPA using AQS. The details for preparing this report can be found in part .8 (data) of CTDEP's various SOPs.

Section 21.4 Annual Data Certification

By May 1st of each year, all state air monitoring programs operating under the Clean Air Act are required to submit a data certification package to EPA for the previous calendar year. The certification covers all criteria pollutants, as well as data collected for the Photochemical Assessment Monitoring Stations (PAMS) and Speciation Trends Network (STN) programs. Currently, certification of meteorological data is optional, and CTDEP does not include such data in the certification statement. However, if at some time in the future, CTDEP is required to chooses to certify all or some meteorological data, the detailed requirements will be provided by EPA in guidance documents that are available prior to the submission deadline. Prior to the Bureau Chief's signing of the certification statement, Data and QA personnel will complete a thorough review of the data for completeness and compliance with the MQOs.

Section 21.5 Technical Systems Audits

CTDEP's audit personnel perform Technical Systems Audits (TSAs). TSAs performed by CTDEP to evaluate field technicians and results are provided to the field technician and reported to the field technician's supervisor. Auditing details can be found in part **.**7 (audits) of CTDEP's various SOPs.

Region 1 conducts TSAs every three years for its member states. This is a thorough investigation of a state's air monitoring efforts.

Section 21.6 Response/Corrective Actions

Records of QA activity for this program provide valuable documentation of response and corrective action taken to assure the quality of the data reported. Parts **.**3 (calibration) and **.**7 (audits) of CTDEP's various SOPs provide these details.

Section 21.7 Responsible Organizations

Data reports, as described above, are to be submitted to the EPA Region 1 Air Program Chief. This responsibility lies within CTDEP's Data Group. Section 4 (page 5) of this QAPP is more detailed in this aspect.

Section 22 Data Review, Verification and Validation

Meteorological data is reviewed at several levels before uploading to EPA's AQS database. Automated data transfer (polling) from the remote site PC's to the Central Polling Server (CPS) is accomplished hourly. The data logging and database storage are performed using Envitech's Enview and Envista software applications in combination with DR DAS applications. The data on the CPS is maintained by the Envista SQL server database application. From the data base maintained on the SQL, validation of data is performed through Envista ARM interfaces on remote PCs in the local network.

Using Envista ARM, hourly meteorological data "Edit Tables" are generated for user-defined sites, monitored parameters and time periods. The "Status" field of the data is utilized to enter status codes as appropriate that are associated with AQS null data codes for reporting to EPA. Data that cannot be corrected or verified is null coded as missing or invalid. Forms and procedures used for data review, verification and validation can be found in the various parts of the CTDEP Meteorological Monitoring SOPs. The calibration, operation, audits and data parts (Parts **.**3, **.**4, **.**7 and **.**8, respectively) of the SOPs provide the details of this comprehensive review and validation process.

Section 23 Verification and Validation Methods

After data verification, meteorological data undergoes evaluation compliance with measurement quality objectives (MQO) criteria. The MQOs are classified as corrective action criteria and acceptance criteria. Meteorological data from daily reports, audits, calibrations, and operation checks are reviewed to determine if these criteria are being met. Corrective action violations will allow CTDEP to perform corrective action before there is any violation of the acceptance criteria. Data that does not meet acceptance criteria specified in the MQO tables will result in the invalidation of data when Data Group personnel conclude that the underlying cause of the violation likely has significant data quality impact. In the validation phase, the Data Group reviews the previous steps as well as performing additional checks for spatial or temporal anomalies using statistical and graphical techniques. Any suspect data identified during these steps is further investigated, as is done for violations of MQO criteria, by a thorough review of related field operation's documentation, calibrations, audits, electronic memos, and high-resolution data records.

When validation is complete, AQS formatted files are generated using the DR DAS Reporter software application. Generally, separate text files are created for each parameter for the entire network and calendar quarter. Final data checks include confirming the total number of records is correct, and that the data was correctly coded. This is done by checking the parameter, method and units codes, the order of magnitude of the data sets, and a few specific values in each file. Details of the QA and Data Groups evaluation and validation procedures can be found in part .8 of the Meteorological Monitoring SOP.

Section 24 Reconciliation with User Requirements

The goal of CTDEP's air and meteorological monitoring programs is to provide the highest quality of data possible to the public, air quality modelers, USEPA, and other miscellaneous users. This is accomplished by establishing and following DQO's and MQO's pertinent to the specific type of monitoring being performed, detailed SOP's, staff training, and dedication of CTDEP's air monitoring personnel. Data are reviewed in a timely manner in order to identify problems and keep data loss to a minimum. All these factors result in data that is complete, precise, accurate, representative of the time and location sampled, comparable to other data sets, and defensible in a court of law.

Section 24.1 Data Comparison with MQO's

On a calendar quarter basis, and prior to submission to AQS, meteorological data will be compared to the MQOs listed in Tables 7.1, 7.2 and 7.3 of Section 7. Data for a given parameter meeting the critical criteria of the MQOs for that parameter will be deemed valid.

The Supervisors of the Field Operations / Data Groups will receive quarterly reports detailing the status of each site's data with respect to MQOs. The Systematic Issues, Table 7-3 (page 16), has criteria that indicate potentially systematic problems with the environmental data collection activity. Such systematic problems may affect the ability to make decisions with the data. The Data Group tracks each site's performance from quarter to quarter to detect quality-related trends and identify any issues to the Field Operations Sections. The supervisors in charge of the Data and Field Operations Groups will be notified immediately of the failure of any site to meet its MQOs. Any site failing to meet its MQOs will receive immediate attention either to correct infrastructure or equipment malfunctions or to retrain the site operator.

Corrective activities and actions will be documented in memo form to the appropriate Field Operations and Data Group personnel up to the level of Manager.

The quarterly review of site performance is included in the precision and accuracy quarterly review. The equation for percent difference of a one-point precision check or accuracy audit is:

$$d_i = \frac{Y_i - X_i}{X_i} \times 100$$

where:

d_i = one-point accuracy or precision check percent difference

Y_i = indicated test value

X_i = actual test value for the accuracy measurement (within +/- 20%) or the previous test value for the precision measurement (within +/- 15%)

Section 24.1 Data Comparison with MQO's

Completeness is calculated by:

$$C = \frac{N_v}{N_t} \times 100$$

where:

C = Completeness of Data (greater than 75%)

N_v = total valid data points

N_t = total data points

Section 25 References

All Weather Inc. Tipping Bucket Rain Gauge Models 6011-A /6011-B User's Manual

Climatronics F460 Wind Sensors Specification Sheet

Kipp & Zonen Instructional Manual CMA/CMP Series Pyranometer Instruction Manual

Met One Instruments Model 370C/372C 8" Rain Gauge Operation Manual

Met One Instruments Model 50.5 Sonic Anemometer Operation Manual

Rotronic MP 601A Humidity Probe Instruction Manual

Rotronic Humidity Standards Specification Sheet

Setra Model 276 Barometric Sensor Transducer Specification Sheet

USEPA Quality Assurance Handbook for Air Pollution Measurement Systems
Volume IV: Meteorological Measurements Version 2.0 (Final)
Date: 01/20/2008

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