Standard Operating Procedures for the CASTNET Audit Program

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° C	degrees Celsius
A/D	analog to digital converter
ARS	Air Resource Specialist, Inc.
ASTM	American Society for Testing and Materials
CASTNET	Clean Air Status and Trends Network
cm	centimeter
DAS	data acquisition system
DC	direct current
DVM	digital voltmeter
EEMS	Environmental, Engineering & Measurement Services, Inc.
EPA	U.S. Environmental Protection Agency
ESC	Environmental Systems Corporation
FSAD	Field Site Audit Database
gm	gram
GPS	global positioning system
Hg	mercury

LPM	liters per minute
MFC	mass flow controller
ml	milliliter
mm	milimeter
mps	meters per second
mv	milivolt
N/A	not applicable
NIST	National Institute of Standards and Technology
NOAA	National Oceanic and Atmospheric Administration
NPS	National Park Service
OSHA	Occupational Safety and Health Administration
ppb	parts per billion
ppm	parts per million
QA/QC	Quality Assurance/Quality Control
QAPP	Quality Assurance Project Plan
RPM	revolutions per minute
RTD	resistance temperature device
SOP	standard operating procedure
STP	standard temperature and pressure
TEI	Thermo Environmental Instruments
USGS	U.S. Geological Survey
USNO	United States Naval Observatory
UTM	Universal Transverse Mercator
V	volts
WRR	World Radiation Reference

1.0 SOP for Audits of Field Site Performances

1.1 Objectives

This Standard Operating Procedure (SOP) describes an overview of the procedures for conducting performance audits of Environmental Protection Agency (EPA) and National Park Service (NPS) designated Clean Air Status and Trends Network (CASTNET) ambient air quality monitoring stations. The contractors responsible for operating the stations are MACTEC E&C for EPA sites and Air Resource Specialist, Inc. (ARS) for NPS sites. More specific instructions are provided in separate SOPs for each measurement system usually found at a CASTNET station. Those systems include meteorological sensors, ambient gas analyzers, data acquisition systems (DAS), and ambient air-sample flow rate regulation systems. The individual SOPs are referenced in section 1.3 Instruments and Materials of this SOP.

The purpose of a performance audit is to assess the measurement process under normal operating conditions, "as found", without any special preparation or adjustment of the system. Performance audit results are used to ensure the measurement process and data collection systems are operating within the project acceptance criteria as defined in the Quality Assurance Project Plan (QAPP). Proper implementation of an auditing program will ensure data integrity and assess data accuracy.

Performance audits include:

- Verifying that the sensors, analyzers, associated systems, and DAS are capable of making valid and accurate measurements.
- Challenging each sensor or analyzer with an independent audit standard (traceable to National Institute of Standards and Technology (NIST) or other authoritative standards) to determine if the instrument is operating within defined project accuracy goals provide in the QAPP.
- Verifying that the measurement made by the sensor or analyzer is accurately collected, stored, and reported by the DAS.
- Documenting audit results using the appropriate form(s) and database.
- Distributing audit results to designated project personnel.

The CASTNET ambient air quality stations will be audited at least once every two years and can be audited at any time of the year. Performance audits are normally required just after the initiation of a monitoring station and following any major repair or change of monitoring equipment type.

1.2 Responsibilities

1.2.1 Project Manager

The project manager shall:

- Coordinate with the auditor regarding audit schedules, audit procedures, audit standards and constants, and required supplies.
- Review all audit results.
- Distribute the audit results to designated personnel in a timely fashion.
- Review and approve any changes to the audit procedures.

1.2.2 Auditor

The auditor shall:

- Coordinate with the project manager regarding audit schedules, audit procedures, accuracy goals, required materials, and audit standards.
- Perform all required audits in accordance with approved audit protocols as described in the specific SOP.
- Maintain all audit standards.
- Obtain the assistance of the site operator as needed during audits.
- Document the audit results using the appropriate form(s) and database.
- Prepare and forward audit reports to the project manager(s).

At least one month prior to conducting a site audit, the EPA and NPS project managers, the Quality Assurance (QA) contact of the contractor responsible for operating the station (MACTEC E&C or ARS), and the station operator will be contacted. A schedule and brief agenda of anticipated activities for the audit visit will be provided at that time. The station operator will be contacted again at least one week prior to the audit to confirm that the schedule has not changed and that the operator will be present as required.

Upon completion of the station audit, the auditor will conduct an exit interview with the station operator and discuss all important aspects of the audit results and findings. Emphasis will be given to findings that can or do impact data accuracy or quality. A schedule of the corrective actions required to address any deficiencies or failures will be developed with the site operator at this time. A printed hard-copy of the audit spot report will be given to the station operator to file with the station records.

1.2.3 Site Operator

The site operator shall be available to assist the auditor during audits, and to demonstrate his/her knowledge and ability to perform the required site operational activities to ensure data integrity.

1.3 Instruments and Materials

The individual SOPs listed here are required for conducting performance audits at EPA and NPS designated CASTNET monitoring stations. They are intended to be used by qualified technicians that understand general instrument operation and audit techniques. The following SOPs provide technical guidance and detailed information regarding specific CASTNET auditing procedures:

- SOP-02058-1101 – ***Audit Procedures, Ozone Analyzer, TEI 49 (CASTNET Installations).***
- SOP-02058-1200 – ***Audit Procedures, Meteorological Sensors (CASTNET Installations).***
- SOP-02058-1300 – ***Audit Procedures, Data Acquisition Systems, (CASTNET Installations).***
- SOP-02058-1400 – ***Audit Procedures, Mass Flow Controlled- Dry Deposition Sample (CASTNET Installations).***
- SOP-02058-1500 – ***Audit Procedures, Field Systems (CASTNET Installations).***

In addition to the specific instruments and equipment listed in the individual SOPs, the following materials are required to audit CASTNET ambient air quality monitoring stations.

- CASTNET QAPP.
- Station Log.
- Laptop computer with approved Field Site Audit Database (FSAD) and audit data forms (forms provided with parameter specific SOP).
- Global Positioning System (GPS).
- Miscellaneous supplies.
- Manufacturer's instruction manuals.

1.4 Methods

All challenge results will be acquired and recorded from all on-site data logging device(s). The results obtained from the primary DAS at each site will be used to verify the instrument or sensor accuracy. Prior to performing any instrument or system test, the recording channel(s) of the DAS(s) will be flagged to indicate the parameter is being tested and not recording actual data. Following the audit tests and after sufficient time for the measurement system(s) to equilibrate to ambient conditions, the parameter channel(s) will be enabled for routine data recording. Overviews of the specific methods for auditing ambient air quality parameters and systems are provided in the following sections. Detailed technical guidance and instructions are provided in the individual SOPs and referenced materials.

1.4.1 Acceptance Criteria

Meteorological measurement systems are audited in accordance with the EPA's ***Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV - Meteorological Measurements.*** Ambient gas analyzers and flow rate regulation systems are audited in accordance with the EPA's ***Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II - Ambient Air Specific Methods.***

EEMS uses NIST or American Society for Testing and Materials (ASTM) traceable test equipment for flow rate and all meteorological parameters except solar radiation. Solar radiation transfer standards are traceable to the World Radiation Reference (WRR) standard. Gas analyzer audit standards are traceable to EPA primary photometers.

Accuracy goals for all parameters are obtained from the project-specific QAPP. Specific acceptance criteria for the type of system being audited is provided in the individual SOP as listed in section 1.3 Instruments and Materials for that parameter or system.

1.4.2 Auditing Specific Parameters

Although the parameters measured at all CASTNET stations are the same, the sensors, instruments, and systems used to measure each parameter are supplied by different manufacturers. For example, to measure ozone the EPA sponsored sites utilize a Thermo Environmental Instruments (TEI) ozone analyzer while the NPS sites may employ a Dasibi, API, Forney Corporation, Monitor Labs, or TEI. Mass Flow Controllers (MFC) supplied by either Tylan or Teledyne Hastings are used at all sites. Meteorological instruments manufactured by Climatronics or R. M. Young are operated at all sites. Despite the fact that the systems used may be different, all of the sensors and instruments should be capable of making accurate measurements within the acceptable limits provided in the QAPP.

The following general procedures are used to audit each parameter regardless of the system manufacturer. Some of the audit tools used and information recorded will be different depending on the manufacturer. In the case of wind direction a calibration disc supplied by R. M. Young is used to audit the R. M. Young model AQ wind sensors while an alignment tool developed by EEMS is used to audit the Climatronics F460 wind direction sensors. The variable speed motors used to audit wind speed are the same, but the speeds used for each type of sensor are different. This is due to the fact that the wind speed output is different for the same shaft revolution. Depending on the wind speed translator used, the audit response will be measured in frequency or volts. All of the Climatronics translators housed in the F460 meteorological rack contain internal zero/span test switches to test the circuitry, where as the R. M. Young systems do not.

Specific instructions are provided where needed in the individual parameter SOP listed in section 1.3 Instruments and Materials. Audit forms used for each parameter are also provided in the individual parameter SOP.

Ambient Pollutant Gas Analyzers (ozone)

A transfer standard photometer and independent zero-air supply, or an in-station calibrator is used to audit the station analyzers. Ozone free air and at least three (3) upscale ozone concentrations in the ranges of 0.03 – 0.08, 0.15 – 0.20, and 0.36 – 0.45 ppm are compared. The audit reference gas is introduced at the particulate filter on the sample tower and observed through the entire site sample train.

Meteorological Sensors –Wind Speed

Dynamic tests of the horizontal wind speed sensors are performed using a variable wind speed motor calibrator. Each sensor is challenged at zero plus at least five (5) shaft revolution speeds with the highest speed above 90% of the sensor range. A bearing integrity check is also performed using a torque wheel to check the starting threshold of the sensors.

Meteorological Sensors –Wind Direction

A certified compass and transiting telescope is used to ensure proper alignment of the wind direction sensor with respect to true north. Sensor accuracy and linearity are then verified with distant points and/or sensor orientation fixtures. Bearing integrity is also tested with a torque gauge.

Meteorological Sensors –Temperature System

Each temperature sensor is audited by immersion in at lest three (3) uniform temperature baths and comparing the sensor output with a certified standard. The temperatures tested will include near 0° C, ambient (approximately 20° C), and as near as possible to the full scale of the site system. If the station operates a temperature difference (ΔT) system, it is assessed by simultaneously immersing both sensors in each of the three baths and noting the measured temperature difference between sensors. The associated sensor mounts and blowers are also assessed for proper operation.

Meteorological Sensors –Relative Humidity

Relative humidity (RH) sensors are audited by comparing to a NIST traceable audit sensor and/or standard salt solutions in a humidity chamber at three or more humidity levels. One standard must be greater than 90% RH, and one standard must be lower than 35% RH. The associated mounts, filters, and blowers (if equipped) are assessed as well.

Meteorological Sensors –Solar Radiation

Solar radiation sensors are audited by installing and operating a clean and level certified reference sensor adjacent to the station sensor. Data are collected from both sensors during the entire station audit visit for comparison. Ideally a complete diurnal cycle of global solar radiation would be used for comparison, but project specific requirements dictate that the maximum value is of most interest. At least three one-hour data collection periods must be collected for comparison.

Meteorological Sensors –Precipitation

Tipping bucket precipitation gauges are audited using a metered volumetric separatory funnel to deliver a known amount of water through the gauge orifice at a rate equivalent to approximately 2 inches of precipitation per hour. Tip counts of the DAS(s) are verified and compared to the actual introduced volumes. Gauge heaters, screens, and levels are checked if the tipping buckets are so equipped.

Meteorological Sensors –Surface Wetness

Wetness sensors are challenged in both the "wet" and "dry" states using a small amount of distilled water or damp cloth. A standard resistance is installed across the sensor grid to measure the sensitivity of the sensor. Audit results are reported as wet at XX ohms and dry at YY ohms, and can be used to assess network consistency.

Data Acquisition Systems (DAS)

Various programmable settings of the station DAS(s) are checked including time, date, and averaging interval. The configuration of the DAS is verified to be correct with respect to each type of input parameter (i.e. 360° and 540° wind direction). The accuracy of the DAS(s) (and strip chart recorder if applicable) analog to digital (A/D) converter(s) is challenged by connecting a certified voltage source and a certified reference digital voltmeter (DVM) between an input channel from 1 – 8, and an input channel from 9 – 16 and system ground. Voltages are applied between 0.000 and DAS channel full scale in at least six increments.

Mass Flow Controllers

CASTNET Dry Deposition Filter and sampling integrity must be maintained using the sample handling protocol established in the QAPP. The general steps are to remove the filter pack sample from the sample train and install a primary flow audit device in its place. Then, operate the vacuum pump and record the flow readings observed on the audit flow device, station mass flow controller display, and the recorded dry deposition flow rate on the DAS. The sample train is also checked for leakage by sealing the sample inlet at the audit device and verifying that the flow rate readings are negligible for both

the audit device and the system mass flow controller. The system is also checked for blockages or other problems.

1.4.3 Recording Audit Results

Audit results are written on hard copy forms, documented in the station log, and input into the electronic (FSAD).

1.4.4 Reporting Audit Results

On the same day of completion of a performance audit, a written "spot" report will be e-mailed to the designated project personnel. The site operator will also receive a "spot" report during the exit interview described in section 1.2.2 above.

Final, fully documented written performance audit reports will be delivered with the Quarterly Reports within 15 days of the end of each calendar quarter.

1.4.5 Distributing Audit Results

Performance audit reports will be distributed to the project personnel specified in the individual station or network QAPP, or in specific contract documentation.

2.0 SOP for Audits of Ozone Analyzers

2.1 Objectives

This SOP describes the procedures for conducting performance audits of ozone analyzers at EPA and NPS designated CASTNET ambient air quality monitoring stations. The contractors responsible for operating the stations are MACTEC E&C for EPA sites and ARS for NPS sites.

The purpose of a performance audit is to assess the measurement process under normal operating conditions, "as found", without any special preparation or adjustment of the system. Performance audit results are used to ensure the measurement process and data collection systems are operating within the project acceptance criteria as defined in the QAPP. Proper implementation of an auditing program will ensure data integrity and assess data accuracy.
Ozone analyzer performance audits include:

- Verifying that the analyzers, associated systems, and Data Acquisition System (DAS) are capable of making valid and accurate measurements.
- Challenging each analyzer with an independent audit standard traceable to NIST to determine if the instrument is operating within defined project accuracy goals provide in the QAPP.
- Verifying that the measurements made by the analyzer are accurately collected, stored, and reported by the DAS.
- Documenting audit results using the appropriate form(s) and database.
- Distributing audit results to designated project personnel.

The ozone analyzers at CASTNET ambient air quality stations will be audited at least once every two years and can be audited at any time of the year. Performance audits are normally required just after the initiation of a monitoring station and following any major repair or change of monitoring equipment type.

2.2 Responsibilities

2.2.1 Project Manager

The project manager shall:

- Coordinate with the auditor regarding audit schedules, audit procedures, audit standards and constants, and required supplies.
- Review all audit results.
- Distribute the audit results to designated personnel in a timely fashion.
- Review and approve any changes to the audit procedures.

2.2.2 Auditor

The auditor shall:

- Coordinate with the project manager regarding audit schedules, audit procedures, accuracy goals, required materials, and audit standards.
- Perform all required audits in accordance with approved audit protocols as described in the specific SOP.
- Maintain all audit standards.
- Obtain the assistance of the site operator as needed during audits.
- Document the audit results using the appropriate form(s) and database.
- Prepare and forward audit reports to the project manager(s).

At least one month prior to conducting a site audit, the EPA and NPS project managers, the Quality Assurance (QA) contact of the contractor responsible for operating the station (MACTEC E&C or ARS), and the station operator will be contacted. A schedule and brief agenda of anticipated activities for the audit visit will be provided at that time. The station operator will be contacted again at least one week prior to the audit to confirm that the schedule has not changed and that the operator will be present as required.

Upon completion of the station audit, the auditor will conduct an exit interview with the station operator and discuss all important aspects of the audit results and findings. Emphasis will be given to findings that can or do impact data accuracy or quality. A schedule of the corrective actions required to address any deficiencies or failures will be developed with the site operator at this time. A printed hard-copy of the audit spot report will be given to the station operator to file with the station records.

2.2.3 Site Operator

The site operator shall be available to assist the auditor during audits, and to demonstrate his/her knowledge and ability to perform the required site operational activities to ensure data integrity. These activities include the interpretation and documentation of the internal ozone zero, span, and precision test results.

2.3 Instruments and Materials

Together with this SOP, the following instruments and materials are required for conducting performance audits of ozone analyzers at EPA and NPS designated CASTNET monitoring stations. They are intended to be used by qualified technicians that understand general instrument operation and audit techniques:

- SOP-02058-1000 – ***Field Site Performance Audits (CASTNET Installations)***.
- SOP-02058-1500 – ***Audit Procedures, Field Systems (CASTNET Installations)***.
- CASTNET QAPP.
- Station Log.
- Laptop computer with approved FSAD and audit data forms (F-02058-1100-O3-rev001).
- Miscellaneous supplies and tools.
- Manufacturer's instruction manuals.

2.4 Methods

All challenge results will be acquired and recorded from all on-site data logging device(s). The results obtained from the primary DAS at each site will be used to verify the instrument or sensor accuracy. Prior to performing any instrument or system test, the recording channel(s) of the DAS(s) will be flagged to indicate the parameter is being tested and not recording actual data. Following the audit tests and after sufficient time for the measurement system(s) to equilibrate to ambient conditions, the parameter channel(s) will be enabled for routine data recording.

2.4.1 Acceptance Criteria

Ambient ozone gas analyzers are audited in accordance with the EPA's ***Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II - Ambient Air Specific Methods.*** EEMS uses ozone gas transfer standard photometers which are traceable to EPA primary photometers for field audits. EPA primary photometers are NIST certified.

Accuracy goals for ozone gas concentration measurements are obtained from the project-specific QAPP and are listed in **Table 1. Audit Acceptance Criteria for Ozone Analyzers**.

Table 1. Audit Acceptance Criteria for Ozone Analyzers

Parameter	Audit Challenge	Warning Criteria	Acceptance Criteria

% difference from actual ozone concentration	Multi-point test gas concentration	≥ 5 % and < 10 % or ≤ -5 % and > -10 %	< 10% and > -10%
Slope	Linear regression of multi-point test gas concentration	≥ 1.0500 and < 1.1000 or ≤ 0.9500 and > 0.9000	0.9000 < m < 1.1000
Intercept		≥ 3.0 ppb and < 5.0 ppb or ≤ -3.0 ppb and > -5.0 ppb	-5.0 ppb < b < 5.0 ppb
Correlation Coefficient		≤ 0.9970 and > 0.9950	> 0.9950

Note:

m = slope
b = intercept
ppb = parts per billion

2.4.2 Auditing Specific Parameters

The EPA sponsored CASTNET sites utilize a TEI model #49-103 ozone analyzer to measure ozone. The NPS sites may employ a Dasibi, API, Forney Corporation, Monitor Labs, or TEI to measure ozone. Although the systems used to measure ozone are supplied by different manufacturers, all of the instruments should be capable of making accurate measurements within the acceptable limits provided in the QAPP.

The following procedures are used to audit the ozone parameter regardless of the system manufacturer. Some of the audit tools used and information recorded will be different depending on the manufacturer.

- Turn on the power to the transfer standard photometer and allow it to warm up for a minimum of two hours. If using an independent zero-air supply and the transfer standard to generate ozone concentrations, connect the zero-air supply to the transfer standard with clean tubing.
- Connect the voltage output of the transfer standard analyzer to an unused channel of the DAS and verify that it is scaled correctly.
- Record all the diagnostic information for both the station analyzer and the transfer standard. Refer to the **Ozone Data Form (F-02058-1100-O3-rev001)** included in Appendix A. The diagnostic information may include:
    - Cell temperature
    - Cell pressure
    - Cell noise

- Lamp voltage
- Detector frequency
- Detector intensity
- Lamp temperature
- Sample flow
- Span or calibration coefficient
- Offset or background

- If using the transfer standard to generate the ozone test gas concentrations, connect clean tubing from the transfer standard outlet port to the station sample inlet. This connection should be at the top of the sample tower if possible to allow the test gas to enter through the entire station sample train. Ensure that excess test gas is supplied and vented at the sample inlet.
- If the in-station calibrator is used to generate the ozone test gas concentrations, connect the gas supply to the transfer standard sample inlet using clean tubing. Ensure that excess test gas is supplied and vented.
- Generate ozone free air, and at least three (3) upscale ozone concentrations in the ranges of 0.03 – 0.08, 0.15 – 0.20, and 0.36 – 0.45 ppm.
- Allow sufficient time for the measurements to stabilize, and then record ten readings from the displays of both instruments for each concentration generated. Also record the analyzer response recorded and averaged by the DAS. Use the values recorded by the DAS for the accuracy calculations.
- Return all the analyzer settings and connections to their pre-audit positions.

2.4.3 Recording Audit Results

Audit results are written on hard copy forms, documented in the station log, and input into the electronic FSAD. A copy of the Ozone Data Form (F-02058-1100-O3-rev001) is included in Appendix A.

2.4.4 Reporting Audit Results

On the same day of completion of a performance audit, a written "spot" report will be e-mailed to the designated project personnel. The site operator will also receive a "spot" report during the exit interview described in section 2.2.2 above.

Final, fully documented written performance audit reports will be delivered with the Quarterly Reports within 15 days of the end of each calendar quarter.

2.4.5 Distributing Audit Results

Performance audit reports will be distributed to the project personnel specified in the individual station or network QAPP, or in specific contract documentation.

3.0 SOP for Audits of Meteorological Sensors

3.1 Objectives

This SOP describes the procedures for conducting performance audits of meteorological sensors at EPA and NPS designated CASTNET ambient air quality monitoring stations. The contractors responsible for operating the stations are MACTEC E&C for EPA sites and ARS for NPS sites.

The purpose of a performance audit is to assess the measurement process under normal operating conditions, "as found", without any special preparation or adjustment of the system. Performance audit results are used to ensure the measurement process and data collection systems are operating within the project acceptance criteria as defined in the QAPP. Proper implementation of an auditing program will ensure data integrity and assess the accuracy of the data.

Performance audits include:

- Verifying that each sensor, associated systems, and Data Acquisition Systems (DAS) are capable of making valid and accurate measurements.
- Challenging each sensor with an independent audit standard (traceable to NIST or other authoritative standards) to determine if the instrument is operating within defined project accuracy goals provided in the QAPP.
- Verifying that the measurement made by the sensor is accurately collected, stored, and reported by the DAS.
- Documenting audit results using the appropriate form(s) and database.
- Distributing audit results to designated project personnel.

Meteorological equipment for the CASTNET program will be audited at least once every two years and can be audited at any time of the year. Performance audits are normally required just after the initiation of a monitoring station and following any major repair or change of monitoring equipment type.

3.2 Responsibilities

3.2.1 Project Manager

The project manager shall:

- Coordinate with the auditor regarding audit schedules, audit procedures, audit standards and constants, and required supplies.
- Review all audit results.
- Distribute the audit results to designated personnel in a timely fashion.
- Review and approve any changes to the audit procedures.

3.2.2 Auditor

The auditor shall:

- Coordinate with the project manager regarding audit schedules, audit procedures, accuracy goals, required materials, and audit standards.
- Perform all required audits in accordance with approved audit protocols as described in the specific SOP.
- Maintain all audit standards.
- Obtain the assistance of the site operator as needed during audits.
- Document the audit results using the appropriate form(s) and database.
- Prepare and forward audit reports to the project manager.

At least one month prior to conducting a site audit, the EPA and NPS project managers, the Quality Assurance (QA) contact of the contractor responsible for operating the station (MACTEC E&C or ARS), and the station operator will be contacted. A schedule and brief agenda of anticipated activities for the audit visit will be provided at that time. The station operator will be contacted again at least one week prior to the audit to confirm that the schedule has not changed and that the operator will be present as required.

Upon completion of the station audit, the auditor will conduct an exit interview with the station operator and discuss all important aspects of the audit results and findings. Emphasis will be given to findings that can or do impact data accuracy or quality. A schedule of the corrective actions required to address any deficiencies or failures will be developed with the site operator at this time. A printed hard-copy of the audit spot report will be given to the station operator to file with the station records.

3.2.3 Site Operator

The site operator shall be available to assist the auditor during audits, and to demonstrate his/her knowledge and ability to perform the required site operational activities to ensure data integrity.

3.3 Instruments and Materials

The individual sensor parameters and the audit standards used to verify those parameters are listed in Table 2. Audit Instruments. The following materials are required in addition to the specific instruments listed in Table 2.

- CASTNET QAPP.
- SOP-02058-1300 – ***Audit Procedures, Data Acquisition Systems (CASTNET Installations).***
- SOP-02058-1000 – ***Field Site Performance Audits (CASTNET Installations)***.

- Station Log.
- Laptop computer with approved FSAD and audit data forms (forms provided in Appendix A).
- Global Positioning System (GPS).
- Miscellaneous supplies.
- Manufacturer's instruction manuals.

This SOP and the instruments and materials listed above, are intended to be used by qualified technicians that understand general instrument operation and audit techniques.

Table 2. Audit Instruments

Station		Audit Instrument		
Sensor	**Parameter**	**Manufacturer**	**Model**	**Description**
Precipitation	Accuracy	NALGENE®	Calibrated Ware	250ml graduated cylinder and separatory funnel
Relative Humidity	Accuracy	Rotronics	A1H Hygromer and aqueous salt solutions	Calibrated to ASTM
Solar Radiation	Accuracy	Eppley	PSP	WRR certified sensor
Surface Wetness	Response	Various	N/A	Distilled water mist bottle
Surface Wetness	Sensitivity	Ohmite	Ohm-Ranger	1% accuracy decade resistance
Temperature and Temperature Difference	Accuracy	Eutechnics	4600 Thermometer	NIST certified electronic RTD
Wind Direction	Orientation	Sokkia	PC-2 Surveyors Compass	Magnetic compass used with GPS and DeLorme Topo USA
Wind Direction	Linearity	R.M. Young; EEMS	1812 N/A	Vane angle test fixtures
Wind Direction	Threshold	R.M. Young	18331	Vane torque gauge

Station		Audit Instrument		
Sensor	**Parameter**	**Manufacturer**	**Model**	**Description**
Wind Speed	Accuracy	R.M. Young	18802 and 18831A	Anemometer synchronous drive 20-15,000 RPM
Wind Speed	Threshold	R.M. Young	18310	Propeller/cup torque disc

3.4 Methods

The specific methods for auditing meteorological parameters and systems are detailed in the following sections.

3.4.1 Acceptance Criteria

Meteorological measurement systems are audited in accordance with the EPA's ***Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV - Meteorological Measurements,*** (March 1995).

EEMS uses test equipment traceable to NIST, WRR, or the ASTM standard for all meteorological sensor accuracy audits.

Accuracy goals for all parameters are obtained from the project-specific QAPP. Specific acceptance criteria for each parameter audited is provided in **Table 3. Audit Acceptance Criteria for Meteorological Sensors**.

Table 3. Audit Acceptance Criteria for Meteorological Sensors

Sensor	Parameter	Audit Challenge	Warning Criteria	Acceptance Criteria
Precipitation	Response	10 manual tips	N/A	1 DAS count per tip
Precipitation	Accuracy	2 introductions of known amounts of water	$\geq \pm 3.0\%$ and $\leq \pm 5.0\%$	$\leq \pm 5.0\%$ observed or ±0.05 inches /inch introduced
Relative Humidity	Accuracy	Compared to reference instrument or standard solution	$\geq \pm 3.0\%$ at or above 85.0% RH; $\geq \pm 10.0\%$ below 85.0% RH	$\leq \pm 5.0\%$ at or above 85.0% RH; $\leq \pm 20.0\%$ below 85.0% RH

Solar Radiation	Accuracy	Compared to WRR traceable standard	≥ ±5.0% and ≤ ±10.0%	≤ ±10.0% of daily average; ≤ ±10.0% of highest hourly value
Surface Wetness	Response	Distilled water spray mist	N/A	Positive response
Surface Wetness	Sensitivity	1% decade resistance	285k ohm ≥ response ≥ 185k ohm	N/A
Temperature	Accuracy	Comparison to 3 NIST measured baths (~ 0° C, ambient, ~ full-scale)	≥ ±0.2° C and ≤ ±0.5° C	≤ ± 0.5° C
Temperature Difference	Accuracy	Comparison to station temperature sensor	≥ ±0.20° C and ≤ ±0.50° C	≤ ± 0.50° C
Wind Direction	Orientation Accuracy	Parallel to alignment rod/cross-arm, or sighted to distant point	≥ ±3° and ≤ ±5°	≤ ±5° from degrees true
Wind Direction	Linearity	Eight cardinal points on test fixture	≥ ±3° and ≤ ±5°	≤ ±5° mean absolute error; ±10° per point
Wind Direction	Response Threshold	Starting torque tested with torque gauge	≥ 75% of acceptance criteria	< 8 gm·cm Climatronics; < 10 gm·cm R.M. Young
Wind Speed	Accuracy	Shaft rotational speed generated and measured with certified synchronous motor	≥ ±0.2 mps and ≤ ±0.5 mps at or below 5.0 mps; ≥ ±3.0% and ≤ ±5.0% above 5.0 mps	≤ ±0.5 mps at or below 5.0 mps input; ≤ ±5.0% of input above 5.0 mps
Wind Speed	Starting Threshold	Starting torque tested with torque gauge	≥ 75% of acceptance criteria	≤ 0.2 gm·cm Climatronics; ≤ 0.3 gm·cm R.M. Young

3.4.2 Auditing Specific Parameters

All sensor audits are conducted through the entire measurement system including signal cables, connections, and DAS. Since the audit results are recorded from the station DAS any error in the analog to digital converter (A/D) of the DAS will be accounted for during the sensor audits. However it is good practice to audit the DAS prior to performing any other station audits so any error associated with the DAS will be properly attributed to that system and not to a particular sensor. Refer to SOP-02058-1300 Audit Procedures, Data Acquisition Systems (CASTNET Installations) for specific instructions and technical guidance to perform a DAS audit.

All challenge results will be acquired and recorded from all on-site data logging device(s). The results obtained from the primary DAS at each site will be used to verify the instrument or sensor

accuracy. The combined error of the sensor and the DAS will be reported for all parameters audited.

Prior to beginning an audit of any parameter the DAS(s) must be accessed to flag the recorded parameter as "disabled" or "down". This will prevent the recorded audit data from being included in the reported station data. Parameters audited and the time of the audits will also be recorded in the station log.

After flagging the appropriate parameters on the DAS(s) lower the meteorological tower using the winch installed at the tower location. Observe all safety precautions while lowering the tower to the tower rest provided at the station.

Meteorological Sensors – Precipitation

- The condition of the tipping bucket rain gauge is observed to verify that it is level and clean of any obstruction that might block the orifice or limit the movement of the tipping mechanism.
- Ten (10) manual tips of the mechanism are performed to verify that the DAS responds and records 10 counts (usually recorded as 0.10 inches).
- Water is measured in a clean calibrated graduated cylinder to a volume equivalent to 0.50 inches of precipitation for the specific gauge being audited. The water is transferred to a metered volumetric separatory funnel and delivered (dripped) through the gauge orifice at a rate equivalent to approximately 2 inches of precipitation per hour.
- The accuracy challenge is repeated and the results are reported individually. The average error is also reported.
- Gauge heater, screen, and level are checked if the tipping bucket is so equipped.
- Complete and record all information in the Tipping Bucket section of the Precipitation Data Form (F-02058-1200-PRECP-rev001) included in Appendix A.

Meteorological Sensors – Relative Humidity (RH)

- The humidity sensor is thoroughly inspected prior to the audit to verify reasonable operation. The condition of sensor mounts, dust filters and blowers (if equipped) are also assessed.
- Relative humidity accuracy challenges are conducted by comparing the station sensor to a NIST traceable audit sensor and/or ASTM standard aqueous salt solution in a constant humidity chamber, at three or more humidity levels. One challenge point must be greater than 90% RH and one challenge point must be lower than 35% RH.
- Check and record Climatronics translator zero/span test results.

- Complete and record all information on the Humidity Data Form (F-02058-1200-RH-rev001) included in Appendix A.

Meteorological Sensors – Solar Radiation

- The sensor is inspected to verify that it is clean and level and being properly maintained. The condition is reported.
- Solar radiation sensors are challenged by installing and operating a clean and level certified reference sensor adjacent to the station sensor. Data are collected and logged by the DAS from both sensors during the entire station audit visit for comparison. Ideally a complete diurnal cycle of global solar radiation would be used for comparison but project specific requirements dictate that the maximum value is of most interest. At least three hourly-averaged data periods must be collected for comparison.
- Audit results are reported for both the average of all solar radiation data collected and the highest single hourly average.
- Check and record Climatronics translator zero/span test results.
- Complete and record all information on the Solar Radiation Data Form (F-02058-1200-SR-rev001) included in Appendix A.

Meteorological Sensors – Surface Wetness

- The wetness sensor is inspected and the condition of the sensor grid is reported. The orientation of the grid is verified to be facing true north and inclined approximately 30° from horizontal.
- The wetness sensor is challenged in both the "wet" and "dry" states using a small amount of distilled water or damp cloth. If the sensor is “wet” before the audit, it is dried to verify the “dry” response. The DAS output of both the “wet” and “dry” sensor states are recorded.
- A standard resistance is installed across the sensor grid to measure the sensitivity of the sensor. Audit results are reported as “wet” at XX ohms and “dry” at YY ohms, and can be used to assess network consistency.
- The wetness sensor is restored to ambient operational conditions following the audit.
- Complete and record all information in the Wetness Sensor section of the Precipitation Data Form (F-02058-1200-PRECP-rev001) included in Appendix A.

Meteorological Sensors – Temperature System

- The temperature sensors, shields, and blowers are inspected prior to the audit. Conditions which might affect data accuracy but would not be accounted for during

the sensor challenge are noted. Those conditions include a malfunctioning blower, an unusually dirty shield, or a sensor contacting a shield surface.

- Each temperature sensor is removed from the shield and immersed in at least three (3) uniform temperature baths. The bath temperatures are near freezing (~ 0°C), near ambient (~ 20°C), and near full-scale (~ 50° C). The baths are stirred by a magnetic stirring plate. A NIST traceable sensor is inserted at the same depth as the station sensors and the DAS output is compared to the certified standard. If the station operates a temperature difference (ΔT) system it is challenged by simultaneously immersing both sensors in each of the three baths and noting the measured temperature difference between the station sensors.
- None of the sensors shall touch each other or the bath container during the challenge.
- Check and record Climatronics translator zero/span test results.
- Complete and record all information on the Temperature Data Form (F-02058-1200-T-rev001) included in Appendix A.

Meteorological Sensors – Wind Direction

- The wind direction sensor condition is inspected. Any condition that might affect data accuracy such as bent or damaged vane, non-functional sensor heater, or sensor out of plumb is reported.
- A certified compass and transiting telescope is used to ensure proper alignment of the wind direction sensor with respect to true north. True north is determined by using a GPS to obtain the station latitude, longitude and elevation. This data is then used with the current National Oceanic and Atmospheric Administration (NOAA) database and software to determine the magnetic declination for that location at the time of the audit.
- Sensor accuracy and linearity are then verified with distant points and/or sensor orientation fixtures. At least eight (8) cardinal points separated by 45° are verified and the DAS output recorded.
- Bearing integrity is also verified using a torque gauge.
- Check and record Climatronics translator zero/span/540 test results.
- Complete and record all information on the Wind Direction Data Form (F-02058-1200-WDR-rev001) included in Appendix A.

Meteorological Sensors – Wind Speed

- The wind speed sensor condition is inspected. Any condition which might affect data accuracy, such as non-functional heater, damaged prop/cups, or sensor not plump, is reported.

- Dynamic tests of the horizontal wind speed sensor are performed using a variable wind speed motor calibrator. Each sensor is challenged at zero plus at least four (4) shaft revolution speeds with the highest speed above 90% of the sensor range. The equivalent wind speeds are calculated according to the manufacturer's specifications for the shaft rpm. The sensor output is recorded from the DAS and compared to the equivalent wind speed.
- A bearing integrity check is also performed using a torque wheel to check the starting threshold of the sensor.
- Check and record Climatronics translator zero/span test results.
- Complete and record all information on the Wind Speed Data Form (F-02058-1200-WSP-rev001) included in Appendix A.

After all the meteorological parameters are audited, the tower is raised to its proper operational position and secured with the provided guy wires. The orientation of the wind direction sensor is rechecked after returning the tower to the vertical position to verify that the tower is properly aligned.

When the sensors are in the normal operating position and recording reasonable data for the ambient conditions the parameters are flagged as "online" or "up" by accessing the DAS.

3.4.3 Recording Audit Results

Audit results are written on hard copy forms, documented in the station log, and input into the electronic FSAD. Blank copies of the audit data forms are provided in Appendix A.

3.4.4 Reporting Audit Results

The same day as the conclusion of a performance audit, a written "spot" report will be e-mailed to the designated project personnel. A hard-copy of the "spot" report will be printed and provided to the site operator during the exit interview (refer to SOP-02058-1000 – ***Field Site Performance Audits (CASTNET Installations)***).
Final, fully documented written performance audit reports will be included in Quarterly Reports delivered within 15 days of the end of each calendar quarter.

3.4.5 Distribution Audit Results

Performance audit reports will be distributed to the project personnel specified in the individual station or network QAPP, or in specific contract documentation.

4.0 SOP for Audits of Data Acquisition Systems

4.1 Objectives

This SOP describes the procedures for conducting performance audits of Data Acquisition Systems (DAS) at EPA and NPS designated CASTNET ambient air quality monitoring stations. The contractors responsible for operating the stations are MACTEC E&C for EPA sites and ARS for NPS sites.

The purpose of a performance audit is to assess the measurement process under normal operating conditions, "as found", without any special preparation or adjustment of the system. Performance audit results are used to ensure the measurement process and data collection systems are operating within the project acceptance criteria as defined in the QAPP. Proper implementation of an auditing program will ensure data integrity and assess data accuracy.

DAS performance audits include:

- Verifying that DAS(s) are capable of making valid and accurate measurements.
- Challenging each analog to digital (A/D) converter and multiplexer in the DAS with an independent audit standard (traceable to NIST to determine if the instrument is operating within defined project accuracy goals provide in the QAPP.
- Verifying that the measurement made by the DAS is accurately collected, stored, and reported with any calculations, status flags, and time stamps applied.
- Documenting audit results using the appropriate form(s) and database.
- Distributing audit results to designated project personnel.

The data acquisition systems for CASTNET ambient air quality stations will be audited at least once every two years and can be audited at any time of the year. Performance audits are normally required just after the initiation of a monitoring station and following any major repair or change of monitoring equipment type.

4.2 Responsibilities

4.2.1 Project Manager

The project manager shall:

- Coordinate with the auditor regarding audit schedules, audit procedures, audit standards and constants, and required supplies.
- Review all audit results.
- Distribute the audit results to designated personnel in a timely fashion.

- Review and approve any changes to the audit procedures.

4.2.2 Auditor

The auditor shall:

- Coordinate with the project manager regarding audit schedules, audit procedures, accuracy goals, required materials, and audit standards.
- Perform all required audits in accordance with approved audit protocols as described in the specific SOP.
- Maintain all audit standards.
- Obtain the assistance of the site operator as needed during audits.
- Document the audit results using the appropriate form(s) and database.
- Prepare and forward audit reports to the project manager(s).

At least one month prior to conducting a site audit, the EPA and NPS project managers, the Quality Assurance (QA) contact of the contractor responsible for operating the station (MACTEC E&C or ARS), and the station operator will be contacted. A schedule and brief agenda of anticipated activities for the audit visit will be provided at that time. The station operator will be contacted again at least one week prior to the audit to confirm that the schedule has not changed and that the operator will be present as required.

After completing the audit, the auditor will conduct an exit interview with the station operator and discuss all important aspects of the audit results and findings. Emphasis will be given to findings that can or do impact data accuracy or quality. A schedule of the corrective actions required to address any deficiencies or failures will be developed with the site operator at this time. A printed hard-copy of the audit spot report will be given to the station operator to file with the station records.

4.2.3 Site Operator

The site operator shall be available to assist the auditor during audits, and to demonstrate his/her knowledge and ability to perform the required site operational activities to ensure data integrity. This will include interfacing with the DAS to generate data reports for the purpose of reviewing the operation of site sensors and equipment for proper site operation.

4.3 Instruments and Materials

The following instruments and materials are required for conducting performance audits of DAS(s) at EPA and NPS designated CASTNET monitoring stations. They are intended to be used by qualified technicians that understand general instrument operation and audit techniques.

- CASTNET QAPP.
- SOP-02058-1500 – ***Audit Procedures, Field Systems (CASTNET Installations).***
- SOP-02058-1000 – ***Field Site Performance Audits (CASTNET Installations).***
- Station Log.
- Laptop computer with approved FSAD and audit data forms (F-02058-1300-DAS-rev001).
- Reference voltage source capable of generating test voltages between zero and 10 volts DC with one milivolt (mv) resolution.
- Digital voltmeter (DVM) certified to NIST standards capable of measuring voltages between zero and 10 volts DC to one tenth mv resolution.
- Various test leads and banana-plug connections.
- Miscellaneous hand tools.
- Means of acquiring accurate time from the United States Naval Observatory (USNO).
- Manufacturer's instrument manuals.

4.4 Methods

All challenge results will be acquired from all on-site data logging device(s). Prior to performing the Data Acquisition Systems tests, the recording channel(s) of the DAS(s) will be flagged to indicate the parameter is being tested and not recording actual data. In order to perform the test sensor signal wires may need to be removed from the DAS(s). Following the audit tests and reinstallation of any removed signal wires, and after sufficient time for the measurement system(s) to equilibrate to ambient conditions, the parameter channel(s) will be enabled for routine data recording.

4.4.1 Data Acquisition System Acceptance Criteria

Accuracy goals for all parameters are obtained from the project-specific QAPP. Specific acceptance criteria for DAS are defined as the difference between the measured input voltage from the NIST traceable DVM and the measured response obtained from the DAS. The warning and acceptance thresholds are:

- Warning criteria, greater than ± 0.002 V
- Acceptance criteria, less than ± 0.003 V

The local standard time of day of the DAS will be checked using the reference time standard from the USNO. The warning and acceptance thresholds are:

- Warning criteria, greater than ± 4 minutes
- Acceptance criteria, less than ± 5 minutes

4.4.2 Auditing Specific Parameters

CASTNET stations employ DAS supplied by at least two manufacturers, Oddessa Engineering and Environmental Systems Corporation (ESC). The A/D converter and multiplexer accuracy will be tested by generating at least six voltage signals with a digital reference voltage source generator connected to one channel from the first eight input channels and one channel from the second eight input channels of each DAS including strip-chart recorders. The reference voltages will be generated from zero to the full scale input of the channel being tested which may be 1.000 V, 5.000 V, or 10.000 V. The generated test signal will be measured with a DVM certified to NIST standards.

The programmable configuration of the DAS(s) will be checked and verified against the documented site configuration. This will include the DAS date, day of year, and calculated channel configurations such as parameter scaling and sigma theta. Hard-copy printouts for data backup purposes will be checked, if the DAS is designated to generate them on-site.

The function of automatic calibrations programs will be verified to determine if they are operating as described in the project QAPP. The verification will include automation day and time, phase duration, and proper flagging.

4.4.3 Recording Audit Results

Audit results of A/D accuracy for each DAS will be written on hard copy forms, documented in the station log, and input into the electronic FSAD. The DAS Data Form (F-02058-1300-DAS-rev001) is included in Appendix A of this SOP. Audit findings regarding DAS configuration will also be recorded on the hard copy forms, in the station log, and in memo fields within the FSAD.

4.4.4 Reporting Audit Results

On the same day of completion of a DAS performance audit, a written "spot" report will be e-mailed to the designated project personnel. The site operator will also receive a "spot" report during the exit interview described in section 4.2.2 above. Performance audits of DAS(s) are usually performed during a complete station systems and performance audit. Therefore any error associated with the DAS that is likely impact the accuracy of other station measurements will be described in the audit results for that parameter as well. If necessary, DAS configuration findings will also be discussed in the Field Systems Audit Results section of the audit report.

Final, fully documented written performance audit reports will be delivered with the Quarterly Reports within 15 days of the end of each calendar quarter.

4.4.5 Distributing Audit Results

Performance audit reports will be distributed to the project personnel specified in the individual station or network QAPP, or in specific contract documentation.

5.0 SOP for Audit of the Mass Flow Controller of the Dry Deposition Sample

5.1 Objectives

This SOP describes the procedures for conducting performance audits of Mass Flow Controlled (MFC) ambient air-samples at EPA and NPS designated CASTNET ambient air quality monitoring stations. The contractors responsible for operating the stations are MACTEC E&C for EPA sites and ARS for NPS sites.

The purpose of a performance audit is to assess the measurement process under normal operating conditions, "as found", without any special preparation or adjustment of the system. Performance audit results are used to ensure the measurement process and data collection systems are operating within the project acceptance criteria as defined in the QAPP. Proper implementation of an auditing program will ensure data integrity and assess data accuracy.

Mass flow controlled air-sample performance audits include:

- Verifying that the MFC, associated systems, and DAS are capable of making valid and accurate measurements.
- Verifying the flow rate with an independent audit standard (traceable to NIST or other authoritative standards) to determine if the instrument is operating within defined project accuracy goals provide in the QAPP.
- Verifying that the measurement made by the MFC is accurately collected, stored, and reported by the DAS.
- Documenting audit results using the appropriate form(s) and database.
- Distributing audit results to designated project personnel.

CASTNET station MFC ambient air-sampling systems will be audited at least once every two years and can be audited at any time of the year. Performance audits are normally required just after the initiation of a monitoring station and following any major repair or change of monitoring equipment type.

5.2 Responsibilities

5.2.1 Project Manger

The project manager shall:

- Coordinate with the auditor regarding audit schedules, audit procedures, audit

standards and constants, and required supplies.

- Review all audit results.
- Distribute the audit results to designated personnel in a timely fashion.
- Review and approve any changes to the audit procedures.

5.2.2 Auditor

The auditor shall:

- Coordinate with the project manager regarding audit schedules, audit procedures, accuracy goals, required materials, and audit standards.
- Perform all required audits in accordance with approved audit protocols as described in the specific SOP.
- Maintain all audit standards.
- Obtain the assistance of the site operator as needed during audits.
- Document the audit results using the appropriate form(s) and database.
- Prepare and forward audit reports to the project manager(s).

At least one month prior to conducting a site audit, the EPA and NPS project managers, the Quality Assurance (QA) contact of the contractor responsible for operating the station (MACTEC E&C or ARS), and the station operator will be contacted. A schedule and brief agenda of anticipated activities for the audit visit will be provided at that time. The station operator will be contacted again at least one week prior to the audit to confirm that the schedule has not changed and that the operator will be present as required.

Upon completion of the audit, the auditor will conduct an exit interview with the station operator and discuss all important aspects of the audit results and findings. Emphasis will be given to findings that can or do impact data accuracy or quality. A schedule of the corrective actions required to address any deficiencies or failures will be developed with the site operator at this time. A printed hard-copy of the audit spot report will be given to the station operator to file with the station records.

5.2.3 Site Operator

The site operator shall be available to assist the auditor during audits, and to demonstrate his/her knowledge and ability to perform the required site operational activities to ensure data integrity.

5.3 Instruments and Materials

Together with this SOP, the following instruments and materials are required for conducting MFC performance audits at EPA and NPS designated CASTNET monitoring stations. They are

intended to be used by qualified technicians that understand general instrument operation and audit techniques.

- SOP-02058-1500 – ***Audit Procedures, Field Systems (CASTNET Installations).***
- SOP-02058-1000 – ***Field Site Performance Audits (CASTNET Installations).***
- CASTNET QAPP.
- Station Log.
- Laptop computer with approved FSAD and audit data forms (F-02058-1400-MFC-rev001).
- Portable primary flow measurement device certified to NIST standards such as a BIOS model DC system or equivalent.
- Tubing and connections capable of connecting the flow standard to the CASTNET sampling head.
- Miscellaneous supplies.
- Manufacturer's instruction manuals.

5.4 Methods

All challenge results will be acquired from all on-site data logging device(s). The results obtained from the primary DAS at each site will be used to verify the instrument or sensor accuracy. Prior to performing any instrument or system test, the recording channel(s) of the DAS(s) will be flagged to indicate the parameter is being tested and not recording actual data. Following the audit tests and after sufficient time for the measurement system(s) to equilibrate to ambient conditions, the parameter channel(s) will be enabled for routine data recording.

5.4.1 Acceptance Criteria

Accuracy goals for all parameters are obtained from the project-specific QAPP. Flow rate regulation systems are audited in accordance with the EPA's ***Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II - Ambient Air Specific Methods.*** EEMS uses NIST or ASTM traceable test equipment for flow rate audits.
The CASTNET warning and acceptance accuracy goals for MFC ambient air-sampling systems are:

- Warning criteria, ± 3%
- Acceptance criteria, ± 5%

5.4.2 Auditing Specific Parameters

Depending on the location of the CASTNET station, different flow rates are used to collect the ambient air-sample. Sites in the east operate at 1.50 LPM, and sites in the west operate at 3.00 LPM due to lower concentrations of sulfur and nitrogen species.

Mass Flow Controllers

- CASTNET Dry Deposition Filter and sampling integrity must be maintained using the sample handling protocol established in the QAPP.
- After flagging all affected channels as "down" (see section 5.4 Methods above) turn off the air-sample pump and note the time and the system hour-meter reading (if applicable) in the station log and on the data form. Lower the sampling tower slowly using the rope provided at the station. Do not allow the tower to descend quickly or stop suddenly at the hinge point as this can cause damage to the tower. Use caution to avoid any obstructions.
- Once the tower is lowered and secure, remove the filter pack sample from the sample train using clean latex gloves, seal the open ends with the provided shipping caps, and store in the plastic shipping bag until completing the audit.
- Install the primary flow audit device in its place using the appropriate fitting and tubing to avoid leaks in the sample train.
- Operate the vacuum pump and observe the flow readings on the audit flow device, station mass flow controller display, and the recorded dry deposition flow rate from the DAS. Record the results on the MFC Data Form. Include both the volumetric and standard condition (760 mmHg and 25 ° C) flow rate for the standard.
- Check the sample train for leaks by sealing the sample inlet at the audit device and verifying that the flow rate readings are negligible for both the audit device and the system mass flow controller.
- Check the flow tubing, water-trap, and rotometer for blockages or other problems.
- Remove the audit device and reinstall the filter pack sample using clean gloves.
- Return the sampling tower to the sampling position and turn the vacuum pump on. Note the time and the hour-meter reading on the form and in the station log.

5.4.3 Recording Audit Results

Audit results are written on hard copy forms, documented in the station log, and input into the electronic FSAD. A copy of the MFC Data Form (F-02058-1400-MFC-rev001) is included in Appendix A.

5.4.4 Reporting Audit Results

On the same day of completion of a performance audit, a written "spot" report will be e-mailed to the designated project personnel. The site operator will also receive a "spot" report during the exit interview described in section 5.2.2 above.

Final, fully documented written performance audit reports will be delivered with the Quarterly Reports within 15 days of the end of each calendar quarter.

5.4.5 Distributing Audit Results

Performance audit reports will be distributed to the project personnel specified in the individual station or network QAPP, or in specific contract documentation.

6.0 SOP for Field Systems Audits

6.1 Objectives

This SOP describes the procedures for conducting technical field systems audits of EPA and NPS designated CASTNET ambient air quality monitoring stations. The contractors responsible for operating the stations are MACTEC E&C for EPA sites and ARS for NPS sites.

The purpose of a field systems audit is to qualitatively appraise the total measurement system. This includes a thorough, on-site evaluation of facilities, equipment, personnel, training, procedures, documentation and reporting aspects of the field operations systems. Field systems audit results are used to ensure that good quality assurance/quality control (QA/QC) practices are being applied as defined in the QAPP.

Technical field systems audits include:

- Verifying that the site conforms to the characteristics as described in the QAPP.
- Verifying that the instruments and equipment are sited, installed, maintained, and operated regarding Occupational Safety and Health Administration (OSHA) compliance.
- Verifying that the instruments and equipment are properly sited, installed, maintained, and operated with respect to project guidelines.
- Verifying that procedures are in place to ensure that collected data are of sufficient quality to meet the project objectives.
- Verifying that current documentation relating to each component of the measurement system is on-site.
- Observing and evaluating the site operator's proficiency of his/her duties and the understanding of the project goals.
- Recording all information including any sketches or photographs using the appropriate form(s) and database.
- Distributing audit results to designated project personnel.

Technical field systems audits of the CASTNET ambient air quality stations will be conducted at least once every two years and can be performed at any time of the year. Technical field systems audits are normally required just after the initiation of a monitoring station and following any major change of monitoring procedures.

6.2 Responsibilities

6.2.1 Project Manager

The project manager shall:

- Coordinate with the auditor regarding audit schedules, audit procedures, and required supplies.
- Review all audit results.
- Distribute the audit results to designated personnel in a timely fashion.
- Review and approve any changes to the audit procedures.

6.2.2 Auditor

The auditor shall:

- Coordinate with the project manager regarding audit schedules, audit procedures, and required materials.
- Perform all required audits in accordance with approved audit protocols as described in the specific SOP.
- Obtain the assistance of the site operator as required for completion of the audit.
- Document the audit results using the appropriate form(s) and database.
- Prepare and forward audit reports to the project manager(s).

At least one month prior to conducting a site audit, the EPA and NPS project managers, the Quality Assurance (QA) contact of the contractor responsible for operating the station (MACTEC E&C or ARS), and the station operator will be contacted. A schedule and brief agenda of anticipated activities for the audit visit will be provided at that time. The station operator will be contacted again at least one week prior to the audit to confirm that the schedule has not changed and that the operator will be present as required.

Upon completion of the station audit, the auditor will conduct an exit interview with the station operator and discuss all important aspects of the audit results and findings. Although emphasis will be given to performance audit findings, any technical systems findings that pose a safety hazard, or need immediate attention, will be addressed.

6.2.3 Site Operator

The site operator shall be available as required to demonstrate his/her knowledge and ability to perform the required site operational activities to ensure data integrity. If the station is audited during a regularly scheduled site visit, the site operator will be observed performing the routine

operational functions. If the station is audited on a day other than the regularly scheduled weekly visit, the site operator will be interviewed on-site during the audit.

6.3 Instruments and Materials

Together with this SOP, the materials listed here are required to conduct technical field systems audits at EPA and NPS designated CASTNET monitoring stations. They are intended to be used by qualified technicians that understand field site operations, instrument operation, and QA/QC techniques:

- CASTNET QAPP.
- Station Log.
- Laptop computer with approved FSAD and systems audit data forms.
- Global Positioning System (GPS).
- Digital camera.
- Transit.

6.4 Methods

The specific methods used to conduct technical field systems audits are detailed in the following sections.

6.4.1 Acceptance Criteria

Technical field systems audits are qualitative and therefore acceptance criteria are not established. Methods used are in accordance with the EPA's ***Quality Assurance Handbook for Air Pollution Measurement Systems: Volume I: A Field Guide To Environmental Quality Assurance,*** and ***Volume II: Part 1 Ambient Air Quality Monitoring Program Quality System Development.***

6.4.2 Auditing Specific Parameters

Specific issues addressed while conducting a technical field systems audit are:

- That the site locations and configurations match those provided in the CASTNET QAPP. (Prepare sketches and acquire digital photographs if necessary for clarification.)
- That the meteorological instruments are in good physical and operational condition and are sited at appropriate height and distances from obstacles, to meet EPA ambient monitoring guidelines (EPA-600/4-82-060).
- Ensure that the site is accessible, orderly, and, if applicable, compliant with OSHA safety standards.

- Inspect the sample lines for leaks, kinks, visible contamination, weathering and moisture.
- Inspect the condition of the instrument towers, guy-wires, anchors, signal cable, and hardware.
- Inventory all monitoring equipment by manufacturer, model number, serial number, and owner property number.
- Confirm all ambient air quality instruments are functional, being operated in the appropriate range, and the zero air supply desiccant is unsaturated.
- Verify that the instrument shelter is weather-tight and provides adequate temperature control.
- Confirm that all instruments are in current calibration with supporting documentation.
- Review the site documentation (instrument manuals, on-site SOPs, maintenance schedules, station logbook, weekly report forms, control charts, etc.) to verify that they are current and complete.
- Confirm that the site operator(s) demonstrate an adequate knowledge and ability to perform the required site activities, including documentation.

6.4.3 Recording Audit Results

Audit results are written on hard copy forms, and input into the electronic (FSAD). Blank copies of the technical field systems audit forms are included in Appendix A. If a site has been previously audited, that record will be available during the current audit, and used to determine if corrective actions were needed and implemented.

6.4.4 Reporting Audit Results

On the same day of completion of a performance audit, a written "spot" report will be e-mailed to the designated project personnel. Any safety concerns or conditions that require immediate attention that were found during the technical field systems audit will be noted and conspicuous on the “spot” report. The site operator will also receive a "spot" report during the exit interview described in section 6.2.2 above.

Final, fully documented technical field systems audit reports will be delivered with the Quarterly Reports within 15 days of the end of each calendar quarter.

6.4.5 Distributing Audit Results

Technical field systems audit reports will be distributed to the project personnel specified in the individual station or network QAPP, or in specific contract documentation.

References:

Clean Air Status and Trends Network (CASTNET) Quality Assurance Project Plan (2003) – EPA.

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume I: - A Field Guide To Environmental Quality Assurance – EPA.

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II: Part1 Ambient Air Quality Monitoring Program Quality System Development – EPA.

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II - Ambient Air Specific Methods – EPA.

Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV - Meteorological Measurements – EPA.

APPENDIX A

SOP Field Forms – CASTNET Audit Program

Field Systems Data Form (F-02058-1500-S1-rev003)

Client Site ID:		**Audit Date:**	
Site Name:			
Air Program:			
Site Initiation Date:		**Site Reporting Date:**	

Site sponsor (agency)		USGS map	
Operating group		Map scale	
AQS#		Map date	
Meteorological type			
Air pollutant analyzers		QAPP latitude	
Deposition measurement		QAPP longitude	
Land use		QAPP elevation (meters)	
Terrain		QAPP declination	
Conforms to MLM		QAPP declination date	

Site telephone		Audit latitude	
Site address 1		Audit longitude	
Site address 2		Audit elevation	
County		Audit declination	
State			Present (inspection date if any)
Zip code		Fire extinguisher	
Time zone		First-aid kit	
Primary operator		Safety glasses	
Primary operator telephone		Safety hard-hat	
Primary operator e-mail		Climbing belt	
Backup operator		Security fence	
Backup operator telephone		Secure shelter	
Backup operator e-mail		Stable entry steps	

Does the shelter have adequate working room? (list shelter make, model, size)

	Model:		**cuft**	**s/n:**

Does the site appear to be clean, organized, and well maintained both inside and outside? Note shelter condition

Is the site accessible, appear to be safe and reasonably hazard free?

Driving directions to the site:

Signature:

Date:

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Field Systems Data Form (F-02058-1500-S2-rev003)

Siting Criteria

Is the site compliant with the site-specific criteria from the QAPP listed below? (list distance if not)

Clean Air Status and Trends Network — *Quality Assurance Project Plan*

Table 2-1 Site-Specific Siting Criteria for CASTNET Monitoring Sites

Potential Interferant	Minimum Distance From Measurement Apparatus
Large point source of SO_2 or NO_x	20 to 40 km
Major industrial complex	10 to 20 km
City, > 50,000 population	40 km
City, 10,000 to 50,000 population	10 km
City, 1,000 to 10,000 population	5 km
Major highway, airport, or rail yard	2 km
Secondary road, heavily traveled	500 m
Secondary road, lightly traveled	200 m
Feedlot operations	500 m
Intensive agricultural operations (including aerial spraying)	500 m
Limited agricultural operations	200 m
Large parking lot	200 m
Small parking lot	100 m
Tree line	50 m
Obstacles to wind	10 times obstacle height

distance

Provide additional explanation (photograph or sketch if necessary) regarding conditions listed above, or any other features natural or man-made, that may affect the monitoring parameters:

Are distances adequate?

Signature:

Date:

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Field Systems Data Form (F-02058-1500-S3-rev003)

Siting Criteria

Are the meteorological sensors and probes sited in accordance with EPA QA Handbook, Vol. IV

1	Are wind speed and direction sensors sited so as to avoid being influenced by any obstructions?	**Yes** **No**	comments:
2	Are wind sensors mounted so as to minimize tower effects? *(i.e. wind sensors should be mounted atop the tower or on a horizontally extended boom >2x the max diameter of the tower into the prevailing wind.)*	**Yes** **No**	comments:
3	Are the tower and wind sensors plumb?	**Yes** **No**	comments:
4	Are the temperature sensor shields pointed north or positioned to avoid radiated heat sources such as buildings, walls, etc?	**Yes** **No**	comments:
5	Are the temperature and RH sensors sited to avoid unnatural conditions? *(i.e. ground below the sensors should be natural surface and not steeply sloped. Ridges, hollows, and areas of standing water should be avoided.)*	**Yes** **No**	comments:
6	Is the solar radiation sensor plumb?	**Yes** **No**	comments:
7	Is it sited to avoid shading, or any artificial or reflected light?	**Yes** **No**	
8	Is the rain gauge plumb?	**Yes** **No**	comments:
9	Is it sited to reduce shading effects from buildings, trees, towers, etc?	**Yes** **No**	
10	Is the surface wetness sensor sited with the grid surface facing north?	**Yes** **No**	comments:
11	Is it inclined approximately 30 degrees?	**Yes** **No**	

Provide additional explanation (photograph or sketch if necessary) regarding conditions listed above, or any other features natural or man-made, that may affect the monitoring parameters:

Signature:

Date:

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Field Systems Data Form (F-02058-1500-S4-rev003)

Meteorological sensors operations and maintenance

1	Do all the meteorological sensors appear to be intact, in good condition, and well maintained?	**Yes** **No**	comments:
2	Are all the meteorological sensors operational on-line, and reporting data?	**Yes** **No**	comments:
3	Are the shields for the temperature and RH sensors clean?	**Yes** **No**	comments:
4	Are the aspirated motors working?	**Yes** **No**	
5	Is the solar radiation sensor lens clean and free of scratches? (Properly maintained?)	**Yes** **No**	comments:
6	Is the surface wetness sensor grid clean and undamaged?	**Yes** **No**	comments:
7	Are the sensor signal and power cables intact, in good condition, and well maintained?	**Yes** **No**	comments:
8	Are the sensor signal and power cable connections protected from the elements and well maintained?	**Yes** **No**	comments:

Meteorological sensor inventory

Parameter	Manufacturer	Model	S/N	Client ID
Met tower				
Wind speed				
Wind direction				
Temperature (10 meter)				
Temperature (2 meter)				
Humidity				
Solar radiation				
Precipitation				
Surface wetness				
Shield (10 meter)				
Shield (2 meter)				
Shield other (RH)				

Provide additional explanation (photograph or sketch if necessary) regarding conditions listed above, or any other features natural or man-made, that may affect the monitoring parameters:

Signature:

Date:

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Field Systems Data Form (F-02058-1500-S5-rev003)

Siting Criteria

Are the pollutant analyzers and deposition equipment sited in accordance with 40 CFR 58, Appendix E

1	Do the sample inlets have at least a 270 degree arc of unrestricted airflow?	**Yes** **No**	comments:
2	Are the sample inlets 3 - 15 meters above the ground?	**Yes** **No**	comments:
3	Are the sample inlets > 1 meter from any major obstruction, and 20 meters from trees?	**Yes** **No**	comments:

Pollutant analyzers and deposition equipment operations and maintenance

1	Do the analyzers and equipment appear to be in good condition and well maintained?	**Yes** **No**	comments:
2	Are the analyzers and monitors operational, on-line, and reporting data?	**Yes** **No**	comments:
3	Describe the ozone sample line.		
4	Describe the dry dep filter sample line.		
5	Are in-line filters used in the ozone sample line? (if yes indicate location)	**Yes** **No**	comments:
6	Are sample lines clean and free of kinks, moisture and obstructions?	**Yes** **No**	comments:
7	Is the zero air supply desiccant unsaturated?	**Yes** **No**	comments:
8	Are there moisture traps in the sample lines?	**Yes** **No**	comments:
9	Is there a rotometer in the dry deposition filter line, and is it clean?	**Yes** **No**	comments:

Pollutant analyzer and deposition equipment inventory

Parameter	Manufacturer	Model	S/N	Client ID
Sample tower				
Ozone				
Filter pack MFC				
MFC power supply				
Zero air pump				
Filter pack flow pump				

Provide additional explanation (photograph or sketch if necessary) regarding conditions listed above, or any other features natural or man-made, that may affect the monitoring parameters:

Signature:

Date:

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Field Systems Data Form (F-02058-1500-S6-rev003)

DAS, sensor translators, and peripheral equipment operations and maintenance

1	Do the DAS instruments appear to be in good condition and well maintained?	**Yes** **No**	comments:
2	Are all the components of the DAS operational? (printers, modem, backup, etc)	**Yes** **No**	comments:
3	Do the analyzer and sensor signal leads pass through lightning protection circuitry?	**Yes** **No**	comments:
4	Are the signal connections protected from the weather and well maintained?	**Yes** **No**	comments:
5	Are the signal leads connected to the correct DAS channel?	**Yes** **No**	comments:
6	Are the DAS, sensor translators, and shelter properly grounded?	**Yes** **No**	comments:
7	Does the instrument shelter have a stable power source?	**Yes** **No**	comments:
8	Is the instrument shelter temperature controlled?	**Yes** **No**	comments:
9	Is the met tower stable and grounded?	**stable**	**grounded**
10	Is the sample tower stable and grounded?	**stable**	**grounded**

DAS, sensor translators, and peripheral equipment inventory

Parameter	Manufacturer	Model	S/N	Client ID
Primary data logger				
Backup data logger				
Strip chart recorded				
Mainframe				
Mainframe power supply				
F460 translator				
Temperature translator				
Humidity translator				
Solar radiation translator				
R.M. Young wind interface				
Computer				
Modem				
Printer				

Provide additional explanation (photograph or sketch if necessary) regarding conditions listed above, or any other features natural or man-made, that may affect the monitoring parameters:

Signature:

Date:

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Field Systems Data Form (F-02058-1500-S7-rev003)

Documentation

Does the site have the required instrument and equipment manuals?

Wind speed sensor	Yes	No	N/A	Data logger	Yes	No	N/A
Wind direction sensor	Yes	No	N/A	Data logger	Yes	No	N/A
Temperature sensor	Yes	No	N/A	Strip chart recorder	Yes	No	N/A
Relative humidity sensor	Yes	No	N/A	Computer	Yes	No	N/A
Solar radiation sensor	Yes	No	N/A	Modem	Yes	No	N/A
Surface wetness sensor	Yes	No	N/A	Printer	Yes	No	N/A
Wind sensor translator	Yes	No	N/A	Zero air pump	Yes	No	N/A
Temperature translator	Yes	No	N/A	Filter flow pump	Yes	No	N/A
Humidity sensor translator	Yes	No	N/A	Surge protector	Yes	No	N/A
Solar radiation translator	Yes	No	N/A	UPS	Yes	No	N/A
Tipping bucket rain gauge	Yes	No	N/A	Lightning protection device	Yes	No	N/A
Ozone analyzer	Yes	No	N/A	Shelter heater	Yes	No	N/A
Filter pack flow controller	Yes	No	N/A	Shelter air conditioner	Yes	No	N/A
Filter pack MFC power supply	Yes	No	N/A				

Does the site have the required and most recent QC documents and report forms?

Document	Present		Comements, version, or dated	Current	
Station log	Yes	No		Yes	No
Site Status Report Form	Yes	No		Yes	No
Site Operator's Manual	Yes	No		Yes	No
Health and Safety Plan	Yes	No		Yes	No
Field Operations Manual	Yes	No		Yes	No
Calibration reports	Yes	No		Yes	No
Ozone z/s/p control charts	Yes	No		Yes	No
Preventive maintenance schedule	Yes	No		Yes	No
additional instruction material:					

1	Is the station log properly completed during every site visit?	**Yes** **No**	comments:
2	Are the Site Status Report Forms properly completed and current?	**Yes** **No**	comments:
3	Are the chain-of-custody forms properly used to document sample transfer to and from lab?	**Yes** **No**	comments:
4	Are the ozone z/s/p control charts properly completed and current?	**Yes** **No**	comments:

Comments:

Signature:

Date:

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Field Systems Data Form (F-02058-1500-S8-rev003)

Site operation procedures

1	Has the site operator attended a formal CASTNET training course? If yes when and who instructed?	**Yes** **No**	comments:
2	Has the backup operator attended a formal CASTNET training course? If yes when and who instructed?	**Yes** **No**	comments:
3	Is the site visited regularly on the required Tuesday schedule?	**Yes** **No**	comments:
4	Are the standard CASTNET operational procedures being followed by the site operator?	**Yes** **No**	comments:
5	Is the site operator(s) knowledgeable of, and able to perform, the required site activities? *(all documentation, control charts etc.)*	**Yes** **No**	comments:

Are regular operational QA/QC checks performed on meteorological instruments?

QC check performed			Frequency	Compliant	
Multi-point calibrations	**Yes**	**No**		**Yes**	**No**
Visual inspections	**Yes**	**No**		**Yes**	**No**
Translator zero/span tests (Climatronics)	**Yes**	**No**		**Yes**	**No**
Manual rain gauge test	**Yes**	**No**		**Yes**	**No**
Confirm reasonableness of current values	**Yes**	**No**		**Yes**	**No**
Test surface wetness response	**Yes**	**No**		**Yes**	**No**

Are regular operational QA/QC checks performed on the ozone analyzer?

QC check performed			Frequency	Compliant	
Multi-point calibrations	**Yes**	**No**		**Yes**	**No**
Automatic zero/span tests	**Yes**	**No**		**Yes**	**No**
Manual zero/span tests	**Yes**	**No**		**Yes**	**No**
Automatic precision level tests	**Yes**	**No**		**Yes**	**No**
Manual precision level tests	**Yes**	**No**		**Yes**	**No**
Analyzer diagnostics tests	**Yes**	**No**		**Yes**	**No**
In-line filter replacement (at inlet)	**Yes**	**No**		**Yes**	**No**
In-line filter replacement (at analyzer)	**Yes**	**No**		**Yes**	**No**
Sample line check for dirt/water	**Yes**	**No**		**Yes**	**No**
Zero air desiccant check	**Yes**	**No**		**Yes**	**No**

1	Do multi-point calibration gases go through the complete sample train including all filters?	**Yes** **No**	comments:
2	Do automatic and manual z/s/p gases go through the complete sample train including all filters?	**Yes** **No**	comments:
3	Are the automatic and manual z/s/p checks monitored and reported? If yes how?	**Yes** **No**	comments:

comments:

Signature:

Date:

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Field Systems Data Form (F-02058-1500-S9-rev003)

Site operation procedures

1	Is the filter pack being changed every Tuesday as scheduled?	**Yes** **No**	comments:
2	Are the Site Status Report Forms being completed and filed correctly?	**Yes** **No**	comments:
3	Are data downloads and backups being performed as scheduled?	**Yes** **No**	comments: **No longer required**
4	Are general observations being made and recorded? How?	**Yes** **No**	comments:
5	Are site supplies on-hand and replenished in a timely fashion?	**Yes** **No**	comments:
6	Are sample flow rates recorded? How?	**Yes** **No**	comments:
7	Are samples sent to the lab on a regular schedule in a timely fashion?	**Yes** **No**	comments:
8	Are filters protected from contamination during handling and shipping? How?	**Yes** **No**	comments:
9	Are the site conditions reported regularly to the field operations manager or staff?	**Yes** **No**	comments:

Are regular operational QA/QC checks performed on deposition instruments?

QC check performed			Frequency	Compliant	
Multi-point MFC calibrations	**Yes**	**No**		**Yes**	**No**
Flow system leak checks	**Yes**	**No**		**Yes**	**No**
Filter pack inspection	**Yes**	**No**		**Yes**	**No**
Flow rate setting checks	**Yes**	**No**		**Yes**	**No**
Visual check of flow rate rotometer	**Yes**	**No**		**Yes**	**No**
In-line filter inspection/replacement	**Yes**	**No**		**Yes**	**No**
Sample line check for dirt/water	**Yes**	**No**		**Yes**	**No**

comments:

Signature:

Date:

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DAS Data Form (F-02058-1300-DAS-rev001)

Site: **Date:**

site system

manufacturer	
s/n	
owner ID	
model #	
name	
source type	
channels used	
hard-copy printouts	

transfer standard system

source gen manufacturer	
source gen s/n	
owner ID	
DVM manufacturer	
DVM s/n	
owner ID	
transfer slope	
transfer intercept	
transfer correlation coefficient	
certification date	

source voltage	measured DVM volts	DAS measured channel # volts
average error (volts)		
maximum error (volts)		
slope		
intercept		
correlation		

source voltage	measured DVM volts	DAS measured channel # volts
average error (volts)		
maximum error (volts)		
slope		
intercept		
correlation		

System Conditions: **Comments:**

	site:	audit:
date		
time		
day of year		
configuration		
auto cal programs		
battery test		

Signature:

Date:

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Ozone Data Form (F-02058-1100-O3-rev003)

Site: _____ **Date:** _____

	Site Analyzer				Transfer Standard	
	As Found		As Left			
Mfg:						
Model:						
S/N						
Owner ID#						
Offset or Bkg:						
Span or Coef:						
Zero Voltage:						
Fullscale Voltage:						
	A	B	A	B	A	B
Cell Freq (kHz):						
Cell Noise:						
Cell Flow (lpm):						
Pressure (mmHg):						
Cell Temp (deg C):						
Lamp temperature:						
Slope:						
Intercept:						
Correlation Coef:						

Site analyzer initial settings

level A	
level B	
zero air	
ch #	

Ozonator Setting: **Zero air (psi) =**

Site		Transfer		Site		Transfer		Site		Transfer		Site		Transfer		Site		Transfer		Site		Transfer	
Display average:																							
Corrected*:																							
% Diff:	**NA**																						
DAS average:																							
Corrected*:																							
% Diff:	**NA**																						

* The transfer corrected result is the transfer average reading minus the transfer intercept, divided by the transfer slope.

System Conditions:

tubing type/condition		
water trap/water present		
tower type/condition		
battery backup test		

Comments:

Line-loss

Signature:

Date:

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MFC Data Form (F-02058-1400-MFC-rev002)

Site: | **Date:**

site system	
MFC manufacturer	
MFC s/n	
owner ID	
PS manufacturer	
PS s/n	
owner ID	
cal factor zero	
cal factor full-scale	
existing rotometer reading	

transfer standard system	
manufacturer	
cell size and s/n	
owner ID	
translator manufacturer (nexus)	
translator s/n	
owner ID	
transfer slope	
transfer intercept	
transfer correlation coefficient	
certification date	

	BIOS		MFC	DAS# ch#		DAS# ch#		DAS# ch#		DAS# ch#	
	volumetric	STP	display	volts	LPM	volts	LPM	volts	LPM	volts	LPM
pump off											
leak check											
test 1											
test 2											
test 3											
test 4											
test 5											
	Ave										
	Error of ave.										
	Max error										

System Conditions:

tubing type	
tubing condition	
rotometer	
rotometer condition	
moisture trap	
moisture present	
tower type	
tower condition	

Comments:

Signature:

Date:

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Humidity Data Form (F-02058-1200-RH-rev001)

Site: _____ **Date:** _____

site system	
sensor manufacturer	
sensor s/n	
owner ID	
translator manufacturer	
translator s/n	
owner ID	
aspiration	
translator zero	
translator span	

transfer standard system	
sensor manufacturer	
sensor s/n	
owner ID	
slope	
intercept	
correlation coefficient	
certification date	
solution date	
solution date	

input device	input % RH	standard raw % RH	standard corrected %	ch# site response DAS#1 volts	ch# site response DAS#1 % RH	ch# site response DAS#2 volts	ch# site response DAS#2 % RH
maximum error (below 85 %)							
average error (below 85 %)							
maximum error (above 85 %)							
average error (above 85 %)							

System Conditions:

filter	
blower	
shield	

Comments:

Signature:

Date:

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Solar Radiation Data Form (F-02058-1200-SR-rev002)

Site:

Date:

site system

sensor manufacturer	
sensor s/n	
owner ID	
translator manufacturer	
translator s/n	
owner ID	
translator zero	
translator span	

transfer standard system

sensor manufacturer	
sensor s/n	
owner ID	
translator manufacturer	
translator s/n	
owner ID	
transfer slope	
transfer intercept	
transfer correlation coefficient	
certification date	

Ch#

date	time	standard raw w/m2	standard corrected w/m2	site response DAS#1 w/m2	site response DAS#2 w/m2	site response DAS#3 w/m2	site response DAS#4 w/m2
		average					
		% difference of average					
		% difference of max value					

System Conditions:

	Y/N
sensor clean	
sensor level	
properly sited	

Comments:

Signature:

Date:

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Wind Direction Data Form (F-02058-1200-WDR-rev001)

Site: | **Date:**

site system

sensor manufacturer	
sensor s/n	
owner ID	
translator manufacturer	
translator s/n	
owner ID	
vane s/n	
vane torque	
crossarm alignment	
translator zero	
translator span	
540 span	

transfer standard system

transit manufacturer	
transit s/n	
transit owner ID	
alignment tool manufacturer	
alignment tool s/n	
alignment tool owner ID	
transit certification date	
latitude	
longitude	
elevation	
magnetic declination	

orientation device	orientation degrees true			ch #		ch #	
				site response DAS#1 volts	site response DAS#1 deg	site response DAS#2 volts	site response DAS#2 deg
			maximum error				
			average error				
linearity	degree						
1							
2							
3							
4							
5							
6							
7							
8							
			maximum error				
			average error				

System Conditions:

vane	
heater	
tower	
plumb	
mast	

Comments:

Signature:

Date:

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Wind Speed Data Form (F-02058-1200-WSP-rev001)

Site: **Date:**

site system

sensor manufacturer	
sensor s/n	
owner ID	
translator manufacturer	
translator s/n	
owner ID	
prop or cups s/n	
prop or cups torque	
translator zero	
translator span	
prop correction factor	

transfer standard system

motor manufacturer	
motor s/n (low speed)	
motor owner ID (low speed)	
motor s/n (high speed)	
motor owner ID (high speed)	
motor controller manufacturer	
motor controller s/n	
motor controller owner ID	
certification date	

input device	clim / RMY input rpm	climatronics m/s	RMY 49 / 512 input m/s	ch # site response DAS#1 volts	ch # site response DAS#1 m/s	ch # site response DAS#2 volts	ch # site response DAS#2 m/s
none	zero	0.2	0.2				
	50 / 200	1.40	0.98 / 1.02				
	100 / 400	2.57	1.96 / 2.05				
	170 / 800	4.22	3.92 / 4.10				
	250 / 1200	6.10	5.88 / 6.14				
	500 / 2400	11.97	11.76 / 12.29				
	800 / 4000	19.02	19.60 / 20.48				
	2000 / 9400	47.22	46.06 / 48.13				
maximum error (below 5 m/s)							
average error (below 5 m/s)							
maximum % difference (above 5 m/s)							
average % difference (above 5 m/s)							

System Conditions:

prop/cups	
heater	
tower	
plumb	

Comments:

Signature:

Date:

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Temperature Data Form (F-02058-1400-T-rev002)

Site: _____ **Date:** _____

site system	
system manufacturer	
T1 sensor s/n	
T1 owner ID	
T2 sensor s/n	
T2 owner ID	
translator s/n	
translator owner ID	
temperature zero	
delta temp zero	
temperature span	
delta temp span	

transfer standard system	
system manufacturer	
standard sensor s/n	
standard sensor owner ID	
translator s/n	
translator owner ID	
transfer slope	
transfer intercept	
transfer correlation coefficient	
certification date	

Note: T1 = ten meter sensor, T2 = two meter sensor Climatronics delta T = T2 - T1, RM Young delta T = T1 - T2

standard system		DAS# ch# T1		DAS# ch# T1		DAS# ch# T2 or delta T		DAS# ch# T2 or delta T	
raw deg C	corrected deg C	volts	deg C	volts	deg C	volts	deg C	volts	deg C
	Ave error								
	Max error								

standard system		Shelter Temperature		DAS# ch#	Manufacturer:		s/n:	
raw deg C	corrected deg C	volts	deg C		Model:		owner ID:	
	Ave error							
	Max error							

System Conditions: **Comments:**

	Yes/No
T1 shield clean	
T1 blower functioning	
T1 status functioning	
T2 shield clean	
T2 blower functioning	
T2 status functioning	
properly sited	

Signature:

Date:

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Precipitation Data Form (F-02058-1200-PRECP-rev003)

Site: | **Date:**

site system

rain gauge manufacturer	
rain gauge s/n	
rain gauge owner ID	
translator manufacturer	None
translator s/n	None
owner ID	None

transfer standard system

cylinder manufacturer	
cylinder s/n	
cylinder owner ID	
delivery device s/n	
delivery device owner ID	

standard volume	equivalent	time per tip	test time	ch# site response DAS#1	site response DAS#2	site response DAS#3	site response DAS#4
ml	in or mm	sec	min	in or mm	in or mm	in or mm	in or mm
tip check							
maximum error				N/A			
average error				N/A			
max % difference							
ave % difference							

site system

wetness manufacturer	
wetness sensor s/n	None
wetness sensor owner ID	
translator manufacturer	None
translator s/n	None
owner ID	None

transfer standard system

decade box manufacturer	
decade box s/n	
decade box owner ID	

water test	decade box test	decade box test		site response DAS# Ch#		site response DAS# Ch#	
wet or dry	on or off	ohm		volts	units	volts	units
wet							
dry							
	on						
	off						

System Conditions: **Comments:**

rain gauge	Y/N
TB gauge clean	
TB funnel clean	
TB heater working	
TB screen installed	
TB level	
drain screen installed	

wetness	
grid clean	
grid angle	
grid orientation	
grid condition	
type holes Y/N	

Signature:

Date:

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