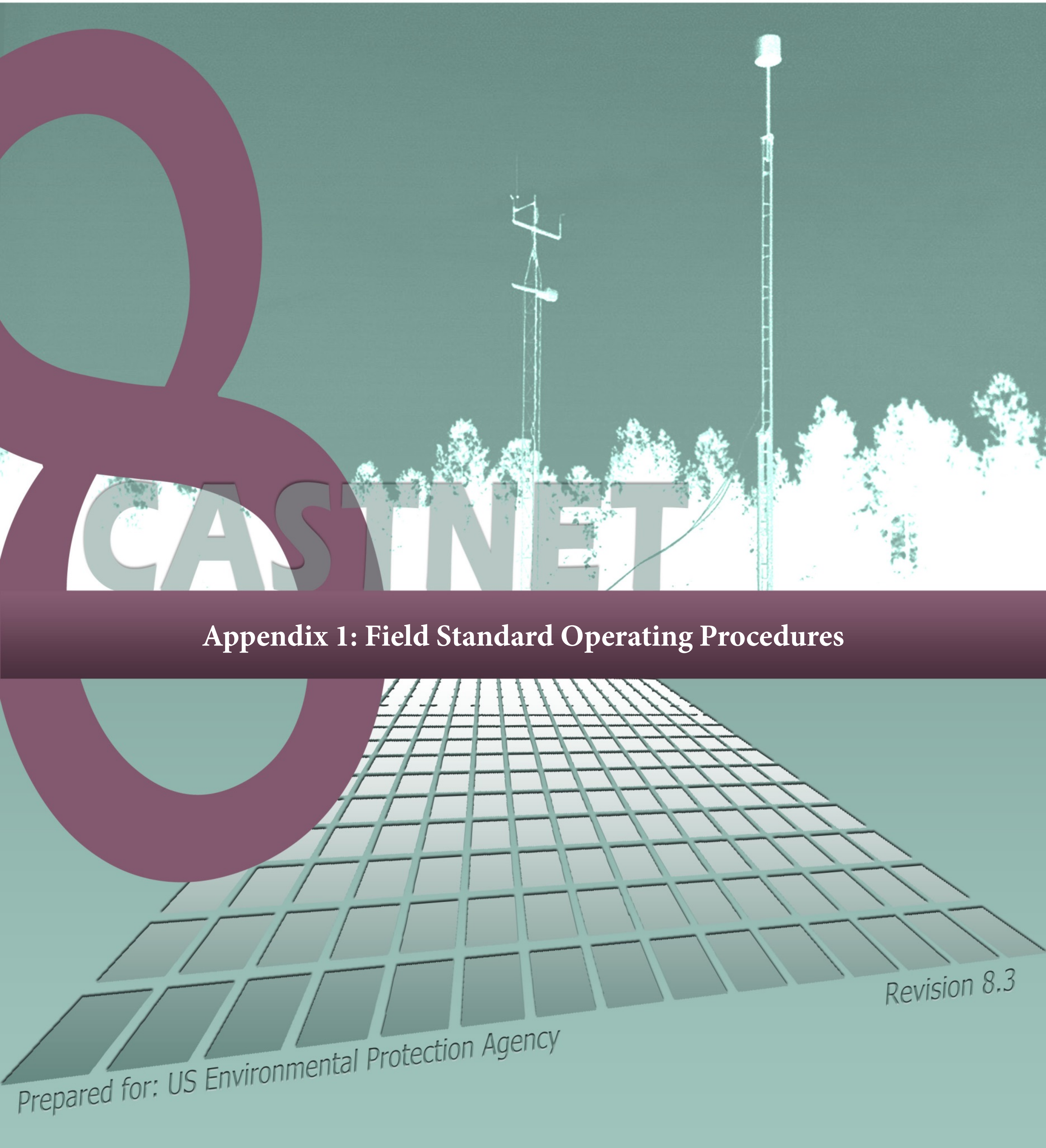
amec foster wheeler



Appendix 1: Field Standard Operating Procedures

Revision 8.3

Prepared for: US Environmental Protection Agency

Clean Air Status and Trends Network

Quality Assurance Project Plan

Revision 8.3

Appendix 1:

CASTNET Field Standard Operating Procedures

October 2015

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PDF Page Numbers

CASTNET Field Operation Standard Operating Procedures (SOP)

Introduction

CASTNET monitoring sites were selected to support the investigation of relationships between pollutant emissions and atmospheric concentrations/depositions using the procedure described in Section 1.1 of the CASTNET Quality Assurance Project Plan (QAPP). Ambient measurements of atmospheric pollutants are performed at each site. CASTNET Field Operations staff ensure that each EPA site is maintained and operated to meet project objectives. Field Operations personnel are trained to perform their designated functions so that data collection meets or exceeds established measurement criteria. Training procedures are discussed in Sections 1.6 and 2.3 of the QAPP.

The field operations portion of the project can be divided into four groups. The first group describes the Site Installation and Initiation Procedures for CASTNET sites. These procedures are discussed shown in Section I of these SOP.

The second group is Site Operations, which includes the functions performed by the site operators. These functions are described in Section II. The main function of the site operator is to collect the exposed filter pack and replace it with a new, unexposed filter pack each week. The operator also performs a reasonableness check of the recorded measurements and completes the Site Status Report Form (SSRF). Additional investigation, repair, or replacement of any site instrument is performed only through direct instructions from Amec Foster Wheeler Field Operations personnel.

The third group is Field Calibrations. The functions included in this group are described in Section III of these SOP and include calibration and maintenance procedures performed every 6 months at each site. These procedures are performed by Amec Foster Wheeler technicians or qualified subcontractors.

The fourth group includes the functions that are performed in the CASTNET Calibration Laboratory. These procedures are described in Section IV of these SOP. Calibration Laboratory personnel provide support for the entire network of sites and the field technicians by repairing, rebuilding, calibrating, and distributing the sensors and equipment used throughout CASTNET. Figure I-1 provides a work flow diagram. All calibrations are performed using standards traceable to a national certified standard. Each measurement parameter has a designated set of procedures and work stations which have been developed and documented to handle the routine requirements of repair, maintenance, calibration and post-calibration[1] of that measurement system.

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[1] Post-calibration refers to a procedure wherein a sensor, instrument, or system is removed from a remote site and tested at the Field Calibration Laboratory to support or verify the remote field calibration results. The device is tested via comparison with a known and traceable standard without performing any adjustment prior to testing.

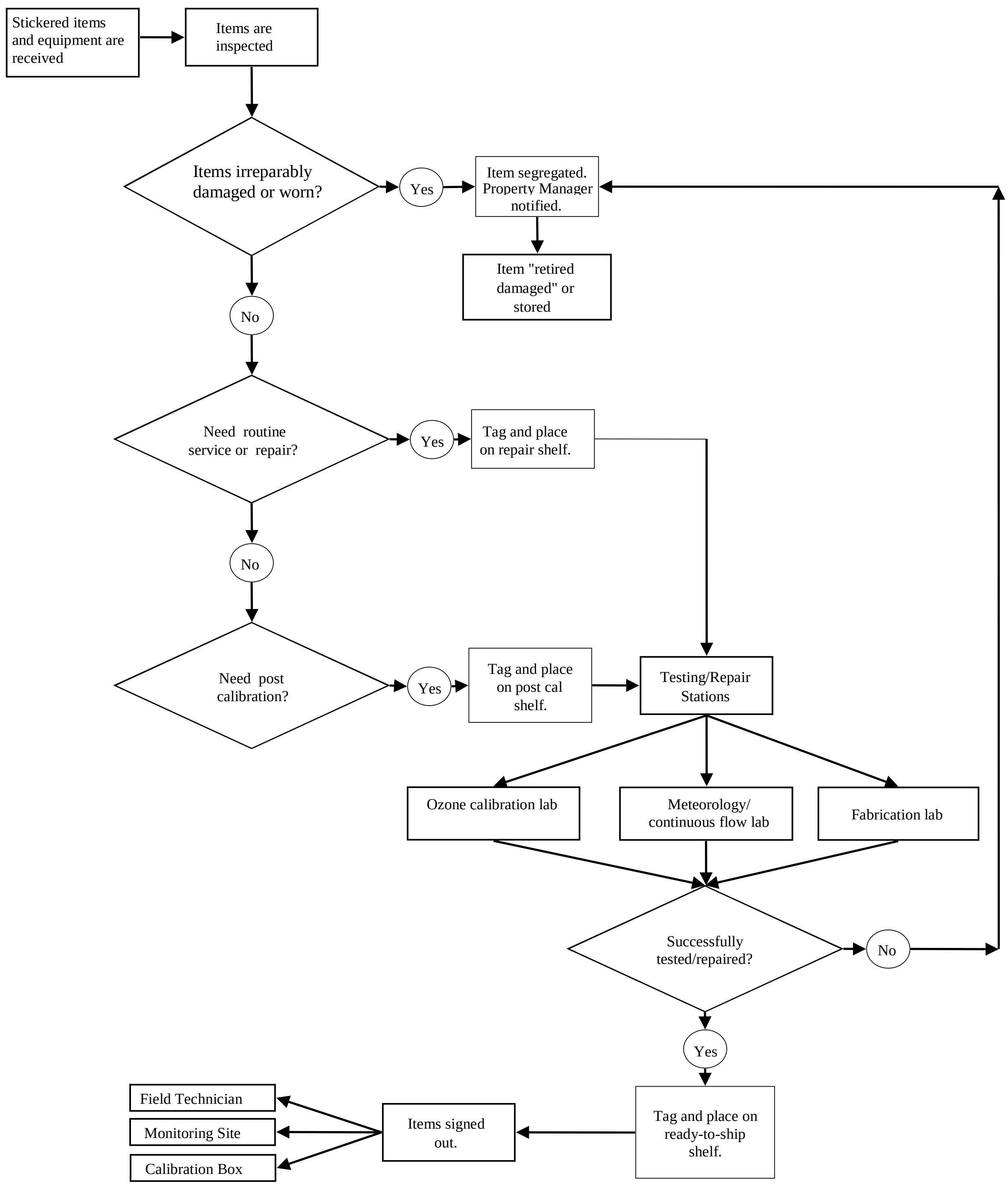
The operation and maintenance of site instruments is common among the four groups introduced above. Sections II thought IV provides separate descriptions of the instruments and related equipment. The subsections that detail the instruments are listed in Table I-1. Section II.A.2 provides a general overview of the instruments. Section II.D furnishes instructions for site operators. Section III gives calibration procedures for Amec Foster Wheeler and subcontractor field technicians.

Table I-1. Appendix 1 Sections that Describe the Site Instruments and Related Equipment

Instrument	Overview Instruments Section II.A.2	Site Operations Field Operations Section II.D	Field Calibrations Field Manual Section III
Data Acquisition	3.2	II.D.1	6.1 & 6.2
Regulatory O_3	3.3	II.D.3	6.3
Trace Gas*	3.4		
Filter Sampling	3.5	II.D.2	6.4
Precipitation Gauge**	3.6	II.D.4	6.6.1
Wetness	3.7	II.D.5	6.6.2
Solar Radiation	3.8		6.6.7, 6.6.8
Meteorological Systems			
Climatronics	3.9	II.D.6	6.6.1
RM Young	3.10	II.D.7	6.6.3, 6.6.4, 6.6.5, 6.6.6

* See QAPP Appendix 11 for details of trace gas measurements.
** Meteorological measurements have been discontinued at all but four EPA sites.

Figure I-1. CASTNET Field Calibration Laboratory Procedural Flowchart



I. SITE SELECTION PROCEDURES
A. SITE INSTALLATION, INITIATION, AND OPERATOR TRAINING

Effective Date: 10/30/14

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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Reviewed by:	Title:	Date:	Signature:
MS	QA Mgr	11/2/15	

I. A. SITE INSTALLATION, INITIATION, AND OPERATOR TRAINING

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide consistent guidance to the Field Installation Team and the Station Initiation Team or a combined Installation/Initiation Team.

2.0 SCOPE

This SOP applies to all CASTNET site installation and initiation activities.

3.0 SUMMARY

The procedures discussed in this section were prepared to support the installation and initiation of a new site at a new geographic location. New CASTNET sites have sometimes been located at existing monitoring sites or sites with other operations. These sites already included much of the logistics required for air quality monitoring. Consequently, only one team was needed for both installation and initiation. However, the procedures herein apply to site installation and initiation activities or both.

The general approach employed in site installation and initiation minimizes travel and shipment of equipment while maximizing the efficiency of field installation and initiation teams. When possible, sites are scheduled for installation in geographic clusters. Field equipment is drop-shipped to or near each site, further minimizing travel time and shipping costs.

Installation of the shelters and towers (Figure 1) does not require onsite power. Therefore, two teams of AMEC employees might be involved. The first team on site is the Field Installation Team, and the second is the Station Initiation Team. As noted above, an installation may only require a combined installation/initiation team. In such cases, the work scope is more limited than discussed in Section 6.0. The composition and responsibilities of each team is discussed in the following sections.

4.0 MATERIALS AND SUPPLIES

Site materials will include all necessary site sensors and sampling equipment plus the tools and hardware necessary for the specific site installation. Refer to Figure 2 for an example of the "Site Installation Materials Kit"

5.0 REPAIR AND MAINTENANCE

N/A

6.0 PROCEDURES

6.1 Field Installation Team

The Field Installation Team consists of two technicians. The technicians are knowledgeable in the use of electrical and hydraulic equipment, as well as utility installation requirements. Additionally, the technicians are familiar with land surveying equipment and the CASTNET equipment siting requirements.

The Field Installation Team is responsible for delivery of the shelter, towers, support materials, and all monitoring equipment procured and tested in accordance with the Property Control Procedures Manual in Appendix 9 of this Quality Assurance Project Plan (QAPP). The team typically requires 2 to 3 days to install all pilings, footers, conduits, towers, and internal hardware, and to confirm final arrangements for electricity and telephone service. When the team leaves, all necessary materials are installed onsite and awaiting the arrival of the Station Initiation Team. Occasionally, the field installation work is subcontracted to a contractor experienced with CASTNET sites.

6.2 Station Initiation Team

The Station Initiation Team consists of one senior and one junior or trainee technician. The Station Initiation Team installs and calibrates onsite equipment and brings the station up to full operational status. The Station Initiation Team is responsible for ensuring proper alignment of all meteorological sensors (if necessary), configuring the data acquisition system (DAS)/CR3000 data logger, and performing initial calibrations prior to the arrival of the independent field audit personnel. The Station Initiation Team is also responsible for establishing initial modem communications between the site and the AMEC Data Management Center (DMC). Please refer to Section 1, "Project Overview," of this QAPP for the list of sites performing meteorological measurements.

6.3 Pre-installation Activities

Considerable work must be completed after the selection of a site for installation but prior to mobilizing the installation and initiation teams. These activities include arranging utilities installation, site security, shipping of major equipment and support materials, and ensuring compliance with local codes.

6.3.1 Electricity, Telephone, and Communications Requirements

As part of the initial site survey, the names, addresses, and telephone numbers of providers of electrical and telephone/communications service for the area are recorded. These include NL-115 ethernet port for cellular service or a COM 220 telephone modem for sites which lack reliable cellular phone service. The DAS includes a laptop computer with the software package PC200W.

Initial determinations of right-of-way requirements are also made during the site-selection visit. If the site is located within a state or National Park; on university, commercial, or research property; information including the name, telephone number, and address of the point of contact for the agency will be obtained. In the majority of installations, it is also necessary to have from 50 feet (ft) to approximately 2,000 ft of telephone and electrical service line installed. Whether such installation can be provided by the utility company, private contractor, or by the host agency must be determined early in the process.

6.3.2 Electrical Requirements

6.3.3 The electrical requirement is 220 volts alternating current (VAC) consisting of two 110-VAC single-phase lines. The maximum load requirement for the existing equipment is approximately 50 amperes (amps). To accommodate any future additions to the demand, 100-amp service is installed at all sites. The 220-VAC service is required for provision of separate 120-VAC legs to ensure isolation of monitoring equipment from heating, ventilation, and air-conditioning (HVAC) equipment. All equipment is 120 VAC, 60 Hertz (Hz).

6.3.4 Telephone Line Requirements

6.3.5 Telecommunication with the data logger by way of telephone modem (cellular or land line) is an integral part of network operations and data collection. A connection of sufficient quality must be available. A good indication of the quality of service to be expected can be obtained by talking with the applications personnel from the company that services the area.

6.3.6 Fees, Deposits, and Billings

6.3.7 All fees, deposits, and billings are handled directly by AMEC. Installation fees and deposits are identified and paid as quickly as possible to minimize time between placement of the work order request and power or telephone installation. Documentation is retained for all deposits made. All monthly utility billings are handled by AMEC. Billings are checked for reasonableness in rates, consumption, and documented adjustments.

6.3.8 Utility Installation Schedule

6.3.9 Utility installation is scheduled (and tracked) to ensure timely provision of services. Such scheduling is coordinated with the Field Installation Team, Station Initiation Team, and providers of utility services so that power is available prior to the arrival of the Station Initiation Team.

6.3.10 Site Operator Assistance

6.3.11 Prospective site operators are required to assist in the selection of local contractors, as needed, and to assist in the arrangement of utility installation. The site operator provides the utility personnel with access to the site should utility installation take place in the interim between onsite Field Installation Team and Station Initiation Team activities.

6.3.12 Drop-Shipment of Equipment

Arrangements are made with the manufacturers of the towers, shelters, other equipment (e.g., rain gauges, wet-dry collectors, if necessary) and numerous electrical components to have the equipment shipped directly to the sites or a nearby AMEC office. However, sensors, analyzers, and sensitive equipment which must undergo acceptance testing are first shipped to AMEC's Gainesville, Florida office.

6.3.13 Advance Installation

Where possible, the services of the host agency or a local contractor are sought for preparation of shelter foundations and tower bases prior to arrival of the Field Installation Team. Local services are also enlisted for trenching and installing power and telephone cables. Provision of such advance services further minimize the time required onsite by the Field Installation Team the availability of such services are determined with assistance from the site operator.

6.3.14 Building Codes and Rights-of-Way

Prior to the initial planning of any installation, the applicability of local building and electrical codes, right-of-way requirements, and requirements for use of union labor are determined. In many instances, such an installation is considered temporary and code applicability is minimal or nonexistent. In other cases, footers must be poured below the frost line, towers guyed, and the electrical configuration inspected prior to initiation of service. Requirements for right-of-way authorization are also highly variable and will be determined early in the site-selection process.

6.4 Site Installation

A typical site configuration is shown in Figure 1. All physical components shown will be installed, as necessary, either prior to arrival of or by the Field Installation Team using procedures described in the Appendix to this section. Variations will occur as a function of existing facilities, security, or other site-specific considerations.

6.4.1 Site Preparation

Trees, low-lying vegetation, and overgrowth are cleared at most sites. Host agencies or institutions are requested to provide such services where possible.

If such assistance is not available or has not been arranged in advance, the Field Installation Team accomplishes as much clearing as possible and flags larger trees and areas for subsequent clearing by local contractors. The Field Installation Team arranges for such services prior to the arrival of the Station Initiation Team, if possible.

6.4.2 Tower Installation

A CASTNET station will include an air quality tower for sampling atmospheric pollutants and may include a meteorological instrument tower if required. A third, minor structure is a 1-meter (m) tubular aluminum “T”, which supports the tipping-bucket rain gauge and solar pyranometer, if required. Alternatively, these instruments may be mounted on separate 1-m masts.

6.4.3 Arrangement of Internal Equipment

6.4.4 All required monitoring equipment is stored inside the shelter upon arrival at the site. Prior to departure of the Field Installation Team, the equipment is unpacked and placed in the positions that they will occupy during normal operation. All EPA barcodes and serial numbers are verified and any equipment shortage noted so that needed materials may be shipped with, or prior to the arrival of, the Station Initiation Team.

6.4.5 Data Logger

Each piece of equipment that provides either a continuous analog or digital output is connected to the CR3000. This includes outputs from all flow meters and controllers. The following parameters have recordable outputs: precipitation, wind speed (scalar and vector) and direction, temperature 1 (T1 at 9m), temperature 2 (T2 at 2m), relative humidity, solar radiation, wetness, filter pack flow, shelter temperature, and gas analyzers including ozone (O_3) and trace gases.

6.4.6 Installation of External Monitoring Components

All instruments are installed following recommendations and requirements specified in EPA Prevention of Significant Deterioration (PSD) Monitoring Guidelines and the *QA Handbook for Air Quality Measurement Systems,* Volumes I through IV. Wind, temperature, and humidity sensors are installed on the meteorological tower.

6.4.7 Site Security

At certain CASTNET monitoring sites, security is a major consideration. In those cases, additional measures are taken, such as the installation of a 6-ft chain-link fence (with barbed-wire top, if deemed necessary). The exact dimensions of the fenced area may vary from site to site. Where there is existing fencing, tie-ins are made to share a common run and reduce costs. In all cases, local contractors or installers are employed and fencing materials acquired locally.

6.5 Station Initiation

The site initiation task is accomplished by the Station Initiation Team and requires the final installation and calibration of all monitoring and data acquisition equipment.

6.5.1 Site Operator Assistance

It is essential that the site operator(s) be onsite during the configuration and installation of the equipment. The system as a whole is covered in detail during installation. The site operator's assistance expedites the initiation process and provides valuable training. During such onsite assistance, the Station Initiation Team reviews all phases of training, with the site operator. Following training, the Station Initiation Team requires the site operator to perform all site tasks as if routine operations were underway.

6.5.2 Initial Equipment Calibration

All equipment installed is carefully calibrated by the Station Initiation Team prior to departure. Summaries of field calibration procedures for each respective device are discussed in Section III, Field Calibrations. All instruments are installed, tested, and calibrated following these SOPs.

6.5.3 Data Logger

The CR3000 data logger is checked and all operations verified prior to departure of the Station Initiation Team. The programmed zero, span, and precision control sequence for the gas analyzers, and other instruments are exercised and recorded. The programmed actuation of the various flow sampling systems are tested, and the resultant flows are measured on the respective sample lines. All channels on the data logger are properly sequenced and initialized. The communications equipment is tested to ensure proper functioning.

After all systems are calibrated and all equipment is operating, the telephone and modems connections are tested. The data logger is equipped with a Raven cellular modem and a network router, both of which are mounted to a second metal plate. This assembly is referred to as the “communications backplane”. It is mounted near the data logger backplane. The Raven modem allows AMEC remote access to the data logger, stored data, ozone analyzer and site laptop computer. The router allows these devices to communicate with one another and the Raven modem.

6.5.4 Support Materials

Prior to departure of the Station Initiation Team, all onsite support materials are inventoried. The quantity of materials onsite should be sufficient to ensure uninterrupted operation for at least one calendar quarter. The site operator is familiarized with the mailing and shipping protocols, FedEx account and procedures, U.S. Postal Service Return Merchandise account, and contact points (work and home telephone numbers) for key personnel on the CASTNET project. In addition, a large calendar showing sample dates, maintenance schedules, data shipment dates, and site visit dates is installed in the shelter.

6.5.5 Site Initiation Closeout Session

Prior to departure of the Station Initiation Team, all site operations are reviewed with the site operator providing a hands-on demonstration of performance of all tasks. The Station Initiation Team documents and evaluates the site operator's performance and assists as necessary. The Station Initiation Team checks all electronic calibration forms for completeness and make entries in the site narrative log to document the calibrations and other significant installation-related tasks performed.

Copies of all calibration forms and property inventories are maintained both onsite and at the AMEC Gainesville office. Equipment shortages or discrepancies, if any, are noted and corrective actions initiated.

Site-specific inventory forms, which documents model numbers and the EPA barcodes (generated for each site prior to mobilization of equipment), are verified prior to departure of the Station Initiation Team. Upon return to the AMEC office, the Station Initiation Team Leader submits the verified inventory document for cross checking with the database inventory file, which is maintained by the Custodial Property Manager.

6.5.6 Site Collocation

To determine precision of the CASTNET measurements, a site may be designated as a collocated. All instruments are installed in identical configurations and carefully calibrated. Sensors are located so that they will not interfere with each other's operation or response, yet are expected to provide identical results (i.e., wind speed and direction sensors separated so as not to create turbulence).

6.6 Operator Training

6.6.1 Initial Site Operator Training

Potential site operators are required to attend and successfully complete a training seminar provided onsite. The details of the training are discussed in Section II, Site Operations, in the subsection titled “Site Operator’s Instructions.” The training topics include a CASTNET overview, the operations of sampling equipment and procedures, and the importance of documentation.

The CASTNET site operator training plan consists of an overview of general project operations and goals, and provides intensive instruction in specific site operator responsibilities. The project overview orients the trainee as to his/her role within the network and stresses the importance of proper site operation in the accomplishment of project goals. The instructional session provides the means for producing proficient site operators.

6.6.2 Follow-up Training

During the site initiation, the site operator training continues. Site operators observe instrument installation and initial calibration. It is essential for site operators to be able to change out equipment or components, if necessary.

Once the station is completely operational, the Site Initiation Team members thoroughly cover the operations of the site as configured with the site operator. They then observe the site operator's performance on all tasks that are required to operate a site without assistance. The Site Initiation Team repeats tasks as required until both the site operator and trainer feel comfortable with the site operator's performance. Emphasis is placed on instrument maintenance, repair, and sample change-out procedures. Site operators may be required to visit sites during semi-annual calibrations for additional training as necessary.

6.6.3 Verification of Training

The Site Initiation Team assesses the abilities of the site operator before departing the site. The team's evaluation of the site operator's performance is discussed with the Project Manager and/or Field Operations Manager.

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring.* 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS).* 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

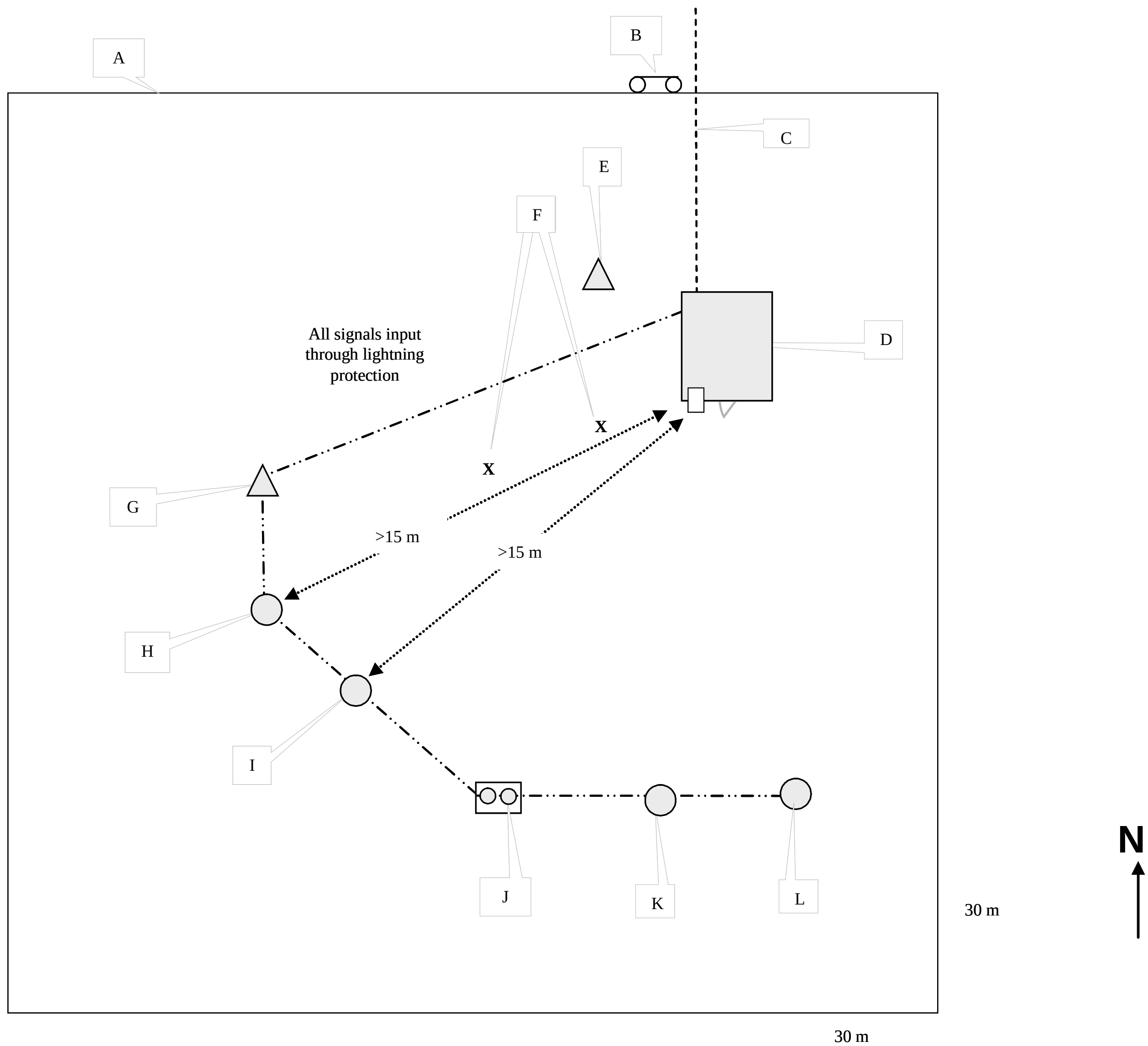
U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods.* EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements.* EPA-600/4-82-060.

8.0 FIGURES

Figure 1. Typical EPA Sponsored CASTNET Site Configuration



A – Site Perimeter
B – Stub Pole, Disconnect, Electric Meter
C – 220 VAC/100 amp and Telephone Line (underground for at least the final 15 to 35 meters)
D – 8’ x 10’ Aluminum Environmental Shelter (Temperature Controlled)
E – Air Sampling Tower
F – Approximate Position of Tower Tops when lowered
G – Meteorological Tower
H – Tipping Bucket Rain Gauge (> 15m from shelter)
I – Solar Radiation Sensor (>15 m from shelter)
J – Wet/Dry Collection (optional)
K – Belfort Weighing Rain Gauge (optional)
L – Wetness Sensor

Figure 2. Site Installation Materials Kit (Page 1 of 2)

SITE INSTALLATION KIT - MASTER FILE - CODE 25								
DATE PULLED	PART NAME	HESE NUMBER	QTY	DESCRIPTION	MANUFACTURE	MODEL NUMBER	VENDOR	PART NUMBER
		601-022	2	CAP SCREW, HEX 3/8-16			MCMASTER CARR	92198A632
		601-038	15	CRIMPS, 1/8"			MCMASTER CARR	3897T5
		601-049	2	NUT, LOCKING 3/8-16			N/A	90099A031
		601-058	4	CABLE CLAMPS			MCMASTER CARR	3465T11
		601-059	4	CABLE CLAMPS			MCMASTER CARR	3465T12
		601-060	4	CABLE THIMBLE			MCMASTER CARR	8914T13
		601-064	2	CLAMP, GROUNDING TO ROD			ACE ELEC SUPPLY	BLKBG5
		601-065	2	CLAMP, GROUNDING PIPE 1/2 TO 3/4			ACE ELEC SUPPLY	BLKBJJR
		601-066	2	CLAMP, GROUNDING PIPE 1 TO 1 1/2			ACE ELEC SUPPLY	BLKBJ2
		601-072	3	TURNBUCKLE, SS TOWERS			MCMASTER CARR	30095T33
		601-073	3	ANCHOR SHACKLES			MCMASTER CARR	3558T46
		701-021	1	training FILTER ASBLY 47mm			SAVILLEX	4-147-4
		701-075	3	PVC 1 1/2" SWEEP			CAMERON & BARKLEY	502-405
		701-088	1	ROD, GROUNDING		N/A	ACE ELEC SUPPLY	BLKBGR-6258
		701-094	250	WIRE, GUY SS			MCMASTER CARR	8908T662
		901-002	2	SILICONE TUBES CLEAR			MCMASTER CARR	7587A37

Figure 2. Site Installation Materials Kit (Page 2 of 2)

SITE INSTALLATION KIT - MASTER FILE - CODE 25								
DATE PULLED	PART NAME	HESE NUMBER	QTY	DESCRIPTION	MANUFACTURE	MODEL NUMBER	VENDOR	PART NUMBER
		901-003	1	TEFLON TAPE			MCMASTER CARR	4591K13
		901-005	1	DUCT TAPE			MCMASTER CARR	7612A1
		901-006	1	ELECTRICAL TAPE			MCMASTER CARR	76455A11
		N/A	1	FISH TAPE			MCMASTER CARR	7313K11
		N/A	1	ASSORTED NAILS			N/A	N/A
		N/A	1	ASSORTED SCREWS			N/A	N/A
		N/A	1	EXTENSION CORD 50'				N/A
		N/A	1	GUY WIRE CRIMPER			MCMASTER CARR	N/A
		N/A	1	GUY WIRE CUTTER			MCMASTER CARR	N/A
		N/A	1	dewalt kit				N/A
		N/A	1	10 lb hammer			N/A	N/A
		N/A	1	2 inch fence post driver			ESE	N/A
				shovel				
				post-hole digger				
				cement mixing tub				

II. SITE OPERATIONS
A. SITE OPERATOR HANDBOOK (SITE OPERATOR OVERVIEW)
1. OVERVIEW: SITE OPERATOR PROCEDURES

Effective Date: 10/30/14

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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Annual Review			
Reviewed by:	Title:	Date:	Signature:
MS	QA Mgr	11/2/15	[signature]

II.A.1. OVERVIEW: SITE OPERATOR PROCEDURES

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide consistent guidance to each Site Operator in performance of weekly site visits.

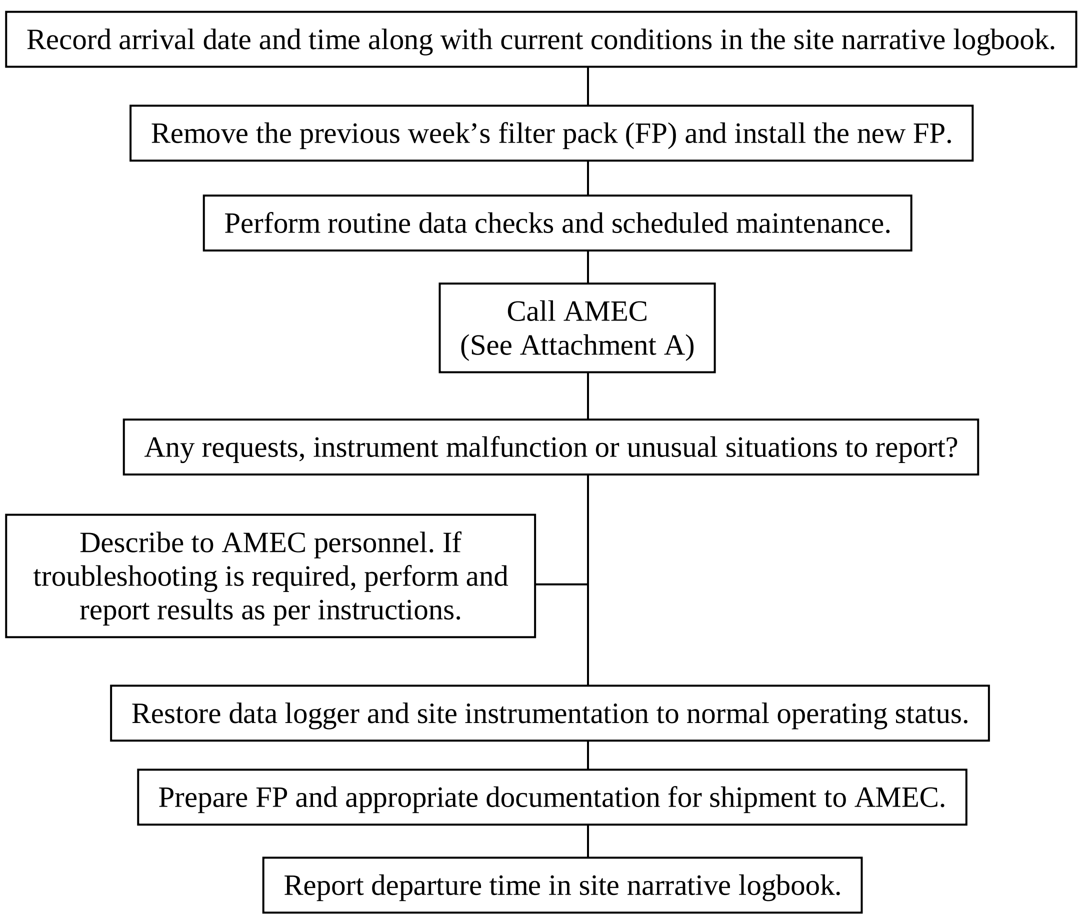
2.0 SCOPE

This SOP applies to all CASTNET Site Operators.

3.0 SUMMARY

Each Tuesday the site operator visits the site, performs routine checks and maintenance, reports results to the Field Operations Manager (FOM), or Field Operations Coordinator (FOC), or their designee by telephone, and installs a fresh filter pack (Figure 1). The exposed filter pack is shipped to the Gainesville office along with documentation of the site visit.

Figure 1. CASTNET Site Operation



4.0 MATERIALS AND SUPPLIES

New (unexposed) filter pack
Filter pack shipping tube
Blank Site Status Report Form (SSRF). See Section II. B., Figure 1.
Site Narrative Log
Ink pen
Disposable non-latex gloves

5.0 SAFETY

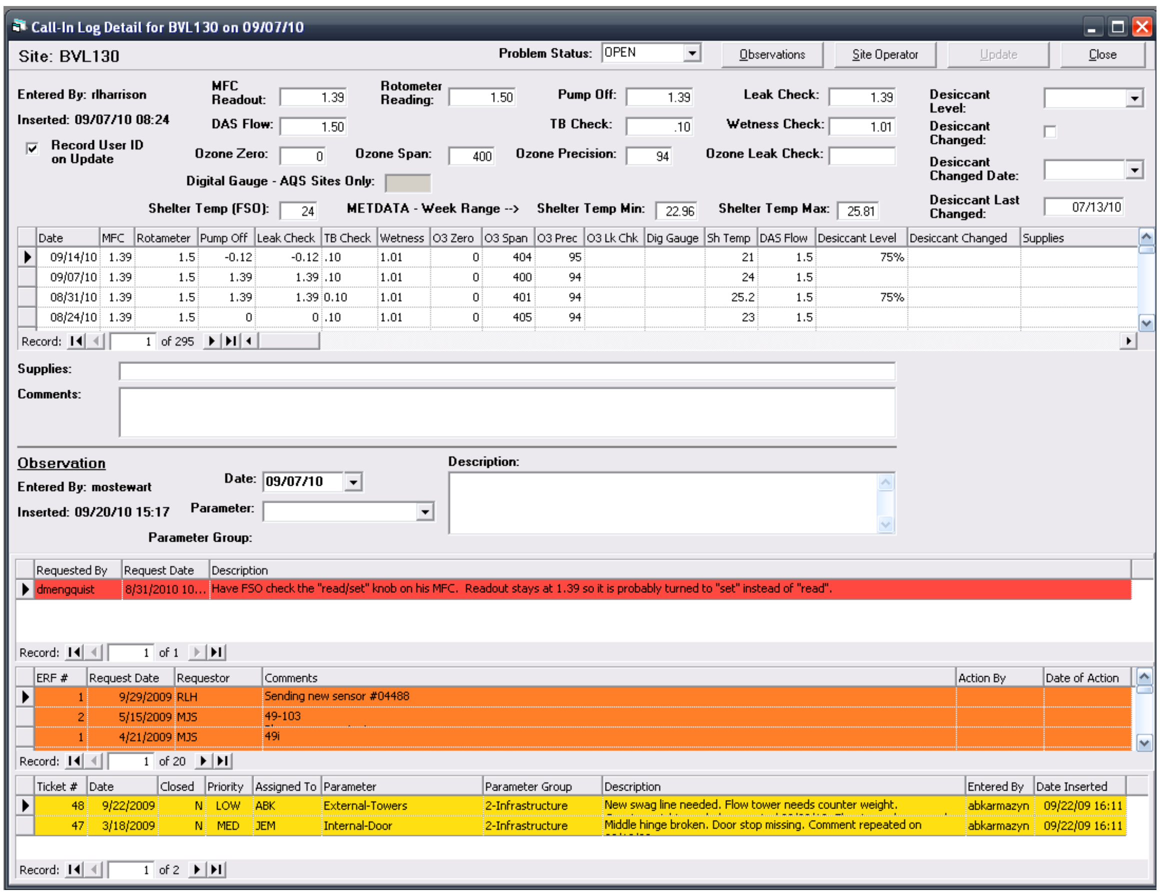
A hard hat must be worn when raising and lowering towers. If it is necessary to repair or service an instrument, remove personal jewelry, turn off the instrument power and disconnect (unplug) to avoid contact with live current. Always use a safety harness when climbing.

6.0 PROCEDURES

- Record arrival **time** and local **weather conditions** in the **log book**.
- Confirm that the **time** and **date** are correct on the **Data Logger.**
- Confirm that the **shelter temperature** has been between 20˚ C and 30˚ C.
- Confirm that the ozone analyzer performed a proper **zero, span and precision check**.
- Record times that channels were down in the site narrative log book.
- Ensure that the equipment is operating properly and that data are reasonable.
- Perform the flow and ozone system **leak checks** and record results.
- **Reset the hour-meter** after the previous week's filter pack is uninstalled.
- Record the **time/date and filter ID** in the **log book** when the new filter pack is installed.
- Turn the **flow pump on** after installation of the new filter pack.
- Ensure that the tipping bucket is clean and level, if a tipping bucket is operated.
- Ensure that the solar radiation sensor is clean and level, if solar radiation is measured.
- Check the zero-air desiccant and replace if more than 50% exhausted.
- Check both knock-out bottles for moisture and report results to AMEC (Attachment A).
- Set all **channels up** for data collection when tasks are complete.
- Complete all **paperwork.**
- Ensure that the **Raven modem** is online and operating properly.
- Ensure that the Ozone Analyzer is in Sample Mode.
- **Reset** the **min/max** thermometer.
- Prepare the filter pack (tube), logbook pages and Site Status Report Form (envelope) for shipment.
- **Call AMEC** to report the site conditions and results of instrument checks. See Attachment A for contact information.

- **Complete AMEC Site Call-In Log**
- All telephone conversations between site operators and the AMEC field operations staff are logged at the AMEC office in Gainesville using the electronic site call-in log. Every Tuesday, when site operators call the field FOM, FOC or other assigned personnel to report the status of their sites, the reported data are entered in the log shown below in Figure 2. After entry, data are available to all CASTNET personnel for review. The form provides areas for:
  - Entering data, equipment status and supply requests provided by the operators,
  - Reviewing open problems and equipment recently shipped to the site, and
  - Viewing the results from previous calls.

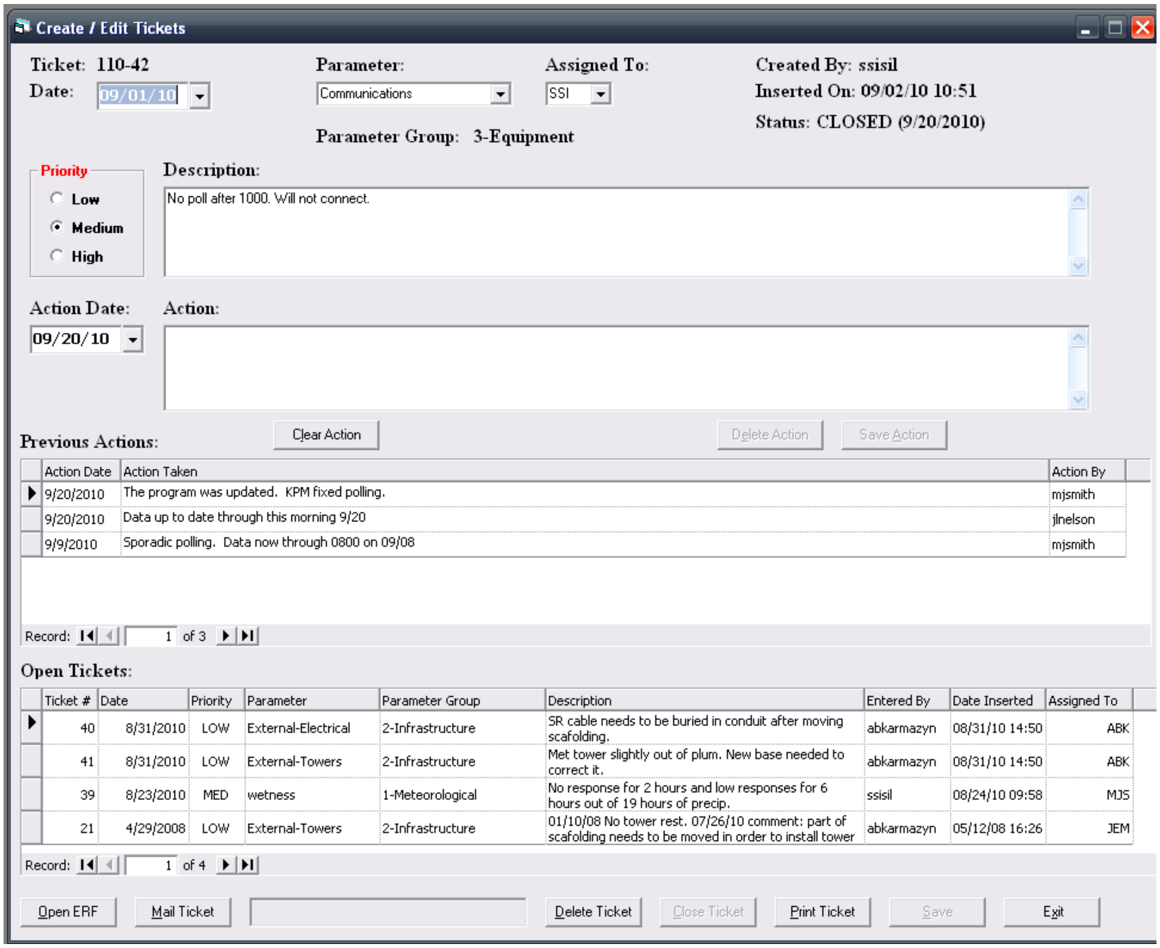
Figure 2. Site Call-In Log



Note: Site Call-In Log serves to document site operator communications, including questions or suggestions from the site operator and onsite troubleshooting performed.

- Field operation problems and related actions detected and/or discussed during the telephone call will be entered into the problem tracking system (PTS) database. The PTS allows staff to ticket documented observations as problems requiring follow-on action (see Figure 3). The open ticket, labeled by site ID and a ticket sequence number, will be used by AMEC staff to monitor known problems and document follow-on actions as well as problem resolution when the ticket is officially closed. The PTS also serves to document the time required to resolve a given problem by the number of days a ticket is open.

Figure 3. Example Ticket Report for CTH110, NY



Create / Edit Tickets

Ticket: 110-42
Date: 09/01/10
Parameter: Communications
Assigned To: SSI
Created By: ssisil
Inserted On: 09/02/10 10:51
Status: CLOSED (9/20/2010)
Parameter Group: 3-Equipment

Priority: Low / Medium (selected) / High

Description: No poll after 1000. Will not connect.

Action Date: 09/20/10
Action:

Previous Actions: Clear Action | Delete Action | Save Action

Action Date	Action Taken	Action By
9/20/2010	The program was updated. KPM fixed polling.	mjsmith
9/20/2010	Data up to date through this morning 9/20	jlnelson
9/9/2010	Sporadic polling. Data now through 0800 on 09/08	mjsmith

Record: 1 of 3

Open Tickets:

Ticket #	Date	Priority	Parameter	Parameter Group	Description	Entered By	Date Inserted	Assigned To
40	8/31/2010	LOW	External-Electrical	2-Infrastructure	SR cable needs to be buried in conduit after moving scafolding.	abkarmazyn	08/31/10 14:50	ABK
41	8/31/2010	LOW	External-Towers	2-Infrastructure	Met tower slightly out of plum. New base needed to correct it.	abkarmazyn	08/31/10 14:50	ABK
39	8/23/2010	MED	wetness	1-Meteorological	No response for 2 hours and low responses for 6 hours out of 19 hours of precip.	ssisil	08/24/10 09:58	MJS
21	4/29/2008	LOW	External-Towers	2-Infrastructure	01/10/08 No tower rest. 07/26/10 comment: part of scafolding needs to be moved in order to install tower	abkarmazyn	05/12/08 16:26	JEM

Record: 1 of 4

Open ERF | Mail Ticket | Delete Ticket | Close Ticket | Print Ticket | Save | Exit

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*. 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)*. 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems*, Vol. I, Principles. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems*, Vol. II, Ambient Air Specific Methods. EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems*, Vol. IV, Meteorological Measurements. EPA-600/4-82-060.

8.0 ATTACHMENTS

Attachment A – AMEC Contact Information
Attachment B – Purpose of CASTNET

ATTACHMENT A
AMEC CONTACT INFORMATION

Field Coordination Center at:

- 1-352-332-5770* or
- 352-333-6611

***This is a direct line to all calibrator desks. It may be busy for long periods of time, and calls to this line cannot be transferred between technicians once it is answered. To use the automated central phone system call:

- **1-352-332-3318 or**
- **1-888-224-5663**
- Field Operations Phone ext. 6611

For urgent assistance, and if above numbers are busy, please dial:

CONTACT	Office Phone	E-mail	Cell Phone
In order of whom you should contact first:			
Mike Smith **Field Coordinator**	**352 333 6620**	**Michael.J.Smith@amec.com**	**N/A**
Kevin Mishoe **Field Operations Manager**	**352 333 6629**	**Kevin.Mishoe@amec.com**	**352 339 5394**
Selma Isil **Data Analyst**	**352 333 6607**	**Selma.Isil@amec.com**	**518 593 9814**
Kemp Howell **Project Manager**	**352 333 6612**	**Kemp.Howell@amec.com**	**352 317 7524**

ATTACHMENT B
Purpose of CASTNET

The Clean Air Status and Trends Network (CASTNET) is a national long-term environmental monitoring program administered and operated by the Environmental Protection Agency and the National Park Service. The network was developed from the National Dry Deposition Network (NDDN) which was established in 1987. CASTNET was established in 1991 under the 1990 Clean Air Act Amendments. The network was created to assess trends in air quality, atmospheric deposition, and ecological effects that result from air pollutant emission reduction regulations, such as the Acid Rain Program (ARP) and NO_x Budget Trading Program (NBP). CASTNET has since become the nation's primary monitoring network for measuring concentrations of air pollutants involved in acidic deposition affecting regional ecosystems and rural ambient ozone levels. Additionally, CASTNET provides data needed to assess and report on geographic patterns and long-term temporal trends in ambient air pollution and dry atmospheric deposition. As of January 2011, meteorological parameters are measured at only four of the EPA-sponsored CASTNET sites: PAL190, TX; CHE185, OK; BVL130, IL; and BEL116, MD.

CASTNET monitors air quality and deposition in cooperation with the National Atmospheric Deposition Program (including the National Trends Network, Atmospheric Mercury Network, and Ammonia Monitoring Network), EPA's National Core Monitoring (NCore), BLM's Wyoming Air Resources Monitoring System (WARMS), the Canadian Air and Precipitation Monitoring Network, and Interagency Monitoring of Protected Visual Environments (IMPROVE).

II. SITE OPERATIONS
A. SITE OPERATOR HANDBOOK
2. OVERVIEW OF CASTNET SITE INSTRUMENTS AND EQUIPMENT

Effective Date: 7-7-16

Reviewed by: Kevin P. Mishoe
Field Operations Manager

Reviewed by: Marcus O. Stewart
QA Manager

Approved by: Holton K. Howell
Project Manager

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Annual Review			
Reviewed by:	Title:	Date:	Signature:

II.A.2. OVERVIEW OF CASTNET SITE INSTRUMENTS AND EQUIPMENT

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide an identification guide for monitoring equipment and sensors utilized at Clean Air Status and Trends Network (CASTNET) sites.

2.0 SCOPE

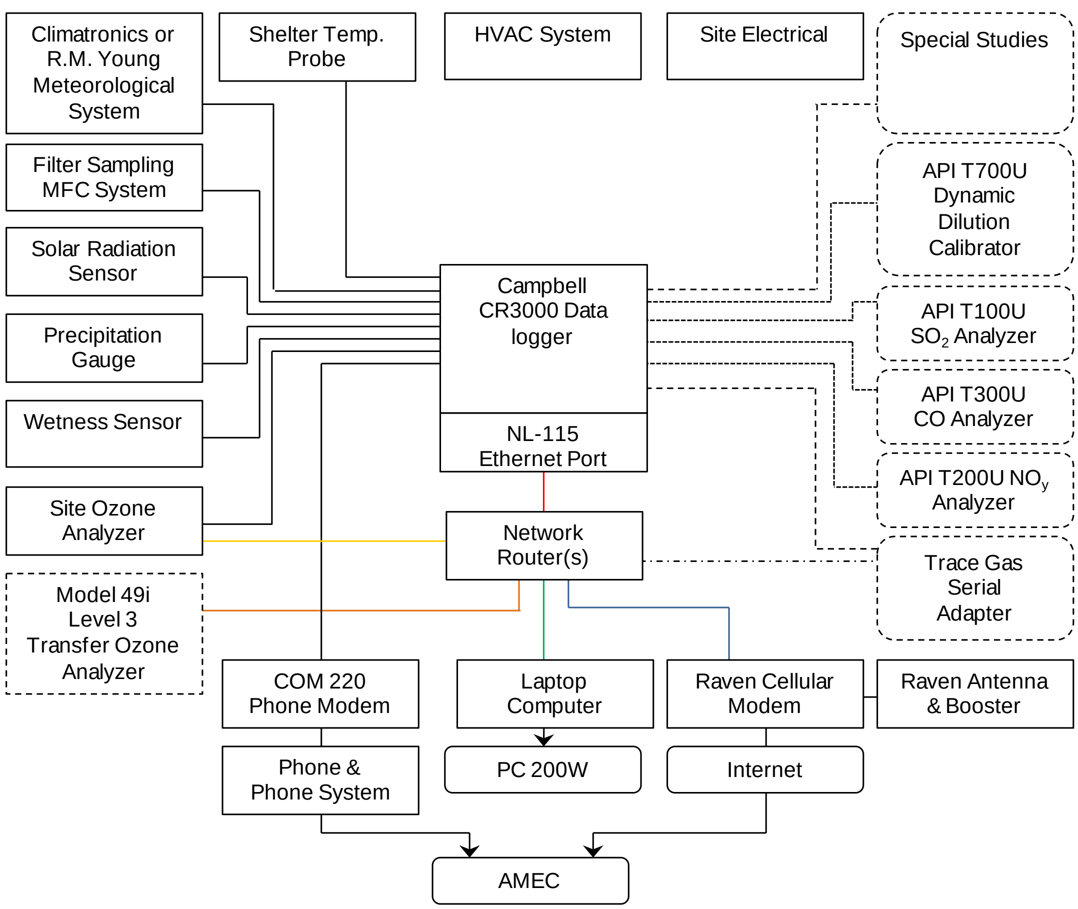
This SOP applies to all CASTNET sites and all CASTNET site operators.

3.0 SUMMARY

3.1 CASTNET Site Overview

Figure 1 shows the instrument and communication system at a CASTNET site. This figure includes the meteorological instruments even though meteorological parameters are currently measured at only four EPA-sponsored CASTNET sites. Meteorological measurements continue at all NPS-sponsored and BLM-sponsored sites.

Figure 1. CASTNET Site Overview



3.2 Data Acquisition System/Data Logger

CASTNET sites are equipped with an array of instruments and software collectively known as the data acquisition system or DAS. The primary purpose of the DAS/data logger is to record sensor and analyzer measurements. Additionally, the DAS includes hardware and software which allows stored data to be retrieved and provides the site operator means to perform weekly checks.

Sensor and analyzer measurements are processed and recorded by a Campbell Scientific Instruments, Inc. (Campbell) CR3000 data logger. The CR3000 data logger is mounted on a metal plate along with a wiring terminal block assembly designed to accommodate necessary sensor wiring and provide electrical surge protection to the data logger. The data logger incorporates an NL-115 ethernet port which is mounted directly to the CR3000. Sites which lack reliable cellular phone signal will also include a COM 220 telephone modem. The entire assembly is referred to as the "data logger back plane" (Figure 2). The data logger backplane is mounted inside the shelter either on the wall or on a 19" rack if the site is so equipped.

The DAS is also equipped with a Raven cellular modem and a network router, both of which are mounted to a second metal plate. This assembly is referred to as the "communications backplane". It is mounted near the data logger backplane. The Raven modem allows AMEC remote access to the data logger, stored data, ozone analyzer and site laptop computer. The router allows these devices to communicate with one another and the Raven modem.

Figure 2. DAS System: Wall Mounted Data logger and Communications Backplane

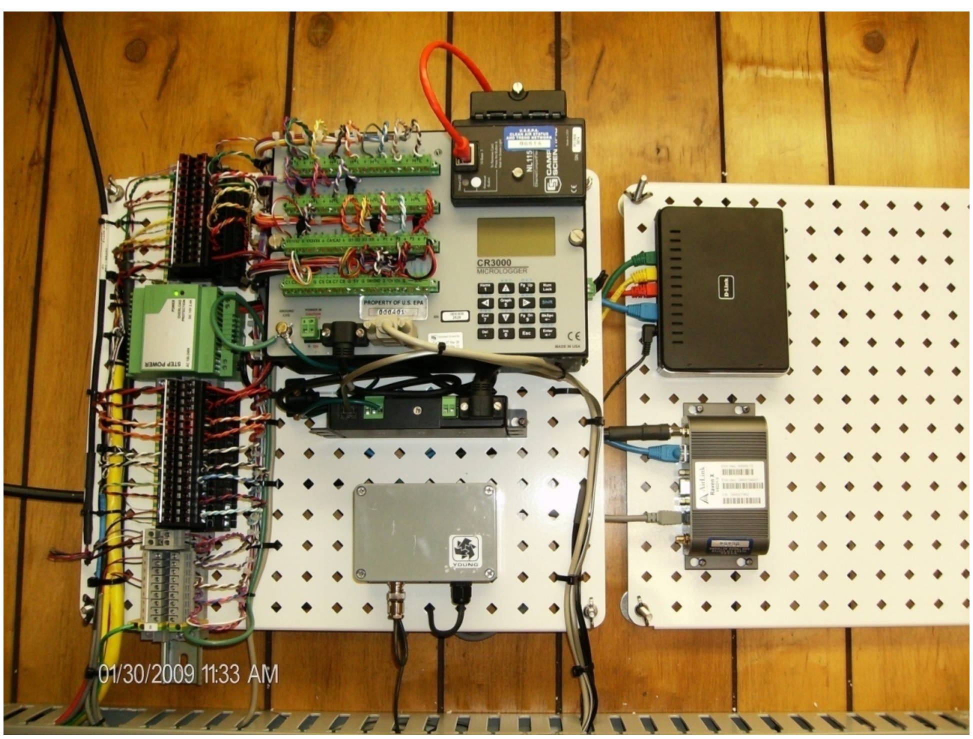
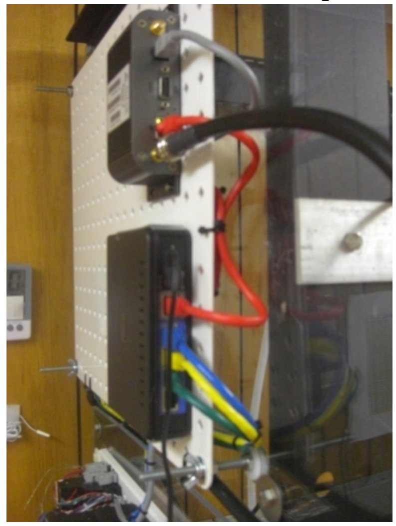


Figure 3 DAS System: Rack Mounted Data logger Backplane

Figure 4. DAS System: Rack mounted Communications Backplane



The DAS includes a laptop computer with the software package PC200W. Through PC200W the site operator is able to monitor measurement data, enable and disable data recording channels enable data logger functions such as the weekly wetness sensor check and precipitation gauge "ten-tip" check and enter numerical correction coefficients when replacing failed sensors.

Figure 5. DAS System: Laptop Computer

Figure 6. DAS System: Yagi Cellular Antenna Mounted on Folding Tower

3.3 Regulatory Ozone Monitoring

CASTNET was not originally designed to operate as a regulatory network. However, as of May 2011, CASTNET O_3 monitoring systems at EPA-sponsored sites comply with regulatory monitoring requirements described in 40 CFR Part 58, Appendix A (EPA 2010), and data collected since the 2011 ozone season have been submitted to the EPA Air Quality System (AQS). The O_3 monitoring systems at NPS-sponsored sites comply with regulatory requirements and data collected are routinely submitted to AQS. Ozone monitoring at CASTNET sites is comprised of two distinct processes. The first process is ambient ozone sampling. The purpose of ambient sampling is to measure the concentration of ozone present in the air. The second process is called a zero, span and precision check, although it is often referred to as a ZSP check or auto-calibration report. The purpose of the ZSP check is to verify that the analyzer is making accurate measurements and that the ozone sample plumbing is not compromised. A single ozone analyzer is used for ambient monitoring and a separate 49i is used as the transfer standard (Figure 7) and the ZSP check.

The data logger controls ambient monitoring and ZSP check processes automatically while recording ozone concentration and the analyzer's operational status. During normal operation the data logger instructs the analyzer to perform ambient sampling. Once per day the data logger instructs the analyzer to perform a ZSP check. During ambient sampling, the parameter "Ozone_ZSP" as displayed in the "1. Site Operator" grid will be reported as "false". During a ZSP check "Ozone_ZSP" will be reported as "true".

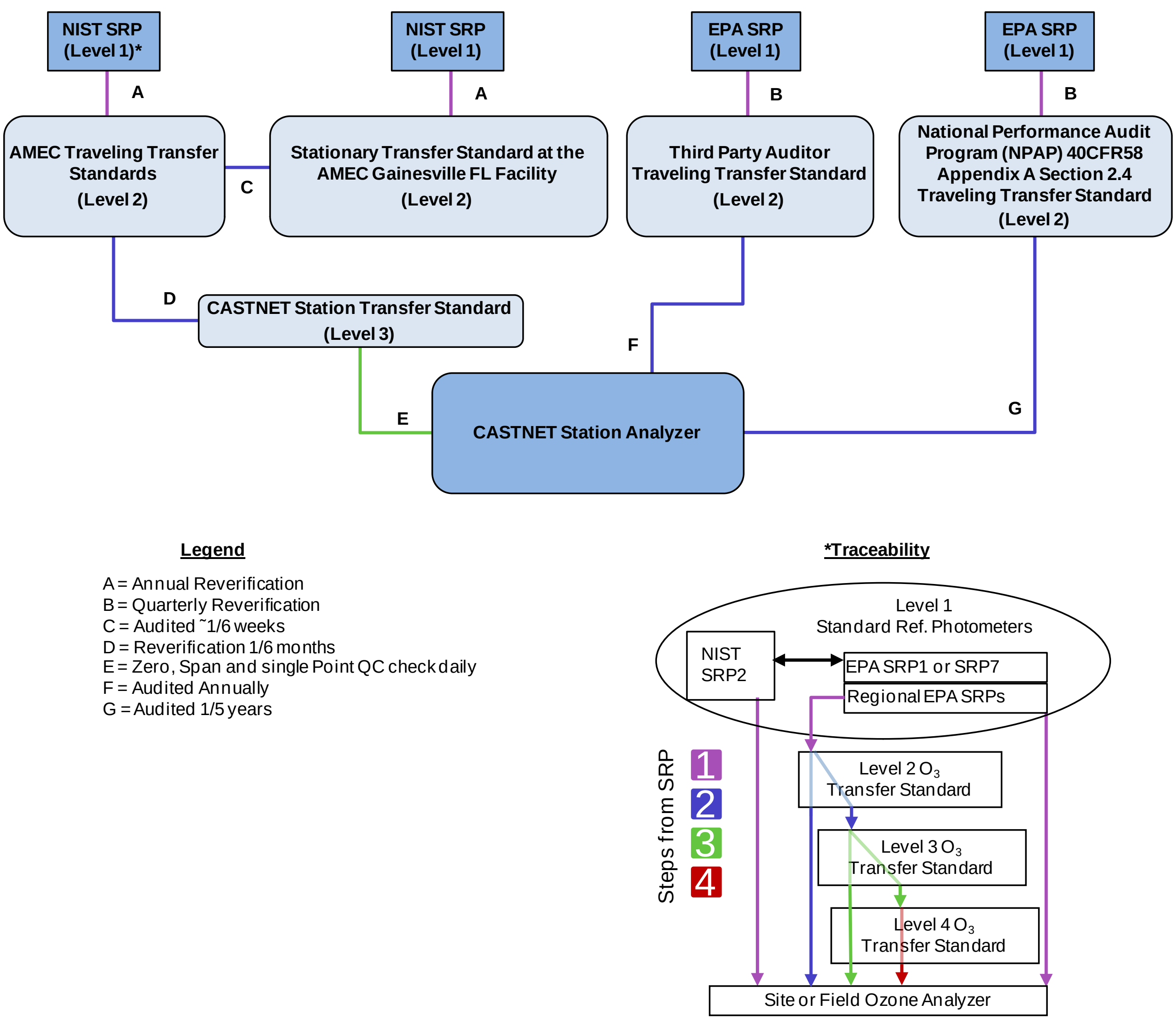
The process of ambient sampling is to draw air from ten meters above the ground into the analyzer. From the inlet port on the flow tower "pot head" the air passes through a 47mm Savillex Teflon filter membrane then travels through tubing into the shelter where it passes through a bottle designed to separate water from the air (knock out or K/O bottle) as well as a second Savillex Teflon filter. The air then enters the analyzer where the amount of ozone present is measured and reported in units of parts per billion (ppb).

Each day a few minutes prior to midnight the data logger tells the ozone analyzer to perform a ZSP check. During the ZSP check the analyzer stops sampling ambient ozone. The zero air system is activated whereby air is forced through a desiccant, reducing agent, and carbon canisters by either a diaphragm pump or in some cases a compressor. The desiccant, reducing agent, and carbon dry the air and remove pollutants including ozone. The carbon canister contains a blend of activated carbon (black pellets), and sodium permanganate (purple pellets). The resulting air stream is known as "zero air" because it has been purified and contains no ozone.

The zero air passes into the analyzer and some of it is routed through the transfer standard where ozone is created within the zero air sample. The sample is then forced out of the analyzer and up to the ozone inlet filter in the flow tower pot head through tubing known as the integrity line. The sample floods the inlet filter and is drawn back to the analyzer's detector and the concentration of ozone is measured.

During the ZSP check the transfer standard produces three different concentrations of ozone for a period of seven minutes each. These concentrations are the zero, span and precision points and correspond to 0 ppb, 225 ppb and 60 ppb respectively. At the end of each phase of the ZSP check the data logger records the concentration of ozone reaching the detector. Following the ZSP check the zero air system and transfer standard are deactivated. The analyzer reverts to sampling ambient air and the data logger records the zero, span and precision values and displays them in the "1. Site Operator Grid of PC200W".

Figure 7. Ozone Certification



If the measured concentrations differ significantly from the targets and prior ZSP check, then diagnostics are performed to assess the measurement system. A leak or analyzer malfunction may be indicated. Table 1 illustrates ozone data quality objectives.

Table 1. Ozone Measurement Quality Objectives

Type of check	Measurement Criteria	Corrective Action*		Multi-Point Calibration Criteria
		Field	Data	
Zero	≤ ± 1.5 ppb	Perform adjusted calibration	Invalid from the last good check until the next good check or adjusted calibration completed	Between 0.0 and ± 1.5 ppb
Precision/Span	≤ ± 7 percent between supplied and observed concentrations	Contact the field coordinator	Invalid from the last good check until the next good check or adjusted calibration completed	All points on calibration curve within ± 2% of full scale as compared to the best fit straight line linearity error < 5%
Correlation Coefficient				≥ 0.995
Frequency of analyzer checks				
ZSP**	One ZSP every day On demand to facilitate trouble shooting Following a multipoint calibration prior to leaving the site			
Calibration	Minimum one multipoint calibration verification every 6 months As required per QC results When performing the semi-annual multipoint verification, calibration adjustment – if needed - must occur within 24 hours of verification			
General				
Verification does not have to be followed by calibration adjustment if all analyzer responses are in a 2 percent of full scale range. **Shelter temperature acceptable range: 20 – 30 degrees C**				

Notes: * Display drifts are frequently due to leaks in the system or lamp degradation/ageing. Verify lamp intensity settings against previously documented values. Perform internal and external leak checks by plugging inlet line in back of the instrument (internal) or tower inlet port (external). A line plug should reduce the internal pressure down to 250 mm Hg or so. Verify external ozone generator pump function and internal pressure using the manual pressure gauge located inside the instrument.

** Zero, Span, Precision automated QC check

Model 49i analyzers communicate with the data logger serially via internet protocol. They are connected to the site router by an Ethernet cable. This allows the data logger to record all of the vital operating parameters except the electronic noise. Noise must be checked manually by the site operator. They are also wired so that the measured ozone concentration is sent to the data logger as an analog voltage signal in the event of communication failure. The ZSP check however will not run automatically if communication fails. Two modes of operation are possible with the 49i: "Sample Mode" and "Service Mode". During normal operation the unit is in "Sample Mode". If left in "Service Mode" for any reason the analyzer will not receive instructions from the data logger.

Most zero air systems utilize a diaphragm pump to supply air to the cartridges and finally the ozone analyzer. In some instances however a compressor may be used instead of a pump. With either type system the normal zero air pressure as indicated by the pressure gauge within the analyzer should be 15 psi when zero air is being used. If not 15 psi, the cause requires investigation.

Zero air is introduced into the analyzer only during a ZSP check. In compressor based systems zero air is always available and a solenoid within the analyzer controls airflow. Diaphragm pump based systems utilize a relay within the analyzer to activate another relay which switches power to the electrical outlet into which the pump is plugged. For Model 49i analyzers the relay and power outlet are located in a black box wired to the rear of the analyzer. The zero air pump for Model 49i systems will switch on anytime the analyzer is not in "Sample Mode".

Ozone analyzers are calibrated every 6 months in the field by AMEC or authorized subcontractor personnel during routine site calibration visits. Inoperative analyzers may be replaced or may be repaired by site operators with the assistance of AMEC Field Operations Personnel. Zero air systems are replaced or repaired as necessary. Routine maintenance of the ozone monitoring system includes replacement of the sample train Savillex 47mm Teflon filter membranes. The outside filter membrane is changed every other week. The inside filter membrane is changed on the first Tuesday of the month. The K/O bottle is emptied of water as necessary and analyzer electronic noise is checked and recorded weekly. The zero air system desiccant is inspected weekly and replaced when 50 percent exhausted.

AMEC Personnel will assist site operators in troubleshooting and repair of an ozone monitoring system that fails to meet ZSP check requirements or if any other form of failure occurs or is suspected. The SOP for AQS-compliant ozone monitoring is given in Section III, Section 6.12 of this appendix.

3.4 Trace Level Gas Monitoring

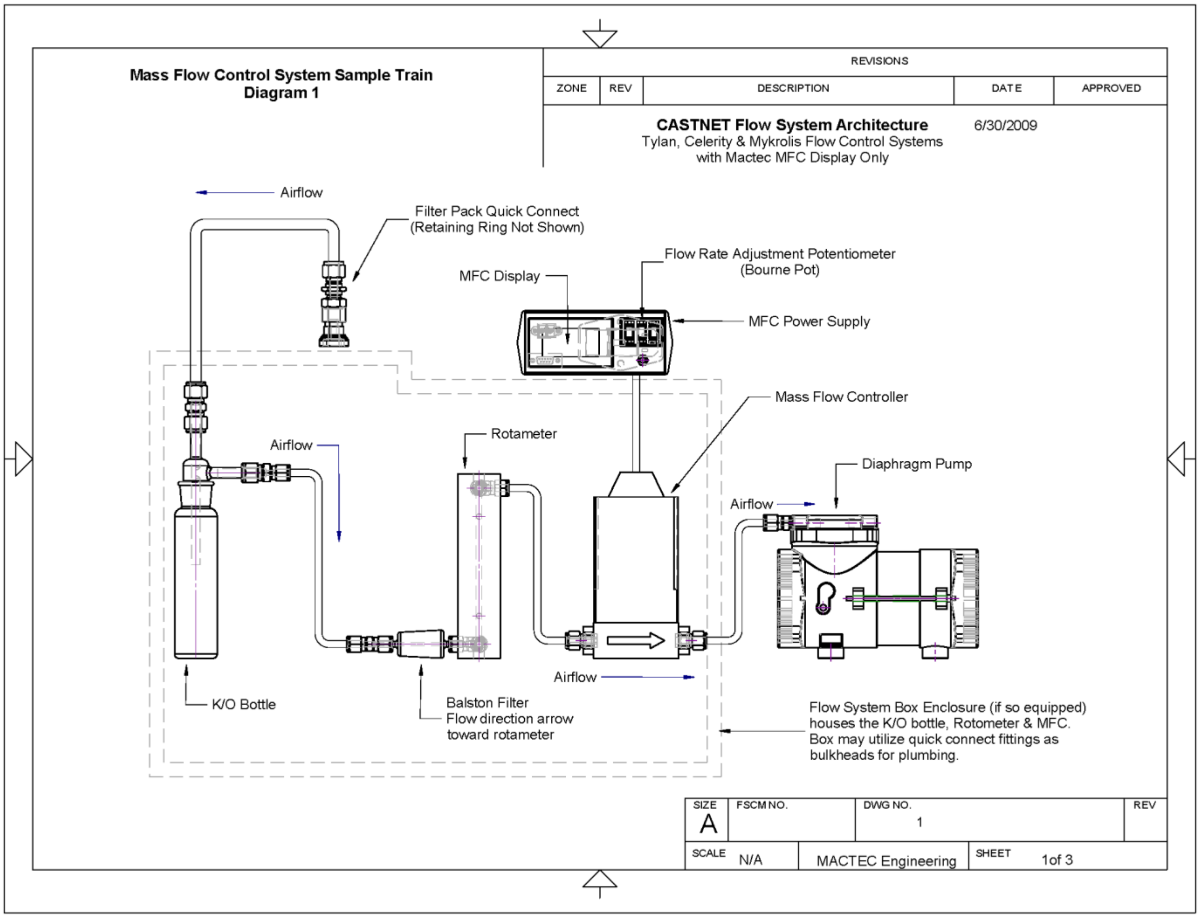
Several CASTNET sites are outfitted with trace level gas monitoring equipment (QAPP Appendix 11). For example, BVL130, IL operates three trace gas analyzers and a separate gas calibrator, which performs calibration checks on the three site monitors. The Teledyne API T700U Dynamic Dilution Calibrator provides a challenge gas to each of the three analyzers every other day to determine whether they are responding properly given a certain concentration of a species. The three site analyzers are Teledyne API Models T200U, T100U and T300U that monitor NO/NO_y, SO_2, and CO, respectively. These analyzers require little maintenance by the Field Site Operators unless given instruction to do so by AMEC Field Personnel. In addition, NO/NO_y and SO_2 are measured at BEL116, MD and NO/NO_y is measured at HWF187, NY, PNF126, NC, ROM206, CO, and PND165, WY.

3.5 Filter Sampling

Filter sampling of ambient air is performed at all CASTNET sites. The purpose of filter sampling is to determine the concentrations of various pollutants in the air. The process of filter sampling is to continuously draw air through a filter pack at a specific, recorded rate for one week. A new, unexposed filter is then installed and the exposed filter pack is then shipped back to AMEC where the pollutants trapped by the filters are analyzed.

The filter pack is attached (Figure 8) to a quick connect fitting in the "pot head" of the flow tower. This arrangement places the sampling location at 10 meters above the ground. Air is pulled through the filter and then passes through tubing down the tower and into the shelter, terminating at a K/O bottle to separate water from the air. The air travels from the K/O bottle to a cylindrical green Balston filter located at the bottom of a rotameter. After passing through the Balston filter the air exits the top of the rotameter and travels to the inlet side of a mass flow controller. This device controls the rate at which air flows through the filter pack and it includes a display to indicate the airflow in liters per minute. Along with the rotameter, the display provides a means to cross-check the rate of airflow against the value recorded by the data logger. The air exits the mass flow controller and travels to a pump, which provides the pressure necessary to move the air. An electromechanical hour-meter with a reset button is installed in the shelter to measure the time that the filter pack is in place with the pump turned on. The hour meter is not automatic and must be turned on and off manually. The hour meter should be turned off anytime the pump is turned off and the hour-meter and pump should be turned off anytime the flow tower is lowered.

Figure 8. Filter Sampling System Sample Train for Sites using Tylan, Mykrolis or Celerity Mass Flow Controllers.



Often the Balston filter, rotameter, hour meter, mass flow controller and power supply are located in a plastic box mounted on the wall within the shelter. CASTNET sites use a variety of mass flow controllers; however all are of the same basic design with the exception of the Alicat MFC. The Alicat unit has an internal power supply and the display is located on the MFC itself. The Tylan, Mykrolis and Celerity MFCs are being replaced by Alicat MFC through attrition.

The mass flow controller continuously controls the rate of airflow in the system based on the voltage it receives from the power supply. The MFC power supply/display then continuously outputs a voltage corresponding to that flow rate to the data logger. This voltage is measured by the data logger and is then converted to flow rate in units of liters per minute following a numerical computation required to calculate the flow rate in reference to standard operating conditions.

To properly calculate standard flow rate each mass flow controller utilizes unique calibration factors which must be input into the data logger upon installation and subsequent field calibration. These factors; "Flow_Offset" and "Flow_FullScale" are unique to each mass flow controller and power supply as one unit. They are found on the calibration certification form that accompanies the mass flow controller.

The sample train of the filter pack sampling system is checked for leaks weekly. The MFC units and power supplies are field calibrated every 6 months. The Balston filter is replaced every 6 months and as needed. The system pump is serviced every 6 months and replaced upon failure. Fuses in the MFC power supply are replaced as necessary. Water collected in the K/O bottle is emptied weekly. CASTNET sites are in the process of transitioning to Alicat mass flow controllers and upon failure all units will be replaced with an Alicat MFC.

In the Eastern U.S. air is drawn through the filter at a rate of 1.5 liters per minute all but nine sites. The rate is 3.0 liters per minute at all western and the nine eastern sites.

Figure 9. MFC Display/Power Supply used with Tylan, Mykrolis and Celerity MFC's.

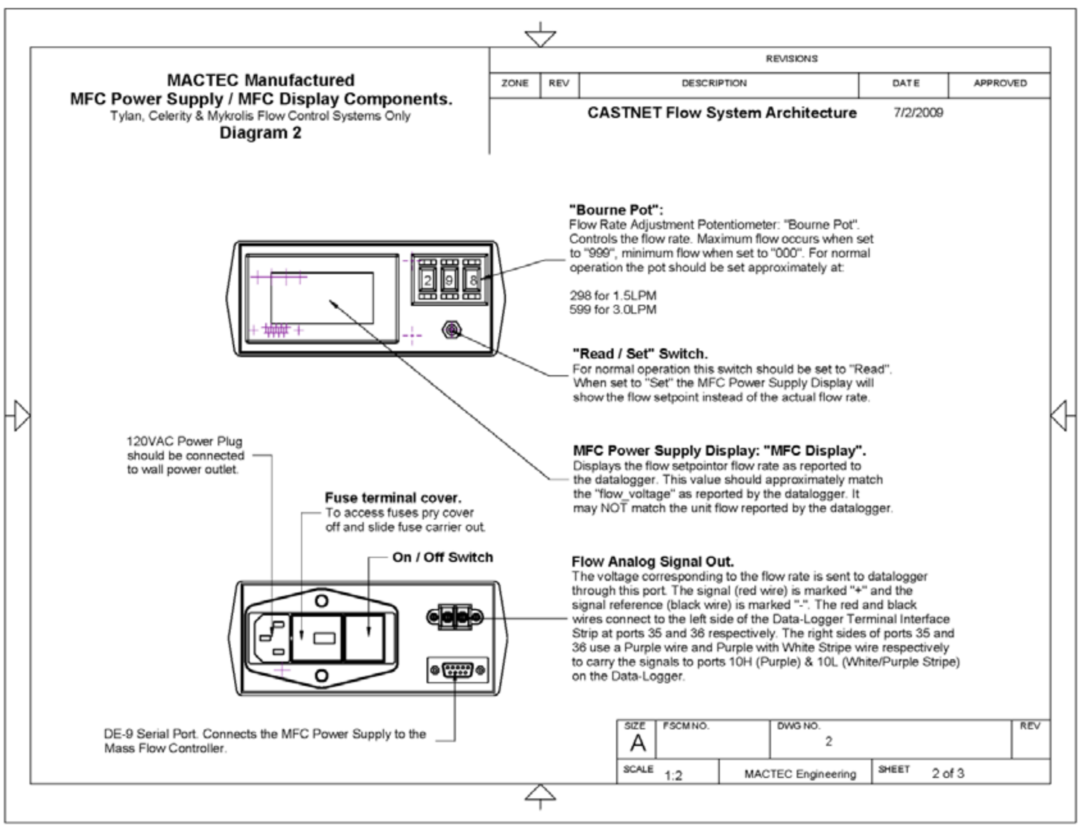


Figure 10. Filter Sampling System: Tylan, Mykrolis and Celerity Mass Flow Controllers Showing Direction of Airflow.

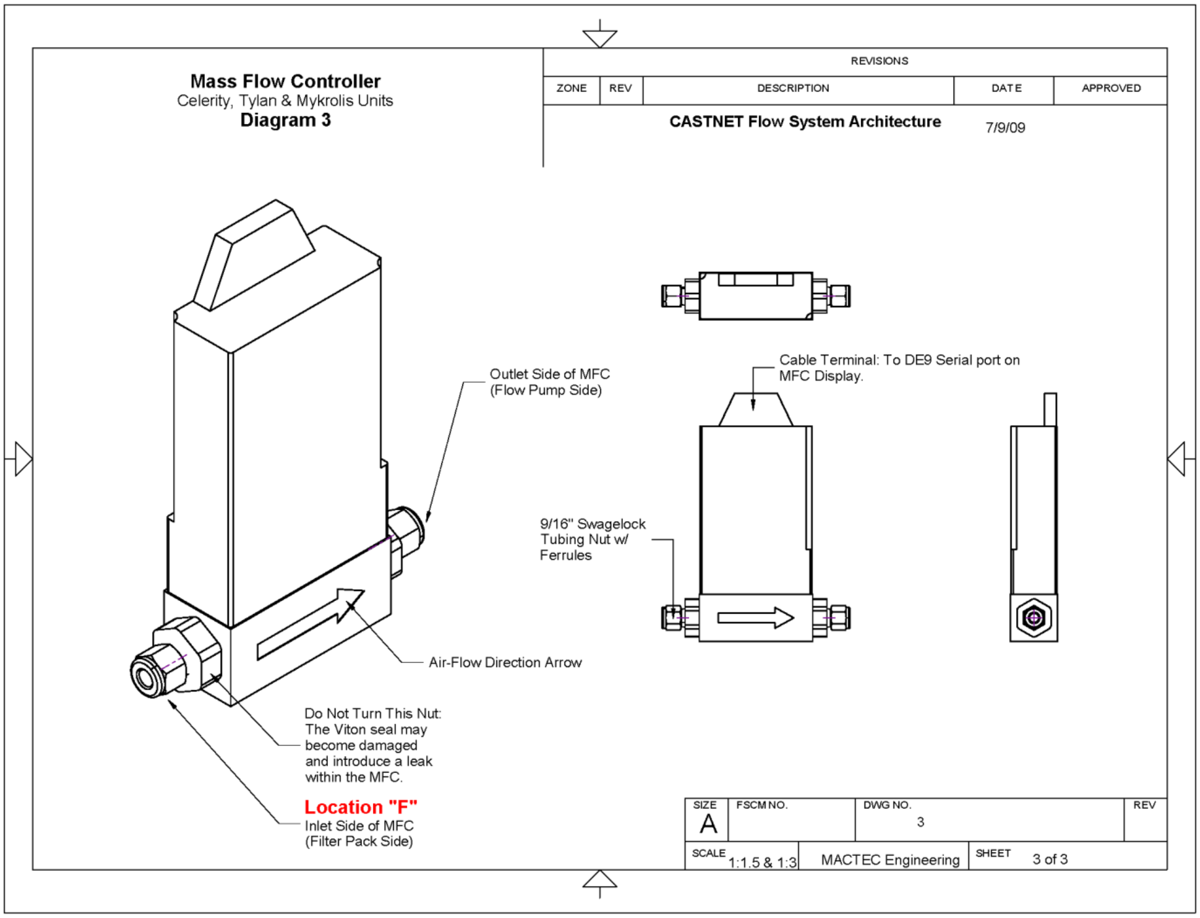
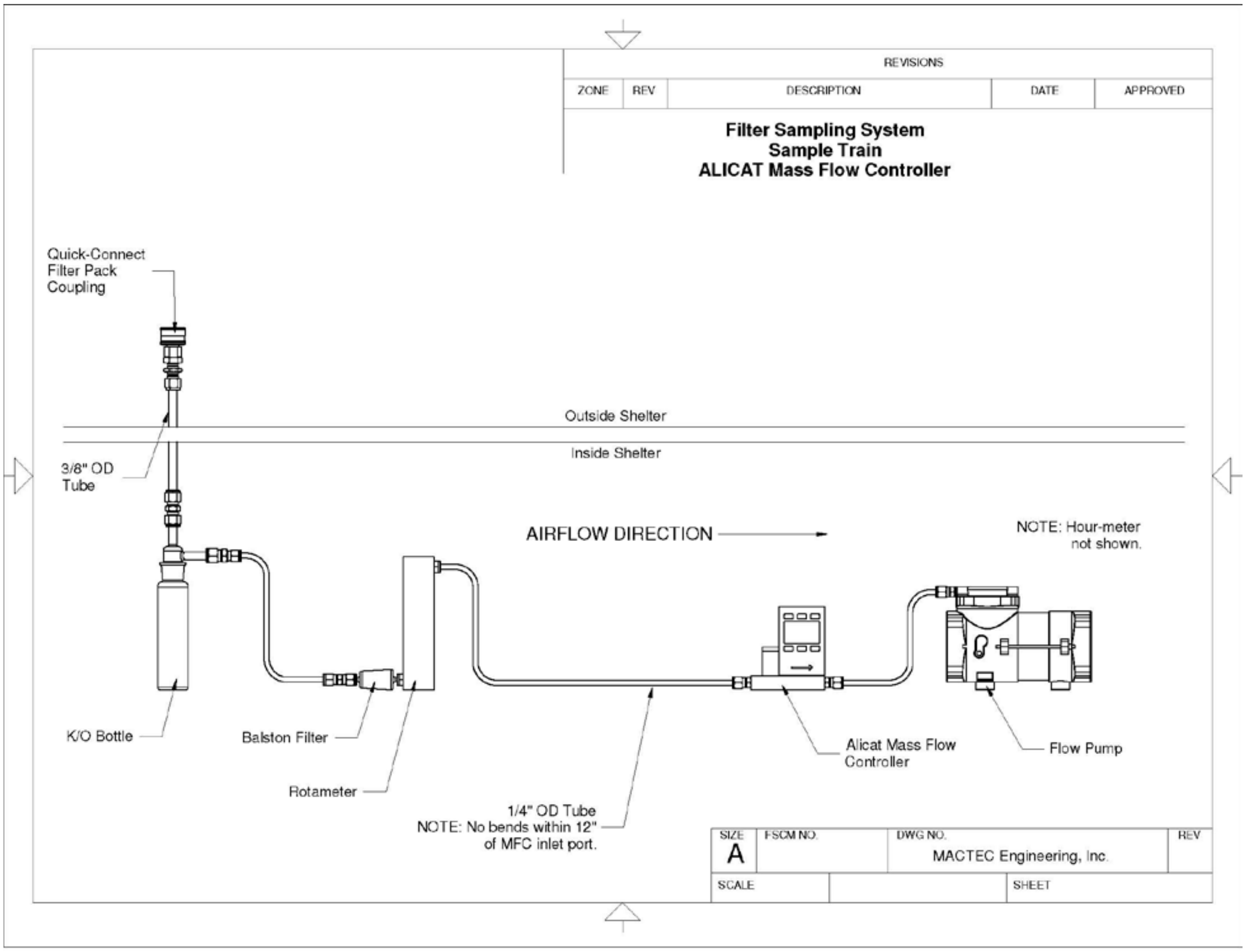


Figure 11. Filter Sampling System: Sample Train of Alicat Mass Flow System



3.6 Precipitation Gauge (Tipping Bucket)

CASTNET sites utilize either a Climatronics or Texas Electronics manufactured precipitation gauge to measure rainfall. Regardless of manufacturer they are essentially identical. This gauge is typically mounted atop a 1 meter mast which utilizes studs to allow leveling (Figure 12).

Rainwater and snow entering the gauge are funneled to a tipping mechanism containing two reservoirs (Figure 13). As one reservoir fills to capacity, the tipping mechanism tips over and makes contact with a switch which increments the data logger precipitation count. The rainwater then spills and the tipping mechanism is re-positioned by gravity to fill the opposing reservoir. Each time the unit tips the data logger records 0.01 inches of rain. The gauge must be level to properly measure rainfall. A bulls-eye bubble level is mounted on the tipping mechanism for this purpose.

Figure 12. Precipitation Gauge

Figure 13. Precipitation Gauge Tipping Mechanism and Wiring.

The gauge is equipped with a screen to reduce fouling of the funnel and tipping mechanism. Because the precipitation gauge measures snowfall, the screen should be removed in winter if the location receives snow. The gauge is equipped with a thermostat and a120 VAC heater to melt accumulated snow and allow accurate measurement of snowfall volume (Figure 14). Thermostat wires are line voltage.

Caution must be exercised when removing the lid of the gauge because damaged heater wires may present an electrical hazard. When reassembling the gauge, all wires are tucked away neatly to not interfere with operation of the tipping mechanism.

Figure 14. Precipitation Gauge Heater

3.7 Wetness Sensor

Some CASTNET sites are equipped with RM Young manufactured wetness sensors (Figure 15). The wetness sensor utilizes a conductive grid to detect surface dampness. The sensor detects the presence of dew or rainwater and is intended to correspond with the state of ground level vegetation.

During proper operation a voltage potential is maintained across the grid. If dry, no electrical current flows across the grid so the data logger receives zero voltage as a signal. If wet, water completes the grid circuit and electrical current flows across the grid wherein the data logger receives a signal of 1 volt corresponding to a unit reading of "1.00", indicating a wet condition.

The sensor is typically mounted on a mast on the South side of the shelter, at a height of no more than 18 inches and no less than 12 inches. The tipping bucket rain gauge is very often mounted at the top of this mast and occasionally on the mast that holds the solar radiation sensor.

The wetness sensor is calibrated during routine site calibration. It is replaced upon failure.

Figure 15. Wetness Sensor

3.8 Solar Radiation Sensor

Some CASTNET sites are equipped with a Li-Cor solar radiation sensor and matching RM Young signal translator (Figures 16 and 17). The solar radiation sensor is mounted to a support arm or mast outside the shelter usually about one meter in height, in the southernmost area of the site in a location where the influence of shadows from other structures or trees can be avoided. The signal translator is housed in a gray box mounted on the bottom of the data logger backplane. The sensor is connected to the translator by a cable with BNC connectors on each end.

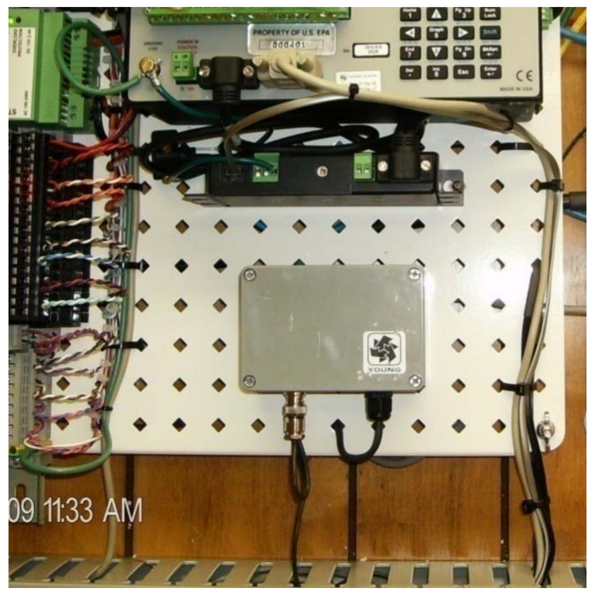
The sensor will not operate properly if it is not clean and level. Consequently, the sensor mount includes leveling screws and a bulls-eye bubble level for verification of proper alignment.

The solar radiation sensor produces a small electrical current proportional to the amount of sunlight incident upon it. When dark, no current is produced. The signal translator conditions and amplifies the sensor current signal to output a voltage to the data logger. The data logger records this voltage in units of watts per square meter.

The solar radiation sensor and translator are a matched set calibrated as a single unit. The individual parts are not interchangeable. They are replaced as a unit anytime either component fails.

Figure 16. Solar Radiation System and Sensor Mast

Figure 17. Solar Radiation System Translator



3.9 Climatronics Meteorological System

CASTNET sites had been equipped with either RM Young or Climatronics meteorological sensor systems. The four EPA sites currently with meteorological measurements are RM Young equipment. All EPA sites measure temperature at 9m. Both types of systems which are described herein, are comprised of all of the sensors and hardware mounted on the meteorological tower. Climatronics systems (Figures 18 and 19) include: wind sensor cross-arm, wind speed sensor, wind direction sensor, upper (9 m) aspirated shield, lower (2 m) aspirated shield, relative humidity sensor, upper (T1 at 9 m) temperature probe, and lower (T2 at 2 m) temperature probe. Additionally, CASTNET sites utilizing Climatronics equipment utilize a specialized subroutine within the data logger program. This "Climatronics_site" parameter enables the data logger program to properly calculate measurement values obtained from Climatronics sensors. At sites using this meteorological system the "Climatronics_site" parameter must always be set to "true" in PC200W interface for proper operation (Figure 20).

Figure 18. Climatronics Meteorological System

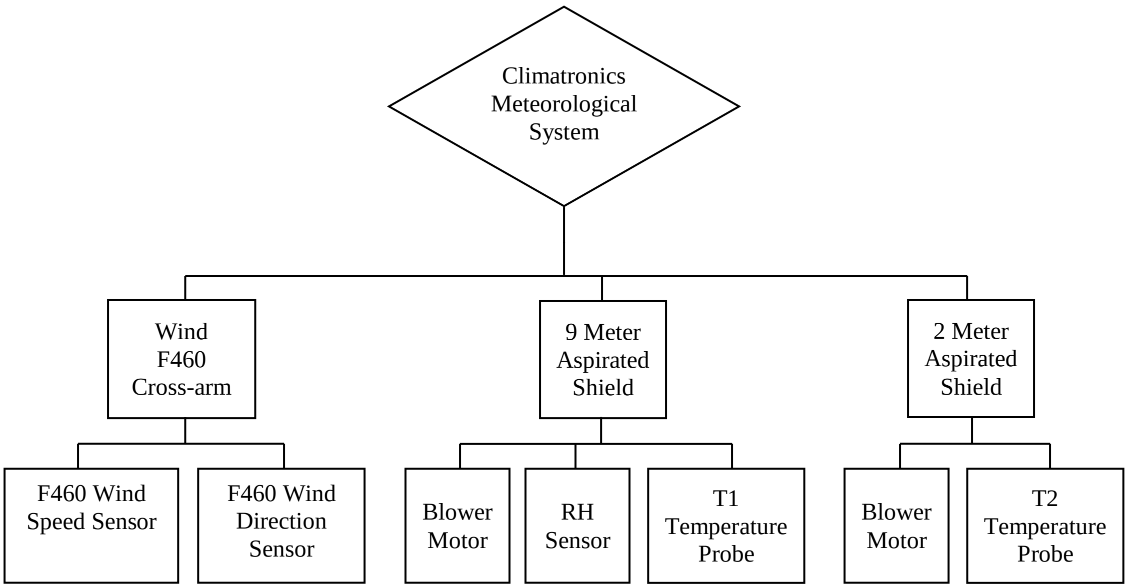
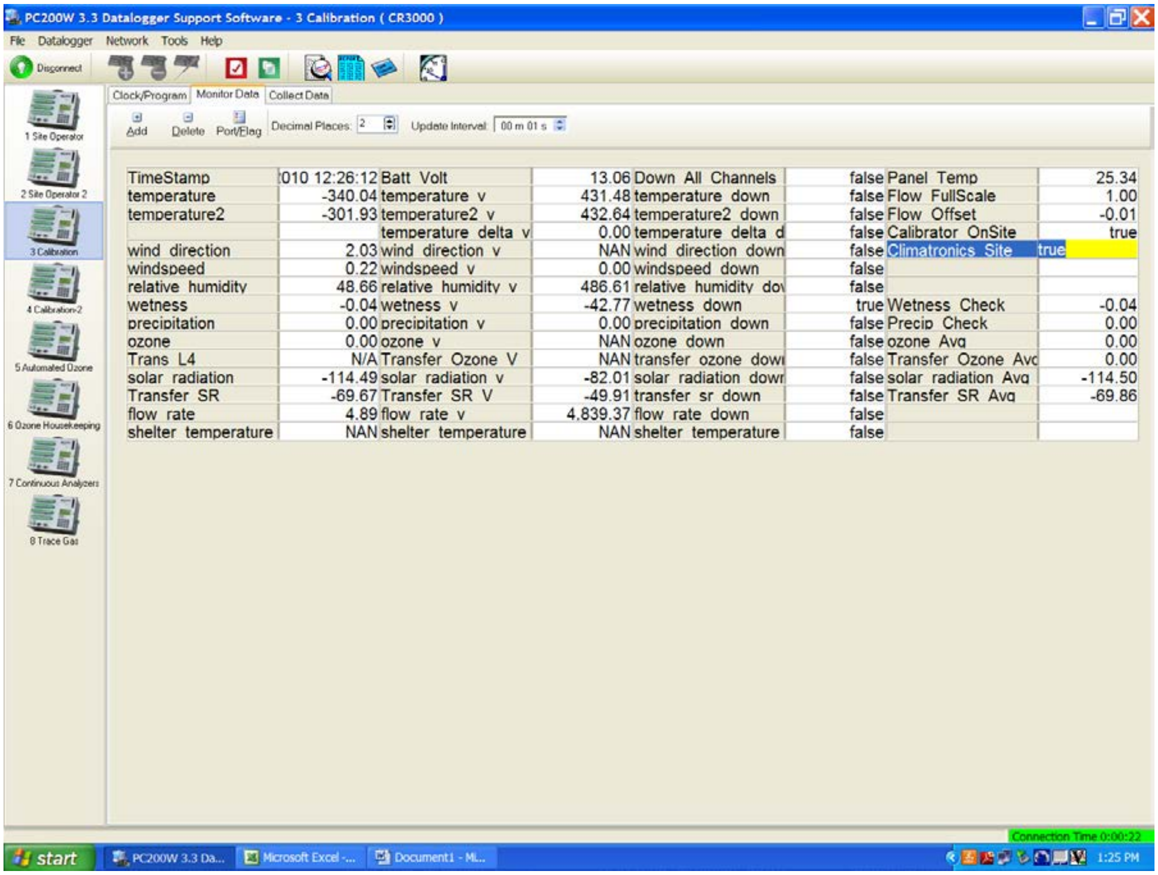


Figure 19. Climatronics Meteorological System. Climatronics Meteorological Tower Showing Wind Speed Sensor, Wind Direction Sensor, Cross-arm and 9-meter Aspirated Temperature Shield containing T1 Temperature Probe and RH Probe.

Figure 20. Climatronics Meteorological System, "Climatronics_Site" always set to "True" in 3 Calibration grid of PC200W.



3.9.1 F460 Wind Cross-Arm

The F460 Wind Cross-arm is located at the top of the meteorological tower (Figure 21). The cross-arm must be properly aligned for correct wind direction measurements. It should always be secure on the tower mast for this reason. It is typically aligned north/south with the F460 Wind Speed sensor located at the north end and the F460 Wind Direction sensor located at the south end. Each sensor is mounted on a keyed connector which assures that the sensors are properly located on the cross-arm. On the underside of the cross-arm a single bayonet connector transfers the wind direction and wind speed sensor signals to a black cable which terminates at the data logger.

Figure 21. Climatronics Meteorological System F460 Cross-Arm

3.9.2 F460 Wind Direction Sensor

The Climatronics F460 wind direction sensor (Figure 22) is mounted on the south end of the sensor cross-arm atop the meteorological tower. The sensor has a 120 volt alternating current (VAC) heater sleeve wrapped around the sensor shaft under the wind direction vane to prevent icing in freezing conditions. The thermostat for this heater also services the wind speed sensor. It is the "Y" shaped device in the power cable at the base of the cross-arm.

The sensor is electromechanical. As the vane rotates into the wind it turns a potentiometer shaft and thereby changes the electrical resistance of the potentiometer. The data logger measures this resistance and determines and records the appropriate wind direction.

The sensor is replaced annually during routine field calibration. Failed sensors are replaced as necessary.

Figure 22. Climatronics F460 Wind Direction Sensor and Sleeve Heater

3.9.3 F460 Wind Speed Sensor

The Climatronics F460 wind speed (Figure 23) sensor is mounted on the north end of the sensor cross-arm located atop the meteorological tower. The sensor has a 120VAC-heater sleeve wrapped around the shaft under the wind speed cups to prevent icing in freezing conditions. The thermostat for this heater also services the wind speed sensor. It is the "Y" shaped device in the power cable at the base of the cross-arm. This sensor operates by sending a pulsed signal to the data logger. The signal frequency is directly proportional to the rotational speed of the cups. The data logger converts the signal frequency to a speed measurement in units of meters per second.

The sensor is replaced during routine field calibration. Failed sensors are replaced as necessary.

Figure 23. Climatronics F460 Wind Speed Sensor and Sleeve Heater

3.9.4 Aspirated Shields, 9 Meters and 2 Meters

Two aspirated shields are located on the meteorological tower. These shields protect the temperature probes from sunlight and are equipped with blower motors to draw air across each probe and the relative humidity sensor to allow acceptable precision and accuracy in measuring temperature and relative humidity. The uppermost shield is mounted at 9 m and contains a blower motor, the T1 probe and the relative humidity sensor. The lower shield at 2 m contains a blower motor and the T2 probe. Sensors are mounted in the bell and each connects to a wiring harness with keyed connectors to ensure the sensors cannot be connected to the wrong connector. The 9-m shield is connected to a yellow cable, and the 2-m shield is connected to a red cable. These cables carry the respective signals to the data logger.

Blowers are used at the four sites with complete meteorological measurements. The data logger records the rpm of each blower motor continuously and will invalidate temperature measurements if the rpm is low. During normal operation the parameters "Temp1_Blower_Bad" and "Temp2_Blower_Bad" found in the Site Operator grid will both be reported as "false", indicating that no failure is observed. Blower motors are cleaned routinely and replaced upon failure. Routine 9-m temperature measurements at all other EPA sites are not aspirated.

3.9.5 Temperature 1, Temperature 2 and Delta Temperature

T1 and T2 measurements are obtained by using two identical resistive temperature probes mounted in the aspirated shields on the meteorological tower (Figure 24). The electrical resistance of each probe changes with temperature. The data logger measures this resistance and computes temperature in degrees Celsius based on the resistance. Each sensor is measured independently.

Following the computation of T1 and T2, delta temperature is computed as the difference between the temperature indicated by the T1 and T2 sensors {delta temperature = T1 – T2}.

As each probe does not have identical resistance at a given temperature, correction coefficients are calculated for each individual probe during calibration. These coefficients: R_0 and Alpha are used by the data logger when computing the temperature of each probe. They are unique to each probe and must be entered into the data logger program. R_0 and Alpha values for a specific temperature probe are found on the probe's calibration certification form and are entered into the data logger through 4-Calibrator 2 of the PC200W network grid.

Temperature probes are replaced upon failure. When doing so the R_0 and Alpha values for the replacement probe must be entered into the data logger.

Figure 24. Climatronics Temperature Probe

3.9.6 Relative Humidity

At sites which employ Climatronics meteorological systems, a Vaisala relative humidity sensor (Figure 25) is clip mounted in the 9-m aspirated temperature shield. It is located in the bell with the sensor tip protruding directly into the air flowing through the blower tube. Air drawn through the tube by the blower aspirates both the temperature probe and the humidity sensor. The relative humidity sensor is replaced upon failure.

Figure 25. Climatronics Meteorological System Vaisala RH Probe

3.10 RM Young Meteorological System

RM Young meteorological systems (Figures 26 and 27) include: Wind Monitor AQ wind speed and direction sensor, upper (9 m) aspirated shield and lower (2 m) aspirated shield, relative humidity sensor, upper (9 m) temperature probe, lower (2 m) temperature probe. At sites with this meteorological system the "climatronics_site" parameter must always be set to "false" in PC200W interface for proper operation (Figure 28).

Figure 26. RM Young Meteorological System

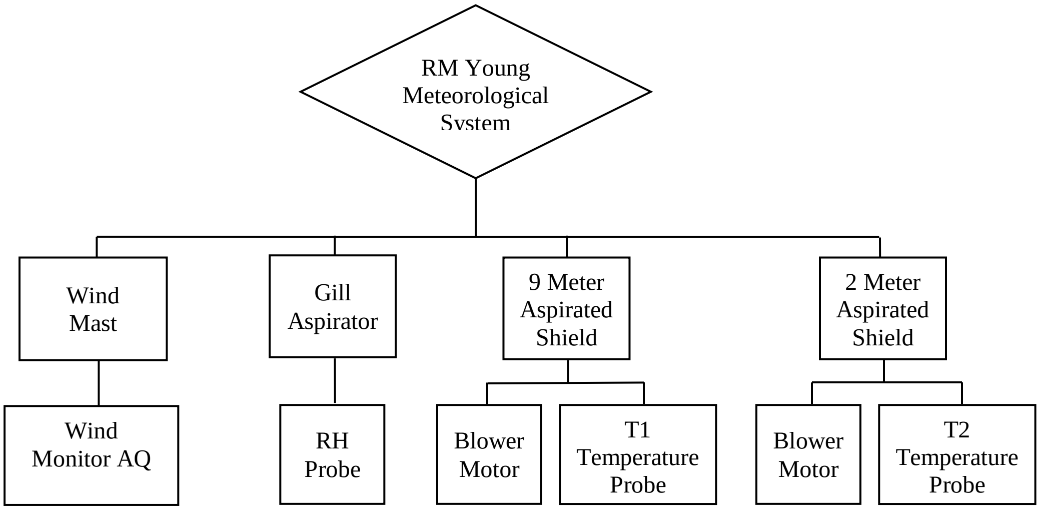
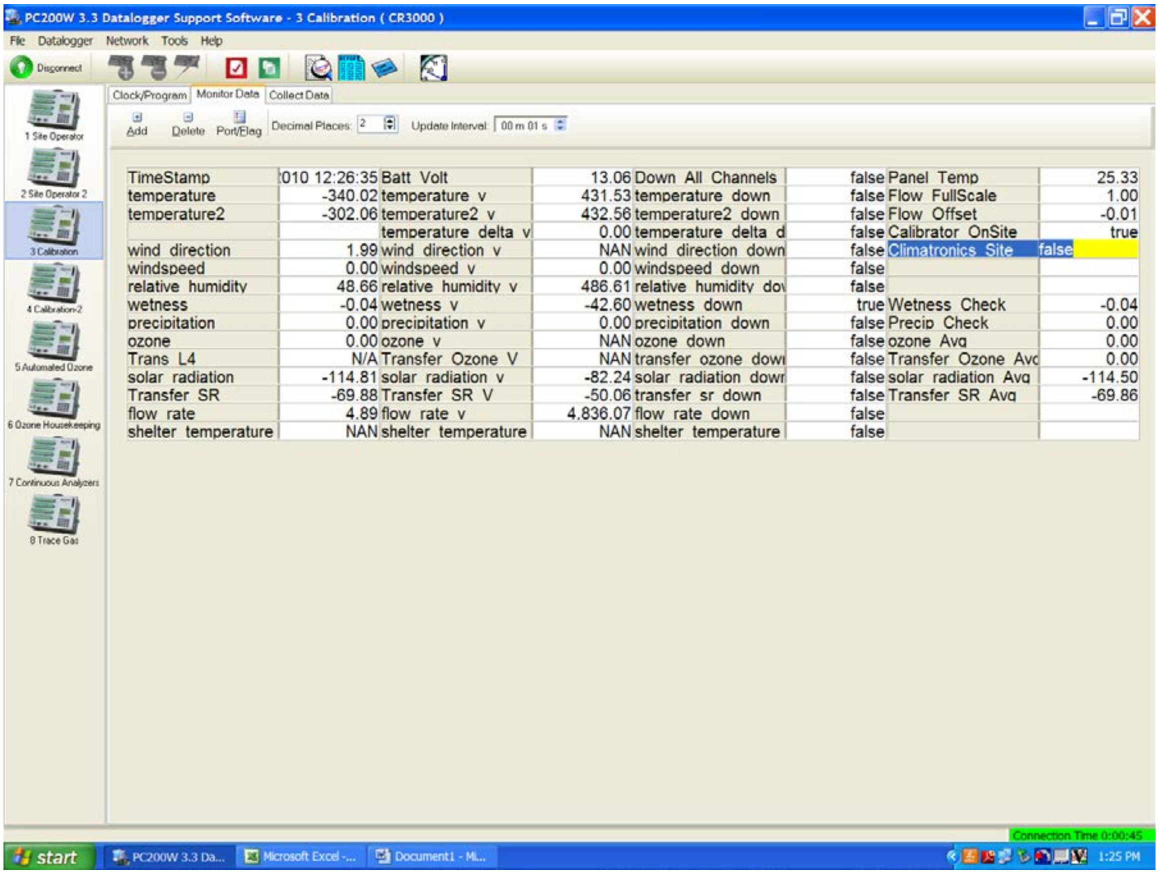


Figure 27. RM Young Meteorological System: (from top to bottom) Meteorological Tower with Wind AQ, Directional Cross-Arm, Gill Aspirated Shield for RH Probe, 9-m Aspirated Temperature Sensor Shield and Waterproof RH Circuit Card "Otter" box.

Figure 28. RM Young Meteorological System, "Climatronics_Site" parameter always Set to "False" for RM Young Equipped Sites



3.10.1 Wind Monitor AQ

The wind sensor is mounted on a mast at the top of the meteorological tower (Figure 29). A rod beneath the sensor is attached to the tower and aligned to either north or south as a directional reference. The sensor has both a lightweight propeller and vane to measure wind speed and direction simultaneously.

The wind direction measurement is made electro-mechanically. As the vane rotates into the wind, it turns a potentiometer shaft and thereby changes the electrical resistance of the potentiometer. The data logger measures this resistance and determines and records the appropriate wind direction. The wind speed sensor operates by sending a pulsed signal to the data logger. The signal frequency is directly proportional to the rotational speed of the cups. The data logger converts the signal frequency to a speed measurement in units of meters per second.

There is no circuit to provide heat to the sensor to prevent icing in freezing conditions. The design of the monitor is such that icing should not occur unless extreme conditions are encountered.

The Wind Monitor AQ is replaced annually during routine calibration or is replaced as needed following failure. The nose cone is replaced every 6 months during routine calibration or is replaced as needed following failure.

Figure 29. RM Young Wind AQ wind monitor

3.10.2 Aspirated Shields, 9 Meter and 2 Meter

Two aspirated shields are located on the meteorological tower. These shields protect the temperature probes from sunlight and are equipped with blower motors to draw air across each probe to allow acceptable precision and accuracy in measuring temperature. The uppermost shield is mounted at 9 meters high and contains a blower motor and the T1 probe. The lower shield is mounted at two meters height and contains a blower motor (Figure 30) and the T2 probe. Sensors are mounted in the opposite end of the shield from the blower.

The data logger records the rpm of each blower motor continuously and will invalidate temperature measurements if the rpm is low. During normal operation the parameters "Temp1_Blower_Bad" and "Temp2_Blower_Bad" found in the Site Operator grid will both be reported as "false", indicating that no failure is observed. Blower motors are cleaned routinely and replaced upon failure.

Figure 30. RM Young Blower Motor

3.10.3 Temperature 1, Temperature 2 and Delta Temperature

T1 and T2 measurements are obtained by using two identical resistive temperature probes mounted in the aspirated shields on the meteorological tower (Figure 31 and 32). The electrical resistance of each probe changes with temperature. The data logger measures this resistance and computes temperature in degrees Celsius based on the resistance. Each sensor is measured independently.

Following the computation of T1 and T2, delta temperature is computed as the difference between the temperature indicated by the 9-m (T1) and 2-m (T2) sensors {delta temperature = T1 – T2}.

As each probe does not have identical resistance at a given temperature, correction coefficients are calculated for each individual probe during calibration. These coefficients, R_0 and Alpha, are used by the data logger when computing the temperature of each probe. They are unique to each probe and must be entered into the data logger program. R_0 and Alpha values for a specific temperature probe are found on the probe's calibration certification form and are entered into the data logger through 4-Calibrator 2 of the PC200W network grid.

Temperature probes are replaced upon failure. The R_o and Alpha values for the replacement probe must be entered into the data logger.

Figure 31. RM Young Temperature Probe

Figure 32. RM Young Temperature Probe Installed in Aspirated Shield.

3.10.4 Relative Humidity

Sites utilizing RM Young meteorological systems may use either a Rotronics Model MP101A or Vaisala Model 102425 relative humidity sensor (Figure 33). The sensor is mounted in a naturally aspirated shield near the top of the tower. No air is forced past the sensor. The Vaisala probe uses a mounting adapter in the shield. The Rotronics probe does not. The sensor is wired to a circuit card inside a waterproof box mounted on the meteorological tower. The circuit card provides a fuse to protect the data logger and probe from transient voltage.

Regardless of model used the relative humidity sensor operates based upon the electrical capacitance of the sensor element. The capacitance varies with temperature and humidity. The data logger records the probe output voltage as unit of percent relative humidity.

During times of light winds, fog, or extended rain, the sensor may become saturated with water and require several hours to respond to decreased humidity levels.

Figure 33. Vaisala RH Probe

3.11 Shelter Temperature / HVAC

The temperature within a CASTNET site shelter must be maintained between 65˚ F and 89˚ F (18˚ C and 32˚ C) or O_3 data collected must be invalidated. Each site is equipped with a Campbell Model 107 temperature probe which is used in continuously monitoring the performance of the site heating, ventilating, and air conditioning (HVAC) system. This sensor is connected to the data logger backplane terminal block strip and either hangs from the ceiling at a height of about seven feet near the center of the shelter or is located beside the site analyzer (Figure 34). The temperature sensor is used only to record the shelter temperature and is not used in controlling the shelter temperature.

Most CASTNET sites utilize a window mounted air-conditioner (Figure 35) for cooling and a resistive strip heater for heating. An electromechanical thermostat is mounted on a junction box near the electrical panel. If the shelter temperature falls by more than 2˚F below the thermostat setting, the thermostat activates a heater relay which switches power to the heater. If the shelter temperature rises by more than 2˚F above the thermostat setting, the thermostat activates an air-conditioner relay which switches power to electrical receptacle directly below the air-conditioner (Figure 36-39). This arrangement assures that the heater and air-conditioner are never operating at the same time but for the system to work properly the air-conditioner must be plugged into the switched receptacle.

Because the air-conditioner is simply switched on or off the coldness setting of the air-conditioner may need to be adjusted seasonally by the site operator to maintain proper shelter temperature. Normal maintenance includes cleaning the air-conditioner filters and testing of the thermostat function as necessary. Failed components of the HVAC system are replaced as necessary. The temperature probes are calibrated biannually during routine site calibration visits. Inoperative probes are replaced upon failure.

Sites may use either 240 VAC or 120 VAC air-conditioners (Figures 36 through 39) depending upon the individual site electrical wiring. In all cases repairs to the HVAC system should only be attempted by qualified personnel due to the potential for electrocution.

A limited number of sites use an integrated furnace and air-conditioner system manufactured by Bard Industries. With this arrangement adjustments are generally not necessary. Maintenance consists of changed fouled air return filters as necessary.

Figure 34. Shelter Temperature Probe

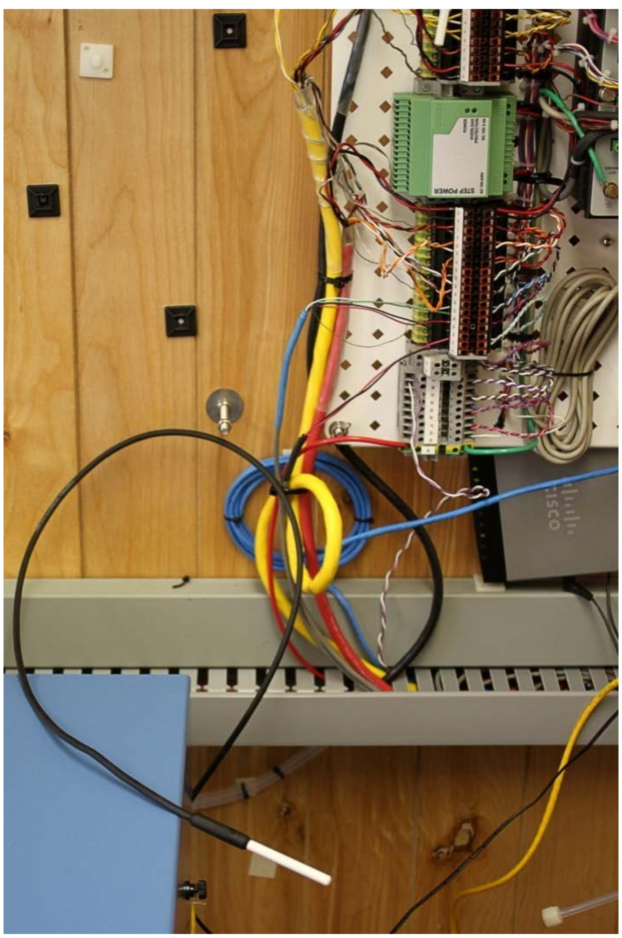


Figure 35. Typical CASTNET Air Conditioner (Note that unit is plugged into outlet directly below. This outlet is switched on and off by the temperature control system.)

Figure 36. 120VAC Power Outlet switched by temperature control system

Figure 37. 220VAC Air-Conditioner Power Outlet

Figure 38. Thermostat Mounted Electrical Box

Figure 39. Cover Removed from Thermostat Electrical Box (To show temperature control relays (wired for 220VAC)

3.12 Site Physical Maintenance

It is the responsibility of the site operator to ensure that the site is in good working condition, the exterior meets standard site criteria and that the interior is neat and free of clutter. If the site operator is not able to complete part of these responsibilities due to lack of knowledge or material, it is their duty to notify an AMEC field technician so proper action may be taken.

3.13 Special Studies

4.0 MATERIALS AND SUPPLIES

A generalized list is provided in 3.0 above.

5.0 SAFETY

Please see Section III, Attachment 5.

6.0 PROCEDURES

This document provides an overview of CASTNET site instruments and equipment.

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements.* EPA-600/4-82-060.

8.0 ATTACHMENTS

This SOP does not contain attachments.

II. SITE OPERATIONS
B. SITE OPERATOR INSTRUCTIONS

Effective Date: 10/30/14

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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II. B. SITE OPERATOR INSTRUCTIONS

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide consistent guidance to each Site Operator.

2.0 SCOPE

This SOP applies to all CASTNET sites using Climatronics Equipment

3.0 SUMMARY

Each Tuesday the site operator visits the site, performs routine checks and maintenance, reports results to the Field Operations Manager (FOM) by telephone, and installs a fresh filter pack. The exposed filter pack is shipped to the Gainesville office along with documentation of the site visit.

4.0 MATERIALS AND SUPPLIES

New (unexposed) filter pack
Filter pack shipping tube
Blank Site Status Report Form (SSRF), see Figure 1.
Site Narrative Log
Ink pen
Disposable latex gloves

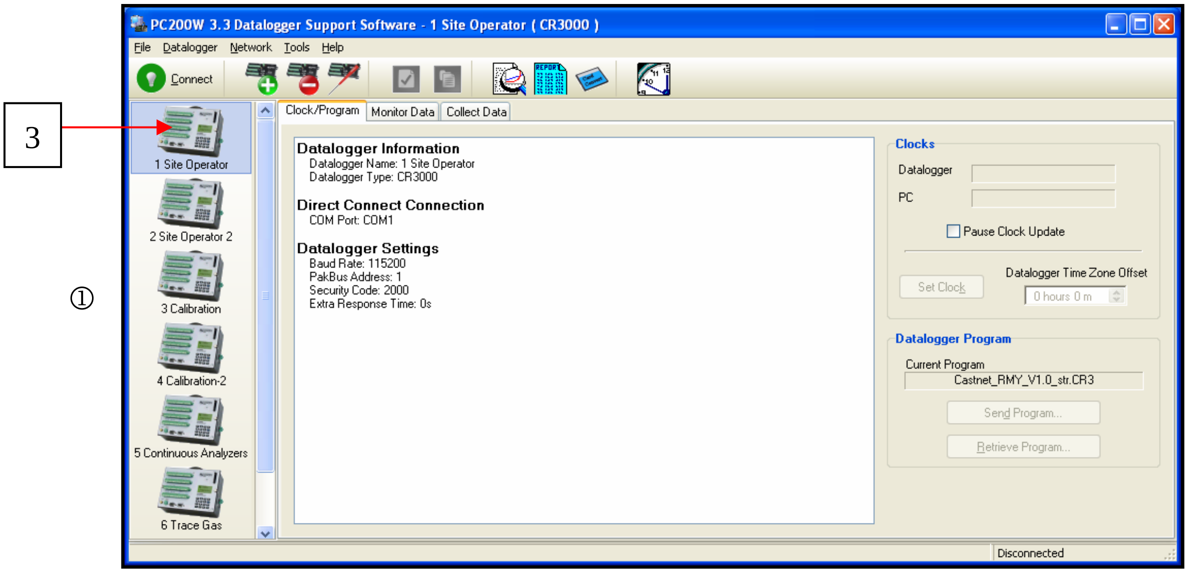
5.0 SAFETY

A hard hat must be worn when raising and lowering towers. If it is necessary to repair or service an instrument, remove personal jewelry, turn off the instrument power and disconnect (unplug) to avoid contact with live current. Always use a safety harness when climbing.

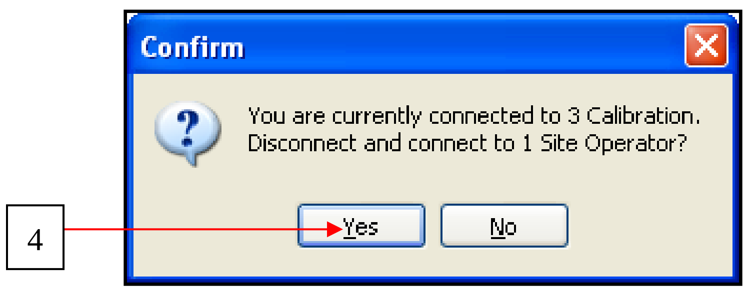
6.0 PROCEDURES

EVERY SITE VISIT:

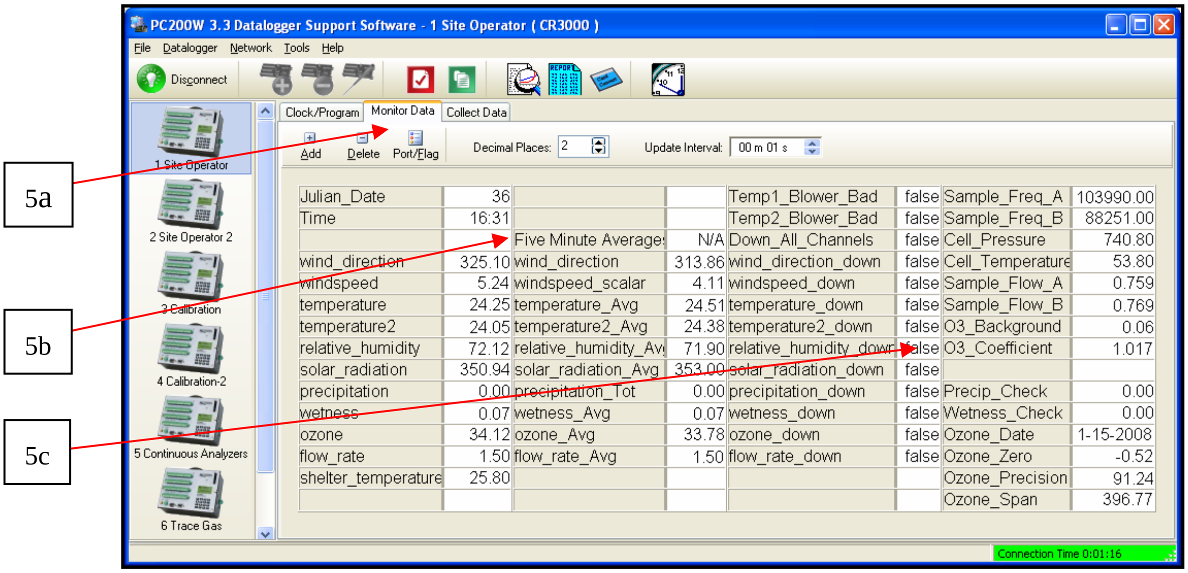
1. Begin Site Narrative Log entry by documenting time and date of arrival, purpose of site visit and all visitors present. Continue narrative during the site visit.
2. Turn site laptop computer on. The application “PC200” will start automatically.
3. From the PC200 main screen DOUBLE-CLICK the icon on the left labeled “1 Site Operator”. This is the top (first) icon in the column.



4. If the icon is only clicked once, PC200 will respond with a Pop-Up window “Do you want to connect?” CLICK **“Yes” or “Connect**”.



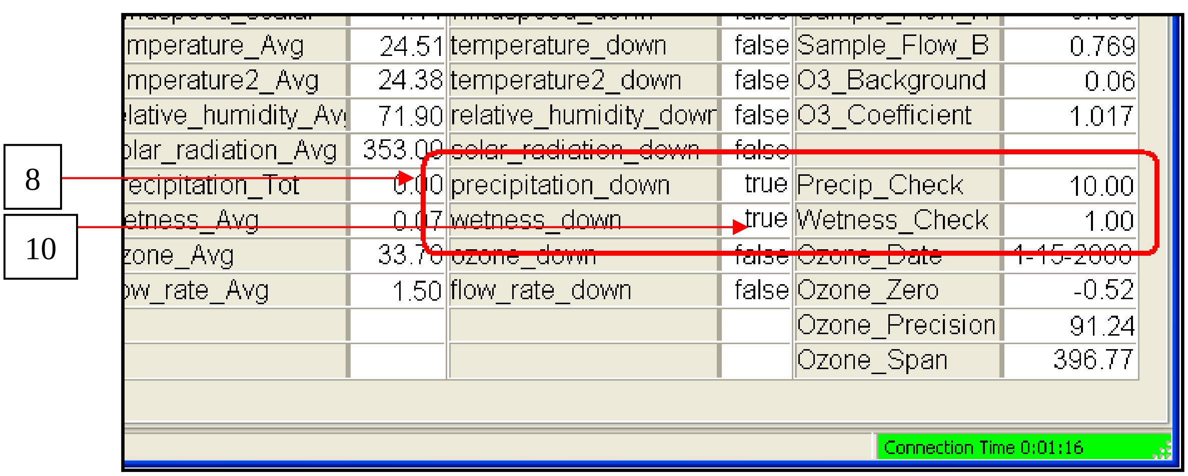
5. SINGLE CLICK on the “Monitor Data” Tab at the top. PC200 will open a new window which displays real time data, channel status, Five Minute Averages, the last Ozone auto-calibration results and current Ozone diagnostic parameters as required for the SSRF. See below for screen shot. The channel status displayed indicates whether a channel is “up” or “down”. A channel status of “FALSE” indicates that the channel is “up” and data is being recorded. This is the normal operating condition.



6. Locate the “Five Minute Average” data column and record the Five Minute Averages as required on the SSRF.

7. To down a channel: DOUBLE-CLICK the word “False” next to the channel status display to activate the control. Then DOUBLE-CLICK the word “False” to down the channel. The “False” indication will change to “True”; indicating that the channel has been downed successfully.

8. Down both the Precipitation and Wetness channels. Downing these two channels will initiate a counter that will count tips of the Tipping Bucket and display your wetness check result.

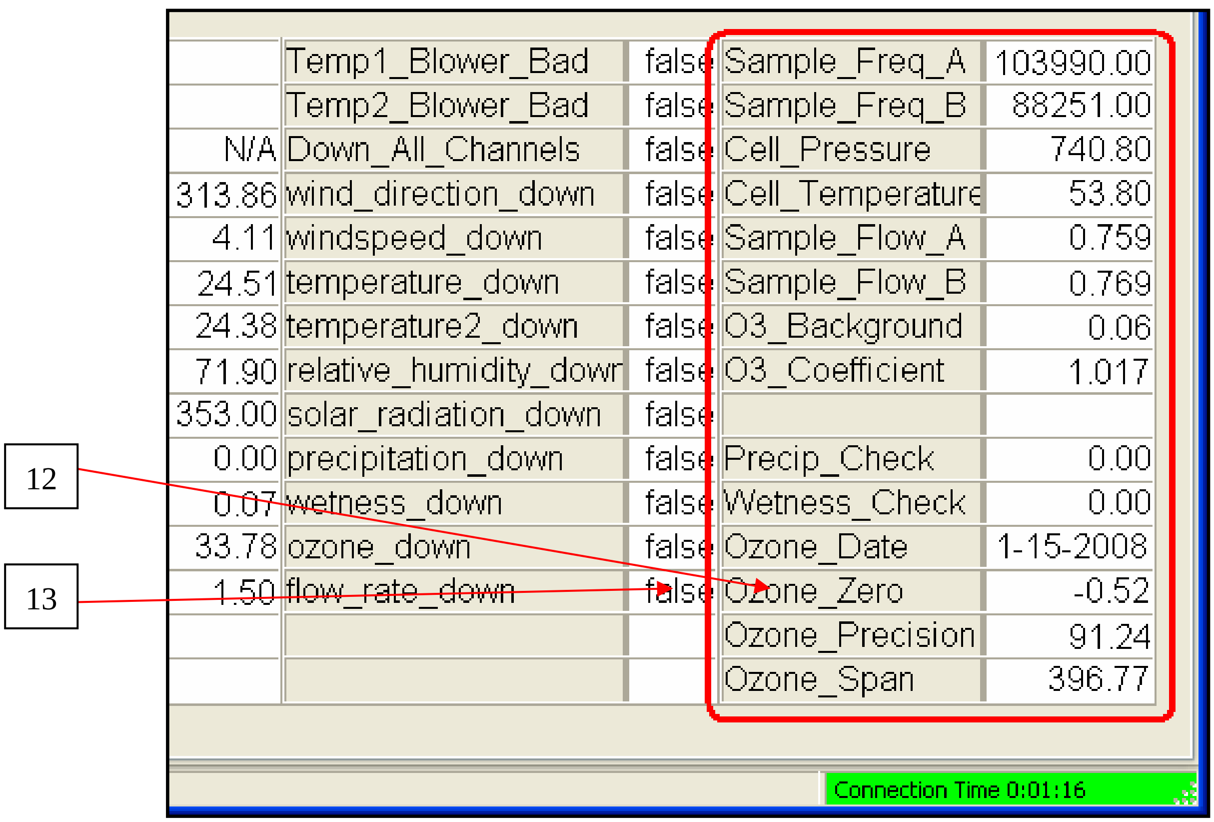


9. Perform a ten-tip check of the tipping bucket and pour water on the Wetness Sensor. Note that you no longer need to wait fifteen seconds between tips – Simply actuate the tipping mechanism ten times.

10. Record the displayed results on the SSRF. Then DOUBLE-CLICK TWICE on the word "TRUE" on each channel status display to "Up" both the Precipitation and Wetness channels.

11. If the Tipping Bucket actuator is accidentally tipped other than ten times, or if the result is not ten, then reset the counter and perform the check again. To reset the counter "Up" the channel and then "Down" the channel according to the previously described procedures.

12. Locate the Ozone data displayed at the bottom right of the PC200 data table. Record the Ozone auto-calibration results (Zero, Span and Precision) on the SSRF. Record the auto-calibration date on the SSRF. Record the diagnostic parameters (Pressure, Temperature, Flow Rates and Intensities) on the SSRF.



13. DOUBLE-CLICK TWICE on the word "FALSE" next to the channel status to "Down" both OZONE and FLOW channels. Both status indicators will change to "True".

14. Turn the Flow hour-meter off. Record the time of day, as indicated by the data-logger and the hour-meter count, in the site logbook. Lower the Flow Tower wearing hard hat. With gloved hands remove, cap and package the Filter Pack for shipping using the resealable plastic bags in which they arrived.

15. With the Flow pump on and after letting the value stabilize, record the Flow rate as indicated by the Mass Flow Controller (MFC) Display in the "Leak Check" (Pump On) box on the SSRF. The MFC display is either a black box with digital display or a tan box with digital display.

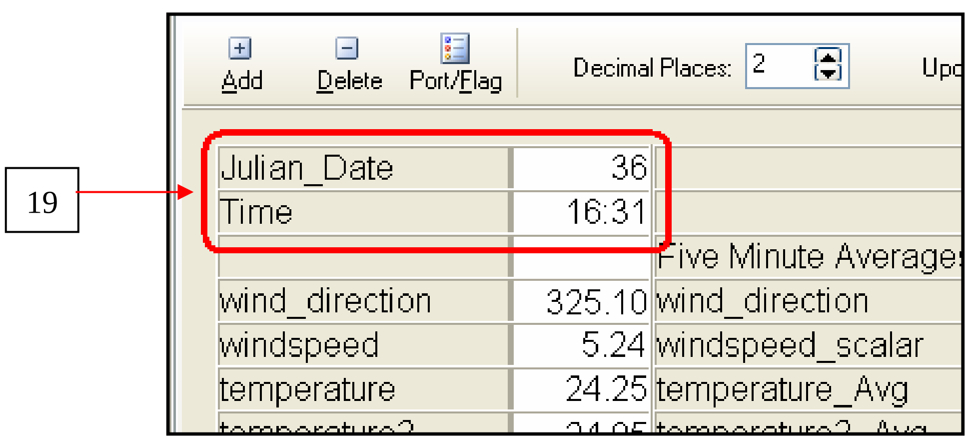
16. Turn the Flow pump off, let the Flow value stabilize and record the MFC Display Flow value in the "Pump Off" box on the SSRF. Verify that there is no water in lines or knockout bottle. If water is present, clear lines and bottle and report the event to AMEC.

17. If scheduled, replace the Savillex filter in the Ozone Inlet Filter and/or in the filter housing inside the shelter near the knock-out (water collection) bottle. Verify that there is no water in lines or knock-out bottle. If water is present, clear lines and bottle and report the event to AMEC.

18. With gloved hands, uncap and install the unexposed Flow filter pack for the new sampling week.

19. Raise the flow tower. Turn the flow pump on. Turn the hour-meter on and reset it. "Up" the Ozone and Flow channels. Record the time of day indicated by the data-logger in the site log book.

20. Remember to **turn off the laptop** before you leave the site



SITE OBSERVATIONS:

6.1 Check site communications. Re-establish if off-line. Call AMEC if necessary.

6.2 Complete all parts of the SSRF in SITE OBSERVATIONS DURING FILTER INSTALLATION block regarding vegetation and moisture.

6.3 EVALUATING METEOROLOGICAL MEASUREMENTS

6.3.1 Assess the reasonableness of the current meteorological measurements. If needed, evaluate wind speed data using the Beaufort Wind Scale developed by British Rear Admiral, Sir Francis Beaufort in 1805 (see Table 1). Data logger output of wind speed should be consistent with the wind effects listed in the table. For example, a wind speed of 6.0 m/sec should be manifested by the movement of small tree branches.

Table 1. Beaufort Wind Scale

Wind Speed (m/sec)	Classification	Sigma Theta (degrees)	Appearance of Wind Effects
0.0 to 1.5	Light Air	32.7	Still wind vane.
2.0 to 3.0	Light Breeze	25.4	Wind felt on face, leaves rustle, vane begins to move.
3.5 to 5.0	Gentle Breeze	17.3	Leaves and small twigs constantly moving.
5.5 to 8.0	Moderate Breeze	11.0	Dust, leaves, and loose paper lifted, small tree branches move.
8.5 to 10.5	Fresh Breeze	8.1	Small trees in leaf begin to sway.
10.8 to 13.8	Strong Breeze	7.1	Large branches in motion. Whistling in overhead wires. Umbrella use becomes difficult.
13.9 to 17.1	Near Gale	7.4	Whole trees in motion. Resistance felt walking against the wind.
17.2 to 20.7	Gale	7.3	Twigs broken from trees. Progress generally impeded.

Note: Mean sigma theta values were calculated from 2002 measurements at Death Valley National Monument (DEV412), CA, which has been discontinued.

6.3.2 The evaluation of sigma theta, the standard deviation of changes in horizontal wind direction within one hour, is more subtle. Observe the behavior of the wind vane and review 1-minute averages of sigma theta. A fluctuating wind vane should be manifested by relatively large values of sigma theta. Sigma theta values can range from a few degrees to almost 90 degrees. A completely still vane should show a sigma theta value of 0.0. Larger values of sigma theta typically occur during stable conditions with light, but fluctuating, winds and decrease with increasing wind speed. Note the mean sigma theta measurements in the Beaufort table.

6.3.3 High RH occurs when dew and/or precipitation are present. A feeling of humidity in the air also suggests high values of RH.

6.3.4 Wind direction measurements can be evaluated by comparing the orientation of the vane (i.e., using the instrument tower's North-South cross-arm as a guide) with 1-minute values from the data logger.

6.3.5 Temperature values should be evaluated for reasonableness. Confirm that the blowers for both the upper and lower sensors are functioning. Feel for proper directional air flow at the opening of the lower housing. To convert data logger values from degrees Celsius (C) to degrees Fahrenheit (F) use the following equation:

$$C * (9/5) + 32 = F$$

6.3.6 Delta temperature is defined as the difference in temperature between the 9 m (T1) and the 2 m (T2) sensors. The normal delta temperature range is -5°C to 5°C. The pattern for delta temperature values in a 24-hour period should generally be negative or smaller at nighttime and positive or larger during the daytime hours. Values should approach 0°C under high wind conditions or during significant rainfall events.

6.4 Tuesday: Call the Field Coordination Center at 1-352-332-5770* or 352-333-6611. Give the site ID number, and report the following:

6.4.1 Mass flow reading,

6.4.2 Rotameter reading,

> **NOTE**: ***** This is a direct line to all calibrator desks. It may be busy for long periods of time, and calls to this line cannot be transferred between technicians once it is answered. To use the automated central phone system call:
>
> **1-352-332-3318 or 1-888-224-5663**
>
> Field Operations Phone ext. 6611

6.4.3 Leak check reading,

6.4.4 10-tip check value,

6.4.5 Wetness sensor response,

6.4.6 Ozone automatic calibration results, and

6.4.7 Any problems.

Ship the Following to AMEC:

6.5 In a PVC TUBE:

Filter packs and the SSRF (white copy). Securely cap the PVC tube, tape the tube shut, put a return label on the tube, and put your initials on the label.

6.6 In a LARGE ENVELOPE:

SSRF (yellow copy) and completed logbook copies (white and yellow copies).

6.7 Verify that channels are up, flow pump is on, and data are reasonable.

6.8 Sign out in the logbook. Note the time.

7.0 REFERENCES

Manufacturer Instructions

U.S. Environmental Protection Agency (EPA). 1998a. Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring. 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS). 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. On-Site Meteorological Program Guidance for Regulatory Modeling Applications. EPA-450/4-87-013.

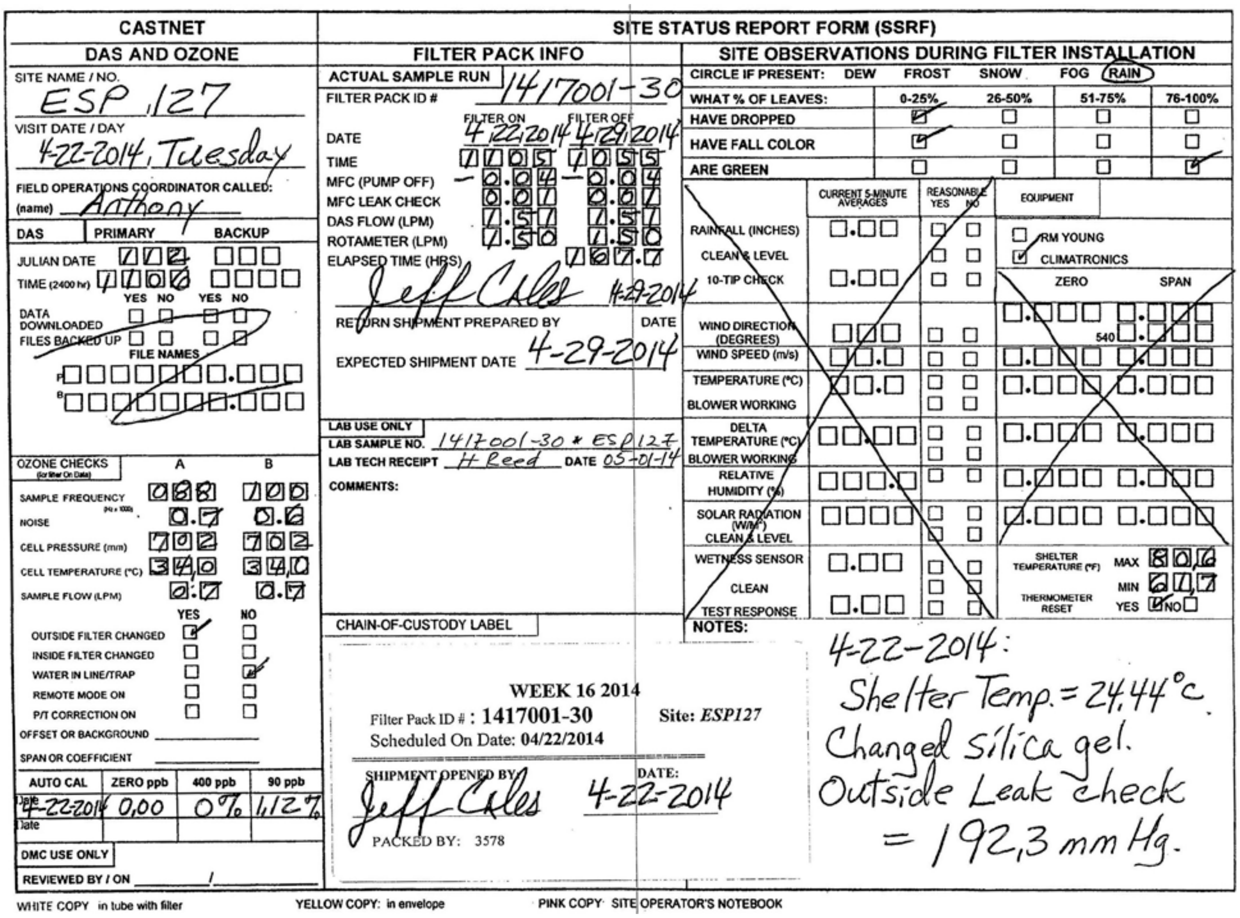
U.S. Environmental Protection Agency (EPA). 1986a. Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods. EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements. EPA-600/4-82-060.

8.0 FIGURES

Figure 1. Site Status Report Form (SSRF)


CASTNET
SITE STATUS REPORT FORM (SSRF)
DAS AND OZONE
SITE NAME / NO. ESP 127
VISIT DATE / DAY 4-22-2014, Tuesday
FIELD OPERATIONS COORDINATOR CALLED: (name) Anthony
DAS PRIMARY BACKUP
JULIAN DATE
TIME (2400 hr)
DATA DOWNLOADED
FILES BACKED UP
FILE NAMES
OZONE CHECKS A B
SAMPLE FREQUENCY
NOISE
CELL PRESSURE (mm)
CELL TEMPERATURE (°C)
SAMPLE FLOW (LPM)
OUTSIDE FILTER CHANGED
INSIDE FILTER CHANGED
WATER IN LINE/TRAP
REMOTE MODE ON
P/T CORRECTION ON
OFFSET OR BACKGROUND
SPAN OR COEFFICIENT
AUTO CAL ZERO ppb 400 ppb 90 ppb
4-22-2014 0.00 0% 1.127
DMC USE ONLY
REVIEWED BY / ON
FILTER PACK INFO
ACTUAL SAMPLE RUN
FILTER PACK ID # 1417001-30
FILTER ON FILTER OFF
DATE 4-22-2014 4-29-2014
TIME
MFC (PUMP OFF)
MFC LEAK CHECK
DAS FLOW (LPM)
ROTAMETER (LPM)
ELAPSED TIME (HRS)
RETURN SHIPMENT PREPARED BY DATE 4-29-2014
EXPECTED SHIPMENT DATE 4-29-2014
LAB USE ONLY
LAB SAMPLE NO. 1417001-30 * ESP127
LAB TECH RECEIPT H Reed DATE 05-01-14
COMMENTS:
CHAIN-OF-CUSTODY LABEL
WEEK 16 2014
Filter Pack ID #: 1417001-30 Site: ESP127
Scheduled On Date: 04/22/2014
SHIPMENT OPENED BY: Jeff Cales DATE: 4-22-2014
PACKED BY: 3578
SITE OBSERVATIONS DURING FILTER INSTALLATION
CIRCLE IF PRESENT: DEW FROST SNOW FOG RAIN
WHAT % OF LEAVES: 0-25% 26-50% 51-75% 76-100%
HAVE DROPPED
HAVE FALL COLOR
ARE GREEN
CURRENT 5-MINUTE AVERAGES
REASONABLE YES NO
EQUIPMENT
RAINFALL (INCHES)
CLEAN & LEVEL
10-TIP CHECK
RM YOUNG
CLIMATRONICS
ZERO SPAN
WIND DIRECTION (DEGREES)
WIND SPEED (m/s)
TEMPERATURE (°C)
BLOWER WORKING
DELTA TEMPERATURE (°C)
BLOWER WORKING
RELATIVE HUMIDITY (%)
SOLAR RADIATION (W/M²)
CLEAN & LEVEL
WETNESS SENSOR
CLEAN
TEST RESPONSE
SHELTER TEMPERATURE (°F) MAX MIN
THERMOMETER RESET YES NO
NOTES:
4-22-2014:
Shelter Temp. = 24.44°C.
Changed silica gel.
Outside Leak check = 192.3 mm Hg.
WHITE COPY in tube with filter
YELLOW COPY: in envelope
PINK COPY: SITE OPERATOR'S NOTEBOOK

II. SITE OPERATIONS
C. SITE OPERATOR INSTRUCTIONS WITH CLIMATRONICS EQUIPMENT

This SOP has been retired.

II. SITE OPERATIONS
D. FIELD OPERATIONS MANUAL
1. SITE DATA ACQUISITION SYSTEM

Effective Date: 10/30/14

Prepared by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Supervisor

Approved by: Holton K. Howell, Project Manager

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Reviewed by:	Title:	Date:	Signature:
MS	QA mgr	11/2/15	

II. D. 1. SITE DATA ACQUISITION SYSTEM

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance to each Site Operator for operating the site data logger.

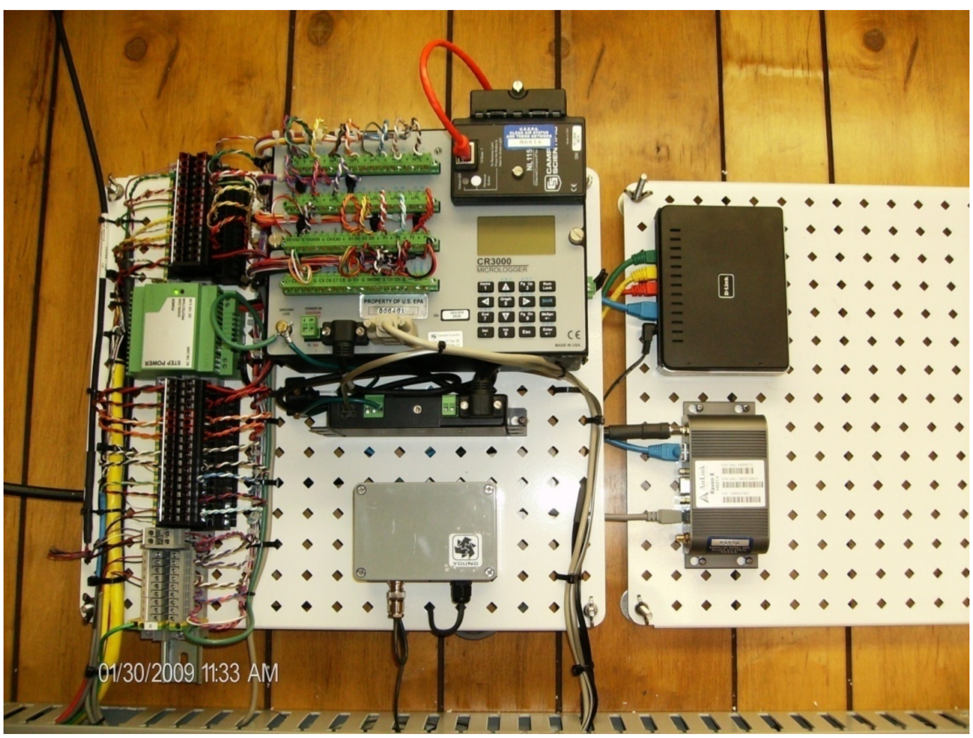
2.0 SCOPE

This SOP applies to the operation of all EPA sponsored CASTNET sites equipped with Campbell Scientific Model CR3000 data loggers.

3.0 SUMMARY

The data acquisition system (DAS) used at EPA sponsored CASTNET sites includes a Campbell Scientific Model CR3000 data logger, Campbell Scientific NL115 Ethernet Module, Laptop Computer and Modem, either cellular Raven or telephone COM220, or both. The specific instructions used by the site operator while performing routine site operations are described in Section II.B. This section is intended to provide a general description of the data logger operation and proper data collection configuration as pertinent to CASTNET operations. A detailed description can be found in the Campbell Scientific Model CR3000 Operating Manual. A photo of the wall mounted data logger and communications backplane is showing in Figure 1. Other photos of the data logger system are provided in Section II.A.2, Subsection 3.2.

Figure 1. DAS System: Wall Mounted Data logger and Communications Backplane



3.1 CR3000 Data Logger

The CR3000 data logger collects and records data independent of the on-site computer. As deployed, however, the CR3000 units utilize a laptop computer to provide user interface and allow onsite access to data and operational features via the application PC200. See Section II.B (subsection 6.0) for illustration of PC200. The computer and modem(s) are used only to communicate with or download data from the data logger.

3.1.1 CR3000 Modes of Operation

The CR3000 has two operational modes: normal data collection mode and calibration mode. For standard site operations including routine monitoring calibration mode should be disabled wherein “calibrator-onsite” is set to “false”. All “channel_down” parameters should be set to “false” The occasion may arise in which the Field Site Operator will be required to replace site equipment which uses a numerical correction factor such as a temperature probe or mass flow system. In this event calibration mode must be enabled or the data logger will not store the new numerical correction factors.

3.1.1.1 Normal data collection mode

Set “Calibrator OnSite” to “false”. All “(channel name)_down” parameters set to “false”. In this configuration the data logger will record each channel normally and two way communications with the ozone analyzer (model 49i) will be enabled.

3.1.1.2 Calibration mode

Set “Calibrator_OnSite” to “true”. Two-way communications with the ozone analyzer will be disabled. Transfer channel five minute averaging functions enabled. Changes to numerical correction factor variables will be enabled.

3.1.2 Site Type: Climatronics or R.M. Young Meteorological Equipment

Each data logger is programmed for deployment at sites utilizing either Climatronics or R.M. Young equipment. For sites utilizing Climatronics equipment however the variable “Climatronics_Site” must be set to “true” for proper wind direction, wind speed and blower status measurements.

Climatronics sites: “Climatronics_Site” set to “true”.
R.M. Young sites: “Climatronics_Site” set to “false”.

3.1.3 PC200 Application

Features of the CR3000 and its associated software are available through the pushbutton and LCD display interface on the data logger front panel. However, site operators and field calibrators use a laptop computer and the software application PC200 to access data, up/down channels, and assess the operational status of the data logger and site instrumentation.

The CR3000 Primary interface for site operations consists of an array of “network configuration grids”. The available grids are displayed within the PC200 application default window on the left side following the establishment of communications with the data logger. The function of each network configuration grid is detailed below:

PC200 Network Configuration Grids	
Network Configuration Grid	Function(s) & Parameters
1 Site Operator	Julian Date and Time (Columns 1&2) Instantaneous data in engineering units (Columns 1&2) Five-minute average data in engineering units (Columns 3&4) Blower status indications (Columns 5&6) Channel up/down controls (Columns 5&6) Ozone ZSP control (Columns 5&6) Ozone housekeeping parameters (Columns 7&8) Precipitation and Wetness check controls (Columns 7&8) Precipitation and Wetness check values (Columns 7&8) Ozone ZSP results (Columns 7&8)
2 Site Operator 2	Trace gas instantaneous engineering units (Columns 1&2) Trace gas channel up/down controls (Columns 3&4) Trace gas ZSP results (Columns 5&6, 7&8)
3 Calibration	Instantaneous data in engineering units (Columns 1&2) Instantaneous transfer data in engineering units (Columns 1&2) Instantaneous data channel voltages (Columns 3&4) Channel up/down controls (Columns 5&6) Calibrator on site toggle (Columns 7&8) Site type RMY/Climatronics toggle (Columns 7&8) Wetness/Precipitation Check values (Columns 7&8) Transfer average engineering unit values (columns 7&8)
4 Calibration-2	Raw and Corrected temperature values (Columns 1&2) Temperature Correction Coefficients: ρ & α (Columns 1&2) Flow rate units and voltage (Columns 5&6) Flow rate Full Scale and Offset values (Columns 5&6) Blower status indicators (Columns 7&8) Calibrator on site toggle (Columns 7&8) Site type RMY/Climatronics toggle (Columns 7&8) Ozone and ozone transfer value and averages (Columns 5&6,7&8)
5 Continuous Analyzers	Continuous gas analyzer instantaneous units (Columns 1&2) Continuous gas analyzer ZSP status (Columns 3&4, 5&6, 7&8) Continuous gas analyzer ZSP toggles (Columns 3&4, 5&6, 7&8)
6 Trace Gas	Continuous gas analyzer instantaneous units (Columns 1&2) Continuous gas analyzer averages (Columns 3&4) Continuous gas analyzer voltages & flags (Columns 5&6, 7&8) Continuous gas analyzer variable conditions (Columns 5&6, 7&8)

Network Configuration grid files are stored on the locally on the site laptop as well as on AMEC Data Collection Operations server(s).

3.2 Campbell Scientific NL115 Ethernet/Compact Flash Module

The data logger NL-115 module is not user serviceable. In the event of failure contact AMEC Field Operations Personnel and replace the unit as instructed.

3.3 Laptop Computer

The site laptop computer should be left on at all times. It is not user serviceable. In the event of failure contact AMEC Field Operations Personnel and replace the unit as instructed.

3.4 Network Router

The site router should be operational at all times. It is not user serviceable In the event of failure contact AMEC Field Operations Personnel and replace the unit as instructed.

3.5 Campbell Scientific COM220 Modem

The COM220 should be operational at all times. It is not user serviceable. In the event of failure contact AMEC Field Operations Personnel and replace the unit as instructed.

3.6 AirLink RAVEN X Modem: All models

RAVEN modems should be operational at all times. In the event of failure power unit should be cycled to reset the connection to the ISP prior to making the determination to replace the unit. AMEC Field Operations Personnel will contact Field Site Operators at sites with Raven modem failures.

3.6.1 Normal operation of Raven modem

All of the LED indicators on the Raven should be ON during normal operation. The “Activity” and “Service” lights typically blink during normal operation. In the event that the modem loses communication with the ISP cycle the power.

3.6.2 Power cycle the Raven modem

Unplug the grey power cord on the rear of the modem housing by depressing the lever clip and pull the connector straight out of its port. Wait ten seconds then plug the connector back into the same port.

4.0 MATERIALS, SUPPLIES, REPAIR AND MAINTENANCE

Campbell Scientific Model CR3000 data logger

Laptop computer with RS232 serial port or USB to RS232 adaptor

Campbell Scientific PC200 Windows XP SP3 executable application

Campbell Scientific COM220 phone modem and/or AirLink Communications Raven X H4223-C

Campbell Scientific CR3000 data loggers cannot be calibrated in the field. Replace the unit if necessary.

Maintenance includes battery replacement as necessary.

Replace Terminal Block if necessary

Replace NL111 if necessary.
Replace power adapter if necessary.

5.0 SAFETY

The same level of care and caution should be exercised while using the laptop/computer as would be taken when using any electrically powered device. Keep all cords out of walkways. If needed, use appropriately rated extension cords and surge protectors, and do not overload the electrical circuit. Keep liquids and food away from the computer and keyboard.

6.0 PROCEDURES

6.1 CR3000 Data Logger Operation through PC200 Interface via Site Laptop

Note: *See Section II.B for depictions of the PC200 interface.*

6.1.1 Starting the PC200 application

PC200 will load automatically upon start up of the site laptop. PC200 may also be started through the MS Windows start button>all programs>PC200W>PC200 menu structure.

6.1.2 Recovery of Corrupted PC200 Network Configuration Grids

Note: *Corruption of Network Configuration grid most often occurs when a cell or cells on the grid are "dragged and dropped" onto adjacent cells or simply deleted from the grid.*

Recovery of the proper Network Grid configuration may be accomplished remotely through AMEC Field Operations or Data Operations Personnel, or locally through the PC200 interface. To recover a Network Configuration remotely call AMEC Field Operations. To perform the task onsite:

In the PC200 application click "Network"
Click "Backup/Restore Network"
On the pop-up dialog box click "Restore".

6.1.3 Enabling and Disabling Data Collection Channels

In normal operation all "channel_down" parameters should be set to "false" for proper data collection.

6.1.3.1 To Down (or disable) a channel set the appropriate channel "channel_down" parameter to "true". Double click the "false" indication in the cell to the right of the "channel_down" parameter TWICE. The "false" indication will toggle to "true" and the channel will be offline.

6.1.3.2 To Up (or enable) a channel set the appropriate "channel_down" parameter to "false". Double click the "true" indication in the cell to the right of the "channel_down" parameter TWICE. The "true" indication will toggle to "false" and the channel will be enabled.

Note: *ALWAYS ENSURE THAT ALL CHANNELS ARE ENABLED PRIOR TO LEAVING SITE.*

6.1.4 Enabling and Disabling Calibration Mode

In normal operation Calibration Mode will be disabled. Field Site Operators should only enable Calibration Mode after replacing a temperature probe or mass flow control system. Calibration Mode must be enabled when new Numerical Correction factors are entered into the data logger or the data logger will not save the new values correctly. The "Calibrator_OnSite" parameter is located in the "3 Calibration" network configuration grid.

6.1.4.1 To enable Calibration Mode" set the "Calibrator_OnSite" parameter to "true". Do so by double clicking the "false" indication in the cell to the right of the "Calibrator_OnSite" parameter TWICE. The "false" indication will toggle to "true".

6.1.4.2 To disable Calibration Mode set the "Calibrator_OnSite" parameter to "false". Do so by double clicking the "true" indication in the cell to the right of the "Calibrator_OnSite" parameter TWICE. The "true" indication will toggle to "false".

6.1.5 Updating Numerical Correction Coefficients when Replacing Sensors

In the event that the Field Site Operator replaces a temperature probe or mass flow control system new numerical correction factors must be installed in the data logger. The new correction coefficients are found on the calibration certification form that ships with the replacement device.

To install new numerical correction factors first enable Calibration Mode by setting "Calibrator_OnSite" ("3 Calibration" grid) to "true". Open the 4 Calibration-2 network grid by double-clicking the 4 Calibration-2 grid icon in the left side pane of the PC200 window. Double-click the appropriate numerical value in the cell to the right of the correction factor name. Once the existing value is highlighted type the new correction faction as found in the certification form in the cell. Press ENTER key. Once the new correction factor has been entered disable Calibration Mode by setting "Calibrator_OnSite" to "false". This process is described in detail in the individual standard operating procedures for site equipment replacement.

Sensors Utilizing Numerical Correction Factors		
Sensor / System	Correction Factor Variable Name	Network Grid
Temperature 1 (9m)	ro_t1	4 Calibration-2
	alpha_t1	
Temperature 2 (2m)	ro_t2	
	alpha_t2	
Mass Flow	flow_offset	
	flow_fullscale	

7.0 ATTACHMENTS

Manual Data Collection

MANUAL DATA COLLECTION

Effective Date: 6-1-13

Prepared by: Kevin P. Mishoe, Field Operations Manager — Kevin Mishoe by Michael J. Smith with permission

Reviewed by: Marcus O. Stewart, QA Supervisor — [signature]

Approved by: Holton K. Howell, Project Manager — Holton K Howell

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MS	QAMgr	10-31-14	[signature]
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MANUAL DATA COLLECTION STANDARD OPERATING PROCEDURES

1.0 PURPOSE

This procedure will explain to Field Site Operators (FSO), how they are to collect data in instances of no telemetric connectivity for remote data collection.

2.0 SCOPE

These procedures apply to all CASTNET sites using Campbell Scientific DAS.

3.0 SUMMARY

Operation of Ambient Air Monitoring sites in remote locations offers a number of challenges, among them, the ability to collect data automatically. Weather and network related problems can cause land-based telephone lines and cellular connectivity to fail, which leads to the inability to connect and access data remotely. In some instances these outages can last for extended periods of time. This procedure instructs the FSO on how to manually collect data, check data, and send to the Field Operations Center.

Upon a communication disruption for more than three days, the Field Operations Manager (FOM) or FOM designee will contact and instruct the FSO to investigate the communication problem and inspect most recent Zero Span Precision (ZSP) check for validity. After seven days without remote data retrieval, a thumb drive will be sent to FSO. The FSO will be asked to download data at their next site visit onto the site laptop and then copy onto the thumb drive before returning it to the AMEC Field Office.

4.0 MATERIALS AND SUPPLIES

Thumb Drive
Laptop Computer equipped with Campbell Scientific PC200 program

5.0 SAFETY

Grounded power

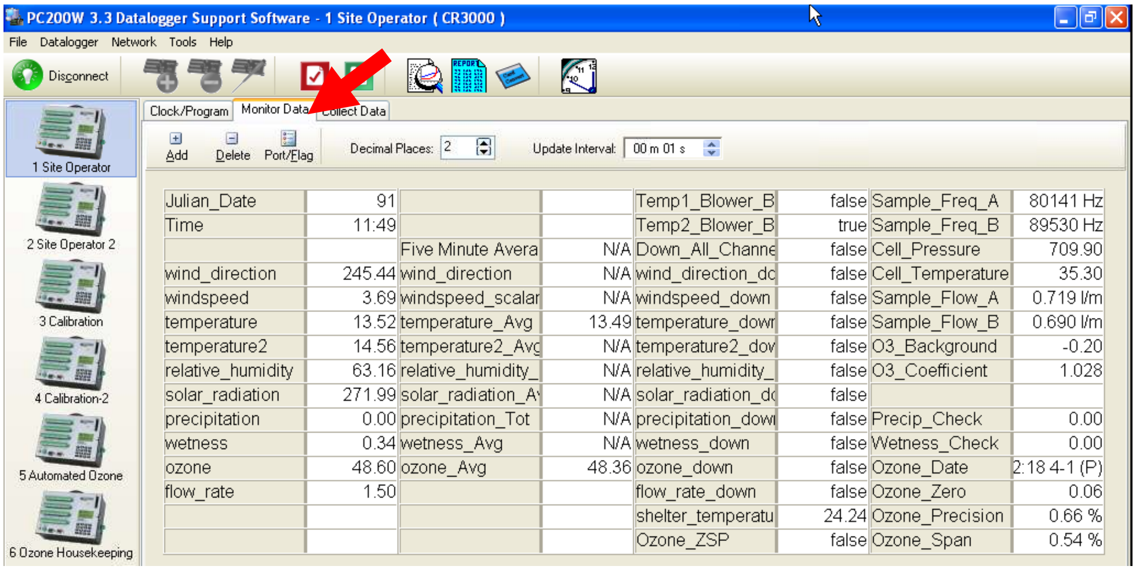
6.0 PROCEDURE

6.1 Checking ZPS results

Since the ozone data is ordinarily reviewed every morning, the ZPS results must be verified manually during an extended communications disruption to ensure the equipment is operating properly and valid measurements will be collected once communications are restored.

6.1.1 Make sure the Campbell Scientific PC200W program is running on the site laptop and is on the 1 Site Operator page of the Monitor Data tab (Figure 1)

Figure 1 1 Site Operator page of the Monitor Data tab



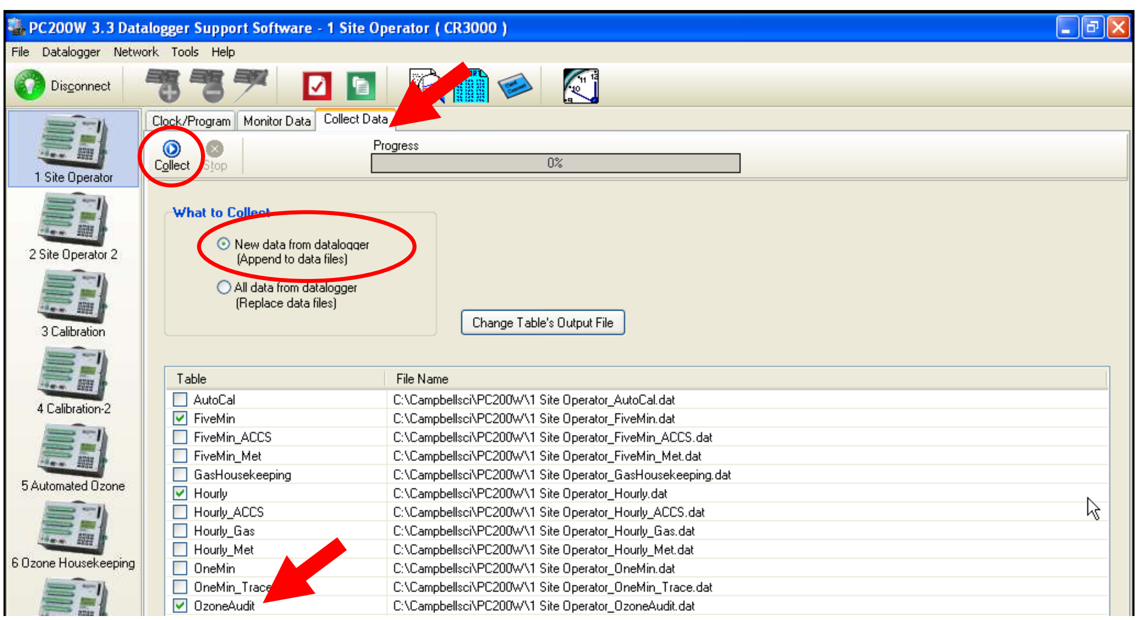
6.1.2 Click the Collect Data tab (Figure 2)

6.1.3 New data from datalogger button should be selected (Figure 2)

6.1.4 Verify the OzoneAudit checkbox is checked (Figure 2)

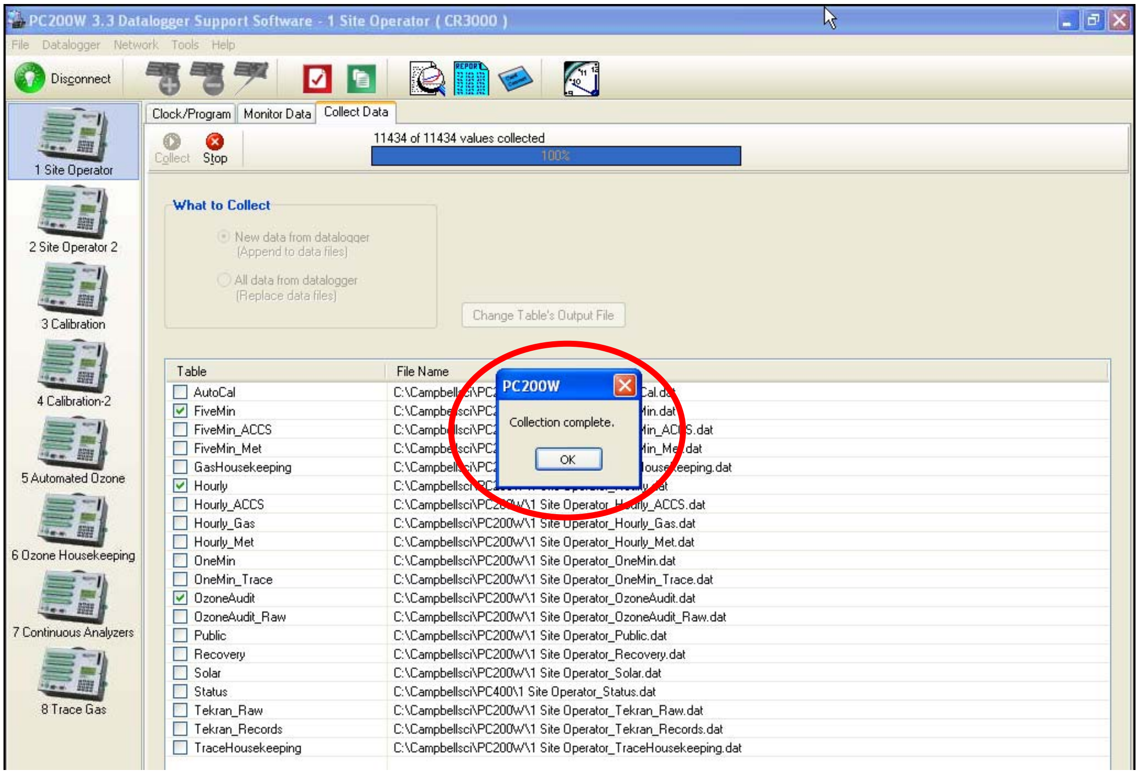
6.1.5 Click on Collect button (Figure 2)

Figure 2 Collect Data tab



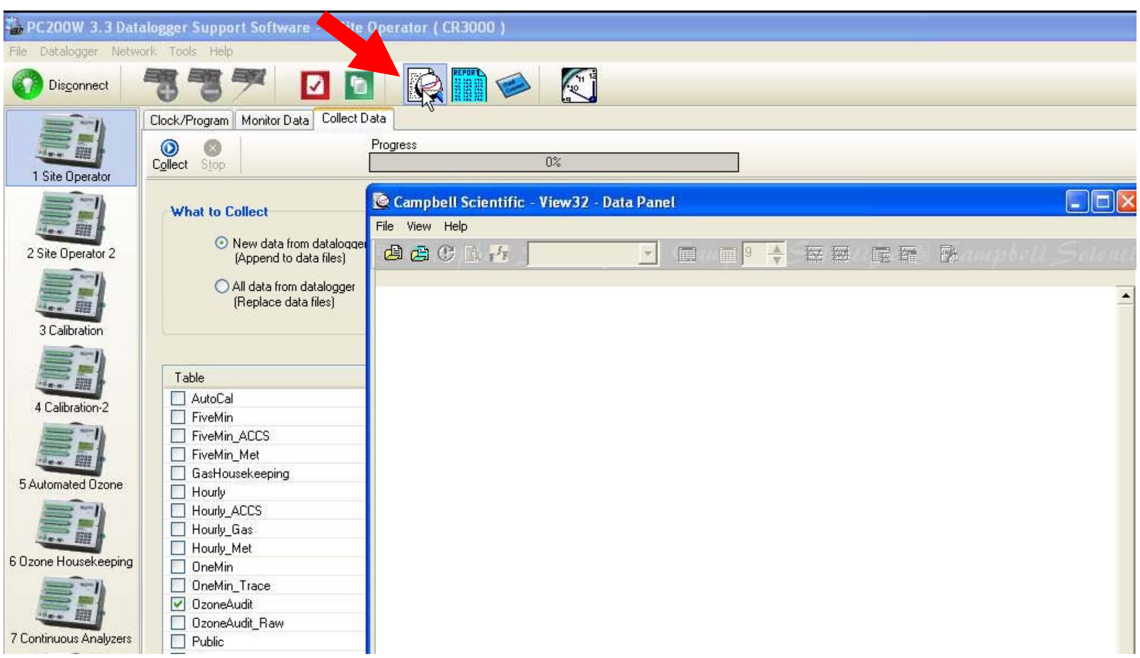
6.1.6 After the data are collected, click OK on the Collection complete pop-up box (Figure 3)

Figure 3 Collection complete pop-up



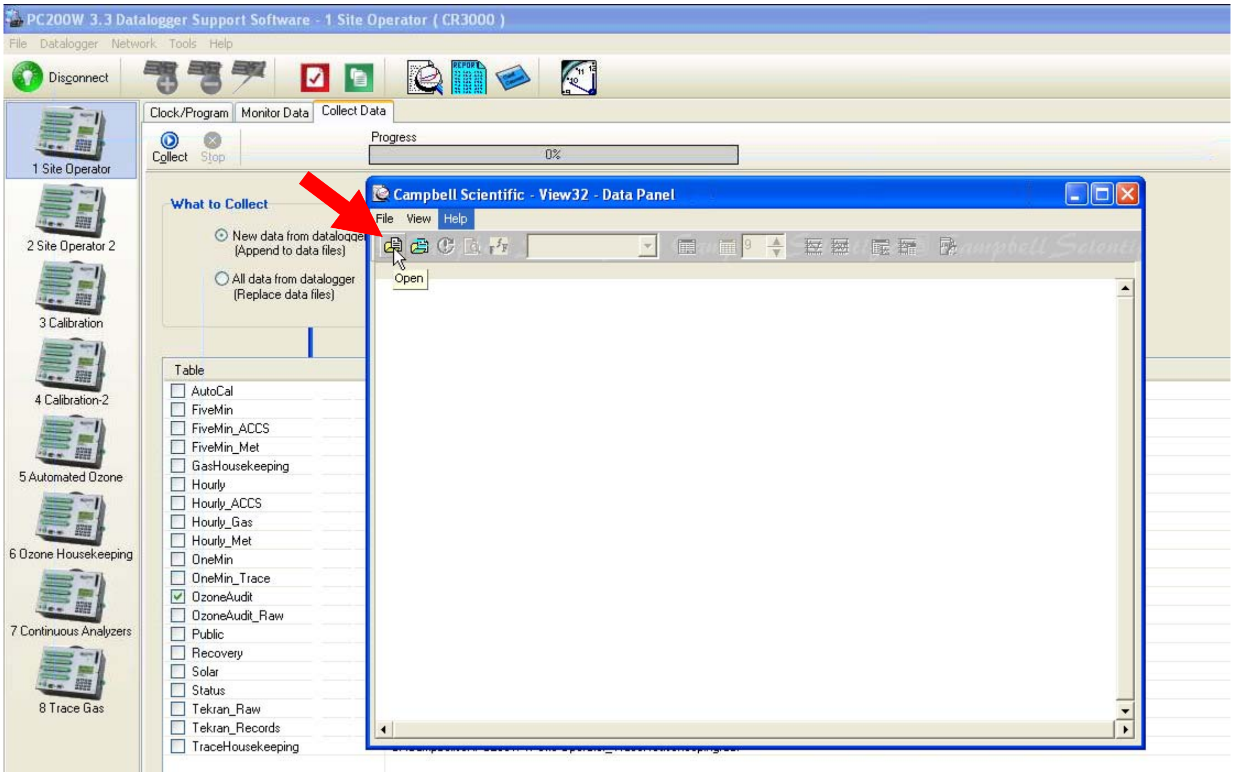
6.1.7 Click the View icon at the top of the page (Figure 4)

Figure 4 View window open



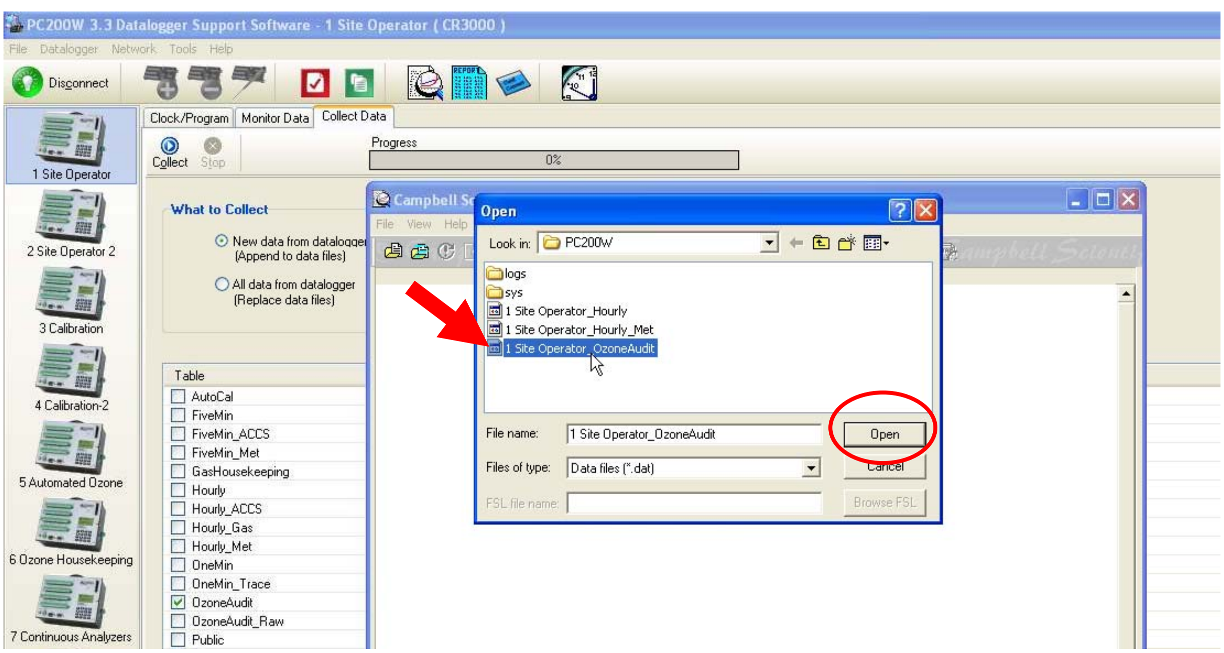
6.1.8 To view the data files, click the Open icon on the View32-Data Panel window (Figure 5)

Figure 5 Open icon



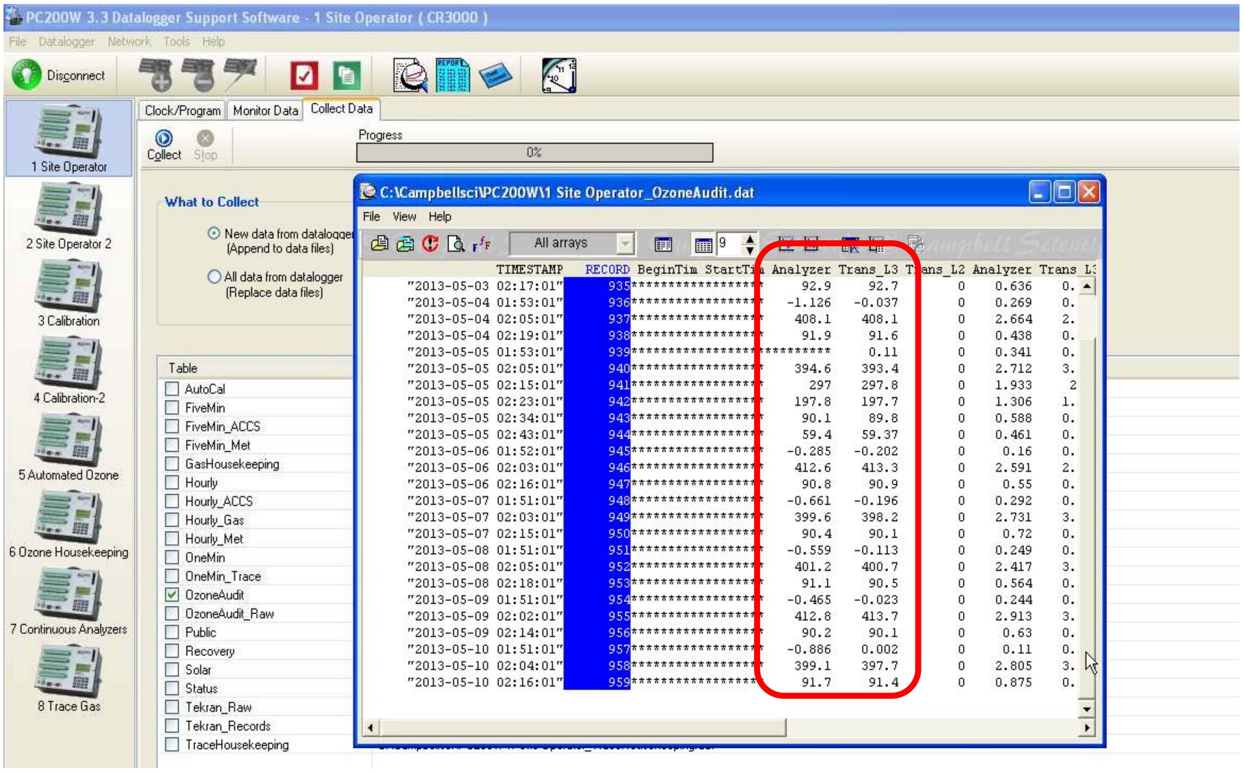
6.1.9 Click the 1Site Operator_OzoneAudit file to highlight it, then click Open (Figure 6)

Figure 6 Opening the OzoneAudit file



6.1.10 Call the Field Office 1-888-224-5663 ext6611 and discuss the recent ZSP results (Figure 7)

Figure 7 ZSP results



6.2 Downloading Data

After a period of seven days without remote data collection, all the data must be collected manually and the data files are sent to the Field Office

6.2.1 Perform steps 6.1.1, 6.1.2, and 6.1.3

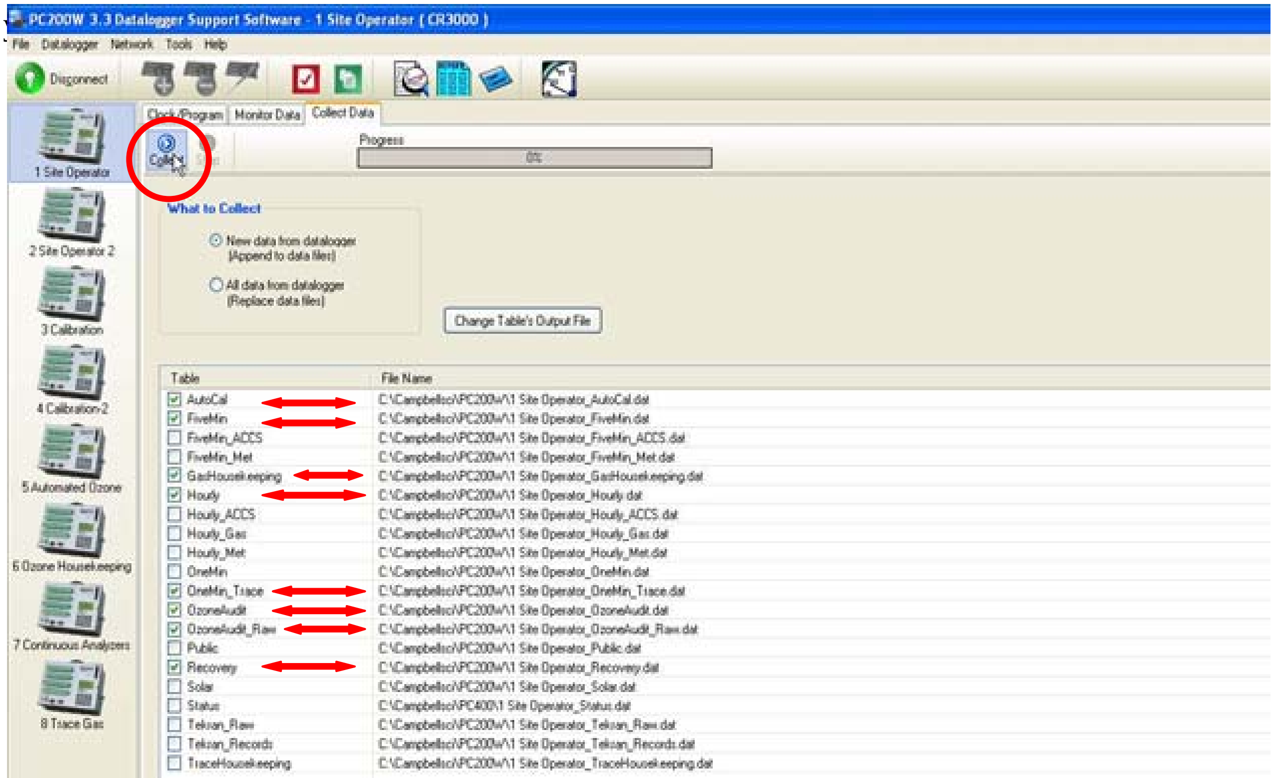
6.2.2 All sites should have the FiveMin, Hourly, and Recovery checkboxes checked

6.2.3 If the following equipment is operating at the site, their associated checkboxes must be checked in addition to the checkboxes in the previous step (see Figure 8 for an example):

- Ozone – OzoneAudit, OzoneAudit_Raw and GasHousekeeping checkboxes
- Trace analyzers (NOy, SO2 or CO) – AutoCal and OneMin_Trace checkboxes
- Meteorological – FivMin_Met and Hourly_Met checkboxes
- Tekran – Tekran_Raw and Tekran_Records

Note: For a site with a filter pack, the data will be collected with check boxes selected in step 6.2.2.

Figure 8 **The eight checkboxes that must be checked and their associated data files for a site operating a filter pack, an ozone analyzer, and a NO_y trace analyzer**



6.2.4 Click on Collect button (Figure 2 and 8)

6.2.5 Perform step 6.1.6

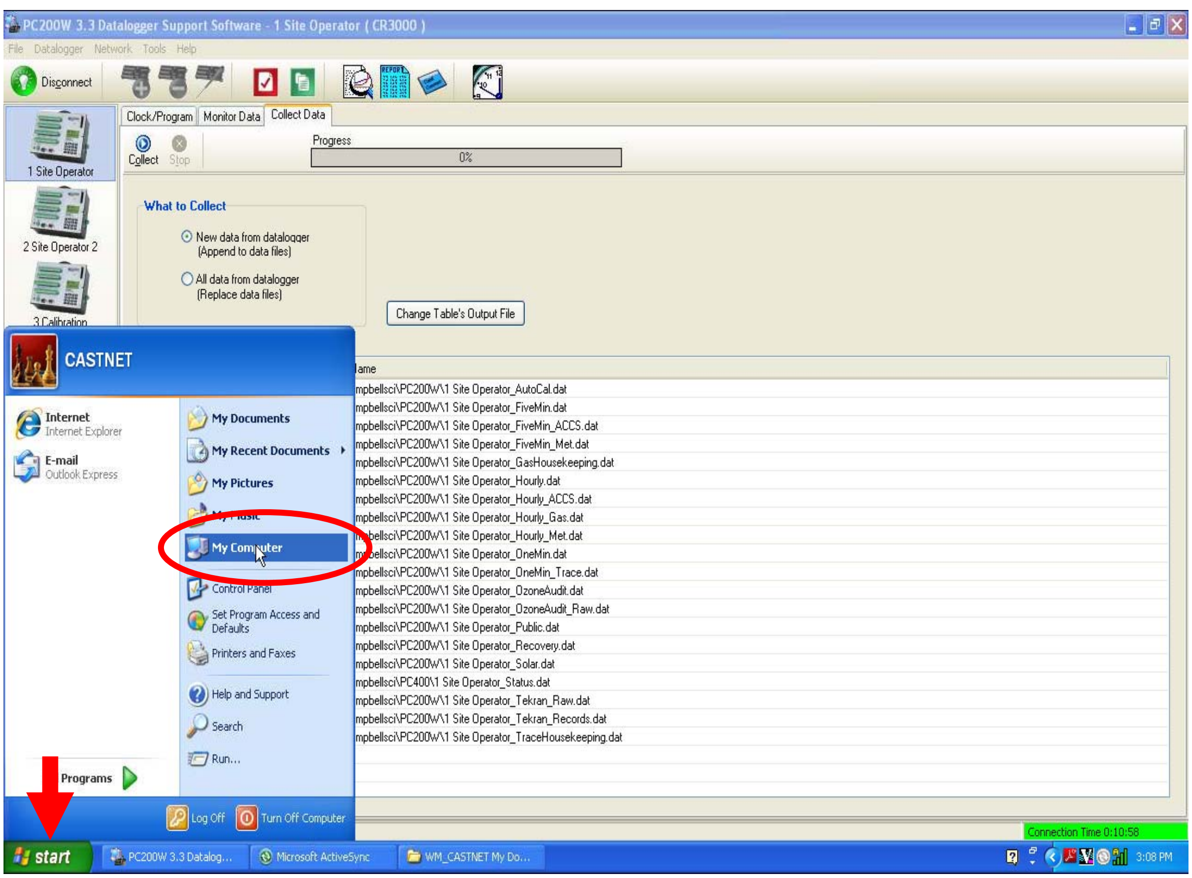
6.2.6 Insert the supplied thumb drive into a USB port on the site laptop (Figure 9 and 10)

Figure 9 **Site laptop USB ports**

Figure 10 Thumb drive inserted into the USB port

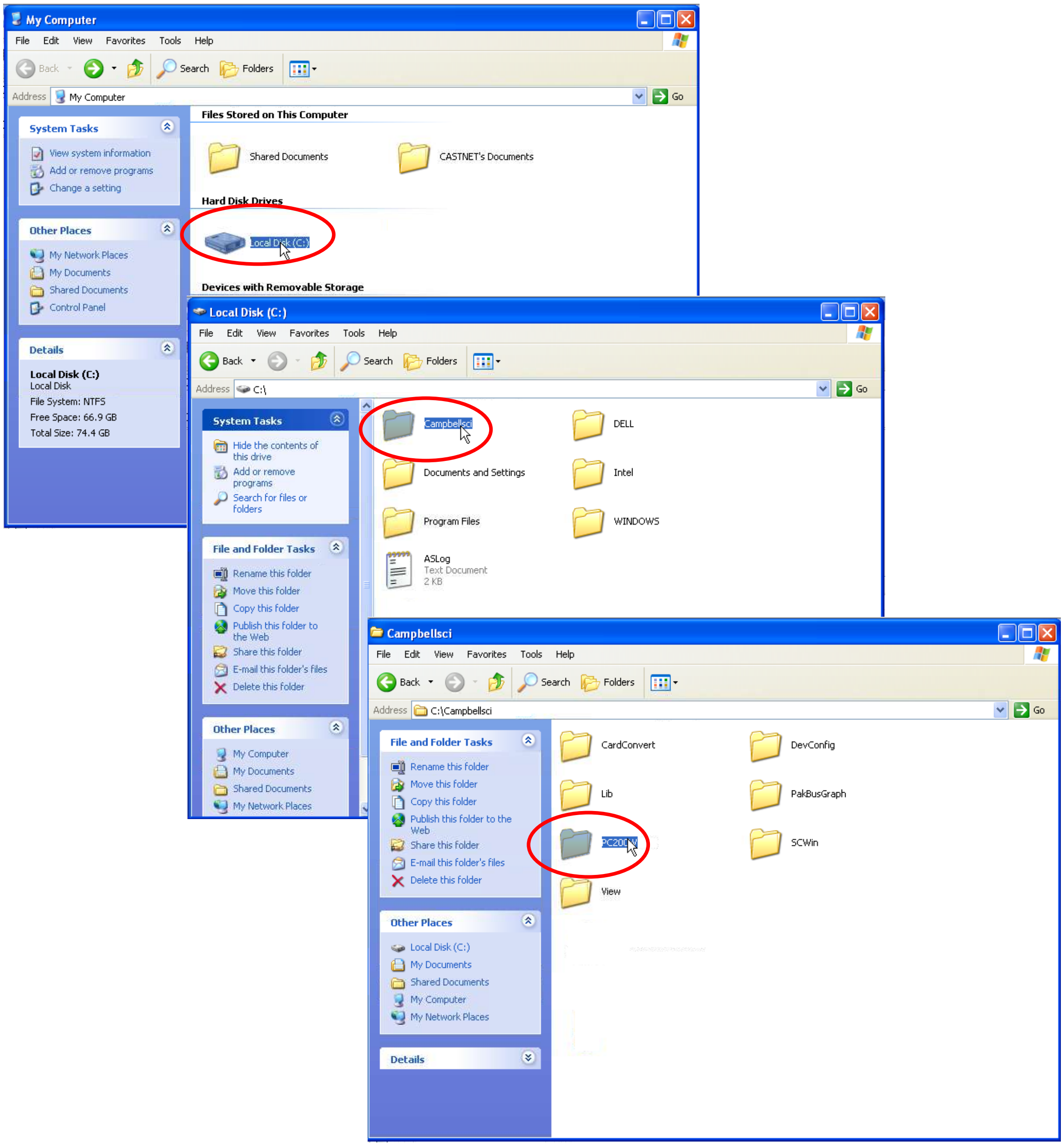
6.2.7 Click the Start button in the lower left-hand corner of the site laptop and then click My Computer (Figure 11)

Figure 11 Click My Computer



6.2.8 Double click Local Disk (C:), Double click the Campbellsci folder, Double click the PC200W folder (Figure 12)

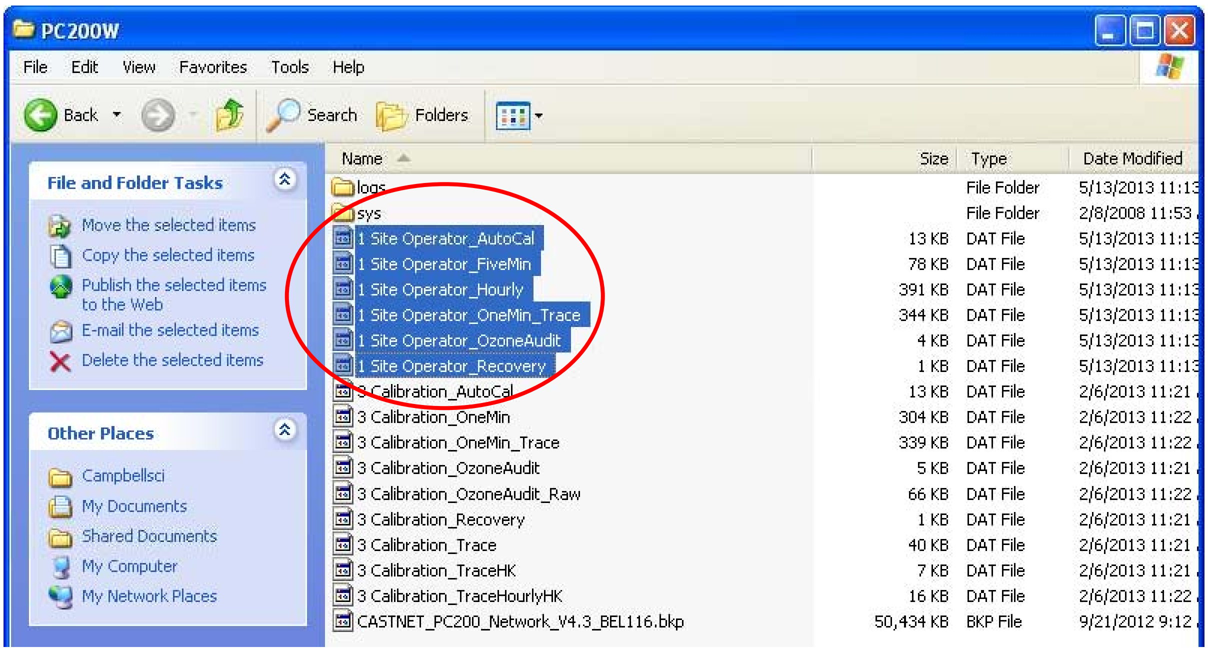
Figure 12 C:\Campbellsci\PC200W



6.2.9 Hold the Ctrl key on the laptop keyboard and click on the appropriate data files determined in steps 6.2.2 and 6.2.3 (see Figure 13 for an example)

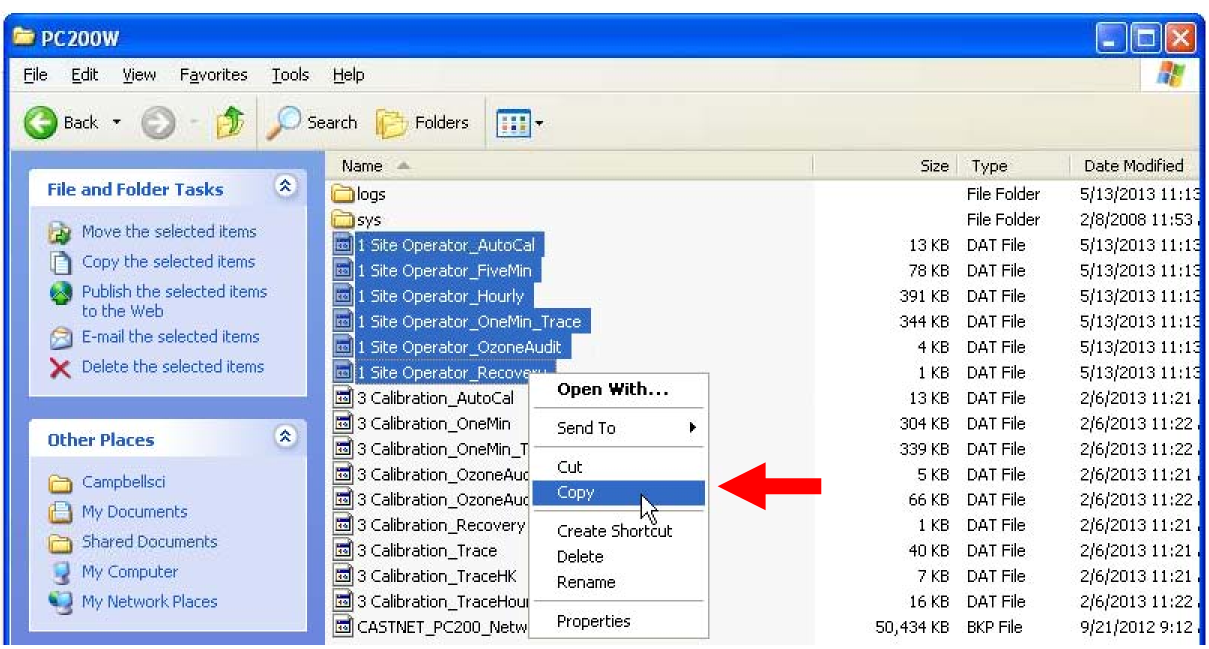
Note: There may be other data files that do not need to be selected.

Figure 13 Highlighted files that were selected in steps 6.2.2 and 6.2.3



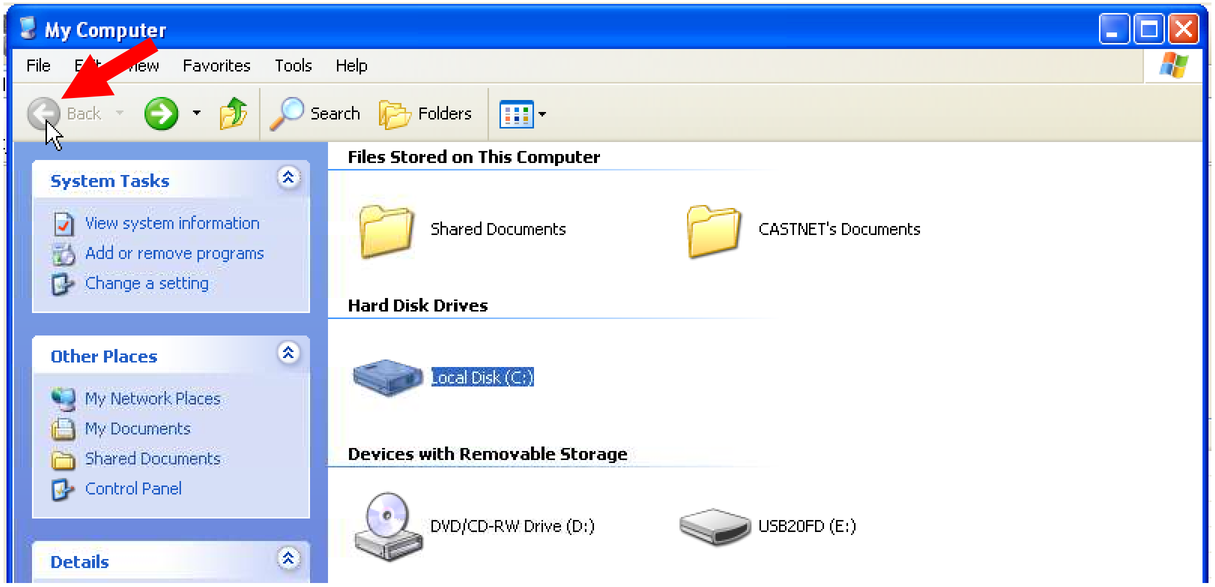
6.2.10 With all the appropriate files highlighted, hover the mouse over any one of the files and right click; click Copy on the next pop-up box (Figure 14)

Figure 14 Click Copy



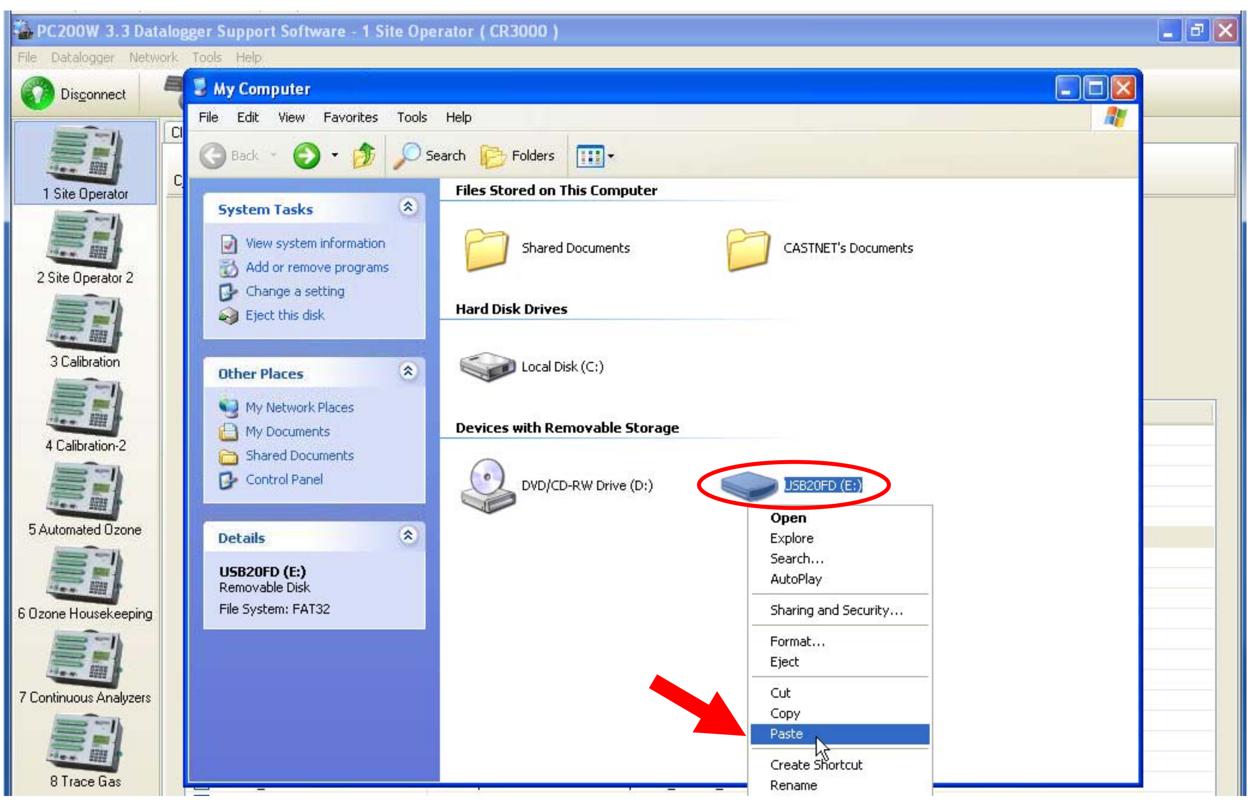
6.2.11 Click the back button three times to get back to the My Computer screen (Figure 15)

Figure 18 Back button



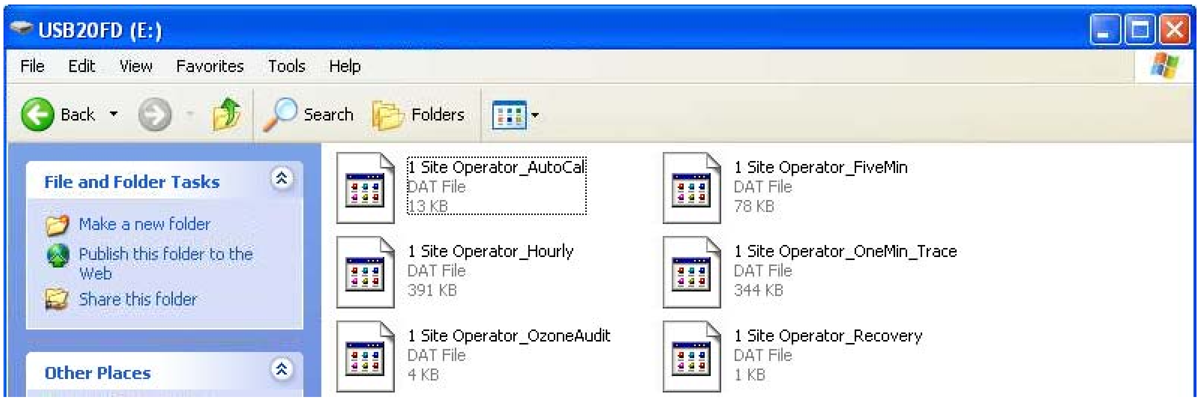
6.2.12 Move the mouse to the drive letter that corresponds to the thumb drive and right click; click paste on the pop-up (Figure 19)

Figure 19 Pasting (copying) data files to the thumb drive



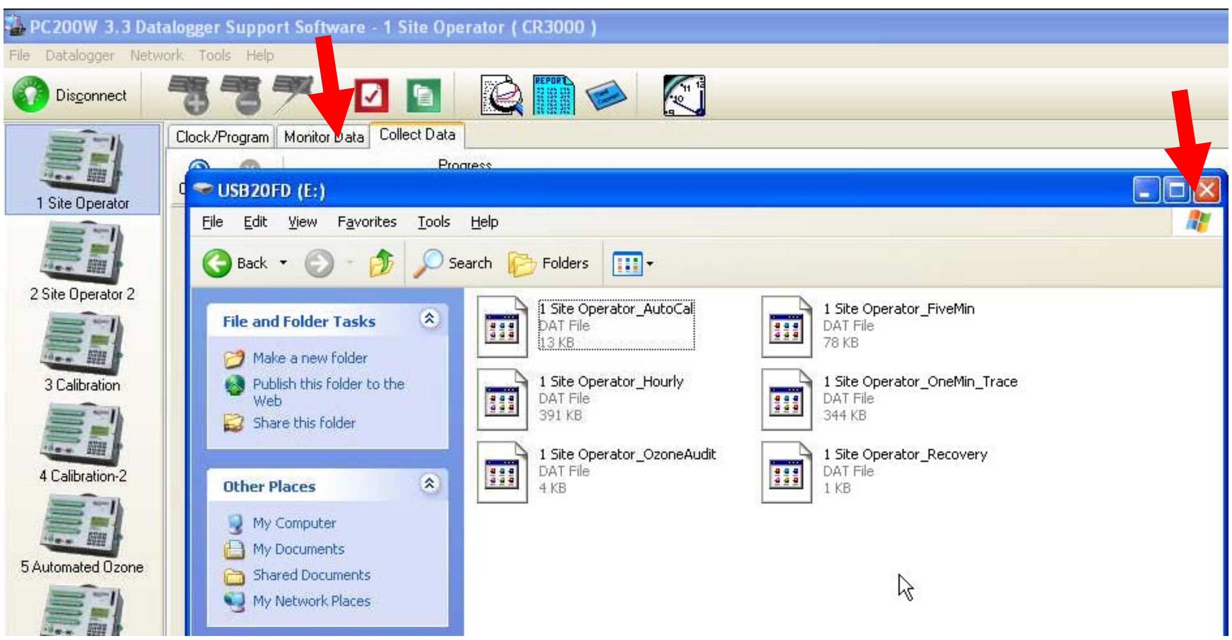
6.2.13 Double click the thumb drive icon to open it and verify the files are present (Figure 20)

Figure 20 Data files on the thumb drive



6.2.14 To return to the 1 Site Operator page on the Monitor Data tab, click the red X on the thumb drive page and then click the Monitor Data Tab (Figure 21)

Figure 21 Close thumb drive page and click Monitor Data Tab



6.3 Data Delivery

Upon successful data collection and storage, e-mail a copy of the data files to the FOM or FOM designee. The thumb drive with data files must be mailed to the AMEC Field Office using the return envelope if one is provided or it can be included with the next filter pack shipment.

7.0 REFERENCES

8.0 ATTACHMENTS

No attachments

II. SITE OPERATIONS
D. FIELD OPERATIONS MANUAL
2. FILTER SAMPLING

Effective Date: 10/30/14

Reviewed by: Kevin P. Mishoe, Field Operations Manager [signature]

Reviewed by: Marcus O. Stewart, QA Manager [signature]

Approved by: Holton K. Howell, Project Manager [signature]

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MS	QA Mgr	11/2/15	[signature]

II. D. 2. FILTER SAMPLING

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide consistent guidance for Filter Pack Sampling Operations to each Site Operator.

2.0 SCOPE

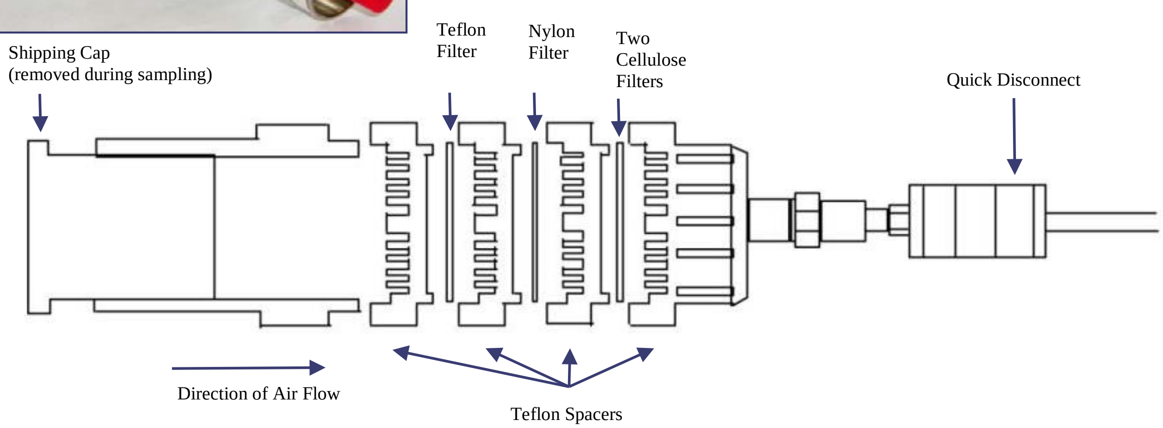
This SOP applies to all routine CASTNET filter pack sample handling and associated activities in the field, including installation, removal, and inspection. CASTNET site configurations vary from filter pack sampling only to sites that also monitor atmospheric gases with automated analyzers and those that include meteorological measurements. Please adhere to the procedures pertinent to the equipment installed onsite.

3.0 SUMMARY

Atmospheric sampling for sulfur and nitrogen species is performed at each CASTNET site integrated over weekly collection periods using a three-stage filter pack (Figure 1). Filter packs are prepared by the AMEC analytical laboratory and shipped to the field weekly. The filter packs are exchanged at each site every Tuesday by the local site operator. The operator replaces the exposed filter pack and ships it to the analytical laboratory. The site operator also evaluates equipment status and performance and performs preventative maintenance. All supporting paperwork is completed.

Figure 1. Three-Stage Filter Pack

Cellulose	=	Gaseous: SO_2
Nylon	=	Gaseous: HNO_3, SO_2
Teflon	=	Particulate: SO_4^{2-}, NO_3^-, NH_4^+, K^+, Ca^{2+}, Mg^{2+}, Na^+, Cl^-



3.1 Tilt Tower

A filter pack is mounted on a sample head at the top of a 10-meter (m) tilt tower. This tower is separate from the 10-m meteorological tower. The tower is made of heavy weight aluminum and is essentially a 10-m pole hinged to a brace. The ozone (O_3) inlet and the sample filter connections are enclosed in protective aluminum housing at the top of the tower. The 10-m mast is hinged at its midpoint and rotates at the hinge to lower the sample head to ground level for service and maintenance. The tower is counterbalanced to minimize acceleration while being lowered and is controlled by a rope attached to the mast. When the tower is in the upright position, it is latched to prevent inadvertent lowering.

3.2 Filter Pack Cassette Holder

The filter pack cassette holder consists of a three-stage Teflon assembly containing four filters. It is attached to the sample inlet port via a quick connect Swagelock fitting. The filter pack's first stage contains a Teflon filter that removes particulate sulfate (SO_4^{2-}), nitrate (NO_3^-), and other ions. The second stage contains a Nylon filter that removes nitric acid (HNO_3), and the third stage contains two cellulose fiber filters impregnated with potassium carbonate (K_2CO_3) which remove sulfur dioxide (SO_2). Filter packs are prepared by the AMEC laboratory in Gainesville, Florida, and are sent to the site each week. Filter packs are capped at each end, sealed in a plastic bag, and shipped in a protective container.

Note: *After receiving a filter pack, site operators should check the filter pack for damage or contamination. The chain-of-custody label that accompanies all filter packs must also be checked. If a filter pack arrives without a chain-of-custody label, contact the Field Operations Coordinator immediately. Site operators should compare the identification number on the filter pack to the number written on the chain-of-custody label. Contact the Field Operations Coordinator if the filter pack number or the site identification number is incorrect.*

3.3 Filter Pack Flow System

Air flow through the filter pack is generated by a vacuum pump and controlled by a mass flow controller (MFC). The MFC is calibrated against a transfer standard mass flow meter traceable to a primary standard. The MFC is set to 1.50 liters per minute (Lpm) at sites in the eastern United States, and 3.00 Lpm in the western states. The flow rate is greater in the western states because of the expected lower concentrations of SO_4^{2-} and NO_3^-; therefore, a greater volume of air must be sampled to achieve the desired analytical detection limits. The mass flow controller display (LED) and rotameter serve as visual indications of the flow rate. An elapsed time indicator is present to record the duration of the sample interval. Figures 8 through 11 in Section II.A.2, Subsection 3.5 illustrate the sampling train for the filter pack sampling system.

3.4 Lowering the Tower

The filter pack and the O_3 systems sample continuously at the 10-m level. Therefore, both systems must be taken offline and the filter pack sample pump turned off before the tower is lowered. All operations are recorded in the appropriate section of the Site Status Report Form (SSRF) and the site logbook.

3.5 Weekly Filter Pack Cassette Exchange

Filter pack exchanges are performed each Tuesday and are documented on the SSRF (see Section II.B, Figure 1). Since the O_3 sample inlet is accessible during the filter pack exchange, changing the O_3 inlet filter is also described in this section. Use the procedures in Section 6.0 to access the filter pack.

4.0 MATERIALS AND SUPPLIES

Unexposed filter pack cassette for proper sample week
Filter pack cassette shipping tube
Clean zip sealing bag
Clean filter pack cassette caps
Clean unexposed 47mm Savillex Teflon filter membrane
Clean Vinyl or Nitrile gloves
Writing implement
SSRF form for installed filter pack
SSRF form for unexposed filter pack
Site narrative log book

5.0 SAFETY

A hard hat must be worn when raising and lowering towers. If it is necessary to repair or service an instrument, remove personal jewelry, turn off the instruments power and disconnect (unplug) to avoid contact with live current. Always use a safety harness when climbing.

6.0 PROCEDURES

6.1 Prior to Lowering Tower

6.1.1 Record the 5-minute average "flow_rate_Avg" value as found on the "1 Site Operator" grid (1.50 or 3.00) as the **Filter Off, DAS Flow (LPM)** on the SSRF for the filter pack that is being removed as well as the site log book. Record the existing rotameter reading as the **Filter Off, Rotameter (LPM)** in the appropriate section of the SSRF and site log book.

6.1.2 Set "ozone_down" and "flow_rate_down" parameters on the "1 Site Operator" grid to "true" to down the flow and ozone channels. Record the time of downing these channels in the site log book.

6.1.3 Unplug the sample pump and record the time as **Filter Off, Time** on the SSRF as well as in the site log book.

6.1.4 Record the sample duration in the **Filter Off, Elapsed Time (HRS)** block of the SSRF as well as the site log book.

6.2 Lowering the Tower

6.2.1 Unlatch the tower. Uncoil the rope from the tower.

6.2.2 While maintaining tension on the rope end secured to the top tower section, allow the tower to begin to rotate. The tower is counterbalanced to minimize acceleration as it is being lowered. Use the rope to control the tower's rotational speed while lowering.

6.2.3 Inspect the sample head for signs of damage or contamination such as bird droppings. Make any necessary notes in the site logbook and on the SSRF. Do not clean the sample head until the filter pack has been removed. If the sample head is damaged, report it immediately to AMEC CASTNET Field Operations Personnel.

6.3 Removing the Filter Pack

Note: *Expel excess air from the bag prior to sealing (this will simplify packaging for shipment).*

6.3.1 Put on a pair of clean vinyl gloves. Remove the large end cap from the filter pack plastic bag and insert the cap into (or over) the inlet end of the filter pack. To remove the filter pack from the sampling head, pull up on the collar of the quick-connect fitting. Cap the other end of the filter pack with the small orange end cap from the bag. Place the filter pack in the plastic bag and seal. Discard the gloves.

6.3.2 Use only water and paper towels to clean the sample head. After the filter pack has been removed, clean the sample head of any excessive dirt or bird droppings. Inspect the sample head for damage, and make any notes in the site logbook and on the SSRF.

6.3.3 Record the MFC display reading while the pump is off in the **Filter Off, MFC (Pump Off)** section of the SSRF. Replace the O_3 inlet filter on the sampler head by unscrewing the Teflon filter holder, removing the filter, and replacing with a new filter. When replacing the O_3 inlet filter, make sure that only one filter is placed in the filter holder.

Use tweezers to handle the clean filter and avoid contamination. In the SSRF **DAS and Ozone** section, check the appropriate box for the O_3 filter replacement.

6.3.4 Test the O_3 sample system for leaks: ONLY PERFORMED AT THE REQUEST OF A **AMEC** TECHNICIAN.

6.3.5 Screw the Teflon end cap onto the inlet of the in-line filter assembly.

6.3.6 Observe the cell flow rates for cells A and B on the O_3 analyzer. When the reading reaches 0.1 Lpm, slowly remove the Teflon end cap from the filter assembly.

Note: *Removing the cap must be done carefully to prevent a destructive flow surge through the O_3 analyzer.*

6.3.7 Contact AMEC CASTNET Field Operations Personnel if the flow readings do not reach 0.1 Lpm or if readings on cells A and B differ by more than 0.1 Lpm.

6.3.8 Leak test the filter pack system: **PERFORMED EACH WEEK.**

6.3.8.1 Plug in the filter pack sample pump.

6.3.8.2 After the mass flow controller readout has stabilized, record the mass flow controller display reading in the appropriate section of the SSRF, Filter Off, MFC Leak Check.

6.3.8.3 Turn off the sample pump.

6.3.8.4 Complete the SSRF for the sample being removed by recording the Filter Off, Date, signing and dating the form, and recording the expected shipment date. All information of the SSRF should be complete at this point. Include the appropriate copy of the SSRF in the filter shipping container.

6.3.8.5 Report the leak check reading to AMEC Field Operations Personnel during the Tuesday call-in.

6.4 Installing the Unexposed Filter Pack

6.4.1 Record the new **Filter Pack ID#** (identification number) on the SSRF, which was shipped with the filter pack. Record the date of installation as the **Filter On, Date**. Record the mass flow controller pump off and leak check readings obtained previously for the **Filter Off** information, which was completed on the SSRF for the previous week’s sample, as the **Filter On** information for the sample being installed.

6.4.2 Put on a new pair of disposable gloves. Remove the end caps from the new filter pack and store them in the plastic bag. Place the plastic bag back in the filter pack mailer.

6.4.3 Install the new filter pack by inserting the color-coded fitting on the base of the filter pack into the matching quick connect fitting on the tower until it locks into place.

6.4.4 Double check the security of the filter pack by pulling on it to be sure that it is locked in place. Be careful not to contaminate or damage the exposed filter.

> ***Warning!*** Be sure the filter pack is secure; if not, it may fall from the tower causing injury. Wear a hard hat.

6.4.5 After installing the filter pack, raise the tower and lock into place. Inspect the sample lines to ensure that they are not crimped at the tower hinge.

6.4.6 Reset the elapsed time indicator.

6.4.7 Turn on the sample pump, and enter the time as **Filter On, Time** in the appropriate box on the SSRF. Allow the MFC display to stabilize (1 or 2 minutes), then verify that the display reads the predetermined value equivalent to 1.50 or 3.00 Lpm established from the most recent calibration data.

6.4.8 Set "ozone_down" and "flow_rate_down" parameters on the "1 Site Operator" grid to "false" to enable the flow and ozone channels. Record the time of enabling these channels in the site log book.

6.4.9 After the sample pump has been running for 5 minutes record the 5-minute average "flow_rate_Avg" value as found on the "1 Site Operator" grid as the **Filter On, DAS Flow (LPM)** on this week's SSRF as well as in site log book.

6.4.10 Record the **Filter On, Rotameter (LPM)** in the appropriate box on the SSRF and site log book. Inspect the inlet lines, water trap, and inline filter for evidence of water. Report water/ice in the system or any unusual conditions to AMEC CASTNET Field Operations Personnel. Note accordingly in site log book.

6.4.11 Complete the remaining sections of the SSRF. The only information not recorded on the SSRF, which was received with the filter being installed, should be the **Filter Off** information, which will be completed when the filter is removed.

7.0 REFERENCES

AMEC Environment & Infrastructure, Inc. (AMEC). 2013. *Clean Air Status and Trends Network (CASTNET) Quality Assurance Project Plan, Revision* 8.1. Prepared for U.S. Environmental Protection Agency (EPA), Washington, DC. Contract No. EP-W-09-028. Gainesville, FL.

II. SITE OPERATIONS
D. FIELD OPERATIONS MANUAL
3. OZONE MONITORING

Effective Date: 10/30/14

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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II. D. 3. FIELD OPERATIONS MANUAL OZONE MONITORING

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide consistent guidance for Manual Ozone (O_3) Monitoring to each Site Operator.

2.0 SCOPE

This SOP applies to CASTNET onsite monitoring activities. Please refer to Section III.A (Field Manual, Site Operators Handbook, Section 6.12) for further details.

3.0 SUMMARY

O_3 analyzer operation is based on the principle that O_3 molecules absorb ultraviolet (UV) light at a wavelength of 254 nanometers (nm). The degree to which the UV light is absorbed is directly related to the O_3 concentration as described by the Beer-Lambert Law:

$$\frac{I}{I_0} = e^{-klc}$$

where:

k	= molecular absorption coefficient, 308 cm^{-1} (at 0^o C and 1 atmosphere)
l	= length of cell, 38 cm
c	= O_3 concentration in parts per million (ppm)
I	= UV light intensity of sample with O_3 (sample gas)
I_o	= UV light intensity of sample without O_3 (reference gas)

An ambient air sample is drawn through a 10-meter high Teflon© inlet. The sample is drawn into the analyzer through the sample bulkhead and is split into two gas streams. One gas stream flows through an O_3 scrubber to become the reference gas (I_o). The reference gas then flows to the reference solenoid valve. The sample gas (I) flows directly to the sample solenoid valve. The solenoid valves alternate the reference and sample gas streams between cells A and B. When cell A contains reference gas, cell B contains sample gas and vice versa.

The UV light intensities of each cell are measured by detectors A and B. When the solenoid valves switch the reference and sample gas streams to opposite cells, the light intensities are ignored for several seconds to allow the cells to be flushed. The analyzer calculates the O_3 concentration for each cell and outputs the average concentration to both the front panel display as well as the electronic outputs.

The O_3 inlet filters are to be replaced every other week, inspected each week and replaced if necessary. Site operators are required to perform additional duties, which include calling AMEC during every Tuesday site visit and troubleshooting as requested by AMEC personnel.

4.0 MATERIALS AND SUPPLIES

Campbell Scientific Model CR3000 Data logger
Thermo Environmental Model 49-103 or Thermo Fisher Model 49i O_3 Analyzer
O_3 Pump
Site Status Report Form (SSRF) for appropriate sampling week
Site Narrative Log for appropriate sampling week
Writing implement

5.0 REPAIR AND MAINTENANCE

N/A

6.0 PROCEDURES

Some things cannot be done to the O_3 analyzer onsite. **Do not adjust the Analyzer's Ozonator (ozone generator) Levels.** For Thermo 49i models these correspond to "Level 1" and "Level 5" of the ozonator "Lamp Drive %" settings. These levels have been set during analyzer calibration to correspond to the actual concentrations determined by the transfer standard. AMEC CASTNET Field Operations Personnel may instruct the site operator to change the settings to determine if the O_3 generator is responding properly, but the software configuration settings must be returned to their original values after the troubleshooting procedures are complete. Since the intent of the zero/span/precision (ZSP) checks is to determine analyzer drift, adjusting the settings of the test concentrations would nullify the checks. The settings for the ozonator lamp levels have been recorded in the site instrument and in the most recent calibration forms.

The air pressure of the zero-air system used to generate the test concentrations has been set to 15 pounds per square inch (psi). A pressure of 15 psi must be maintained for the concentrations to be accurate. **The pressure regulator may be adjusted if the pressure is not at 15 psi.** Some reasons pressure is not at 15 psi are: 1) a leak in the charcoal or desiccant canisters, 2) a leak in a fitting or tubing line between the pump and the analyzer, 3) a weak pump, or 4) a failed regulator. AMEC CASTNET Field Operations Personnel will help to determine the cause of the problem. **Please call and ask AMEC CASTNET Field Operations Personnel any questions concerning the procedures described.**

6.1 O_3 Zero, Span and Precision Checks

O_3 zero, span, and precision checks are normally performed each night **automatically.** The concentrations corresponding to Span 1, Precision and Zero are automatically initiated at 23:46, 23:53 and 24:00 respectively with duration of 7 minutes each. **Manual operation may be required in the event of the failure of the automatic operation.**

The most recent zero, span, and precision check results will be found on the “1 Site Operator” grid of the PC200 application. They will be labeled “Ozone_Zero”, “Ozone_Span” and “Ozone_Precision” corresponding to target concentrations of 0, 225 & 60 ppb respectively. Continue to record the results in the appropriate section of the SSRF as done previously. These values should be reported to AMEC during the routine Tuesday call-in.

THE FOLLOWING MANUAL PROCEDURES ARE TO BE DONE AT THE REQUEST OF AMEC PERSONNEL ONLY!

6.2 Local Triggering of the Zero, Span and Precision Check

In the event of the data logger failing to perform the automatic ZSP check call AMEC Field Operations. When instructed to do so, perform the following procedure to locally trigger the automatic sequence while in contact with AMEC CASTNET Field Operations Personnel:

6.2.1 Set the “ozone_down” parameter on the “1 Site Operator” grid to “true”.

6.2.2 Set the “Ozone_ZSP” parameter on the “1 Site Operator” grid to “true”.

6.2.3 Within two minutes the zero-air pump will activate and the automatic sequence should begin.

6.2.4 Upon completion of the sequence the values of the “Ozone_Zero”, “Ozone_Span” and “Ozone_Precision” fields of the “1 Site Operator” grid will update.

6.2.5 Enter the date and results of this check on the SSRF.

6.3 Manual Operation of Zero, Span, and Precision

In the event of a failure of the automatic procedure, call AMEC and establish contact with CASTNET Field Operations Personnel. The following manual procedure will be followed while telephone assistance is available through AMEC CASTNET Field Operations Personnel:

6.3.1 Record the time and ambient ozone concentration displayed in the “ozone” parameter of “1 Site Operator” grid of PC200.

6.3.2 Set the “ozone_down” parameter on the “1 Site Operator” grid to “true”.

6.3.3 Put the 49i in “Service Mode”.

6.3.4 Push the “Run” button on the front of the 49i one time to toggle the unit from “Sample” mode into “Zero” mode. The zero-air pump will activate.

6.3.5 Wait until the analyzer display is stable and then record the “ozone” parameter value. This will be the zero concentration (ppb) test point. Enter the results in the logbook and on the appropriate SSRF.

6.3.6 Push the “Run” button one time to toggle the unit into “Level1” mode. Repeat the steps above. This will be the “Span 1” Span point corresponding to 225 ppb.

6.3.7 Push the “Run” button four times to toggle the unit from “Level 1” mode to “Level 5” mode. Again repeat the steps above. This will be the “Span 2” Precision point corresponding to 60 ppb.

6.3.8 When complete and all data is recorded press the “Run” button one time to toggle the unit into “Sample” mode. The zero-air pump will deactivate.

6.3.9 Turn “Service Mode” off.

6.3.10 Once the unit displays ambient concentrations set the “ozone_down” parameter on the “1 Site Operator” grid to “false” and record the time in the log book.

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1998a. Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring. 40 CFR 58, Appendix B

U.S. Environmental Protection Agency (EPA). 1998b. Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS). 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1997. National 8-Hour Primary and Secondary Ambient Air Quality Standards for Ozone. 40 CFR 50, Appendix I.

U.S. Environmental Protection Agency (EPA). 1987. On-Site Meteorological Program Guidance for Regulatory Modeling Applications. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods. EPA-600/4-77-027a.

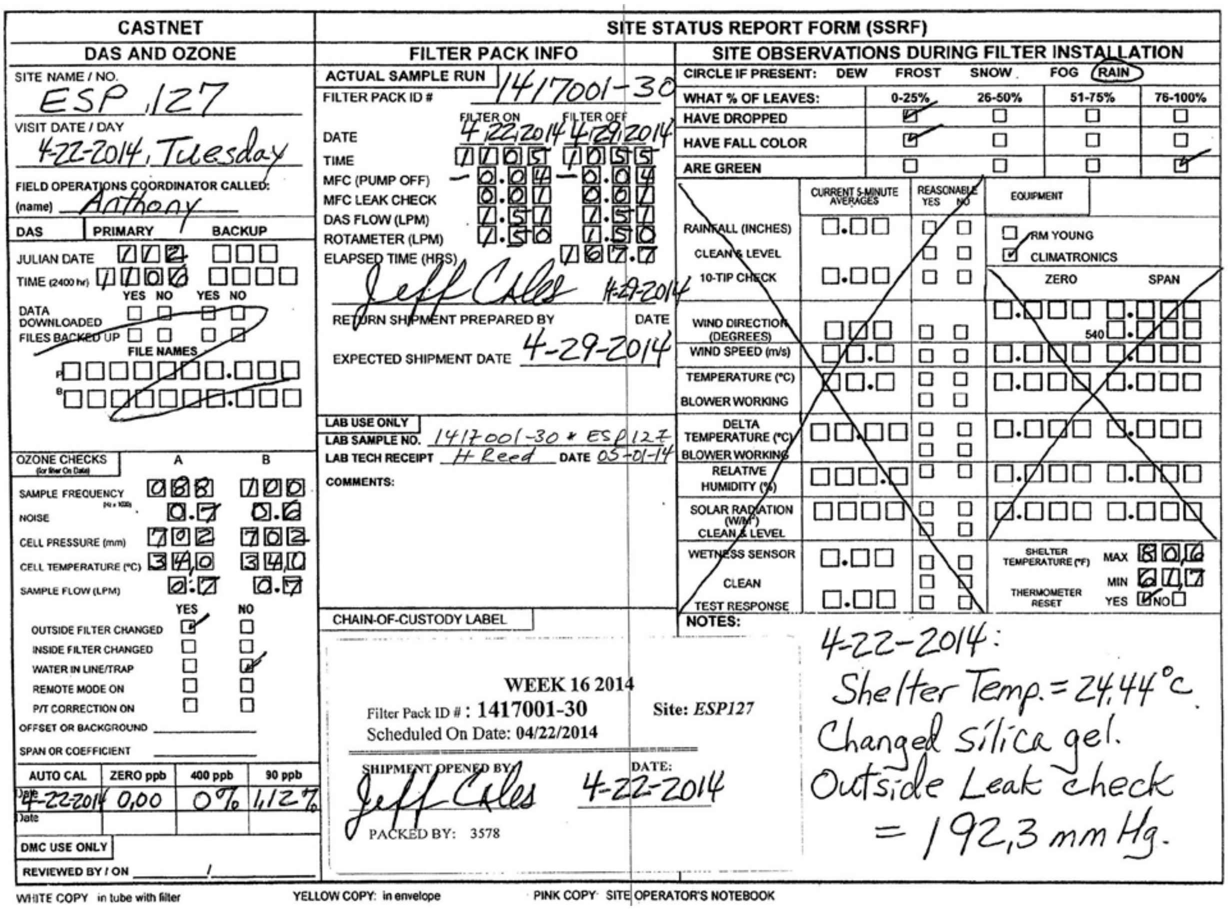
U.S. Environmental Protection Agency (EPA). 1989. Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements. EPA-600/4-82-060.

U.S. Environmental Protection Agency (EPA). 1979. Transfer Standards for Calibration of Air Monitoring Analyzers for Ozone, Technical Assistance Document. EPA-600/4-79-056

Thermo Environmental Instruments. 1997. Model 49C UV Photometric Analyzer Instrument Manual

8.0 FIGURES

Figure 1. Site Status Report Form



CASTNET — SITE STATUS REPORT FORM (SSRF)

DAS AND OZONE

SITE NAME / NO. ESP 127
VISIT DATE / DAY 4-22-2014, Tuesday
FIELD OPERATIONS COORDINATOR CALLED: (name) Anthony

DAS	PRIMARY	BACKUP
JULIAN DATE	112	
TIME (2400 hr)	1100	
DATA DOWNLOADED		
FILES BACKED UP		

FILE NAMES

OZONE CHECKS	A	B
SAMPLE FREQUENCY	088	100
NOISE	0.7	0.6
CELL PRESSURE (mm)	702	702
CELL TEMPERATURE (°C)	34.0	34.0
SAMPLE FLOW (LPM)	0.7	0.7

	YES	NO
OUTSIDE FILTER CHANGED	☑	☐
INSIDE FILTER CHANGED	☐	☑
WATER IN LINE/TRAP	☐	☑
REMOTE MODE ON	☐	☐
P/T CORRECTION ON	☐	☐

OFFSET OR BACKGROUND ____
SPAN OR COEFFICIENT ____

AUTO CAL	ZERO ppb	400 ppb	90 ppb
Date 4-22-2014	0.00	0%	1.127
Date			

DMC USE ONLY
REVIEWED BY / ON ____ / ____

FILTER PACK INFO

ACTUAL SAMPLE RUN 1417001-30
FILTER PACK ID #

	FILTER ON	FILTER OFF
DATE	4/22/2014	4/29/2014
TIME	1005	1055
MFC (PUMP OFF)	-0.04	-0.04
MFC LEAK CHECK	0.01	0.01
DAS FLOW (LPM)	1.51	1.51
ROTAMETER (LPM)	1.50	1.50
ELAPSED TIME (HRS)		167.7

RETURN SHIPMENT PREPARED BY Jeff Cales DATE 4-29-2014
EXPECTED SHIPMENT DATE 4-29-2014

LAB USE ONLY
LAB SAMPLE NO. 1417001-30 * ESP127
LAB TECH RECEIPT H Reed DATE 05-01-14
COMMENTS:

CHAIN-OF-CUSTODY LABEL

WEEK 16 2014
Filter Pack ID #: 1417001-30 Site: ESP127
Scheduled On Date: 04/22/2014
SHIPMENT OPENED BY: Jeff Cales DATE: 4-22-2014
PACKED BY: 3578

SITE OBSERVATIONS DURING FILTER INSTALLATION

CIRCLE IF PRESENT: DEW FROST SNOW FOG (RAIN)

WHAT % OF LEAVES:	0-25%	26-50%	51-75%	76-100%
HAVE DROPPED	☑	☐	☐	☐
HAVE FALL COLOR	☑	☐	☐	☐
ARE GREEN	☐	☐	☐	☑

	CURRENT 5-MINUTE AVERAGES	REASONABLE YES / NO	EQUIPMENT
RAINFALL (INCHES)			☐ RM YOUNG
CLEAN & LEVEL			☑ CLIMATRONICS
10-TIP CHECK			ZERO / SPAN
WIND DIRECTION (DEGREES)			540
WIND SPEED (m/s)			
TEMPERATURE (°C)			
BLOWER WORKING			
DELTA TEMPERATURE (°C)			
BLOWER WORKING			
RELATIVE HUMIDITY (%)			
SOLAR RADIATION (W/m²)			
CLEAN & LEVEL			
WETNESS SENSOR			SHELTER TEMPERATURE (°F) MAX 80.6 MIN 61.7
CLEAN			THERMOMETER RESET YES ☑ NO ☐
TEST RESPONSE			

NOTES:
4-22-2014:
Shelter Temp. = 24.44°C.
Changed silica gel.
Outside Leak check = 192.3 mm Hg.

WHITE COPY: in tube with filter YELLOW COPY: in envelope PINK COPY: SITE OPERATOR'S NOTEBOOK

II. SITE OPERATIONS
D. FIELD OPERATIONS MANUAL
4. TIPPING BUCKET RAIN GAUGE

Effective Date: 10-30-14

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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II. D. 4. TIPPING BUCKET RAIN GAUGE

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide consistent guidance for verifying proper operation of the tipping bucket rain gauge to each Site Operator.

2.0 SCOPE

This SOP applies to tipping bucket rain gauges used at CASTNet sites.

3.0 SUMMARY

The tipping bucket rain gauge, Climatronics Model 100508 or equivalent, consists of an 8-inch-diameter funnel-shaped collection basin and a measuring apparatus (Figures 1 and 2). Precipitation enters the collection basin and is funneled through a small hole in the center to the measuring apparatus. The collection basin is equipped with a thermostatically controlled heater to melt snow for collection purposes. The liquid precipitation is directed into one of two “buckets” balanced on the measuring apparatus. As one bucket fills, the weight of the liquid causes it to tip and bring the other bucket into place for collection of additional precipitation. The gauge is calibrated so that the weight of 0.01 inch (0.25 mm) of collected liquid causes the apparatus to tip. The tipping motion empties the measured liquid out of the bucket into a drain tube. When the apparatus tips, the swinging motion passes a magnet across a frictionless reed, or proximity switch, causing a momentary closure of the switch. This contact closure sends a signal to the data logger, which records the closure as a precipitation event. The amount of precipitation measured by the tipping bucket rain gauge directly corresponds to the number of tips the bucket makes. The rate of precipitation correlates to the number of tips per unit of time.

Figure 1. Precipitation Gauge

Figure 2. Precipitation Gauge Tipping Mechanism and Wiring.

A clear and unobstructed mounting location is necessary to obtain accurate precipitation data. Normally, mast mounting is the simplest method. The gauge is mounted in a level position and in a location free from vibration. The funnel and tipping mechanism must be checked weekly and cleaned if necessary. An accumulation of dirt and bugs on the tipping bucket will adversely affect the calibration.

4.0 MATERIALS AND SUPPLIES

Tipping Bucket Rain Gauge
Campbell Model CR3000 Data Logger
IBM-compatible PC
Site Status Report Form (SSRF)
Writing implement

5.0 SAFETY

Normal care and handling required by any electrical equipment operating outdoors should be undertaken.

***Note**: Must be performed within the sequence and in the order described in 6.0.*

6.0 PROCEDURES

Perform the following checks if it is not raining or snowing.

6.1 Set the “precipitation_down” parameter to “true” to down the channel prior to performing checks on the rain gauge.

6.2 Inspect the rain gauge funnel (cover) for damage, insects, or debris. Remove any debris and record findings on the Site Status Report Form (SSRF), Site Operator Notes.

6.3 Remove the cover, and slowly tip the see-saw apparatus 10 times, allowing at least 10 seconds between tips.

6.4 Confirm that the bull's eye bubble is level. If it is not level, adjust the mounting screws until the bubble is level. Inspect mechanism and remove objects (e.g., spider webs, wasp nests) that could interfere with operation. Replace cover carefully, making sure that wires do not interfere with operation and are not pinched. If in a warm season, check that the screen is properly seated in the bottom of the funnel.

6.5 Record the number of tips registered by the data logger by observing the “precipitation” response (10 tips = 0.10) in the “Tip Check” section of the SSRF.

6.6 Set the “precipitation_down” parameter to “false” to enable the channel. This action will also reset the precipitation counter to zero. If additional testing is required go back to step 6.3.

7.0 REFERENCES

Climatronics Corporation. *Climatronics Precipitation Gauges Manual*

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements*. EPA-600/4-82-060.

II. SITE OPERATIONS
D. FIELD OPERATIONS MANUAL
5. WETNESS SENSOR

Effective Date: 11-10-11

Reviewed by: Kevin P. Mishoe, Field Operations Manager [signature]

Reviewed by: Marcus O. Stewart, QA Manager [signature]

Approved by: Holton K. Howell, Project Manager [signature]

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MS	QA Mgr	10/30/12	[signature]
MS	QA Mgr	10/30/14	[signature]
MS	QA Mgr	11/2/15	[signature]

II. D. 5 WETNESS SENSOR

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide consistent guidance, for checking the Surface Wetness Sensor to each Site Operator.

2.0 SCOPE

This SOP applies to routine wetness sensor checks at all CASTNET sites.

3.0 SUMMARY

The CASTNET sites are equipped with a R.M. Young Model 58101 wetness sensor. The operation of the sensor is based on a detection of a predetermined change in capacitance. Surface wetness is indicated when water droplets cover approximately 0.2 square centimeter (cm^2) of the sensor grid. The grid is designed from low-density fiber to represent a leaf surface. The grid is mounted at least 2 inches away from the sensor housing which contains the circuitry to convert the signal to voltage. When the sensor is wet, it registers 1.00 V, and when dry, it registers 0.00 V. The wetness sensor is mounted at the height of the natural ground-level vegetation. Site Operators inspect the sensor and verify its operation every Tuesday.

4.0 MATERIALS AND SUPPLIES

R.M. Young Model 58101 Wetness Sensor,
Campbell Model CR3000 data logger
Deionized water
Squeeze bottle
Kimwipes®
IBM-compatible PC
Site Status Report Form (SSRF)

5.0 SAFETY

Normal care and handling required by any electrical equipment operating outdoors should be taken.

6.0 PROCEDURE

Always perform in the order listed.

6.1 Inspect the wetness sensor for cracks or other signs of damage. Ensure that the sensor height is within 6 inches of the top of the surrounding vegetation. If not, then the vegetation should be trimmed, or the height of the sensor should be adjusted.

6.2 If it is not snowing, remove any accumulated snow from the sensor and its protective flange, unless it would normally be under the snow-pack.

6.3 Observe the wetness sensor voltage reported by the CR3000 data logger. If there is no evidence of moisture on the sensor and it is not foggy, misty, raining, or snowing, then the response should be 0.000 ± 0.020 volt (V). If moisture is apparent on the sensor, or it is misty, foggy, raining or snowing, then the response should be 1.000 ± 0.010 V. Based on these criteria, determine whether the sensor response is reasonable and enter the result on the SSRF.

6.4 If the current sensor reading is 0.000 ± 0.020 V, then the following checks should be performed:

6.5 Set the “wetness_down” parameter to “true”.

6.6 Place a few drops of water on the wetness sensor using the squeeze bottle provided.

6.7 Observe the wetness sensor voltages as displayed on the Site Operator Grid and enter the reported value on the SSRF.

6.8 Moisten a Kimwipe® with water and carefully wipe the sensor plate clean. Be sure to remove any accumulated dust and debris, as this may affect sensor response. Dry the sensor plate by wiping gently with a clean, dry Kimwipe®.

6.9 Observe the wetness sensor voltage displayed on the Site Operator Grid. When the response returns to 0.000 ± 0.020 V, then the wetness channel can be marked up again, as follows:

Set the “wetness_down” parameter on the Site Operator Grid to “false”.

6.10 Enter the appropriate answer to "sensor cleaned?" on the SSRF.

> ***CAUTION:*** *The sensor plate is fragile and can be cracked easily. Apply very gentle pressure while cleaning and drying*

7.0 REFERENCES

R.M. Young Model 58101 *Wetness Sensor Manual*

U.S. Environmental Protection Agency (EPA). 1987. On-Site Meteorological Program Guidance for Regulatory Modeling Applications. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1989. Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements. EPA-600/4-82-060.

II. SITE OPERATIONS
D. FIELD OPERATIONS MANUAL
6. CLIMATRONICS METEOROLOGICAL SYSTEM

Effective Date: 10/30/14

Reviewed by: Kevin P. Mishoe, Field Operations Manager [signature]

Reviewed by: Marcus O. Stewart, QA Manager [signature]

Approved by: Holton K. Howell, Project Manager [signature: Holton K Howell]

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Reviewed by:	Title:	Date:	Signature:
MS	QA mgr	11/2/15	[signature]

II. D. 6. CLIMATRONICS METEOROLOGICAL SYSTEM

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide an overview of Climatronics site equipment and operations to each Site Operator. Climatronics meteorological systems are not currently operated at any EPA CASTNET site. Only four sites host meteorological measurements.

2.0 SCOPE

This SOP applies to routine site visits performed by the operators of Climatronics equipped CASTNET sites.

3.0 SUMMARY

The Climatronics meteorological system consists of sensors to measure wind direction and speed, temperature 1 (T1 at 9 meters), temperature 2 (T2 at 2 meters), delta temperature, and relative humidity. Signal cables connect the mainframe to the sensors that are mounted on the meteorological tower, and 1-m high solar radiation support. The site operator performs routine checks on this equipment every Tuesday.

4.0 MATERIALS AND SUPPLIES

A brief list is provided in 3.0 above.

5.0 SAFETY

A hard hat must be worn when raising and lowering towers. If it is necessary to repair or service an instrument, remove personal jewelry, turn off the instrument power and disconnect (unplug) to avoid contact with live current. Always use a safety harness when climbing.

6.0 PROCEDURES

The following subsections provide brief descriptions of the operation of each parameter. Operating instructions are provided in Section II.B, “Site Operator Instructions”. Those instructions, the manufacturer’s manual, and troubleshooting direction given by the AMEC field operations group, should be sufficient to perform the required site operator’s duties.

6.1 F460 Wind Direction

The wind direction sensor is mounted on the south end of the sensor cross-arm atop the meteorological tower (Figure 1). The sensor has a 110 volts alternating current (VAC)-heater sleeve wrapped around the shaft, which supports the wind direction vane. The power cord for the heater circuit should be checked to confirm that it is attached to both the sensor thermostat, and the shelter electrical outlet. The vane should be free of obstructions, and able to move in a light breeze. In general if there is enough wind to move the wind speed cups, the wind direction vane should also be moving. The sensor should be in a vertical position on the cross-arm, and the vane should not be damaged or bent. Perform the current conditions checks as described in Section II.B. As a point of reference the sensor cross-arm is aligned north/south.

Figure 1. Climatronics Meteorological System. Climatronics Meteorological Tower Showing Wind Speed Sensor, Wind Direction Sensor, Cross-arm and 9-meter Aspirated Temperature Shield containing T1 Temperature Probe and RH Probe.

6.2 F460 Wind Speed

The wind speed sensor is mounted on the north end of the sensor cross-arm located atop the meteorological tower. The sensor has a 120VAC-heater sleeve wrapped around the shaft, which supports the wind speed cups. The power cord for the heater circuit should be checked to confirm that it is attached to both the sensor thermostat and the shelter electrical outlet. The cups should be free of obstructions, and able to move in a light breeze. In general, if there is enough wind to move the wind direction vane, the wind speed cups should also be moving. The sensor should be in a vertical position on the cross-arm, and the cups should not be damaged or bent. Perform the current conditions checks as described in Section II.B. Wind speed in miles per hour (mph) is a little more than 2 times wind speed in meters per second (m/s). Therefore, if the data logger is recording wind speed as 2 m/s, the equivalent wind speed is about 5 mph.

6.3 T1, T2 and Delta Temperature

T1 and T2 measurements are obtained by using two identical sensors mounted in aspirated shields on the meteorological tower. Both sensors measure temperature by means of changes in resistance. Each sensor is measured independently. A correction is applied to the temperatures reported and Delta Temperature is then computed as the difference between the temperature indicated by the T1 and T2 sensors (Delta Temperature = T1 – T2). Confirm both blowers are functioning by direct observation and confirm through observation of the “blower_rpm” parameter. Perform the current condition checks as described in Section II.B. As a general rule, the ground should heat up during bright sunny days with moderate to light winds. Therefore, during the day the delta temperature should be a negative number (T1 – T2). At night the ground should cool down and the delta temperature should be positive. Under overcast, rainy, or well-mixed conditions, the delta temperature should be near zero.

6.4 Relative Humidity

The relative humidity sensor is mounted in the upper (9-m) temperature aspirated shield, between the blower and the end of the tube containing the temperature sensor. The same blower which pulls air past the upper temperature sensor aspirates the humidity sensor. Be sure the blower is connected and functioning properly. Perform current condition checks as described in Section II.B. Generally, humidity increases at night as the temperature approaches the dew point, with a maximum humidity just before sunrise. Also, warm air can hold more moisture, so if a dry air mass is present and a bright sunny day is encountered, the humidity level relative to that increase in temperature can be very low.

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements.* EPA-600/4-82-060.

II. SITE OPERATIONS
D. FIELD OPERATIONS MANUAL
7. R.M. YOUNG METEOROLOGICAL SYSTEM

Effective Date: 10/30/14

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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Annual Review			
Reviewed by:	Title:	Date:	Signature:
MJ	QA Mgr	1/12/15	

II. D. 7. R.M. YOUNG METEOROLOGICAL SYSTEM

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide an overview of R.M. Young Site meteorological equipment and operation to each Site Operator.

2.0 SCOPE

This SOP applies to routine site visits performed by the operators of R.M. Young equipped CASTNET sites.

3.0 SUMMARY

The R. M. Young meteorological system consists of sensors for wind direction and speed, temperatures T1 and T2, relative humidity, and solar radiation. The sensors are mounted on the meteorological tower, and 1-m solar radiation support. Signal cables connect the solar radiation sensor to an individual translator located on the data-logger backplane. All of the individual sensors receive operating power from the Campbell CR3000 data-logger, which has a regulated 12-volt output. The site operator performs routine checks on this equipment every Tuesday.

4.0 MATERIALS AND SUPPLIES

A brief list is provided in 3.0 above.

5.0 SAFETY

A hard hat must be worn when raising and lowering towers. If it is necessary to repair or service an instrument, remove personal jewelry, turn off the instruments power and disconnect (unplug) to avoid contact with live current. Always use a safety harness when climbing.

6.0 PROCEDURES

The following is a brief description of each parameter. Figure 1 provides a photo of the system. There are no operating instructions other than those provided in Section II.B, “Site Operator Instructions”. Those instructions, the manufacturer’s manual, and troubleshooting direction given by the AMEC field operations group, should be sufficient to perform the required site operator’s duties.

6.1 Wind Monitor

The wind sensor is mounted at the top of the meteorological tower. A rod beneath the sensor is attached to the tower and aligned to either north or south as a reference point. The sensor has both a lightweight propeller and vane to measure wind speed and direction simultaneously. There is no circuit to provide heat to the sensor to prevent icing in freezing conditions. The design of the monitor is such that icing should not occur unless extreme conditions are encountered. The vane should be free of obstructions, and able to move in a light breeze. In general if there is enough wind to move the wind speed propeller, the wind direction vane should also be moving, and vice-versa. The sensor should be in a vertical position on the tower, and the vane should not be damaged or bent. Perform the current condition checks as described in Section II.B. Wind speed in miles per hour (mph) is a little more than 2 times wind speed in meters per second (m/s). Therefore, if the data logger is recording wind speed as 2 m/s, the equivalent wind speed is about 5 mph.

Figure 1. RM Young Meteorological System: (from top to bottom) Meteorological Tower with Wind AQ, Directional Cross-Arm, Gill Aspirated Shield for RH Probe, 9-m Aspirated Temperature Sensor Shield and Waterproof RH Circuit Card "Otter" box.

6.2 T1, T2, and Delta Temperature

T1 and T2 measurements are obtained by using two identical sensors mounted in aspirated shields on the meteorological tower. Both sensors measure temperature by means of changes in resistance. Each sensor is measured independently. A correction is applied to the temperatures reported and Delta Temperature is then computed as the difference between the temperature indicated by the T1 and T2 sensors (Delta Temperature = T1 – T2). Be sure both blowers are functioning by direct observation and confirm through observation of the "blower_rpm" parameter. Perform the current condition checks as described in Section II.B. As a general rule, the ground should heat up during bright sunny days with moderate to light winds. Therefore, during the day the delta temperature should be a negative number (upper sensor temperature is lower than the lower sensor temperature). At night the ground should cool down and the delta temperature should be positive. Under overcast, rainy, or well-mixed conditions, the delta temperature should be near zero.

6.3 Relative Humidity

The relative humidity sensor is mounted in a naturally aspirated shield near the upper temperature housing. No air is forced past the sensor. During times of light winds, fog, or extended rain, the sensor may become saturated and require several hours to respond to decreased humidity levels. Perform the current condition checks as described in Section II.B. Generally, humidity increases at night as the temperature approaches the dew point, with maximum humidity before sunrise. Also warm air can hold more moisture, so if a dry air mass is present and a bright sunny day is encountered, the humidity level relative to the increase in temperature can be very low.

6.4 Solar Radiation

The solar radiation sensor is mounted to a support usually about one meter in height, in the southernmost area of the site. It should be in a location where the influence of shadows from other structures or trees can be avoided. Be sure the sensor is clean and level. Avoid shading the sensor when inspecting, or performing required maintenance. Perform the current condition checks as described in Section II.B. A bright, sunny, cloudless day, in the mid latitudes will produce solar radiation values in the seven to eight hundred watts per square meter range. The values can increase and decrease rapidly during cloudy conditions.

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems,* Vol. I, Principles. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements*. EPA-600/4-82-060.

III. FIELD CALIBRATIONS MANUAL

Effective Date: 7-7-16

Reviewed by: Kevin P. Mishoe, Field Operations Manager [signature]

Reviewed by: Marcus O. Stewart, QA Manager [signature]

Approved by: Holton K. Howell, Project Manager [signature]

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Reviewed by:	Title:	Date:	Signature:

III. FIELD CALIBRATIONS MANUAL

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide consistent guidance to field technicians for calibration of site instruments and equipment.

2.0 SCOPE

This SOP applies to the semi-annual calibration of ambient air monitoring equipment at all EPA sponsored Clean Air Status and Trends Network (CASTNET) sites. All procedures are performed by technicians approved by the CASTNET Field Operations Manager (FOM).

3.0 SUMMARY

3.1 Network Overview

The goal of CASTNET is to measure concentrations of selected air pollutants at approximately 90 locations throughout the United States to evaluate the effectiveness of national and regional emission control programs and to determine compliance with ozone (O_3) National Ambient Air Quality Standards. CASTNET is also designed to determine trends in rural atmospheric O_3, nitrogen, and sulfur concentrations and deposition fluxes of nitrogen and sulfur pollutants. CASTNET data are used to provide input to the Total Deposition (TDEP) Model and also for regional air quality model evaluation. Amec Foster Wheeler's analytical chemistry laboratory analyzes the exposed filters from the filter packs, which sample the pollutants in air, and provides concentration-on-filter data to the Data Management Center (DMC) for the calculation of 7-day average ambient concentrations of sulfate (SO_4^{2-}), nitrate (NO_3^-), ammonium (NH_4^+), sulfur dioxide (SO_2), and nitric acid (HNO_3), magnesium (Mg^{2+}), calcium (Ca^{2+}), sodium (Na^+), potassium (K^+), chloride (Cl^-).

In 2012, CASTNET developed a small-footprint monitoring station that does not require a temperature-controlled shelter. The new type of monitoring station includes a 10-m sampling tower, 3-stage filter pack, pump, flow meter, data logger (CR1000), and cellular modem. Small-footprint monitoring is performed at several rural sites and is expected to expand to other new sites over the next few years.

Approximately 80 O_3 analyzers are operated throughout the network to determine compliance with O_3 NAAQS. Teledyne API analyzers are deployed at several EPA-sponsored CASTNET sites to take measurements of trace-level gas pollutant concentrations. These data are sampled continuously and archived as 1-hour values. QAPP Table 1-1 provides the location of each site by state and includes information on start date, latitude, longitude, elevation, land use, terrain type, and measurements.

Meteorological parameters are measured at only four EPA-sponsored CASTNET sites: PAL190, TX; CHE185, OK; BVL130, IL; and BEL116, MD. These EPA monitoring sites measure:

- Precipitation
- Surface Wetness
- Temperature (measured at 2 and 9 meters)
- Shelter temperature
- Wind direction
- Wind speed (scalar and vector averaging)
- Relative humidity
- Solar radiation

Ozone, filter pack flow, and temperature at 9 meters are measured continuously at most other EPA-sponsored sites where meteorological data are not measured. Calibration and repair activities are limited to these three parameters plus shelter temperature. Measurements are recorded using Campbell Scientific CR3000 data loggers at most EPA-sponsored sites. An ESC8816 data logger is used at CHE185, OK. CR850 data loggers are deployed at the small footprint sites. Data are collected hourly from each site via an automated polling system at Amec Foster Wheeler. The data are processed, validated, and delivered to EPA quarterly by the Amec Foster Wheeler CASTNET Data Management Center (DMC). In addition, O_3 data are submitted monthly to the EPA Air Quality System (AQS). O_3 data and meteorological measurements are submitted daily to AirNow.

3.2 Biannual Calibration Process

Table 1 summarizes the annual schedule of site calibrations. The biannual calibration is a two-step process. As discussed in QAPP Section 5.0, one step is a technical systems audit (TSA). The purpose of the TSA is to evaluate compliance with QAPP requirements. The field technician will determine whether the monitoring equipment is operating according to its design parameters, and whether data previously collected meet quality assurance criteria as defined in the QAPP. In TSA equipment performance is observed, recorded and reported. Additionally, site conditions with regard to siting criteria, overall site condition and infrastructure are recorded.

The second step is a performance evaluation (PE). Sensor performance is assessed through comparison with measurements by a certified transfer standard with a calibration traceable to a recognized national or international standard such as those maintained by the National Institute of Standards and Technology (NIST). This step consists of the audit and subsequent repair, replacement or adjustment of all sensors found to be noncompliant with the performance standards as defined in the QAPP with the express purpose to bring the measurement capacity of the entire site into full compliance with the acceptance criteria defined in Table 2. No calibration, repair, adjustment or replacement activity is performed until the full nature of site operation *"as found"* is recorded.

Table 1. Field Calibration Schedule for 2015

Calibration Group	Months Calibrated	Sites Calibrated			
Eastern Sites (23 Total)					
E-1	February/August	BEL116, MD	WSP144, NJ	ARE 128, PA	PED108, VA
(8 Sites)		BWR139, MD	CTH110, NY	PSU106, PA	VPI120, VA
E-2	April/October	ABT147, CT	WST109, NH	WFM105, NY	UND002, VT
(10 Sites)		ASH135, ME	CAT175, NY	NIC001, NY	
		HOW191, ME	HWF187, NY	EGB181, ON	
E-3	May/November	KEF112, PA	LRL117, PA	CDR119, WV	
(5 Sites)		MKG113, PA	PAR107, WV		
Southeastern Sites (10 Total)					
SE-4	January/July	SND152, AL	BFT142, NC	COW137, NC	
(6 Sites)		GAS153, GA	CND125, NC	SPD111, TN	
SE-5	February/August	CAD150, AR	IRL141, FL		
(4 Sites)		CVL151, MS	SUM156, FL		
Midwestern Sites (19 Total)					
MW-6	January/July	CDZ171, KY	MCK131, KY	PNF126, NC	
(6 Sites)		CKT136, KY	MCK231, KY	ESP127, TN	
MW-7	March/September	ALH157, IL	VIN140, IN	OXF122, OH	
(9 Sites)		BVL130, IL	RED004, MN	QAK172, OH	
		STK138, IL	DCP114, OH	PRK134, WI	
MW-8	April/October	SAL133, IN	ANA115, MI		
(4 Sites)		HOX148, MI	UVL124, MI		
Western Sites (10 Total)					
W-9	March/September	KNZ184, KS	CHE185, OK	ALC188, TX	
(5 Sites)		KIC003, KS	SAN189, NE		
W-10	May/November	GTH161, CO	CNT169, WY	PAL190, TX	
(5 Sites)		ROM206, CO	PND165, WY		

3.3 The Role of Calibrators

The EPA requires that the data be accurate within standard criteria. In order to attain this accuracy, the sites are periodically checked and calibrated by Amec Foster Wheeler or subcontractor personnel. Transfer standards, certified at the Amec Foster Wheeler laboratory, are used for comparison of all site parameters. Any inaccuracy is corrected by either careful adjustment of existing equipment or replacement of sensors. During the Amec Foster Wheeler site calibrations, extensive scrutiny is focused on all systems, and routine preventive maintenance is performed. The calibrator first documents the existing accuracy of site systems using certified transfer standards. Criteria for quality have been established that are guidelines for action. If the parameter in question is outside the tolerance listed in Table 2, the system must be adjusted, or replaced. Field site personnel are under no circumstances authorized to leave a site with any inoperative parameter without the express consent of Amec Foster Wheeler field operations.

Table 2. Measurement Acceptance Criteria

DAS Voltage	± 0.003 VDC
Wind speed	± 0.2 m/s (< 5 m/s) ± 5% (> 5m/s)
Wind direction	± 3° at all points
Temperature	± 0.15° C (± 0.3° C if only one probe is calibrated)
Delta Temperature	± 0.30° C
Shelter Temperature	± 0.30° C
Relative Humidity	± 10% RH units
Precipitation	± 5% (0.48 to 0.52 in.)
Solar Radiation	± 5% of transfer at highest hour and daily average
Ozone	All points on calibration curve within ± 2% of full scale as compared to the best fit straight line linearity error < 5%
Flow	± 2.0% of transfer target value
Wetness	Correct response for wet/dry conditions ± 0.1 VDC

3.4 Calibrator Responsibilities

The purpose of the network is to collect data of the highest quality. The calibrator’s role is critical in this endeavor. The following steps should be completed while calibrating site.

- Data recovery, validation, and completeness are the relevant quality measures. Data transparency after site TSA and PE is very important so that data validators can make informed decisions about data quality and validity.
- If the data are not accurate or of known quality, there are no valid data. Therefore, calibrators should document existing accuracy, and then adjust/replace sensors if out of specifications.
- Write relevant observations in the logbook. Complete all paperwork and iForms.
- Make sure transfer standards are calibrated before and after a site visit.
- Plan trip, call site operators, and call Amec Foster Wheeler FOM or Field Coordinator every day.
- Quality is more important than quantity; do all required maintenance.
- Be careful and safety conscious.
- Do a final hard look around, verify data acquisition.
- Call Amec Foster Wheeler if there are any questions or difficulties prior to leaving the site.

4.0 MATERIALS AND SUPPLIES

Figures 1 and 2 in Section IV.B.1 provide a complete listing of calibration equipment. In addition, a current Site Equipment Inventory List (Figure 1), a complete set of calibration iForms, other necessary forms (Sections 6.0 and 8.0), and a copy of this manual are required for a site calibration. A compact disc with the HASP and Site Operator Handbook (QAPP Appendix 1, Section II) is provided in the shelter. Completed iForms with transfer certifications for the last three years are stored on the site laptop. Vendor instrument manuals are available to the calibrators either as hard copies or electronic copies on the laptop. Blank iForms are located on the calibrator thumb drive, which is shipped in the calibration kits for each calibration visit. Thumb drives store completed iForms and transfer certifications at small footprint sites.

Figure 1. Site Inventory List

CLEAN AIR STATUS AND TREND NETWORK SITE INVENTORY LIST
Sorted By EPA Bar Code Within Site

Monday, October 06, 2014

EPA BAR CODE	CASTNet # ▲	EQUIPMENT NAME ▲	SERIAL #	SITE ID ▲
000700		A-ANALYZER, OZONE	1030244793	KEF112
000438		A-ANALYZER, OZONE - SITE XFER STD	08200014	KEF112
	06922	A-COMPRESSOR, AIR	000836217	KEF112
	06438	D-COMPACT FLASH	2469	KEF112
000256		D-COMPUTER, LAPTOP	3KFNHB1	KEF112
000414		D-DATA LOGGER	2537	KEF112
	06455	D-MODEM, DIGITAL - RAVEN X CDMA	0808337420	KEF112
000671		F-CONTROLLER, MASS FLOW	54757	KEF112
880396X	00965	F-PUMP, VACUUM	00000878	KEF112
880493X	03443	F-TOWER, FOLDING	N/A	KEF112
	06840	M-MONITOR, AQ WIND	100696	KEF112
492148X	02164	M-RAIN GAUGE, TIPPING BUCKET	498	KEF112
	04726	M-SENSOR, RELATIVE HUMIDITY	80731	KEF112
811608X	06488	M-SENSOR, SOLAR RADIATION	PY9157	KEF112
	06388	M-SENSOR, TEMPERATURE	13992	KEF112
	03881	M-SENSOR, WETNESS	N/A	KEF112
492034X	01399	M-SHIELD, RELATIVE HUM/TEMP	N/A	KEF112
492033X	01398	M-SHIELD, TEMPERATURE	0137	KEF112
492064X	06487	M-TOWER, 10 METER	N/A	KEF112
	06622	M-TRANSLATOR, SOLAR RAD	N/A	KEF112
811690		S-SHELTER, 8X8X10, ALUM	2149-14	KEF112
	05001	S-UPS	QB0427147491	KEF112

Note: Bar codes are no longer used. Instead, inventory numbers are used to track equipment.

5.0 REPAIR AND MAINTENANCE

Section 6.0, Subsections 6.1 through 6.8, discuss instrument-specific calibration procedures. QAPP Section IV provides detailed repair and maintenance instructions for a given instrument or procedure. The procedures discussed in Subsection 6.6 were developed to evaluate meteorological measurements. All but four EPA sites now exclude meteorological measurements.

6.0 PROCEDURES

Record all calibrations on the proper iForms (Figures 2, 6, 15, 21, 32, 35, 38, 39, 40, 42, 43 and 44) and write in the site logbook all results as specified by these procedures as well as any other information of note, i.e., weather conditions.

6.1 Arrival at Site

Upon arriving at a site, examine the site and nearby conditions. In the site narrative logbook record any and all conditions that may affect the measurement process. These include initial status of sensors, site conditions, nearby atmospheric conditions such as earthwork, burning of debris, prescribed burns, wild fires, or other events that could affect measurements. Compare the equipment and instruments in the shelter with the Site Inventory List (Figure 1). Update the Site Information Form (Figure 2) if necessary.

6.1.1 Turn site laptop computer on. The application “PC200” will start automatically.

6.1.2 Record the following parameters in the site narrative logbook.

- Time of arrival
- Name of all personnel on site
- Time of “Calibrator_OnSite” set to “true”.
- Time and parameter of any channels disabled.
- Atmospheric conditions

6.1.3 Using a logger interface, review data collected over one week. Record any anomalies in the site log book.

6.1.4 Set *“Calibrator_OnSite”* to *“true”* (Figure 3) and record the data logger timestamp in the site log book.

Figure 2. Site Information Form

SITE INFORMATION

amec

Site Name/Number	Calibrator	Start Date	Start Time	End Date	End Time	Met Manufacturer
PAL 190	TYLER WARD	11/19/2013	09:40	11/20/2013		R.M. Young

Site Equipment Replaced

Parameter	Device	Manufacturer	Model	ID #	Type
Wind AQ	Anemometer	R.M. Young	5305	004354	

Site Equipment as Found

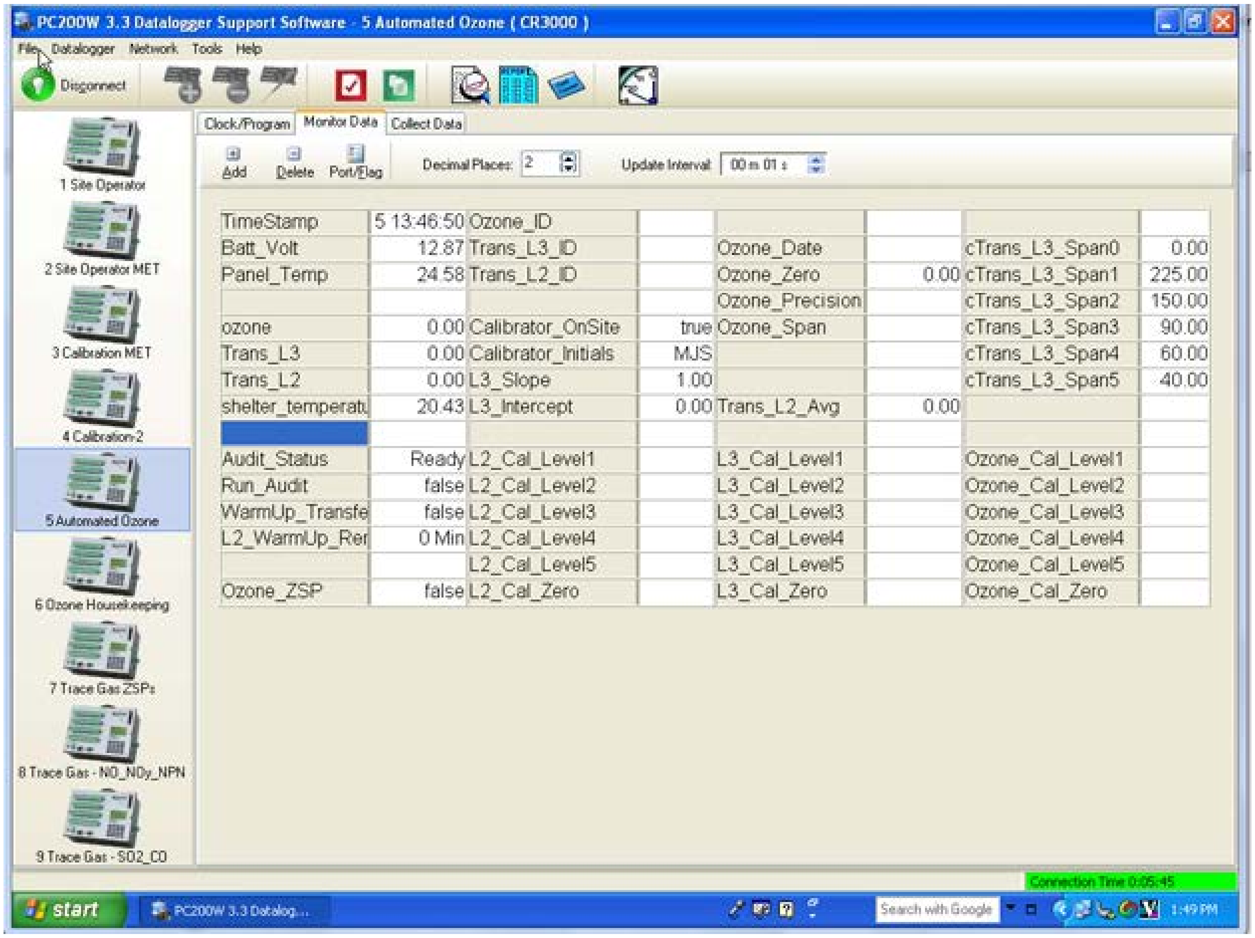
Parameter	Device	Manufacturer	Model	ID #	Type
Signal Input/Output	Datalogger	Campbell Scientific	3000	000347	
Temperature	10-m Thermistor	R.M. Young	43347	006303	
	2-m Thermistor	R.M. Young	43347	006302	
	10-m Signal Translator	R.M. Young			
Relative Humidity	Sensor	Vaisala	102425	006223	
Wind AQ	Vane	R.M. Young			
	Anemometer	R.M. Young	5305	004405	
	Translator	R.M. Young			
Flow	Controller	Apex		000604	
	MFC Display				
Precipitation	Tipping Bucket Gauge	Texas Electronics	TR-5251	006307	
Wetness	Sensor	R.M. Young	58101	006288	
Ozone	Analyzer				
Solar Radiation	Pyranometer	LiCor	Li-200	004009	
	Translator	R.M. Young		004063	

Calibration Equipment Used

Parameter	Device	Manufacturer	Model	ID #	Last Certification Date
Signal Input/Output	Mulitmeter	Fluke		4622	3/26/2013
	Voltage Source	Datel	C-350A	4624	10/22/2013
Temperature	RTD	Eutechnics	4600	4643	8/12/2013
Relative Humidity	Hygrometer	Rotronics	GTL	6834	8/2/2013
	Humidity Chamber	VaporPak		537	
Solar Radiation	Pyranometer	LiCor	Li-200	6533	11/8/2013
	Transfer - Translator			6321	
Flow	Transfer MFM	BIOS	Dry Cal Lite	768	6/21/2013
	Data Module				
Ozone	Transfer - Analyzer				
Wind	Transit	Brunton	F-5006	6554	5/16/2013
	Synchronous Motor	R.M. Young	18802	4631	4/3/2013
Wetness	Mulitmeter	Fluke		4622	3/26/2013
	Decade Box				

Remarks	iForms Version
	1.5.1

Figure 3. Screen Shot Indicating Calibrator is Onsite



Note: *Before any sensor, analyzer, or measurement system accessory is repaired, adjusted replaced or modified, the sensor performance must be documented and the DAS voltage accuracy must be verified.*

Figure 4. O_3 Transfer Standard

Figure 5. Flow Transfer Standard

6.1.5 Set up transfer standards that need warm-up time.

- Install the O_3 transfer standard (Figure 4). See Section 6.3 for the proper procedures.
- Plug in the flow transfer (Figure 5) to allow adequate warm up prior to use.
- Install the transfer solar radiation (SR) system for the sites with meteorological measurements. See Section 6.6.7 for the proper procedure.

Note: *The site SR sensor should not be leveled until after unadjusted data are collected. Position and level the transfer SR sensor alongside the site SR sensor. Be certain "Calibrator_OnSite" is "true" so the data logger will record five minute averages of transfer channel values.*

6.1.6 Measure the cross-arm alignment of the wind system for the sites with meteorological measurements. See Section 6.6.4.

6.2 Data Logger

Record the ID and certification date of the certified precision voltmeter and certified voltmeter on the data logger/DAS iForm (Figure 6). Record the data logger ID as well. Ensure that the site laptop computer has been configured for use with the CR3000 data logger (Section IV, xxx).

6.2.1 Identify the correct transfer electronic certification form found on the root directory of the calibration flash drive. Make sure the certification form is complete and that the transfer ID number matches the ID number on the certification form. Place a copy of the electronic certification form in the site calibration folder on the calibration flash drive to be copied to the site laptop at the completion of the site audit.

6.2.2 Disable the data logger measurement channels by setting *"Down_All_Channels"* to *"true"* (Figure 7). Enable the proper measurement process by setting *"Calibrator_OnSite"* to *"true"*.

Figure 6. Data Logger Calibration Form

Data Logger Calibration

amec

Site Name	Calibrator	Calibration Date	iForms Ver.
PAL 190	TYLER WARD	11/19/2013 - 11/20/2013	1.5.1

Datalogger	As Found	As Left
ID #	000347	
Mfg./Model	Campbell 3000	

MultiMeter	
ID #	04622
Mfg.	Fluke
Cert. Date	3/26/2013

Voltage Source	
ID #	04624
Model	Datel DVC-350A
Cert. Date	10/22/2013

Data Logger Signal Accuracy

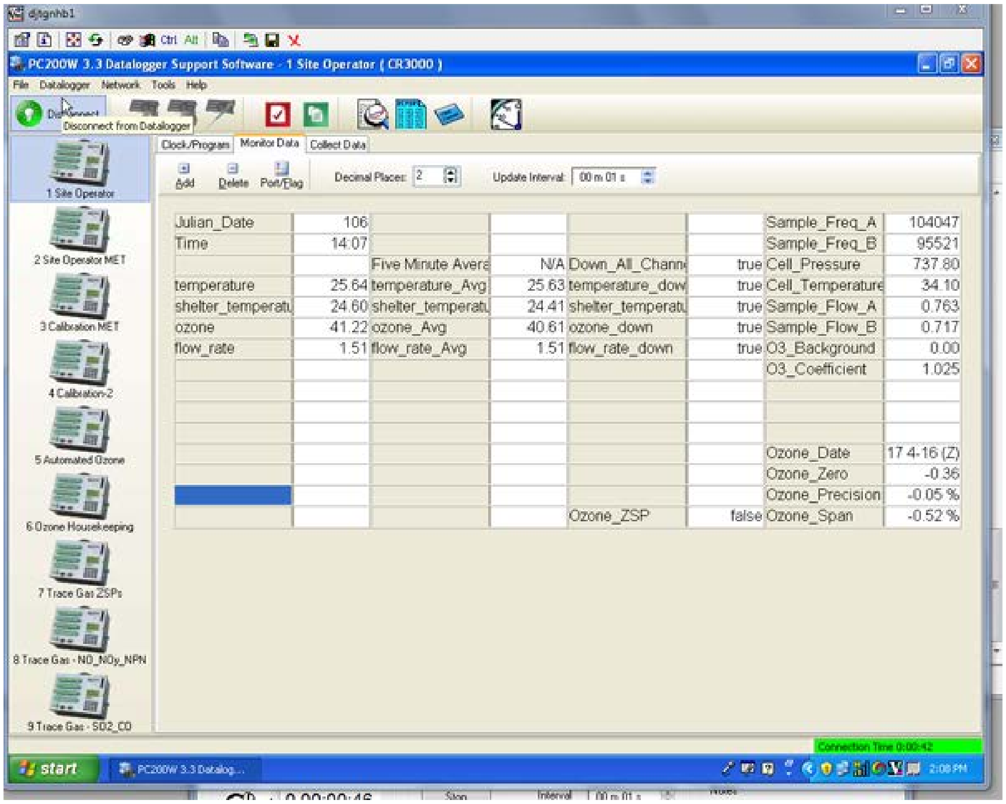
Voltage Source Output	Digital MultiMeter Reading	Datalogger Reading As Found: Voltage	Diff	Max Channel	Diff	As Left: Voltage	Max Channel
0.0000	0.0000	0.0000	0.0000	SR			
0.1000	0.1000	0.0998	-0.0002	F			
0.2000	0.1999	0.1997	-0.0002	WD			
0.3000	0.3000	0.2996	-0.0004	WD			
0.4000	0.4000	0.3997	-0.0003	WD			
0.5000	0.5000	0.4997	-0.0003	WD			
0.6000	0.6000	0.5996	-0.0004	WD			
0.7000	0.7000	0.6997	-0.0003	WD			
0.8000	0.8000	0.7996	-0.0004	WD			
0.9000	0.9000	0.8996	-0.0004	F			
1.0000	0.9999	0.9997	-0.0002	F			
2.0000	1.9980	1.9989	0.0009	F			
3.0000	2.9980	2.9991	0.0011	F			
4.0000	3.9980	3.9987	0.0007	F			
5.0000	4.9980	4.9988	0.0008	F			

	With Charger	Without Charger
Backup Battery Volatge	12.7	11.8
	(+)	(-)
Climatronics Mainframe Power Supply Voltage		
	As Found	As Left
Status Switches		
Channels Changed		

Remarks:

Reviewed By: [signature] Date: 12/23/13

Figure 7. Screen Shot Indicating all Sensor Channels are down



6.2.3 Using a certified voltmeter, determine and record the voltage outputs of the 12VDC and 5VDC ports on terminal block four of the data logger (see Figures 2 through 4 in Section II.A.2, Subsection 3.2, for photos of the data logger system). Record the results in the remarks section of the DAS iForm. Remove the analog input terminal blocks – the top two terminal blocks on the data logger. Install the data logger calibration jig included in the calibration equipment box.

6.2.4 Connect the jig leads (Figure 8) to a certified precision voltage supply, such as a Datel DVC350A and a certified voltmeter to the calibration jig. Set the data interface display resolution to four decimal places.

6.2.5 Input voltages from 0.000 to 1.000 volts direct current (VDC) in increments of 0.1000 VDC for temperature and shelter temperature. For each input voltage value record on the DAS iForm the voltmeter response and the channel name and voltage value of the channel on the data logger with the greatest deviation from the Datel voltage.

6.2.6 Record the full set of data for the two channels if any channel differs by 3mV or more from the Datel voltage. Perform the same check at 2, 3 4 and 5 VDC for the shelter temperature. Simultaneously record the voltmeter response on the data logger iForm for each input voltage.

6.2.7 Note that the data logger is not field serviceable. If the data logger is found out of specification, an entire site audit should be performed. The data logger should then be replaced and a full audit/calibration of the new system should be performed. No sensor should be adjusted or modified prior to full documentation of site performance and data logger replacement. Upon replacement, tag the defective data logger and return to Amec Foster Wheeler.

6.2.8 Data Logger Back-up Battery Check. Record the data logger operational voltage on the data logger iForm (Figure 6). It should be above 12.7 VDC. Unplug the unit from the wall outlet. Wait one minute and then record the operational voltage again. The voltage should remain above 11.9 VDC. If not the internal batteries should be replaced.

Figure 8a. Connection to Voltage Supply

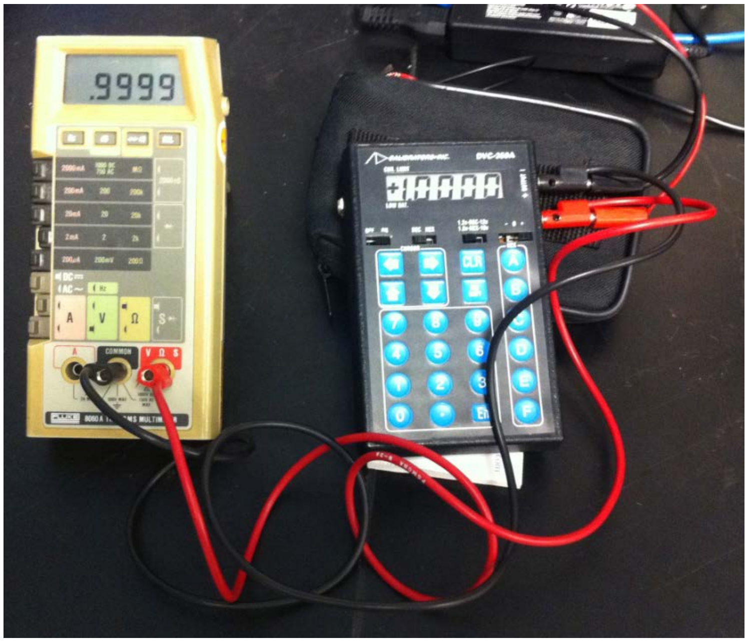
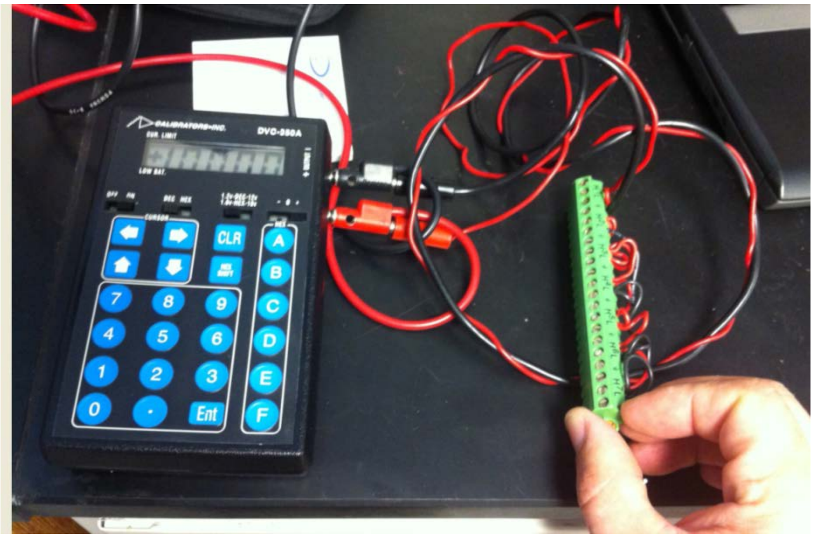


Figure 8b. Connection to Voltage Supply



6.3 Ozone

6.3.1 Install Level 2 Transfer

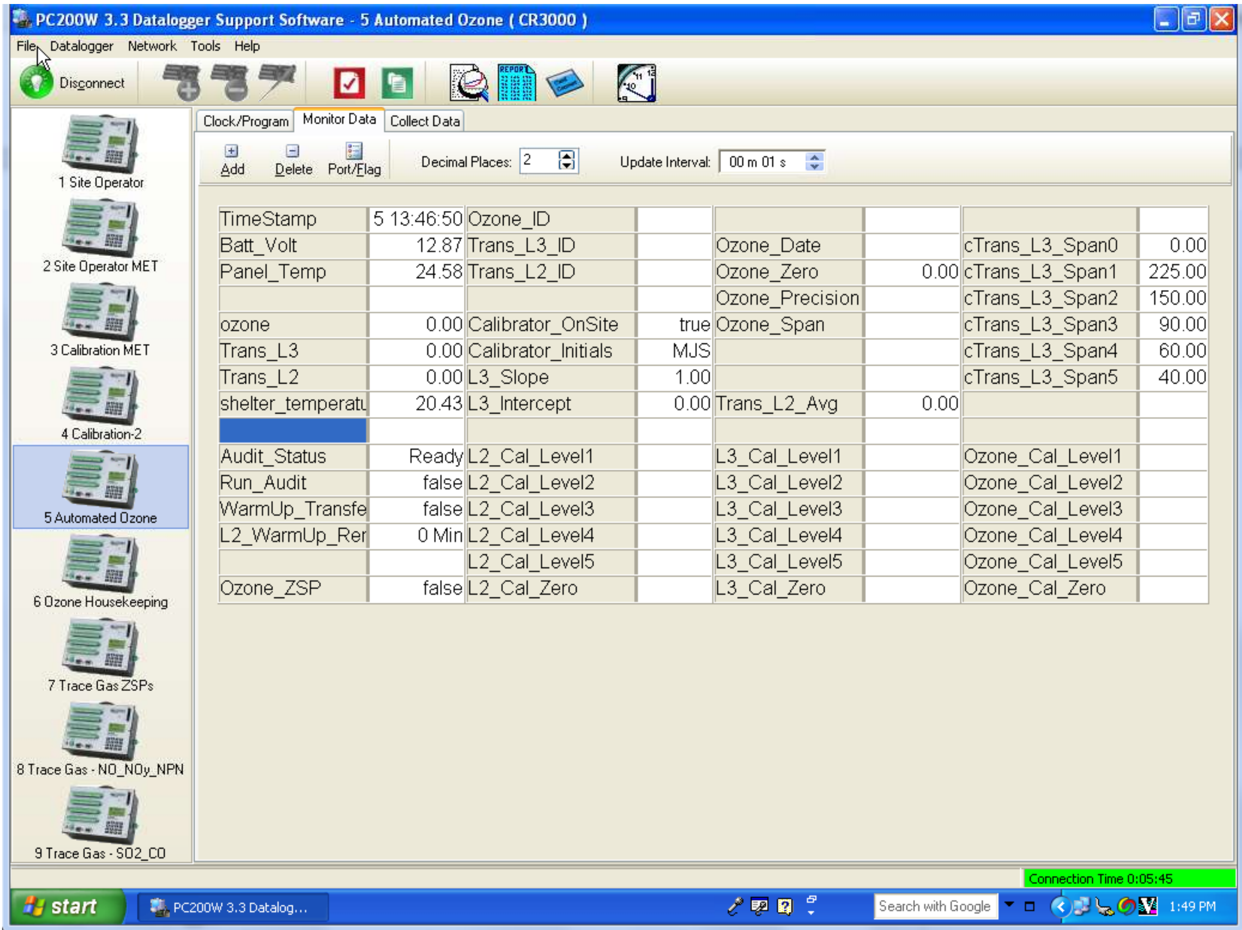
- Remove analyzer from shipping container. Remove lid and then all foam and packing material from inside the analyzer. Remove the sample pump shipping screws. Check all components for damage. If any damage is found, contact Amec Foster Wheeler; the certification may be compromised. Reinstall lid. Place the Level 2 O_3 analyzer (see Figure 4) on the counter inside the shelter for auditing the Level 3 Transfer and site analyzers.
- Identify the correct Level 2 Transfer's electronic certification form found on the root directory of the calibration flash drive. Make sure the certification form is complete and that the transfer's ID number matches the ID number on the certification form. Place a copy of the electronic certification form in the site calibration folder on the calibration flash drive to be copied to the site laptop at the completion of the site audit.
- Connect one end of the Level 2 O_3 Transfer's sample tubing (short piece of 1/4″ Teflon tubing with kynar connectors) (Figure 9) from the calibration kit to the sample port. Leave the other end plugged.
- Connect the exhaust tubing from the calibration kit to the exhaust port on the back of the Level 2 analyzer.
- Confirm that the power switch is off. Connect the power cord from analyzer power port to a receptacle on the shelter wall.
- Connect one end of the Ethernet cable from the calibration kit to the RJ-45 port.
- Turn on the Level 2 analyzer by toggling the power switch to the on position.
- Perform a leak check on the Level 2 analyzer by pressing the button that corresponds to the word Pressure at the bottom of the analyzer display (Figure 10). This screen will indicate the cell pressure of the analyzer. It should fall to or below 200mmHg. If it does not, find and fix leak(s).
- Confirm the Level 2 IP address.
- Turn off Level 2 analyzer by toggling the power switch to the off position.

Figure 9. O_3 Transfer Sample Tubing

Figure 10. O_3 Analyzer Display

Figure 11. Air Compressor

Figure 12. Screen Shot: Automated O_3 Page



6.3.2 Set the air compressor regulator (Figure 11) to 30 psi.

- Gently pull up on the regulator knob to unlock. Turn the knob clockwise and set the regulator gauge to 30 psi. Push in on the regulator knob to lock.

6.3.3 Set the Level 3 Transfer’s level 1 target concentration to 225 ppb.

- Using established procedures, from PC200W on the site laptop, connect to the Automated Ozone page. In the fourth column, double click the *cTrans_L3_Span1* cell (Figure 12) to highlight and activate the cell. Type 225 into the cell and press the enter key on the laptop keyboard to accept the value.

6.3.4 Enter calibrator’s initials

- From the Automated Ozone page, in the second column, double click the *Calibrator_Initials* cell to highlight and activate the cell. Type your initials into the cell and press the enter key on the laptop keyboard to accept the value.

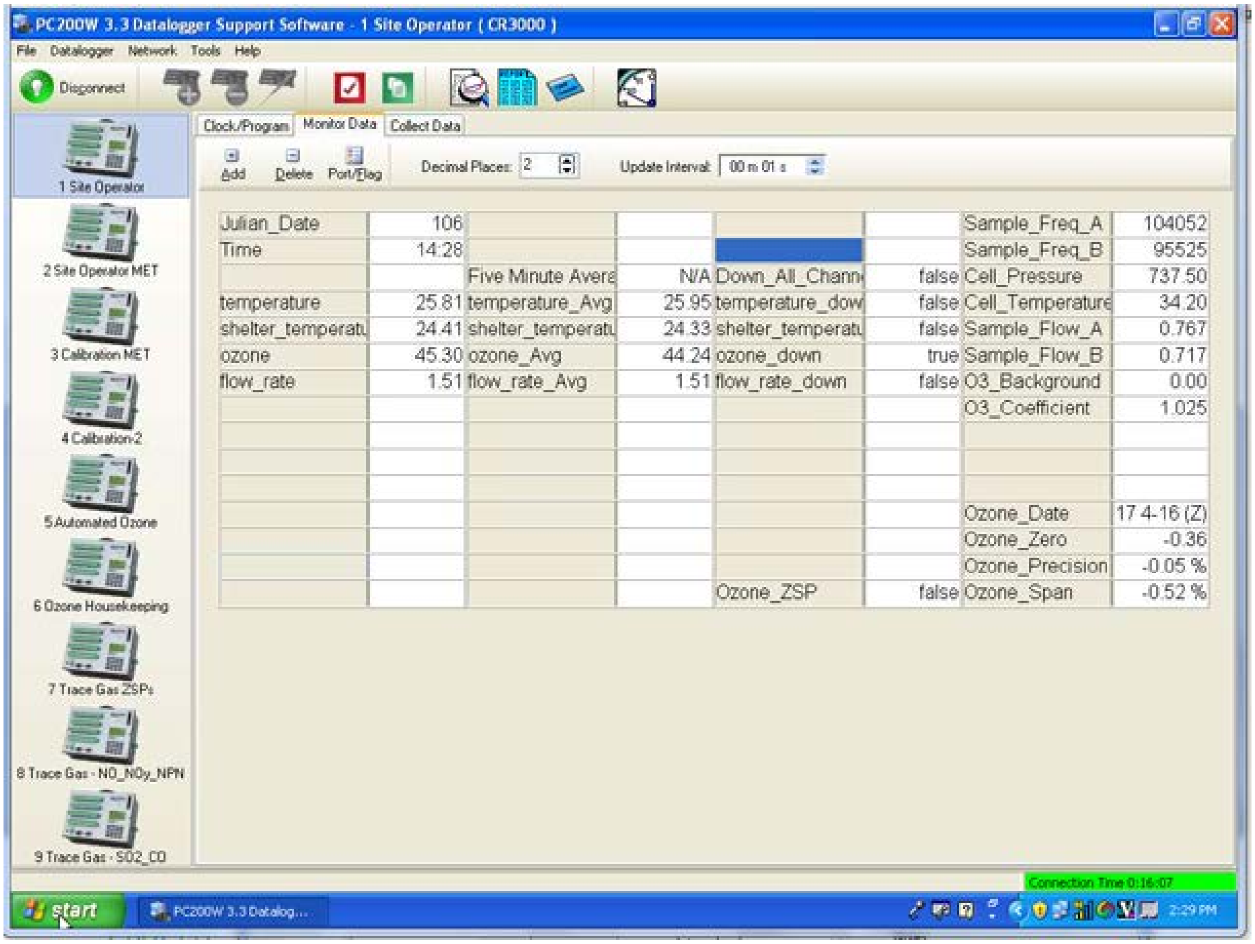
6.3.5 Set Calibrator Onsite to “true”.

- Using established procedures, from the Automated Ozone page, set Calibrator Onsite to “true” if not already performed. Record the date and time in the site log book.

6.3.6 Down the Ozone channel.

- Using established procedures, from PC200W on the site laptop, connect to the Site Operator-1 page. In the second column, double click the *ozone_down* cell to highlight and activate the cell. Double click the cell again to toggle the value to "true". Figure 13. Record the date and time in the site log book.

Figure 13. Screen Shot: Indicating O_3 Channel is Down



6.3.7 Turn on Level 2 Transfer by toggling the power switch to the on position.

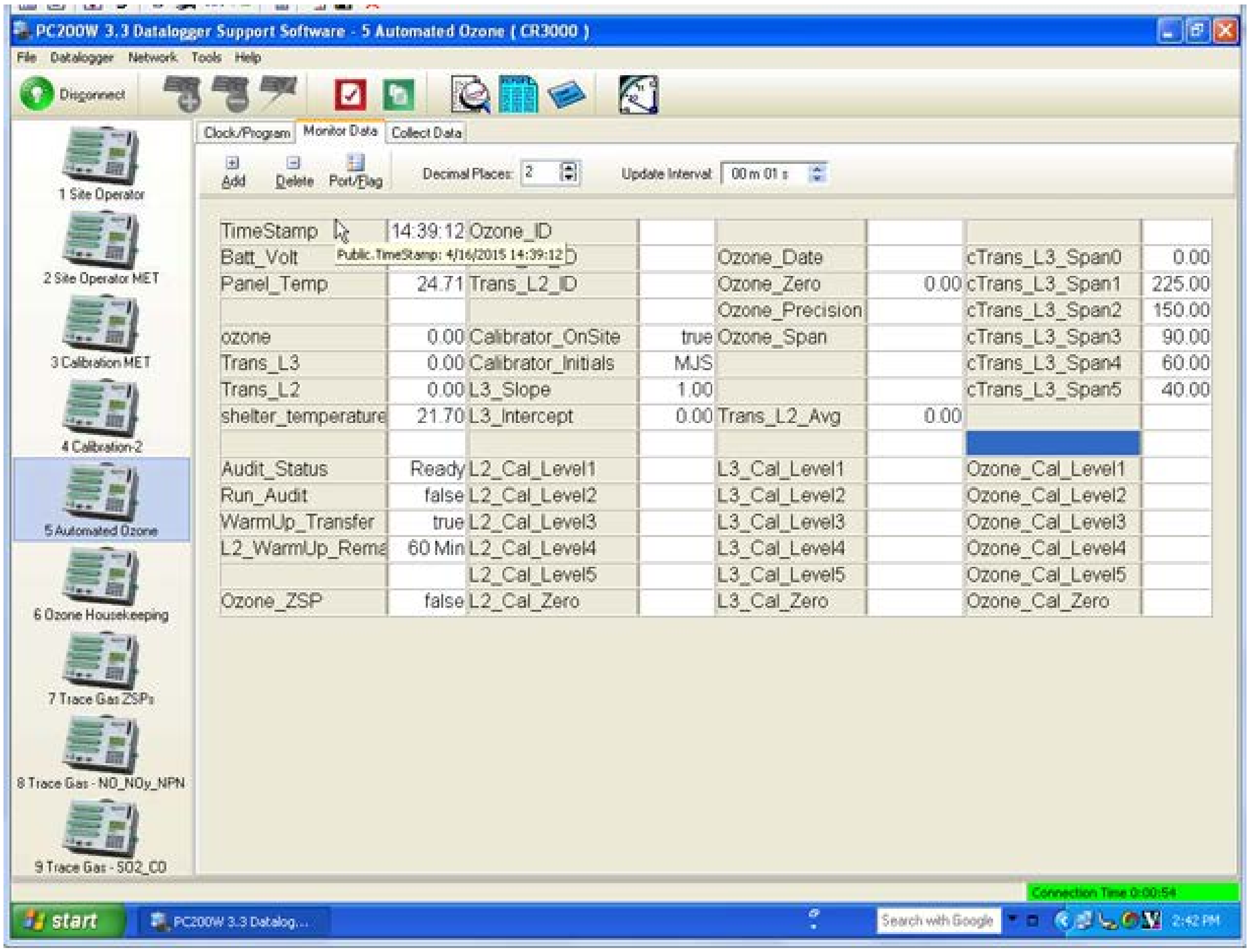
6.3.8 Establish and confirm communication between the data logger and the Level 2 Transfer.

- Connect the loose end of the Ethernet cable that is connected to the Level 2 Transfer to an open RJ-45 port on the switch. The switch is on the communications backplane. On the switch, confirm that the light is on for the Ethernet port that the Level 2 Transfer's Ethernet cable is connected to. The cable may have to be gently adjusted on the Level 2 Transfer Ethernet port to ensure contact.
- Using established procedures given on PC200W on the site laptop, connect to the ozone housekeeping page. Confirm that the transfer's housekeeping values have populated.

6.3.9 Audit the Level 3 Site Transfer and the Site analyzer.

- Using established procedures given on PC200W on the site laptop, connect to the Automated Ozone page.
- In the first column, if the WarmUp_Transfer cell is "false", double click the *WarmUp_Transfer* cell to highlight and activate the cell (Figure 14). Double click the cell again to toggle the value to "true".

Figure 14. Screen Shot: Indicating O_3 Transfer is Warming up



***Note:** If the Level 2 Transfer has already been warmed up 1 hour, this cell can be left at or toggled to "false".*

- In the first column, double click the *Run_Audit* cell to highlight and activate the cell. Double click the cell again to toggle the value to "true".
- Unplug the loose end of the Level 2 Transfer's sample line and connect it to the vent port on the back of the Level 3 Transfer.

6.3.10 Verify the air compressor regulator gauge remains set to 30 psi.

6.3.11 Record the audit values and analyzers' housekeeping data, which populate on PC200W's Automated Ozone page and Ozone Housekeeping page, respectively, into the O_3 iForm

(Figure 15). Bench temperatures for the site analyzer and both transfer standards <u>must</u> stay between 25 and 40°C for valid results.

Figure 15. Ozone Calibration Form

Ozone

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Site Name	Calibrator	Calibration Date	Data Logger	iForms Ver.
PAL 190	TYLER WARD	11/19/2013 - 11/20/2013	Campbell 3000 ID:347	1.5.1

	Site Analyzer				Level 3 Transfer Standard				Level 2 Transfer Std.	
	As Found		As Left		As Found		As Left			
Manufacturer	Thermo				Thermo				Thermo	
Model	49i				49i				49i	
ID #	000733				000214				000679	
Background	0.1				0				0	
Coefficient	1.005				1				1	
Pressure (mmHg)	648 mmHg				748 mmHg				732 mmHg	
Cell Temperature (°C	31.3 °C				32.3 °C				31.0 °C	
	A	B	A	B	A	B	A	B	A	B
Cell Freq. (kHz)	91	97	96	102	84	81	114	110	99	97
Cell Noise	0.6 Hz	0.6 Hz			1.0 Hz	0.9 Hz			1.4 Hz	1.5 Hz
Cell Flow (lpm)	0.66	0.661			0.66	0.702			0.752	0.753
					Date of Last Certification:				8/28/2013	

AutoCal Results	As Found	As Left
Zero	-0.79	
Span	0.3	
Precision	0.11	
Sample Line Loss Check	**As Found**	**As Left**
Inlet		
Analyzer		
Corrected		
Sample Leak Check	**As Found**	**As Left**
Pressure	182	

		Level 2 Transfer		Level 3 Transfer		Site Analyzer	
Target	Lamp	Conc.	Corrected	Conc.	% Diff	Conc.	% Diff
450	49.4%	451.4	451.7	445.25	-1.42%	449.5	-0.48%
300	37.4%	298.4	298.6	293.99	-1.55%	297.5	-0.37%
200	29.6%	198	198.2	194.8	-1.70%	197.2	-0.49%
90	20.9%	87.4	87.5	85.7	-2.07%	87	-0.59%
60	18.6%	60.95	61.1	59.64	-2.31%	60.28	-1.26%
0	0.0%	0.08	0.2	-0.44	-0.59 ppb	0.008	-0.15 ppb

	Level 3 Verification History		
	Date	m	I
1	5/17/11	0.9974	-0.58
2	11/1/11	0.9847	-0.478
3	11/2/11	0.9835	-0.58
4	5/15/12	0.9829	-0.59
5	11/20/12	0.9988	-0.34
6	5/28/13	0.9842	-0.46
Update	11/19/13	0.987	-0.66

	Level 2 Transfer	As Found			As Left		
		Site Analyzer	Level 3 Verification	Level 3 Update	Site Analyzer	Level 3 Verification	Level 3 Update
m	0.99955	0.9961	0.989	0.9869			
I	-0.07305	-0.23	-0.51	-0.52			
s_m	0.1%		0.75%	0.61%			
s_I	0.03733		0.098	0.115			

Remarks

L2 leack check = 175mmHg. Prior to ZSP the L3 lamp setting was adjusted from 30.7% to 35.5% and the site analyzers lamp adjusted from 42.3% to 44%. The resulting intensities are recorded in the as left column.

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6.3.12 Perform line loss test.

- When the audit is complete, the Audit_Status cell in the first column on the Automated Ozone page will read "Line Loss". The Level 3 Transfer will be in level 2 and generate approximately 90 ppb.
- Disconnect the Level 2 Transfer's sample line from the vent port on the back of the Level 3 and cap the vent port.
- Disconnect the sample line from the Level 2 Transfer sample port.
- Connect one end of the 25-ft line loss tubing from the calibration kit with the tee to the sample inlet outside leaving one side open for a vent (Figure 16). Connect the other end to the sample port of the Level 2 Transfer.
- Wait at least five minutes then record the next stable five minute average for the Level 2 Transfer in the iForms. This reading will be populated in the third column of the Automated Ozone page, in the Trans_L2_Avg cell
- Disconnect the line loss tee from the sample inlet, then, connect the site analyzer's sample line (the analyzer end) to the line loss tubing tee and cap the remaining open port of the tee.
- Record the first stable five minute average for the Level 2 Transfer into the iForms. This reading will be populated in the third column of the Automated Ozone page, in the Trans_L2_Avg cell.

Figure 16. Line Loss Tubing

6.3.13 End automated audit.

- From the first column on the Automated Ozone page, double click the Run_Audit cell to highlight and activate the cell. Double click the cell again to toggle the value to "false".

6.3.14 Turn off Level 2 Transfer by toggling the power switch to the off position.

6.3.15 Return the ozone system to its normal sampling configuration.

6.3.16 Ozone system leak check

Note: *If this is an initial installation for regulatory ozone monitoring, this step has been completed.*

- With the site analyzer and the Level 3 Transfer in normal operation, cap the sample probe inlet.
- From the front of the site analyzer, press the button that corresponds to the word Pressure at the bottom of the display. This screen will indicate the cell pressure (Figure 17) of the site analyzer. The cell pressure should fall to or below 225 mmHg. Record this value on the iForms for "As Found" leak check.
- If the cell pressure does not fall to or below 225 mmHg, find and fix leak(s). Record the location of the leak in the remarks section of the iForms.
- Record the final leak check in the iForms for "As Left" leak check.

Figure 17. O_3 Analyzer Display of Cell Pressure

6.3.17 Follow the Ozone AQS Audit Flow Chart on the supplied flash drive to determine the next course of action.

- To calibrate the site analyzer, proceed to step 6.3.23. Then, start at the third bullet of 6.3.1 to re-audit analyzers and record the results in the "As Left" section.

Note: *The line loss test is only required to be performed once per audit unless the sample tubing length has been changed and the Level 3 analyzer is only to be audited once.*

6.3.18 Remove the Level 2 Transfer

- Cap the sample port with a Teflon cap from the calibration kit. Disconnect the exhaust tubing from the exhaust port on the back of the Level 2 Transfer. Cap the exhaust port with a red cap from the calibration kit.
- Disconnect the Ethernet cable from the port on the back of the analyzer and from the switch.
- Disconnect the power cord from analyzer power port on the back of the analyzer and from the receptacle on the shelter wall.
- Place all disconnected tubing and cables from the Level 2 Transfer into the calibration kit.
- If the analyzer is to be shipped, remove the lid and use foam to pack the inside of the analyzer and install the sample pump shipping screws. Make sure inside components are secure and protected. Secure analyzer in the shipping container.

6.3.19 Set the air compressor regulator to 20 psi.

- Gently pull up on the regulator knob to unlock. Turn the knob counter-clockwise and set the regulator gauge to 20 psi. Push in on the regulator knob to lock.

6.3.20 Perform required maintenance.

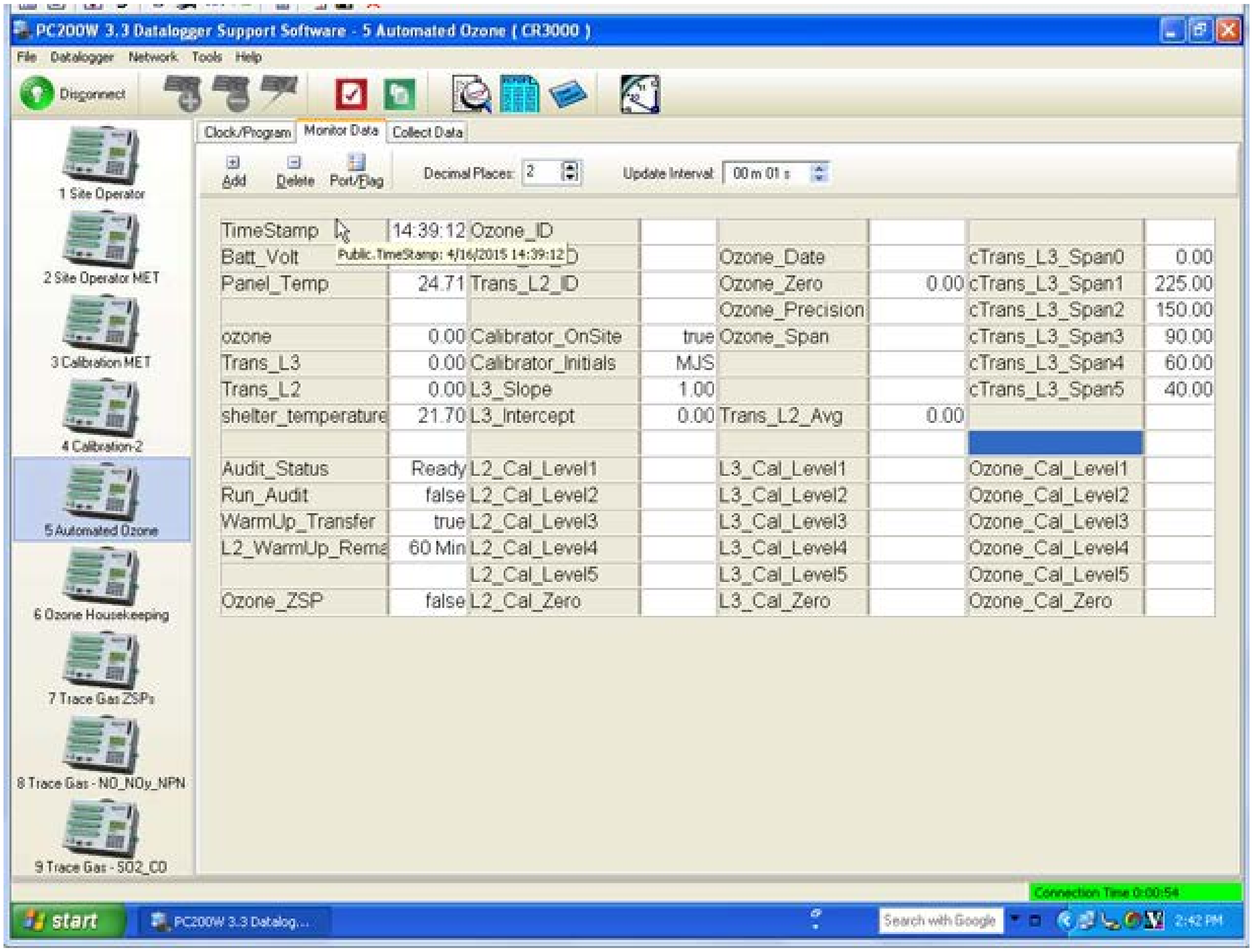
Note: *If this is an initial installation for regulatory ozone monitoring, this step has been completed.*

- Refer to the site maintenance sheet in the Calibration Folder for required maintenance.

6.3.21 Enter the Level 3 Transfer's updated corrections, found on the iForm, into the logger through PC200W.

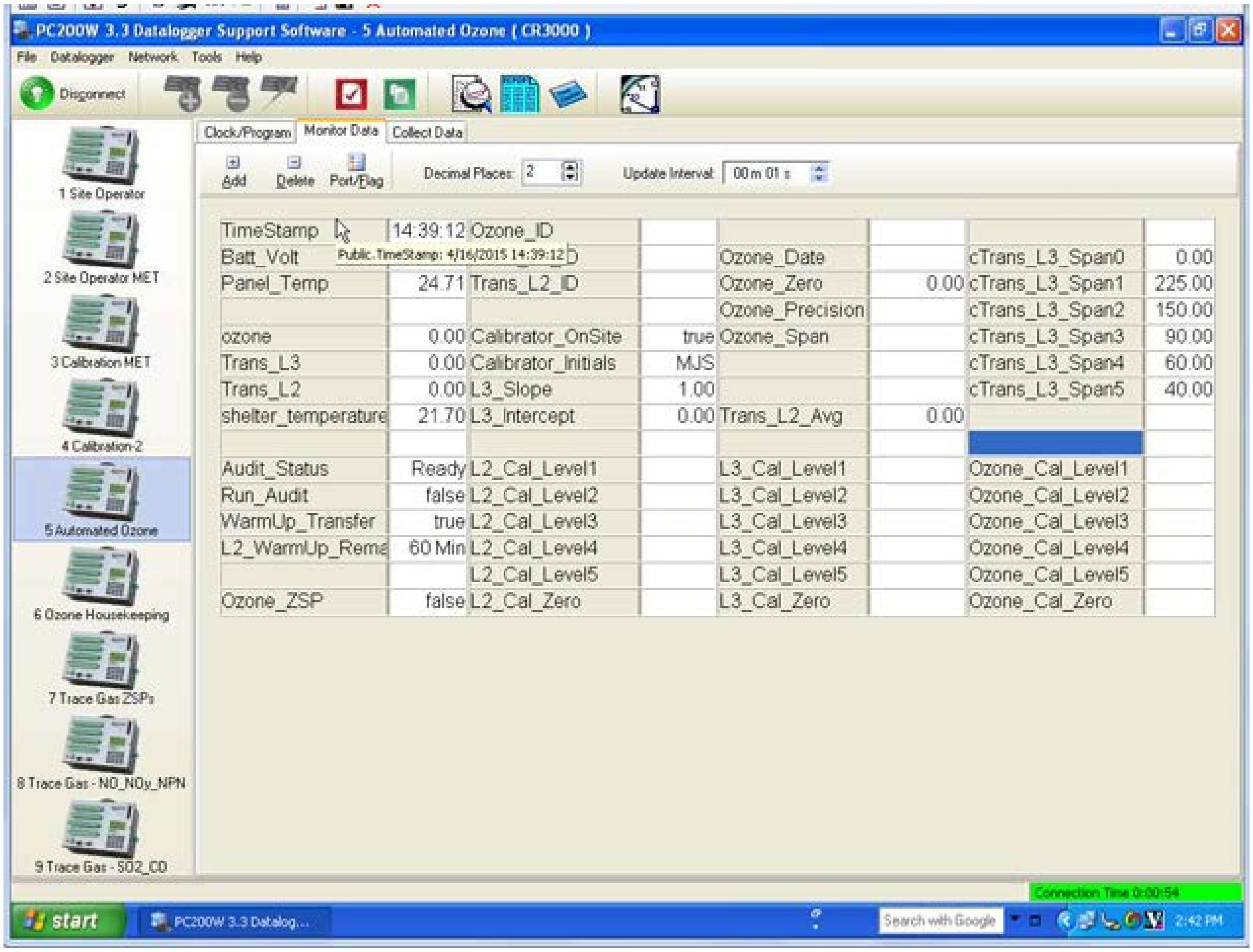
- From the Automated Ozone page, in the second column, double click the *L3_Slope* cell to highlight and activate the cell. Type the Level 3 Transfer's updated six audit average slope (Figure 18), from the O_3 iForm, into the cell and press the enter key on the laptop keyboard to accept the value.

Figure 18. Screen Shot: Indicating Average Slope from Audit Results



- From the Automated Ozone page, in the second column, double click the *L3_Intercept* cell to highlight and activate the cell (Figure 20). Type the Level 3 Transfer's updated six audit average intercept, from the iForms, into the cell and press the enter key on the laptop keyboard to accept the value.

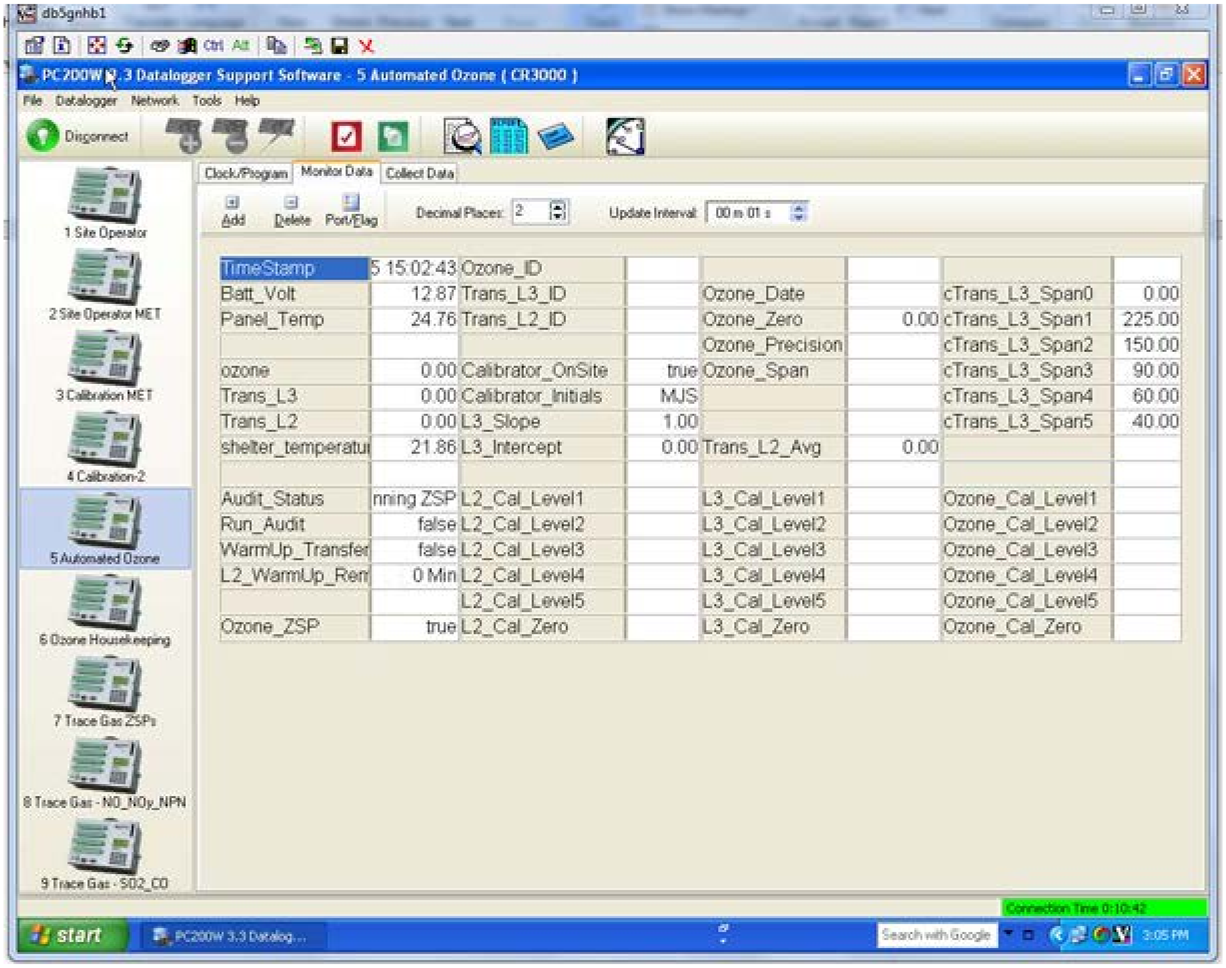
Figure 19. Screen Shot: Indicating Intercept Value from Audit Results



6.3.22 Run ZSP.

- Confirm the air compressor regulator gauge remains set to 20 psi. From the Automated Ozone page, in the first column, double click the *Ozone_ZSP* cell to highlight and activate the cell. Double click again to toggle the cell to “true”. The results will populate into the Ozone_Zero, Ozone_Precision, and Ozone_Span cells in the third column. Record the results in the iForms.

Figure 20. Screen Shot: Indicating ZSP is Running



Note: *The Zero result will be displayed as the ppb difference of the site analyzer from the Level 3 Transfer. The Precision and Span results will be displayed as the percent difference of the Site analyzer from the Level 3 Transfer. Acceptable criteria for the Zero result is ± 1.5 ppb. Acceptable criteria for the Precision and Span results are ± 7%.*

6.3.23 Site Analyzer Calibration

When calibrating the site analyzer to the Level 2 Transfer, the corrections for the Level 2 Transfer must be applied to its concentrations for accurate transfer concentrations. Bench temperatures for the transfer standard and site analyzer must stay between 25 and 40°C for results to be considered valid.

- Prior to calibration and following the audit, perform any repairs necessary and required maintenance.
- Using established procedures, activate Service mode on the Level 3 Transfer.
- Activate the Level 3 Transfer sample pump.
- Press the Run button on the Level 3 Transfer to activate *"Zero"* mode. Allow the concentrations to stabilize.

- Plumb the Level 2 Transfer in its normal audit configuration. See step 6.3.1.
- Using established procedures, activate Service mode on the Level 2 Transfer.
- Activate the Level 2 Transfer sample pump.
- Once the concentrations are stable, adjust the site analyzer *"Background"* so the site analyzer concentration matches the transfer unit's corrected response at zero.
- With the Level 3 Transfer in "Zero" mode, use its push buttons and navigate to Custom Level 1.
- Adjust the percent lamp drive to produce a 225 ppb response from the Level 2 Transfer.
- Once stable at 225 ppb adjust the *"Coefficient"* of the site analyzer until the site analyzer response matches the transfer unit's corrected response.
- Repeat the previous two steps if necessary to produce consistent concentrations of 0 and 225 ppb responses of the transfer.
- When the calibration is complete, turn off the Level 2 Transfer. Record the new *"Background"* and *"Coefficient"* values for the site analyzer in the O_3 iForm (Figure 15).
- Turn *"Service Mode"* off on the Level 3 Transfer and return to step 6.13.17.

6.4 Flow

6.4.1 Record the as-found "Flow_FullScale" and "Flow_Offset" values on the Flow iForm (Figure 22) for Flow Full Scale and Zero, respectively. These values are found on the 3 Calibration MET grid or the 4 Calibration-2 grid on the site laptop. From its tag record the Bios Definer 220 ID and certification date on the iForm. Identify the correct transfer electronic certification form on the root directory of the calibration flash drive. Make sure the certification form is complete and that the transfer's ID number matches the ID number on the certification form. Place a copy of the electronic certification form in the site calibration folder on the calibration flash drive to be copied to the site laptop at the completion of the site audit. Record the as-found rotameter value, MFC model ID, and flow set point on Flow iForm (Figure 21). The flow set point is found on the 3 Calibration MET grid or the 4 Calibration-2 grid (Figure 22) on the site laptop. Figures 8, 9, 10, and 11 in Section II.A.2, Subsection 3.5 illustrate the filter sampling systems and mass flow controllers.

Figure 21. Flow Calibration Form

Flow

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Site Name	Calibrator	Calibration Date	Data Logger	iForms Ver.
PAL 190	TYLER WARD	11/19/2013 - 11/20/2013	Campbell 3000 ID:347	1.5.1

	Mass Flow Controller		MFC Display	
	As Found	As Left	As Found	As Left
ID #	000604			
Description	MFC			
Manufacturer	Apex			
Model				
Serial #				
Full Scale	0.951			
Zero	-0.054			
Set Point	3.04	3.073		
Rotameter	3.5 lpm	3.6 lpm		
Pump Max Flow	4.400 lpm			

Transfer Mass Flow Meter	
ID #	000768
Manufacturer	BIOS
Model	Dry Cal Lite
Date of Last Cert.	6/21/2013
Data Module	
ID #	
Manufacturer	
Model	
Date of Last Cert.	

		Transfer Flow Display	Transfer Flow STP	Site MFC Display	Voltage	Flow lpm	% Diff
Pump Off (Zero Value)			0.000	0.00	0.026	-0.028	
Leak Check				0.02	0.036	-0.018	
Exisiting Flow			2,964	3.04	3.046	3.007	1.5%
Adjusted Zero Value			0.000				
Adjusted Leak Check							
Set Point	2.543		2.496	2.54	2.548	2.507	0.4%
Set Point	3.543		3.450	3.54	3.548	3.512	1.8%
Set Point							
Flow As Left (Unadj.)			3.000	3.07	3.076	3.037	1.2%

Remarks

Set point was changed prior to as left point.

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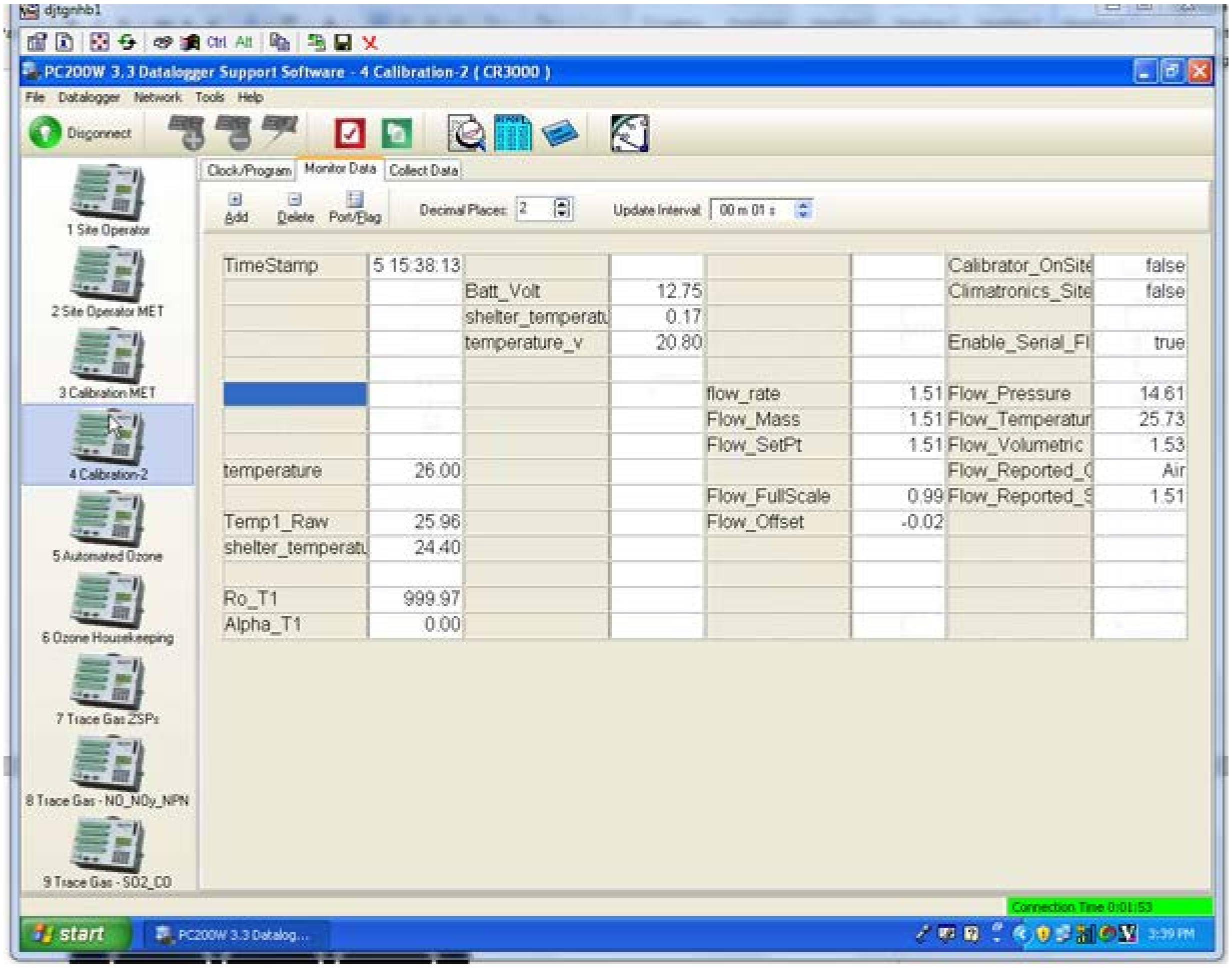
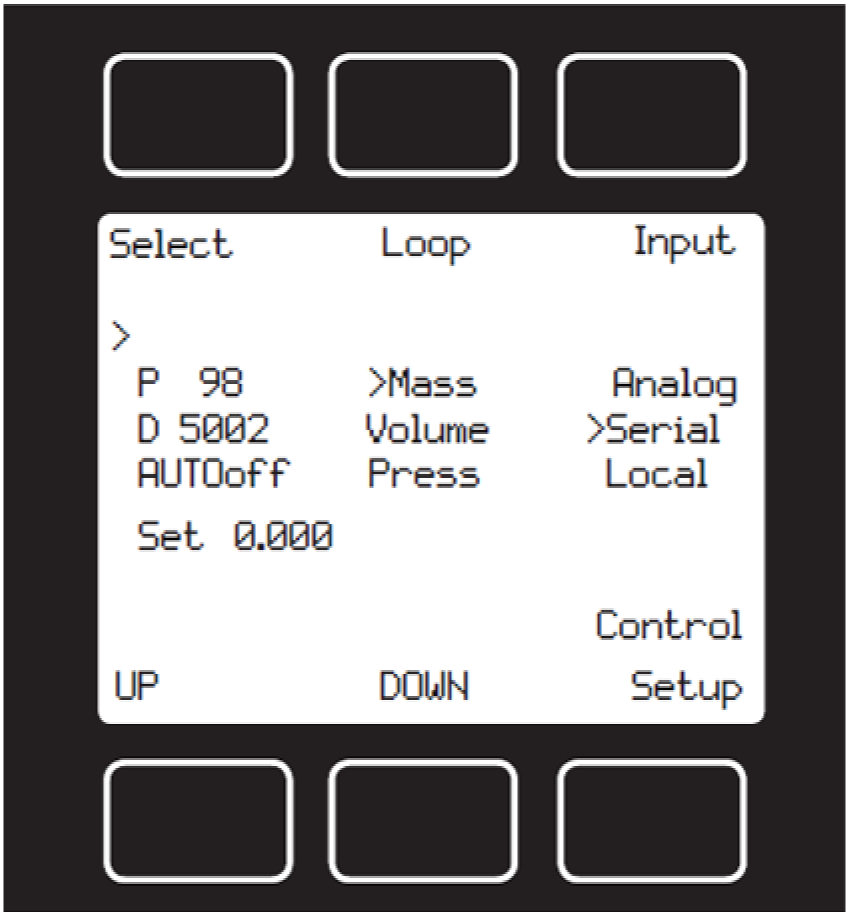
Figure 22. Screen Shot: Full Scale and Offset (Zero) Values



6.4.2 Allow the Definer to warm up for at least 30 minutes without the charger attached since the internal battery heats up during charging, resulting in error in measuring the air temperature. It may be necessary to charge the Definer beforehand to ensure there is sufficient capacity remaining for the duration of the audit.

6.4.3 Verify the flow controller is set to mass flow control by confirming the mass reading in the lower middle of the display (Figure 23) matches the set point in the upper right hand corner. An alternative method is to bring up the Control Setup display by pressing the right hand corner button below the word Main and then the top middle button above the word Control and confirming the caret is next to the word Mass in the center column. If the flow controller is found to be set to anything other than mass, record the current and updated setting in the Remarks section of the Flow iForm.

Figure 23. Screen Shot: Flow Controller Data Display



6.4.4 Set "ozone_down" and "flow_rate_down" to "true" on the 1 Site Operator grid or the 2 Site Operator MET grid on the site laptop. Unplug or turn off the flow pump and hour-meter. Note the time and hour-meter reading in the log book.

6.4.5 Once the MFC Display reading is stable, record the value on the Flow iForm for pump off.

Note: *Make sure to record the standard flow rate in SLPM. The mass flow rate is displayed at the bottom middle of the main display or can be displayed in the larger primary position by pressing the lower middle button below the word mass.*

6.4.6 Lower the flow tower (Figure 24). Remove the filter pack (using clean gloves or a clean plastic bag). Cap and store the filter pack carefully in a clean plastic bag.

Figure 24. Lowered Flow Tower

6.4.7 Plug in or turn on the flow pump. Once the MFC Display reading is stable, record the value on the Flow iForm for leak check.

6.4.8 Unplug or turn off the flow pump.

6.4.9 Connect the Flow transfer tubing (Figure 25) supplied in the calibration kit to the filter pack quick connect fitting in the pothead. Connect the remaining end to the top (suction) fitting of the Definer. If the supplied tubing is not long enough to reach the shelter with the tower lowered, call Amec Foster Wheeler for next steps; DO NOT use a different tubing length unless instructed by Amec Foster Wheeler.

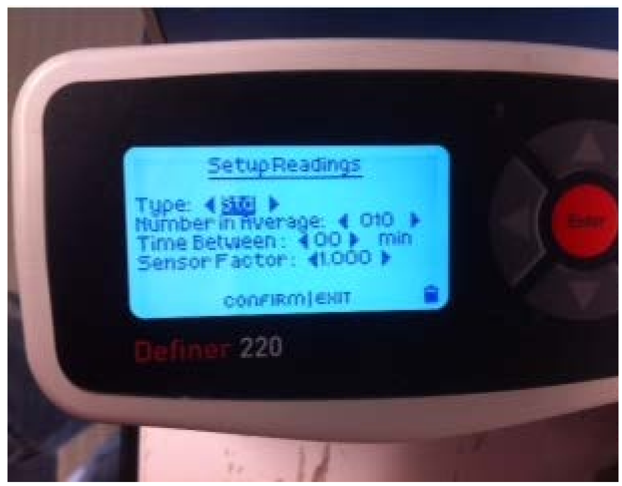
Figure 25a. Flow Transfer Tubing Connected at Pot Head

Figure 25b. Flow Transfer Tubing Connected at Flow Calibrator

6.4.10 The Definer should be leak tested prior to connecting the flow tubing by inverting the unit and allowing the piston to travel to the top, capping the port under test, pressing ENTER while still inverted, then turning the unit upright. The automated test will run. Turn the unit on and verify that it displays the “MEASURE | SETUP” screen (Figure 27). Verify the Definer is set to measure standard flow corrected to 25°C and 760 mmHg. Press the right arrow button once to highlight the word SETUP, and then press the Enter button once to bring up the Setup Definer 200 M menu display. With the word Readings highlighted press the Enter button once to bring up the Setup Readings menu (Figure 28) display. The Type: value should be set to Std. If not, press the right or left arrow button to change the value to Std. With the Type: value set to Std, press the down arrow four times to highlight the word Confirm, and then press the Enter button once. After the setting is confirmed by the transfer, the display will return to the Setup Definer 200 M menu. Press the down arrow once to highlight the word Units, and then press the Enter button once to bring up the Setup Units menu display. The Flow in: value should be set to sL/min. If not, press the right or left arrow button to change the value to sL/min. Once the Flow in: value is set to sL/min, press the down arrow three times to highlight the Std To: value. The Std To: value should be set to 25.0. If not, press the right or left arrow button to change the value to 25.0. With the Flow in: value set to sL/min and the Std To: value set to 25.0, press the down arrow at least once highlight the word Confirm. Press the Enter button once for the transfer to confirm the settings. If any of the Definer settings require changes, record the original and updated value in the Remarks section of the iForm.

Figure 26. Definer Data Display

Figure 27. Definer Setup Readings



6.4.11 Plug in or turn on the flow pump.

6.4.12 With the word MEASURE highlighted on the Definer (If MEASURE is not highlighted, press the down arrow until it is), press the Enter button once. Press the right arrow button once to highlight CONT, and then press the Enter button once to start measuring flow rates and auditing the MFC.

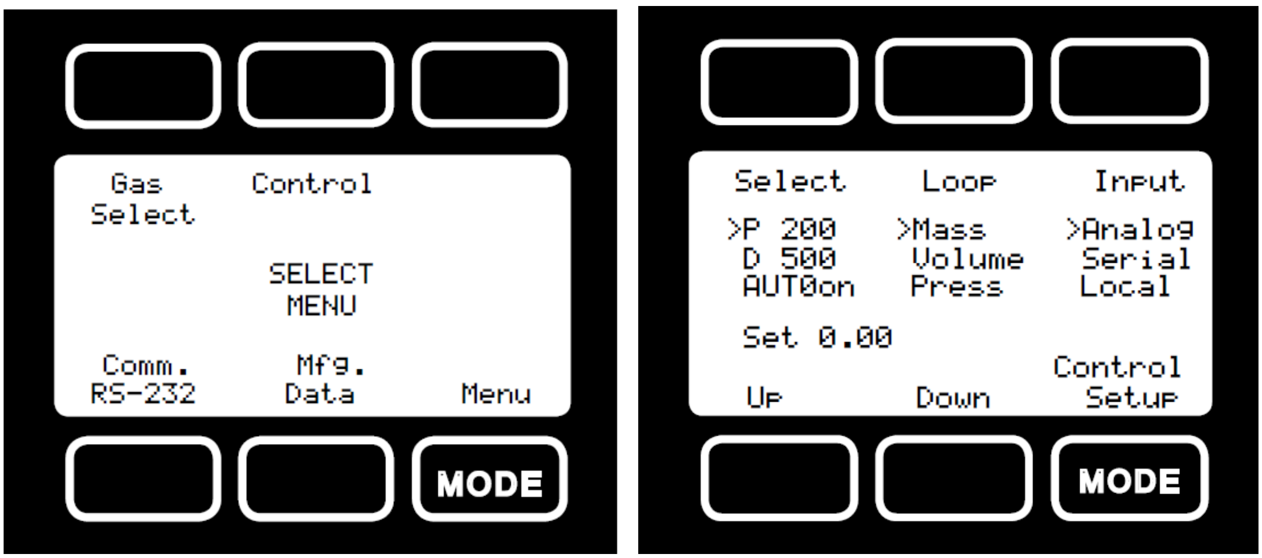
6.4.13 Once stable readings are obtained and the count has reached 10 of 10 on the Definer, press the Enter button. Record the average existing STP corrected flow (Avg) in the STP column on the iForm as reported by the Definer. The Display column on the iForm will remain blank.

6.4.14 Record the MFC Display as well as the data logger flow mass *"Flow Mass"* in the *Existing Flow* row of the iForm. *"flow rate v"* is found on 4 Calibration-2 grid on the site laptop.

6.4.15 Repeat the above procedure at one point 0.5 lpm above and one point 0.5 lpm below the target MFC flow. Record the set point for these flows for Pot. Setting on the iForm

6.4.16 Change the MFC set point (Figure 29) to obtain the desired lpm by using the data logger or logger interface parameter *"Flow_SetPt"*. Double click the set point value to highlight it, type in the new set point value, and press the enter key.

Figure 28. MFC Data Exhibit



6.4.17 Set the MFC set point to 5.00. Record SAvg (or Avg for the Definer) as reported by the transfer standard for the Pump Max Flow value on the iForm.

6.4.18 Unplug flow pump and perform required maintenance on the flow system. Replace the inline filter behind the rotameter and the flow pump diaphragm. Record the maintenance performed in the remarks section of the Flow iForm.

6.4.19 If any of the MFC flow rates vary from the STP value by 2 percent or more as indicated by a red box in the % Diff column, the following steps for a six point calibration must be performed. Otherwise proceed to step 6.4.25.

6.4.20 On the Flow iForm, click the *Show As Left* checkbox to open the As Left section of the iForm.

6.4.21 Plug in flow pump and perform flow rate audits at six set points to obtain the desired flow rates in the table below.

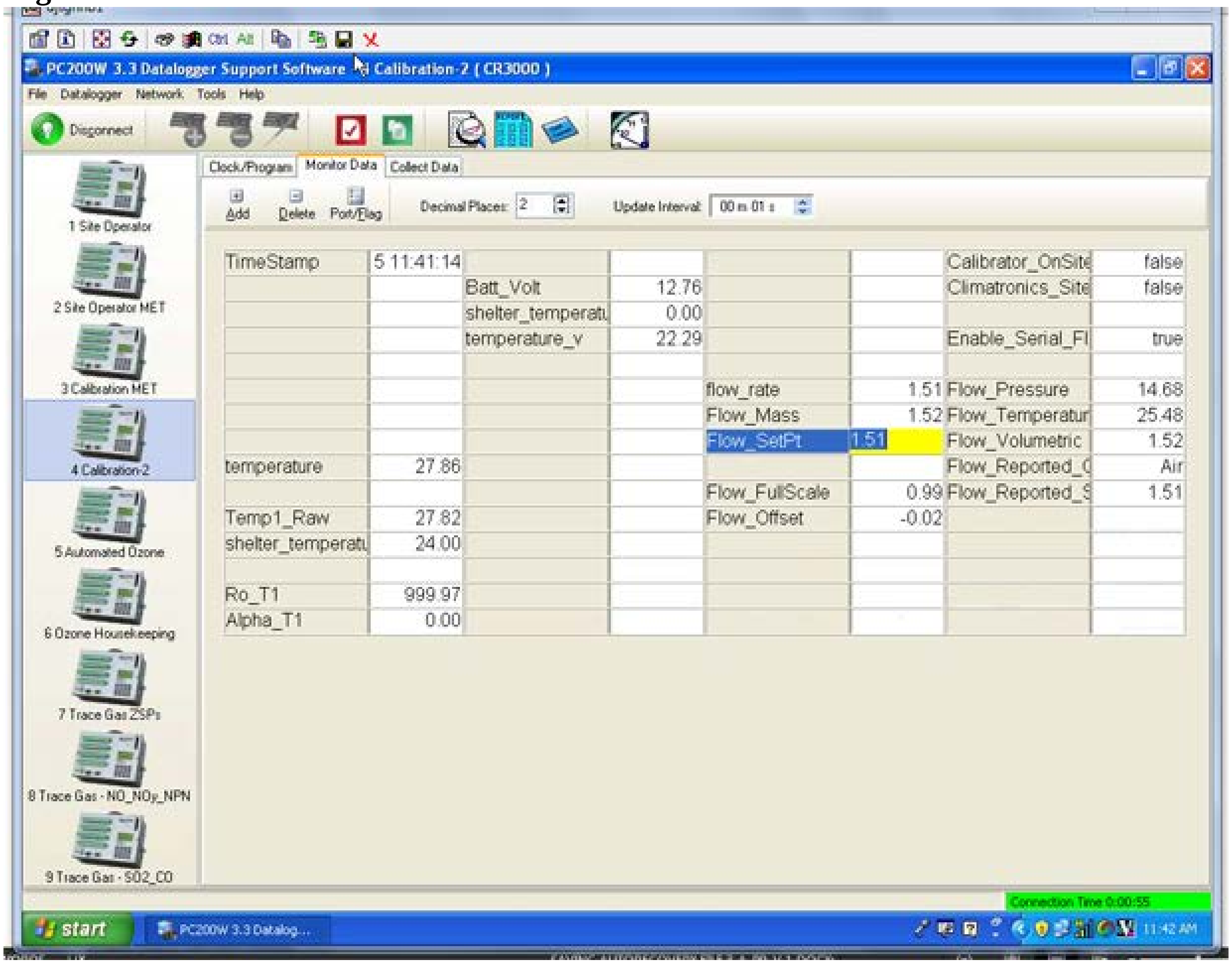
Target Calibration Flow Points (lpm) for CASTNET Sites						
1.5 Nominal Flow	1.00	1.25	1.50	1.75	2.00	2.25
3.0 Nominal Flow	2.25	2.50	2.75	3.00	3.25	3.50

6.4.22 During the As Left calibration, flow rates in SLPM can be previewed by entering Full Scale and Zero values in the left half of the As Left section of the Flow iForm.

6.4.23 Following a six point audit in the As Left section of the Flow iForm, the iForm will compute new Full Scale and Zero values as shown in the As Left column in the Full Scale and Zero rows. Record the new full-scale and zero values in the site log book.

6.4.24 Transfer the new computed values to the data logger through the 4 Calibration-2 grid by double clicking the word “Flow_Full Scale” (Figure 29) to highlight it, typing in the new value, and pressing the Enter key on the keyboard. Repeat for the new Zero by double clicking on the word “Flow_Offset”.

Figure 29. Screen Shot: Flow Set Point



6.4.25 If the flow pump is off, plug it back in or turn it on and perform one final audit at the target flow rate. Using the Avg for the Definer, adjust the MFC set point to achieve a flow rate of 1.50 or 3.00 for the particular site. Record the result on the Flow iForm in the Flow As Left (Unadj.) row or the Post Calibration row if a six point calibration was required.

6.4.26 Record the set point for the As Left Pot Setting and the As Left rotameter value on the iForm.

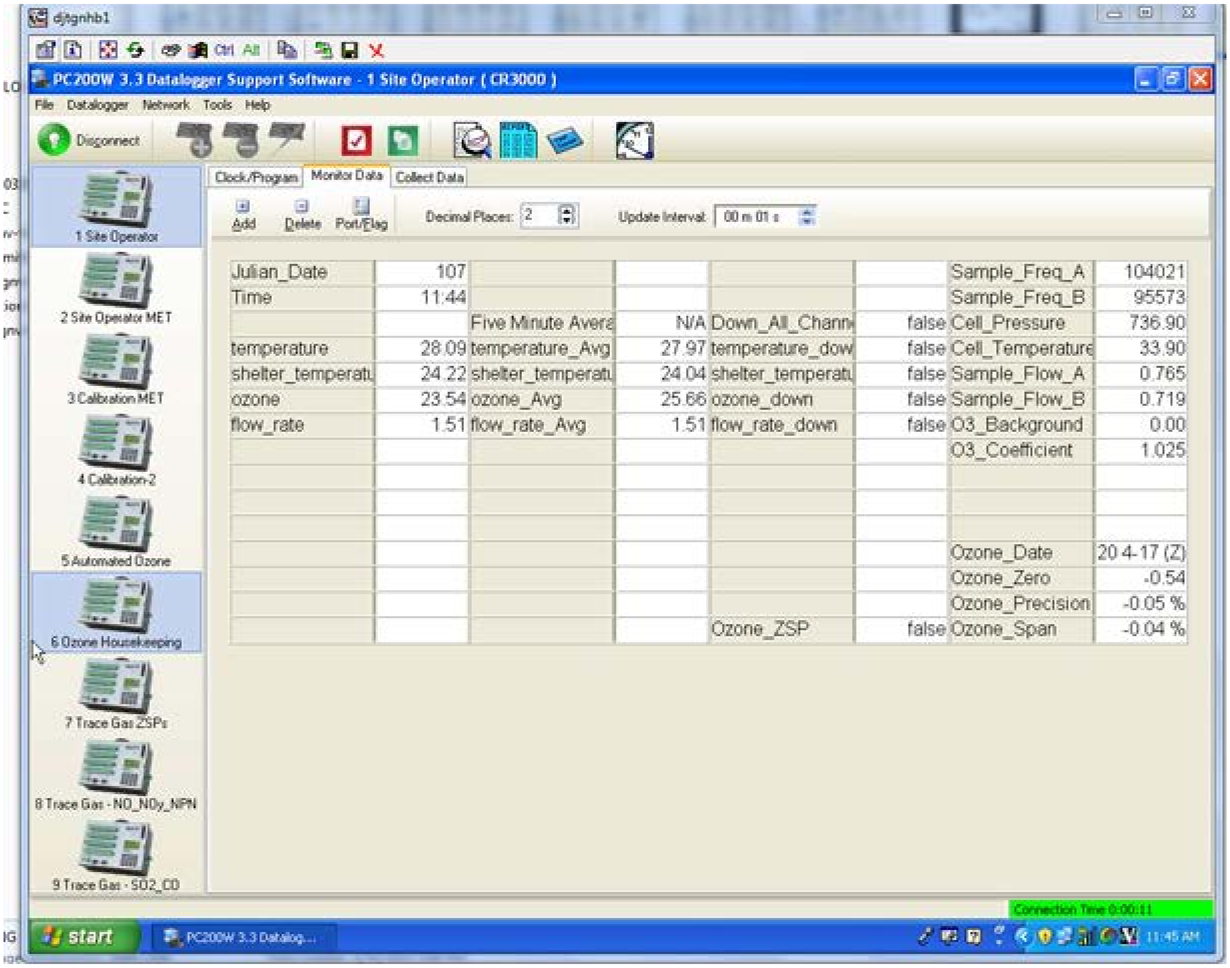
6.4.27 Unplug or turn off the flow pump.

6.4.28 Disconnect transfer tubing from the filter pack quick connect on the flow tower.

6.4.29 Reinstall the filter pack (using clean gloves or a clean plastic bag). Raise the flow tower.

6.4.30 Set "ozone_down" and "flow_rate_down" to "false" on the 1 Site Operator grid (Figure 30) on the site laptop. Plug in or turn on the flow pump and hour-meter. Note the time and hour-meter reading in the log book.

Figure 30. Screen Shot: Reestablishing O_3 and Flow Sampling



6.5 Trace Gas Concentrations

QAPP Appendix 11 describes trace gas concentration instruments, their specifications, data processing and QC requirements, and SOP for each instrument.

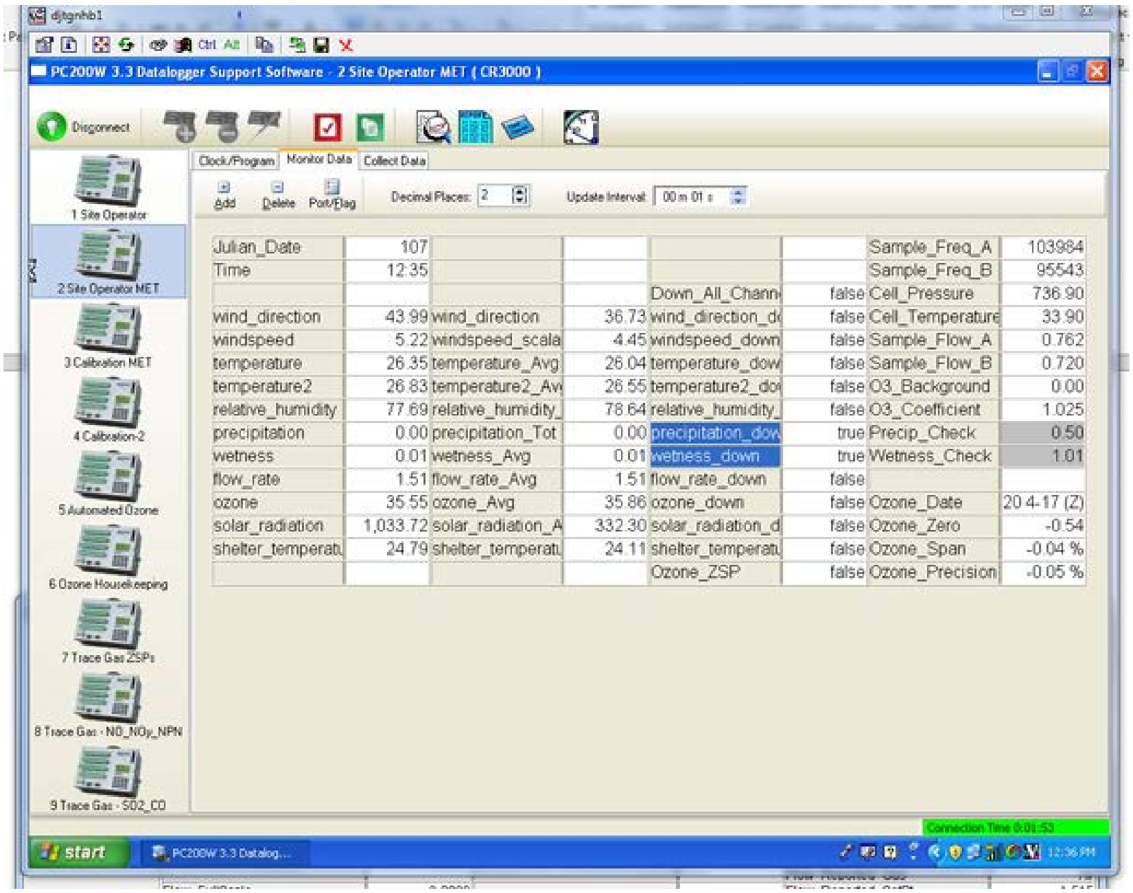
6.6 Meteorological Measurements

6.6.1 Tipping Bucket Rain Gauge

- Set *"precipitation_down"* parameter to *"true"* (available on 1 Site Operator MET and 3 Calibration MET grids). Note time in logbook.
- Measure 231.5 milliliters (mL) of H_2O with a graduated cylinder and pour into the separator funnel. Figures 12 and 13 in Section II.A.2, Subsection 3.2 show photos of the rain gauge.

- Drip this (equivalent to 0.50 inches of precipitation) through the funnel on top of the rain gauge at a rate of approximately one tip per 15 seconds. Not to exceed one tip per 10 seconds.
- Afterwards, record the total precipitation (Figure 31) measured by the DAS as displayed in the *"Precip_Check"* parameter (available on 2 Site Operator MET and 3 Calibration MET grids). Each tip equals 0.01 inch of precipitation on the data logger.

Figure 31. Screen Shot: Checking Precipitation Sensor



- If the error is more than ±0.02 inches, repeat the measurement. Set *"precipitation_down"* to *"false"*, then to *"true"* to reset the *"Precip_Check"* counter. If the results are consistent, clean, level and adjust the rain gauge to accuracy.
- Two screws on the bottom of the gauge (Figure 13 in Section II.A.2, Subsection 3.2) position the resting point of the tipping bucket's measurement mechanism. If the gauge is recording too few tips, adjust the screws clockwise to elevate the bucket rests. If the gauge is recording too many tips, turn the screws counterclockwise. Test again, and repeat until accurate. Again setting *"precipitation_down"* to *"false"* then *"true"* will reset the totalizer function. Set *"precipitation_down"* to *"false"* when finished. Note time and results in logbook.
- Maintenance: (Caution: 120 VAC)
- Clean the buckets.

- Inspect the mechanism and wiring for defects.
- If the temperature is below freezing, check to see if the funnel is warm and the thermostat is working.
- Make sure screen is clean and in place during summer months and not in use during winter months.
- Make sure thermostat is secured to side of bucket.
- Use freeze-spray to test the thermostat and heater.
- Complete precipitation iForm (Figure 32).

Figure 32. Precipitation Calibration Form

Precipitation amec

Site Name	Calibrator	Calibration Date	Data Logger
PAL 190	TYLER WARD	11/19/2013 - 11/20/2013	Campbell 3000 ID:347

Tipping Bucket Gauge	As Found	As Left
Manufacturer	Texas Electronics	
Model	TR-5251	
ID #	06307	

iForms Ver.	1.5.1	
Wetness Sensor	As Found	As Left
Manufacturer	R.M. Young	
Model	58101	
ID #	06288	

Tipping Bucket Rain Gauge							
Volume H_2O		Time/Tip	Datalogger Output			As Found	As Left
mL	inches	Seconds	As Found	As Left			
231.5	0.50	14.0	0.49		Clean	Yes	
231.5	0.50				Level	Yes	
231.5	0.50				Heater OK		
231.5	0.50				Screen In	Yes	

Wetness			Dry		Wet	
Sensitivity			As Found	As Left	As Found	As Left
On (kΩ)	Off (kΩ)	Output Volts DC	0.008	0.008	1.015	1.007
235	245	Sensitivity	319 kΩ	245 kΩ	313 kΩ	235 kΩ

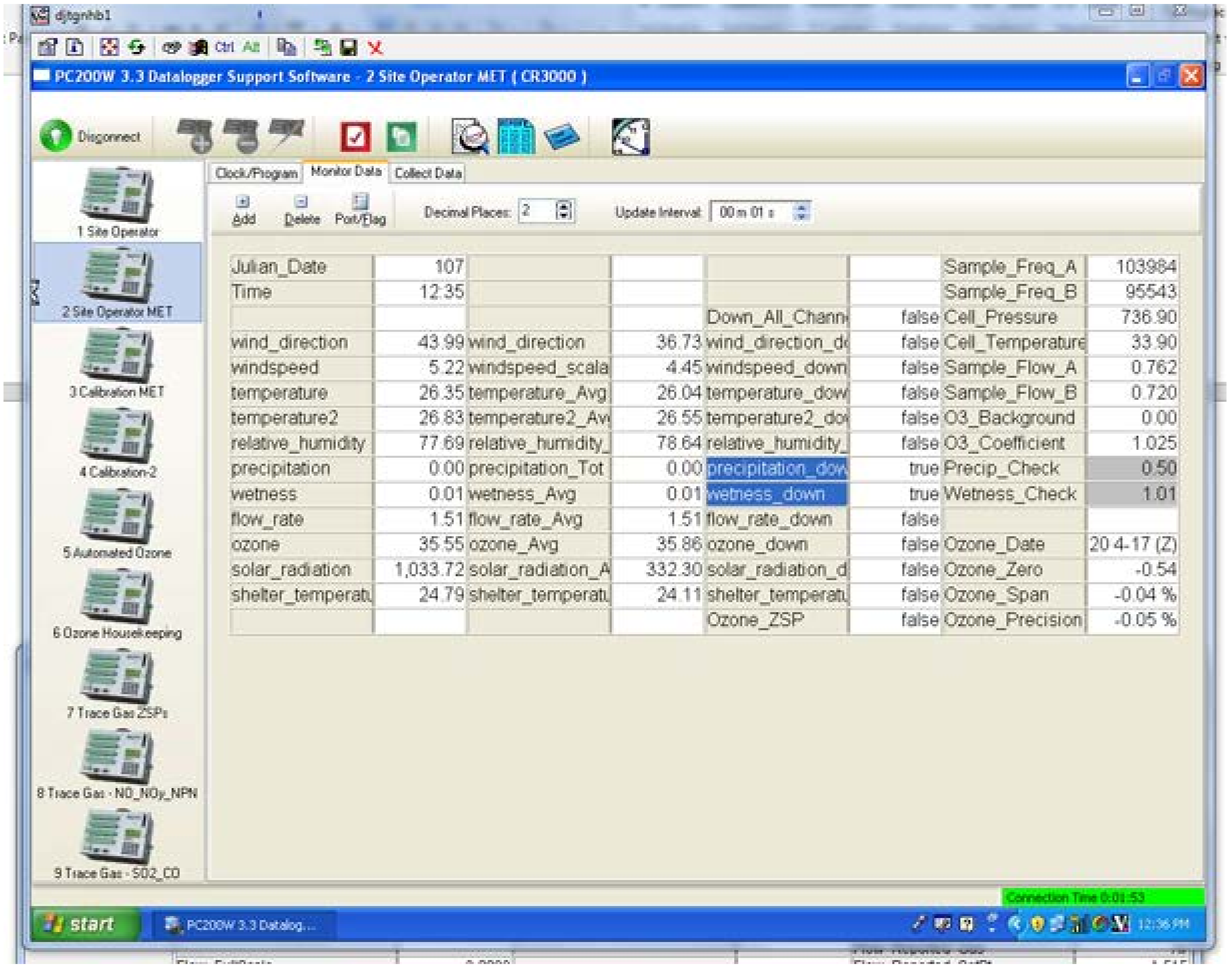
Remarks
Could not check heater because freeze-it nozzle was missing.

Reviewed By: [signature] Date: 12/13/13

6.6.2 Wetness

- Unadjusted Check (Audit):
- Set the *"wetness_down"* parameter to *"true"* [Figure 33 (available on 2 Site Operator MET and 3 Calibration MET grids)]. Note time in site log-book.

Figure 33. Screen Shot: Checking Wetness Sensor



- Check that the sensor is clean; that no weeds are around it; and that the face of the sensor is oriented north at about a 30-degree (°) angle (Figure 34).

Figure 34. Wetness Sensor

- Record the DAS voltage for the ambient condition of wet or dry as reported in the *"Wetness_Check"* parameter (available on 1 Site Operator and 3 Calibration grids).
- Induce the opposite condition by either drying or wetting the leaf sensor grid and record DAS output again for the appropriate condition. Return the sensor to ambient conditions.
- When dry, the sensor should report 0.00±0.02 VDC. When wet the sensor should report 1.00 ± 0.10 VDC.
- Test the dry sensitivity of the sensor by plugging in the decade resistance box into the calibration jack inside the wetness sensor circuit box and beginning at least 4 kilo ohms (kΩ) below the final value, increase the resistance in 1 kΩ intervals until the sensor turns off. Record the lowest resistance at which the sensor remains off.
- Test the wet sensitivity of the sensor by beginning at least 4 kΩ above the final value, decrease the resistance in 1 kΩ intervals until the sensor turns on. Record the highest resistance at which the sensor remains on.
- Additional Check and Adjustment Procedures:
- Insert decade box test jack in the connector labeled test jack.
- If the sensor does not turn on at 235 kΩ, adjust the sensitivity potentiometer until it turns on while the decade box is set at 240 kΩ. Recheck at 245 kΩ that the LED also turns off. Continue to adjust until both of these criteria are met.
- Set the sensor voltage response to 1.000 V using the output or gain potentiometer as recorded by the DAS when the sensor is on. Replace the sensor cover. If the sensor cannot be made to output 1.000 ±0.10 VDC while wet, replace it and perform a full audit of the as left sensor response on the calibration form.
- Set *"wetness_down"* parameter to *"False"* and note time in the logbook. Record all results on the calibration form.
- In winter months, at some sites, snow accumulation may prevent access to the sensor.

6.6.3 Temperature*

- Items needed: ice, water, re-sealable plastic bags, thermos (x2), Styrofoam thermos lid (x2), magnetic stir bar (x2), stir plate, water heater, certified Resistance Temperature Device (RTD), and rubber mallet.
- Identify the correct transfer's electronic certification form found on the root directory of the calibration flash drive. Make sure the certification form is complete and that the transfer's ID number matches the ID number on the certification form. Place a copy of the electronic certification form in the site calibration folder on the calibration flash drive to be copied to the site laptop at the completion of the site audit.
- Record the following on the Temperature iForm (Figure 35): the RTD Transfer ID and certification date, the site probe ID(s), and the "as found" temperature R_0 and alpha values for each site probe. If the site has three ambient temperature probes, a second Temperature iForm must be used. The existing temperature probe's individual R_0 and alpha values are

*Climatronics instruments are no longer used at EPA-sponsored CASTNET sites.

found on either the 3 Calibration MET or 4 Calibration-2 data grid on the site laptop. They are labeled as “R_0_T1” and “Alpha_T1” for the 9 meter temperature probe (“temperature”), and for met stations”R_0_T2” and “Alpha_T2” for the 2 meter temperature probe (“temperature2”). The shelter temperature probe does not use R_0 and alpha values.

- Record the existing R_0 and alpha values in the site narrative logbook.
- Input the Correction Factors into the Temperature iForm for the RTD transfer. The correction factors are found on the RTD transfer certification form.
- Down all temperature channels to be audited by changing their status to “true” on the 1 Site Operator grid or the 2 Site Operator MET for sites with meteorological measurements (Figure 36). If the site includes meteorological measurements, then also down the wind speed, wind direction, and relative humidity (RH) channels. If the site has a temperature3 probe or temperature probe on the flow tower, also down the flow and ozone channels. Note time and action in logbook.

Figure 35. Temperature Calibration Form

Temperature amec

Site Name	Calibrator	Calibration Date	Data Logger	iForms Ver.
PAL 190	TYLER WARD	11/19/2013 - 11/20/2013	Campbell 3000 ID:347	1.5.1

	9 Meter (T1)		2 Meter (T2)	
	As Found	As Left	As Found	As Left
ID #	06303		06302	
Description	RTD		RTD	
Manufacturer	R.M. Young		R.M. Young	
Model	43347		43347	
R_o	1000.56		1000.04	
Alpha	0.003743		0.003738	
Translator Type				

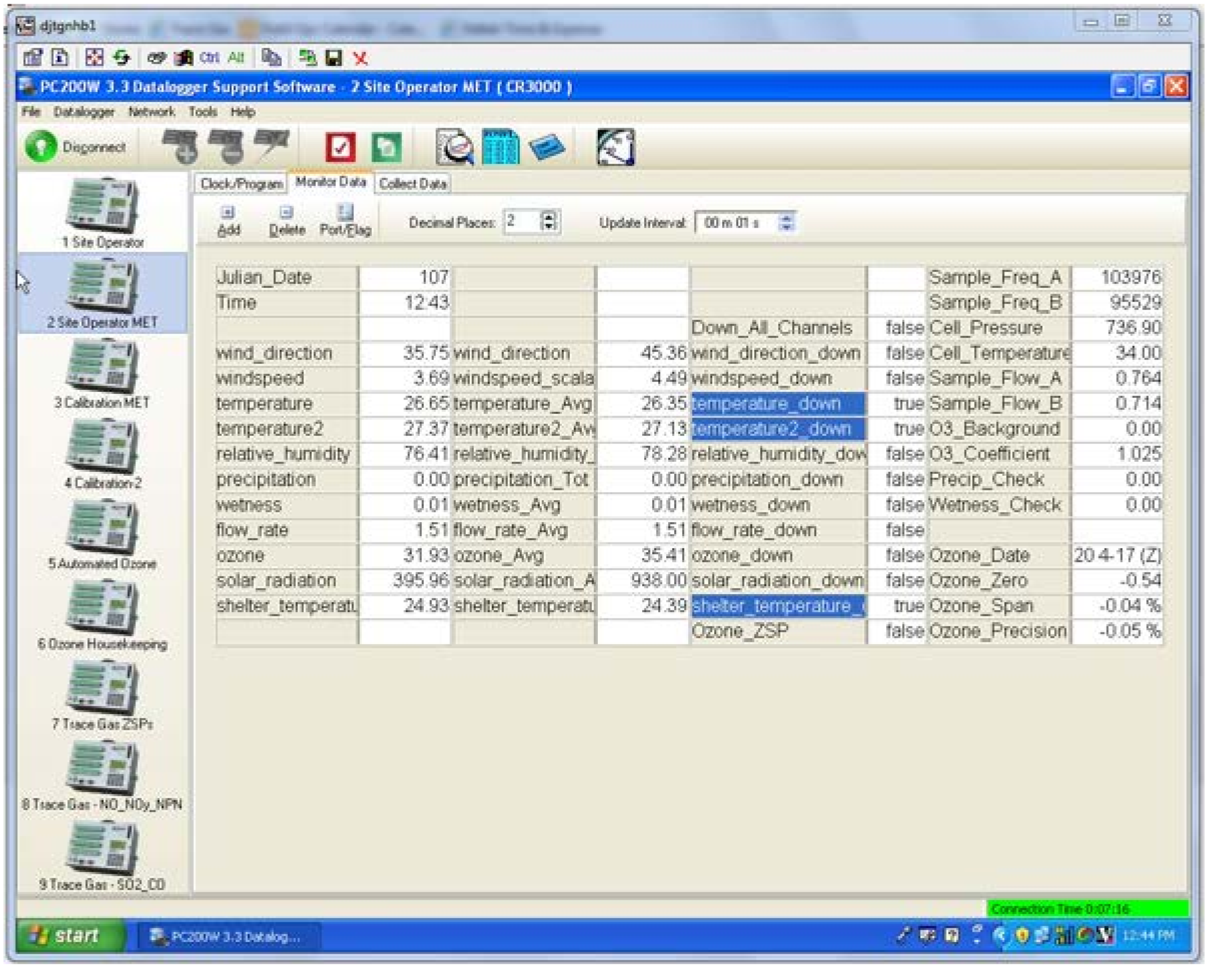
Transfer Standard					
ID #	04643				
Manufacturer	Eutechnics				
Model	4600				
Date of Last Cert.	8/12/2013				
Correction Factors					
0°	10°	20°	30°	40°	50°
-0.01	-0.01	0.00	0.00	0.01	0.01

As Found			Temperature Data Logger Output										
RTD (°C)			Temperature (9m) Output				Temperature 2 (2m) Output				Delta T.	Shelter Temperature	
Uncorrected Temp. (°C)	Correction Factor	Corrected Temp. (°C)	Raw Temp. (°C)	Corrected Temp. (°C)	Raw Diff (°C)	Corrected Diff (°C)	Raw Temp. (°C)	Corrected Temp. (°C)	Raw Diff (°C)	Corrected Diff (°C)	Diff (°C)	Temp. (°C)	Diff (°C)
0.06	-0.01	0.05	0.11	-0.04	0.06	-0.09	0.07	0.06	0.02	0.01	-0.10	-0.13	-0.18
30.29	0.00	30.29	30.35	30.24	0.06	-0.05	30.15	30.23	-0.14	-0.06	0.01	30.07	-0.22
49.33	0.01	49.34	49.42	49.34	0.08	0.00	49.22	49.37	-0.12	0.03	-0.03	48.98	-0.36
44.99	0.01	45.00										44.70	-0.30

Remarks

Reviewed By: ____________ Date: 12/23/13

Figure 36. Screen Shot: Auditing Temperature Sensors



- For sites with no meteorological measurements skip to step 6.7.
- Lower the meteorological tower and verify that both temperature blower motors are operational (Figures 31 and 32 in Section II.A.2, Subsection 3.11). If not, replace.
- Locate the power cord for the blower motor power supply. This power supply is the green unit located on the data logger backplane terminal interface strip. The power cord emerges from behind the backplane and is plugged in near the data logger.
- Unplug the power supply and observe that the green indicator light on the unit goes out.
- Inspect temperature sensors, aspirated and/or nonaspirated shield(s), and blowers, if applicable, conditions; note whether sensors are touching the housings and whether airflow is obstructed and if the temperature probes are installed with the correct length adaptors. Clean blower motors if necessary. Any installation discrepancies and repair activities including cleaning should be documented in the Remarks section of the iForms.
- Crush some ice (in plastic bag with rubber mallet) to a fine consistency. It is very important not to have large pieces of ice to achieve a smooth circulation when temperature probes are immersed in the ice bath. Set up a stirring ice bath by placing one of the magnetic stir bars into one of the thermoses and then, fill this thermos about three quarters full with the crushed

ice. Add water to the ice filled thermos to within about an inch and a half of the top of the thermos. Place the filled thermos on the stir plate. Plug in the stir plate and turn on the magnet to spin the magnetic stir bar as to mix the ice and water.

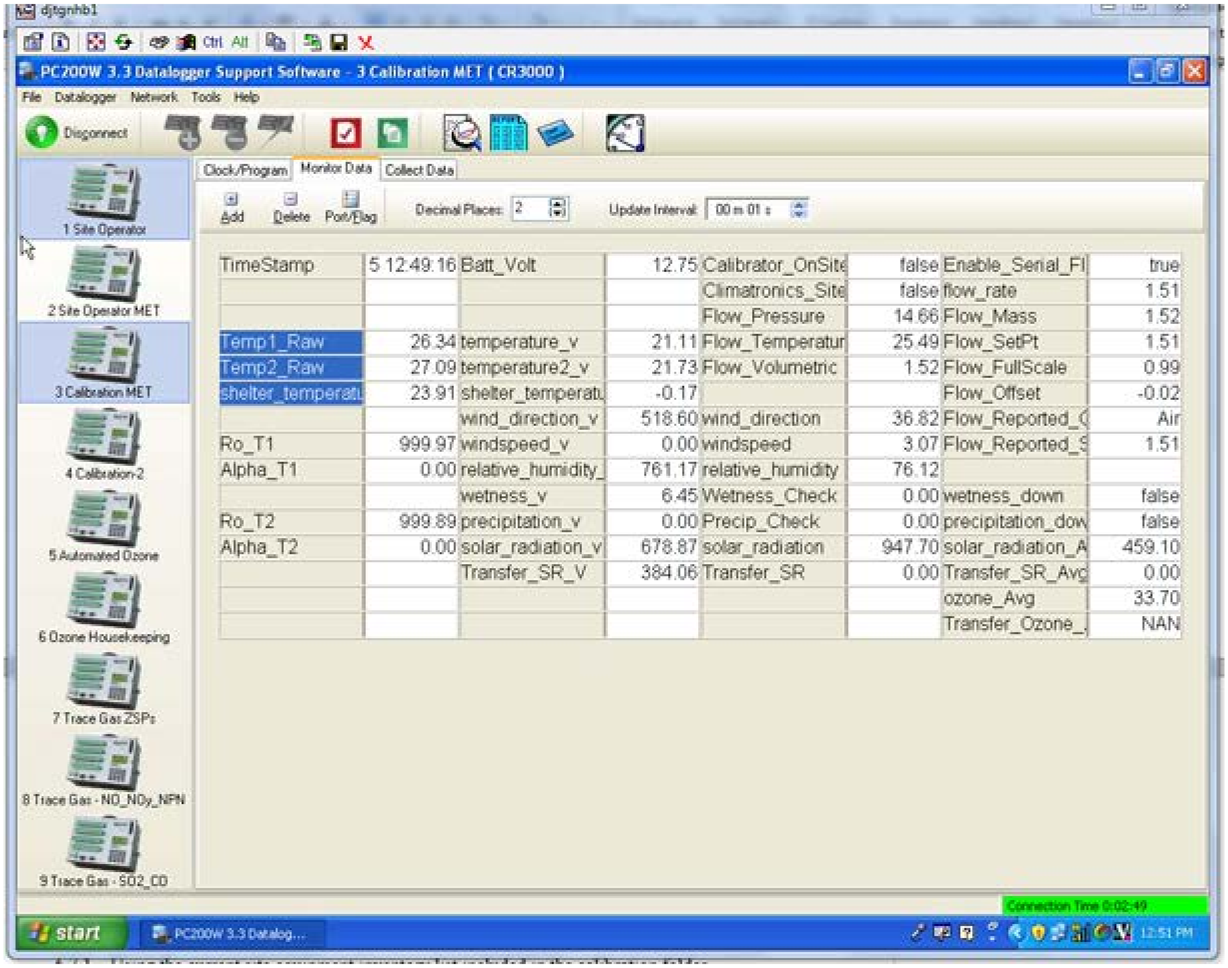
- Insert the “shelter_temperature” [Campbell model 107 temperature sensor (Figure 34 in Section II.A.2, Subsection 3.11)] attached to data logger backplane), “temperature” (9m tagged yellow), and, if operational, “temperature2” (2m tagged red) probes along with the Transfer RTD through the polystyrene foam thermos lid and into the bath. At least three-quarters of the Transfer RTD and site probes should be immersed in the bath water. The shelter temperature probe should be immersed to the bottom of the rubber boot. The probes must not be touching the container or one another.
- If using an EXTECH brand RTD transfer, make sure the reported units are in Celsius by pressing the left side of the green highlighted °C/°F button and make sure the correct range, 0.01, is selected by pressing the left side of the button above the OFF/ON switch.
- Boil water in an electric kettle in preparation for the next steps.
- Allow sufficient time for the probes to equilibrate near 0±0.05 °C, stirring bath as reported by the RTD transfer.

Note: *The shelter temperature probe will generally respond less quickly than the meteorological probes and may require additional time to reach equilibrium.*

- Record simultaneous data logger and transfer RTD measurements in °C on the Temperature iForm (Figure 35).

Note: *The relevant instantaneous data logger measurements to be recorded are the “Temp1_Raw”, “Temp2_Raw”, and “shelter_temperature” as found on the 3* Calibration MET or 4 Calibration-2 *grid on the site laptop (Figure 37). Record the transfer RTD value as displayed on the Temperature iForm.*

Figure 37. Screen shot: Evaluating Temperature Measurements



- The iForm will automatically correct the transfer standard values if the proper calibration factors have been input.
- Transfer all probes to a stirring bath of ambient temperature (use the second thermos). Ambient is defined as between 20 °C and 30 °C to ensure data quality for the *"shelter_temperature"* probe measurement. Repeat the measurement process described previously, simultaneously recording *"Temp1_Raw"*, *"Temp2_Raw"*, *"shelter_temperature"* and the transfer RTD output in °C on the Temperature iForm.
- Transfer all probes into a bath temperature of 50± 0.5 °C. Allow to equilibrate. In general, 120 -150mL of boiling water will raise the thermos bath temperature ~10 °C.
- Again repeat the measurement process described above, simultaneously recording *"Temp1_Raw"*, *"Temp2_Raw"*, *"shelter_temperature"* and the transfer RTD output. All recorded units must be in °C.
- Following the temperature audit, examine the iForm results. If the *"temperature"*, *"temperature2"* or *"temperature3"* probe measurements vary from the transfer probe value by more than ±0.15 °C, then that probe variance will result in a flagged value indicated by a red box in the Temperature iForm and the audit must be extended to include 0, 10, 20, 30, 40

and 50 °C. Likewise if the computed *“delta_temperature”* value varies from the corrected transfer RTD measurement by more than 0.3 °C the audit must as well be extended.

Note: *If the site has only the “temperature” probe, the probe measurements are allowed to vary from the transfer probe value up to ±0.3 °C.*

- If the *“shelter_temperature”* probe measurement varies from the corrected Transfer RTD values by more than 0.3 °C at audit points below 36 °C, the audit must be extended to include three points between 20 °C and 30 °C.

Note: *If only the “shelter_temperature” fails audit criterion extend the audit as instructed but do not input “temperature” or “temperature2” measurement data on the iForm. This will allow the iForm to contain the proper information for data validation without computing a new R_0 and alpha value for the meteorological probes.*

- If six values for the transfer RTD probe and six values for either the “temperature” or “temperature2” probe are entered into the iForm a new R_0 and alpha value will be computed for that site probe. This will only occur if the values are entered into the “As Left” section of the iForm.
- If an extended audit is necessary, click the *“Show As Left”* check box on the iForm and record the audit findings in **both** the *“As Found”* and *“As Left”* sections of the iForm. Following the extended audit of six points of data, which includes both the meteorological probes measurements and the transfer measurements, the iForm will compute new R_0 and alpha values for the *“temperature”*, and *“temperature2”* probes. This will only occur if the six points are recorded in the *“As Left”* section of the iForm. The new R_0 and alpha values for each probe must be entered into the data logger through the 3 Calibration MET grid or the 4 Calibration-2 grid on the site laptop by double clicking the values, one at a time, entering the new value and pressing *Enter* on the keyboard. If either probe does not meet criterion with a new R_0 or alpha value, the probe must be replaced. Record any new R_0 and alpha values and the associated data logger parameter names (*“temperature”* or *“temperature2”*) in the site log book.
- If probe replacement is necessary, continue to the next step. Otherwise, skip the next step (bullet) and go to subsequent step (bullet).
- Replace the probe with an Amec Foster Wheeler certified probe. Enter the R_0 and alpha value for that probe as recorded on its certification form into the data logger and into the As Left section of the iForms. Repeat the three point audit on that probe which includes 0 °C, ambient temperature (°C) and 50 °C. Record all data and probe ID in the *“As Left”* section of the Temperature iForm.
- Re-install the probes on the tower. Make sure the sensors are not touching housings. Inspect wiring and connections. Secure the cables to the tower. Perform required maintenance.
- Enable channels by changing their downed status to *“false”* on the 1 Site Operator grid or the 2 Site Operator MET grid on the site laptop after audit is complete and tower is raised.

6.6.4 Wind Direction†

- Identify the correct transfer electronic certification form found on the root directory of the calibration flash drive. Make sure the certification form is complete and that the transfer ID number matches the ID number on the certification form. Place a copy of the electronic certification form in the site calibration folder on the calibration flash drive to be copied to the site laptop at the completion of the site audit.
- Record the ID and certification date of the synchronous drive motor on the Wind iForm (Figure 38). Record the site wind sensor ID and propeller (Figure 29 in Section II.A.2, Subsection 3.11) serial number on the Wind iForm.
- Record the ID and certification date of the Brunton compass on the iForm.
- Set the certified Brunton compass to the correct declination for the site (Appendix A, Magnetic Declination Adjustments).
- With the meteorological tower standing, position the compass directly under the cross-arm. Orient the compass such that when fully opened the mirror is between the compass dial and the meteorological tower.
- Level the compass using the bulls-eye level in the dial face. Rotate the compass until the sight line in the mirror is parallel to the cross-arm. In this condition the entire length of the cross-arm will appear centered down the alignment line in the mirror. Ensure the compass is still level.
- Record the degree measure indicated by the NORTH (arrow) end of the compass needle in the *"cross-arm alignment"* field of the iForm. This measurement will depend on the direction the cross-arm points away from the tower and may read any value in degrees, but most likely near 0 or 180 degrees.
- Make sure all the meteorological tower sensor channels are down. Lower the meteorological tower.
- Assess the condition of the wind sensor alignment ring making sure that it is tight and will not move.
- Remove the sensor from the tower by loosening the hose clamp at the sensor base. DO NOT LOOSEN THE ALIGNMENT RING. Install the rose compass wheel on the mast, mating it to the alignment ring.
- Hold the wind sensor in a vertical position and torque test the wind sensor's wind direction bearing using the included strain gauge. Record the measured torque on the iForm. Wind direction bearing torque must be less than 10 g/cm

† Climatronics instruments are no longer used at EPA-sponsored CASTNET sites.

Figure 38. Wind Calibration Form

Wind

amec

Site Name	Calibrator	Calibration Date	Data Logger	iForms Ver.
PAL 190	TYLER WARD	11/19/2013 - 11/20/2013	Campbell 3000 ID:347	1.5.1

	Wind Direction As Found	Wind Direction As Left	Windspeed As Found	Windspeed As Left
ID #	04405	04354	04405	04354
Description	Wind AQ	Wind AQ	Wind AQ	Wind AQ
Manufacturer	R.M. Young	R.M. Young	R.M. Young	R.M. Young
Model	5305	5305	5305	5305
Torque	< 10 g/cm	< 10 g/cm	< 0.2 g/cm	< 0.1 g/cm
Vane/Prop ID #			68264	68264
Translator ID #				
Translator: Manufacturer				
Translator: Type				
Translator: Zero				
Translator: 540°				
Translator: Span				

Transit	
ID #	06554
Manufacturer	Brunton
Model	F-5006
Date of Last Cert.	5/16/2013
Synchronous Motor	
ID #	04631
Manufacturer	R.M. Young
Model	18802
Date of Last Cert.	4/3/2013
Wind System Mfg.	R.M. Young
Magnetic Declination	
Degrees	7.0°
Direction	East

Wind Direction

	As Found	As Left
Crossarm Alignment	0.0° True	0.0° True
Wheel Indication	180.0°	180.0°
Alignment Ring	180°	180°

Crossarm	Wheel	Target Direction	True Bearing	Wheel Indication	As Found Datalogger Output Degrees	Sensor Diff	True Diff	As Left True Bearing	As Left Datalogger Output Degrees	Diff
☐	☑	South	180.0°	180.0°	178.70	-1.3°	-1.3°	180.0°	179.30	-0.7°
☐	☑	East	90.0°	90.0°	92.60	2.6°	2.6°	90.0°	89.30	-0.7°
☐	☑	West	270.0°	270.0°	266.10	-3.9°	-3.9°	270.0°	268.60	-1.4°
☐	☑	Crossover Entry	357.0°	357.0°	354.40	-2.6°	-2.6°	355.0°	352.60	-2.4°
☐	☑	Crossover Exit	3.0°	3.0°	1.52	-1.5°	-1.5°	3.0°	0.80	-2.2°

Windspeed

	As Found				As Left			
Prop Correction Factor	0.00512				0.00512			
RPM	Frequency	m/s	Datalogger Output m/s	Diff	Frequency	m/s	Datalogger Output m/s	Diff
0		0.00	0.00	0.00		0.00	0.00	0.00
100		0.51	0.51	0.00		0.51	0.51	0.00
200		1.02	1.02	0.00		1.02	1.02	0.00
400		2.05	2.05	0.00		2.05	2.05	0.00
800		4.10	4.10	0.00		4.10	4.10	0.00
1600		8.19	8.19	0.00		8.19	8.19	0.00
3600		18.43	18.43	0.00		18.43	18.43	0.00
8600		44.03	44.03	0.00		44.03	44.03	0.00

Remarks

Reviewed By: [signature] Date: 12/23/13

Note: *If conditions are too windy to properly test bearing torque wait until after the audit and then remove the sensor from the wiring and perform the torque test in the shelter out of the wind. At the same time test the nose cone bearing torque.*

- Install the wind sensor on the rose compass wheel and tighten.
- Rotate the tail of the wind sensor vane over the cross-arm. Align it with the cross-arm using parallax sighting the tail. Affix the rose compass jig to hold tail in position directly over the cross-arm.
- Record the degree measure indicated by the rose compass wheel on the iForm in the *"wheel indication"* field.
- The *"Alignment ring"* orientation will then be calculated by the iForm and the *"Alignment Ring"* field will be automatically populated. The South, East and West values of the *"Wheel Bearing"* column of the Wind iForm will be automatically populated with the correct target wheel values for the audit. These alignment values are to be used for the next step.
- Align the wind sensor so the *"Wheel Bearing"* value for SOUTH as indicated on the iForm matches the degree indication on the rose compass wheel and affix the wind sensor vane in place. Record the data logger degree measure output, as found in either the *"2 Site Operator MET"* or *"3 Calibration MET"* grid on the iForm in the *"Degrees"* column of the *"Data Logger Output"* field.

Note: *Do not align the wind sensor to 90, 180 and 270 degrees as indicated on the rose compass wheel. Align the sensor on the rose compass wheel to the degree values computed by the iForm in the "Wheel Bearing" Column.*

- Repeat the procedure above for the *"Wheel Bearing"* values as indicated on the iForm (Figure 38) for EAST and WEST. For each point record the data logger degree measure output in the corresponding row of the *"Degrees"* column of the *"Data Logger Output"* field.
- Upon completion of the SOUTH, EAST and WEST points, affix the wind sensor vane approximately 80 degrees NORTH of the WEST target bearing (as indicated on the iForm) on the rose compass wheel.
- Rotate the wind sensor toward the NORTH (clockwise from the top) in one degree increments as indicated by the rose compass wheel until the maximum degree value as output by the data logger is determined.
- **Note:** This maximum will occur immediately prior to the wind sensor's directional potentiometer entering the dead band and should occur at or near 355 degrees for a calibrated and aligned sensor.
- At the maximum degree output reported by the data logger, record the rose compass wheel degree measure in the *"Crossover Entry"* row of the *"Wheel Indication"* column. Record the corresponding maximum degree of data logger output in the *"Crossover Entry"* row in the *"Degrees"* column of the *"Data logger Output"* field.
- Rotate the wind vane one more degree and verify that the wind sensor's direction potentiometer enters the dead band. At this point the data logger degree output will drop to very near zero.

- Continue to rotate the wind sensor vane in one degree increments until the directional potentiometer exits the dead band.

Note: *This will occur approximately five degrees clockwise of the entry point (on the rose compass wheel as from the top). In general terms exit from the dead-band will occur at a data logger degree output of approximately 0.016 degrees. Rotating one more degree will produce a near zero valid measurement. Rotating one more degree will increase the measurement.*

6.6.5 Wind Speed

- Remove propeller and record propeller serial number and sensor ID number on the Wind iForm (Figure 38).
- If not done so already install the torque wheel on the propeller shaft. Test and record the bearing torque on the iForm.
- Attach a variable speed synchronous motor to the propeller shaft. Run the motor at the following rpm: 0, 100, 200, 400, 800, 1600, 3600, and 8600. Record the corresponding data logger wind speeds on the iForm in units of m/s.

Note: *If the propeller serial number is less than 53404, it will need to be replaced following the audit.*

- If the wind speed is not within specifications, replace the sensor and re-audit both the wind speed and wind direction parameters of the replacement sensor. If the nose cone is replaced, inspect to ensure it is not bent. No repeat of wind direction calibration is required. This is also true if just the wind speed bearings are replaced.
- Check bearing and wiring condition and replace if necessary, even if not scheduled for routine maintenance. Be sure the unit is properly assembled and everything is tight. Lubricate the nose cone o-ring with a small amount of high vacuum grease. Note if any future replacements will be needed, such as the vane or signal cable.

Note: *Bearing torque should be $\leq$ 0.2 gm/cm.*

6.6.6 Relative Humidity (RH)

- CASTNET sites employ either a Rotronic or Vaisala hygrometer for relative humidity measurements. Both sensors require 12VDC input and have a 0 to 1 VDC output signal directly proportional to units of percent relative humidity. RH sensors can only be audited in the field. They cannot be calibrated. Malfunctioning sensors or those not meeting criteria must be replaced. Any RH sensor replaced in the field should be tagged for post calibration prior to return to Amec Foster Wheeler.
- Identify the correct transfer’s electronic certification form found on the root directory of the calibration flash drive. Make sure the certification form is complete and that the transfer’s ID number matches the ID number on the certification form. Place a copy of the electronic certification form in the site calibration folder on the calibration flash drive to be copied to the site laptop at the completion of the site audit.
- Record the laboratory correction factors of the RH transfer sensor on the RH iForm. (Figure 39). Record the transfer and site probe ID’s on the RH iForm.
- Set the *“RH_Down”* parameter to *“true”* on the DAS. Note the time in the log.

- Unpack the portable humidity lab. Inspect the unit for proper water level, kinks in attached tubing, and for functional desiccant. Silica desiccant should be used in the Rense Instruments S503. Inspect the chamber for foreign matter. If necessary add distilled water and new desiccant.
- Install the RH Transfer probe arm into the appropriate port on the portable humidity generator. If necessary, wrap Teflon tape or Parafilm one inch from the transfer probe tip to ensure an airtight seal is formed. A leaky seal here will allow high deviations between the sensor, transfer sensor and humidity generator readings. This is particularly true in windy conditions. If necessary, place the portable humidity generator in a Pelican case and close the lid gently to shield from wind.
- Install site probe in proper fixed port atop unit. Leave all other ports sealed.
- Set the portable humidity generator for 20 percent RH and power the unit on. Always start the portable units at low RH and increase to high RH to avoid condensation forming in the chamber.
- Let the unit run at a point below 50 percent until the transfer and the site probe both stabilize. Once stable, record the site sensor units *"relative_humidity"* as found in either the *"2 Site Operator MET"* or *"3 Calibration MET"* grid. Record the RH Transfer sensor value in the RH Calibration iForm. The iForm will then numerically correct the transfer measurements.
- Repeat the above procedure for *"relative_humidity"* for a total of at least three points detailed below, allowing both the transfer and site sensors to fully stabilize at each point.

<table>
<tr><th colspan="2">RH Field Audit Points</th></tr>
<tr><td>Target RH Transfer Value</td><td>Acceptable Site RH Sensor Response Value</td></tr>
<tr><td>Less than 50 percent</td><td rowspan="3">All points ±10 percentage units</td></tr>
<tr><td>Between 50 percent and 85 percent</td></tr>
<tr><td>Approximately 95 percent</td></tr>
</table>

- If the site sensor is not within ±10 percentage units, replace it. Repeat the audit to include the new sensor in the *"as left"* section of the RH iForm. Tag the sensor that was removed and specify the need for a post calibration check.
- Perform required scheduled maintenance.
- Upon completion of the audit turn the RH setting to 0 on the portable humidity generator and let the unit dry prior to re-packing.
- Set the *"RH_Down"* parameter to *"false"* upon raising the tower.

Figure 39. Relative Humidity Calibration Form

Relative Humidity amec

Site Name	Calibrator	Calibration Date	Data Logger	iForms Ver.
PAL 190	TYLER WARD	11/19/2013 - 11/20/2013	Campbell 3000 ID:347	1.5.1

	RH Sensor	
	As Found	As Left
ID #	06223	
Description	RH	
Manufacturer	Vaisala	
Model	102425	
Translator ID #		
Manufacturer		
Zero		
Span		

Humidity Chamber	
ID #	00537
Manufacturer	VaporPak
Model	
Date of Last Cert.	

Transfer Standard	
ID #	06834
Manufacturer	Rotronics
Model	GTL
Date of Last Cert.	8/2/2013

Correction Factors					
10%	30%	50%	70%	85%	95%
-1.90	-2.70	-2.60	-3.10	-3.30	-2.80

As Found	Relative Humidity Datalogger Output		Datalogger Output	
Portable Hygrometer	Correction Factor	Equivalent Relative Humidity	% Relative Humidity	Diff
19.1%	-1.9%	17.20%	16.40%	-0.8%
66.0%	-3.1%	62.90%	62.17%	-0.7%
97.3%	-2.8%	94.50%	95.80%	1.3%

Remarks

Reviewed By: [signature] Date: 12/23/13

6.6.7 Solar Radiation (SR)

Note: *Do not adjust the SR Sensor gain potentiometer when solar radiation values are less than 300 Watts per square meter (W/m^2). Adjustments should be made at the time corresponding to peak incident solar radiation for the day. Ideally, adjustment should occur when incident SR is at or above 700 W/m^2. Doing so will reduce the likelihood of overshoot in the gain only sensor conditioner. If adjustment does not produce acceptable results, replace the SR sensor and translator with a spare unit calibrated by Amec Foster Wheeler. Document the use of the spare parts on the spare parts kit inventory sheet. At times it may not be possible to collect adequate solar radiation data to perform a useful audit. It is suggested in such cases that the site sensor be replaced with a calibrated spare unit. The removed system must be tagged for post-calibration off site. The tag should include the sensor and translator number, site ID, date of removal, reason for removal, date and name of technician.*

- Install the SR transfer sensor next to the site sensor (Figure 16 in Section II.A.2, Subsection 3.9). The transfer sensor must be level, secure and unobstructed. The BNC connector should not contact metal. Do not level or clean the site sensor prior to a full as-found audit.

- Connect the SR transfer signal wire (usually red on the translator) to terminal #37 on the data logger surge protection terminal strip (adjacent to brown wire). Connect the transfer signal reference wire (usually black on the translator) to terminal #38 (adjacent to white wire with brown stripe). Plug the transfer sensor cable BNC connector into the transfer translator box.
- Plug the translator power cord into an available wall outlet.
- Ensure that "Calibrator_OnSite" is "true".
- Check for five-minute averages recorded by logger after five minutes have elapsed.
- Collect two hours and thirty five minutes of data: thirty-one consecutive data points of five-minute averages. The data point values should be above 300W/m2.

Note: *Solar Radiation values less than 300 W/m^2 should not be used in the audit process if possible.*

- Collect the calibration data (W/m^2) and use the data interface display to access the measurements. Omit the first five-minute average. Instead use at least the last thirty values. Record the timestamp of the first average entered and the SR iForm (Figure 40) will populate the time values for consecutive measurements. Record the data on the SR Calibration iForm.
- Identify the correct transfer's electronic certification form found on the root directory of the calibration flash drive. Make sure the certification form is complete and that the transfer's ID number matches the ID number on the certification form. Place a copy of the electronic certification form in the site calibration folder on the calibration flash drive to be copied to the site laptop at the completion of the site audit.
- Record the Transfer SR sensor slope, intercept, ID number and calibration date on the SR Calibration iForm. The iForm will automatically correct the SR transfer values.
- The SR iForm will automatically calculate the maximum percent difference, and the percent difference of the two sensors at max insolation. If either exceeds 5 percent, the value will be flagged in the iForm and the site SR sensor must be adjusted.
- If weather conditions prohibit collection of peak level data, then the DMC may be contacted to determine whether the solar radiation system has been matching satellite data. Also, consult previous calibrations and audits to determine if any questions have arisen in regards to sensor accuracy.
- If all indications suggest proper sensor calibration and solar radiation levels are under 300 W/m^2, do not adjust the system. If the accuracy of the system is questionable and the light levels are too low for adjustment, replace the system with a system that was calibrated at Amec Foster Wheeler.

Figure 40. Solar Radiation Calibration Form

Solar Radiation

amec

Site Name	Calibrator	Calibration Date	Data Logger
PAL 190	TYLER WARD	11/19/2013 - 11/20/2013	Campbell 3000 ID:347

	Sensor	
	As Found	As Left
ID #	04009	04009
Description	Pyronometer	Pyronometer
Manufacturer	LiCor	LiCor
Model	Li-200	Li-200
Translator ID #	04063	04063
Manufacturer	R.M. Young	R.M. Young
Zero		
Span		

iForms Ver.	1.5.1
Transfer Standard	
ID #	06533
Manufacturer	LiCor
Model	Li-200
Date of Last Cert.	11/8/2013
Slope	0.97800
Intercept	2.49110
Translator ID #	06321

As Found

Time	Transfer W/m²	Sensor W/m²	Time	Transfer W/m²	Sensor W/m²	Time	Transfer W/m²	Sensor W/m²
9:50	375	332	10:55	532	512	12:05	569	557
9:55	388	343	11:00	553	533	12:10	551	522
10:00	400	355	11:05	567	558	12:15	593	570
10:05	411	367	11:10	467	447	12:20	609	576
10:10	423	379	11:20	573	549			
10:15	435	391	11:25	568	528			
10:20	446	403	11:30	578	560			
10:25	461	415	11:35	569	558			
10:30	473	433	11:40	584	573			
10:35	482	439	11:45	558	520			
10:40	495	458	11:50	503	466			
10:45	507	488	11:55	475	439			
10:50	517	501	12:00	458	449			

As Found					As Left				
Transfer		Sensor		% Diff	Transfer		Sensor		% Diff
Total	15120	Total	14221	-5.9%	Total	13424	Total	13345	-0.6%
Adj. Max.	620	Max	576	-7.1%	Adj. Max.	687	Max	665	-3.1%
Adj. Average	512.8	Average	474.0	-7.6%	Adj. Average	455.0	Average	444.8	-2.2%

As Left

Time	Transfer W/m²	Sensor W/m²	Time	Transfer W/m²	Sensor W/m²	Time	Transfer W/m²	Sensor W/m²
9:20	312	312	10:25	468	467	11:30	578	570
9:25	329	329	10:30	429	427	11:35	591	582
9:30	354	354	10:35	477	474	11:40	622	613
9:35	370	371	10:40	551	548	11:45	674	665
9:40	464	464	10:45	623	617			
9:45	412	413	10:50	500	497			
9:50	377	376	10:55	536	532			
9:55	335	334	11:00	524	521			
10:00	292	292	11:05	543	538			
10:05	415	413	11:10	381	379			
10:10	405	403	11:15	284	283			
10:15	203	205	11:20	389	386			
10:20	385	386	11:25	601	594			

Remarks

Prior to as left check, a new cable was run from the met tower box to the sensor. Previously this new cable had been run from the datalogger to the met tower box. So now the new cable runs from the datalogger to the sensor. A new barrel connector was installed and the barrel connector connection was taped with electrical tape and zip tied snuggly to a piece of cardboard seperating the connector from the metal railing. This change was performed on 11/19/13. The sensor read a consistant .4

Reviewed By: Selma Uhl (signature) Date: 12/23/13

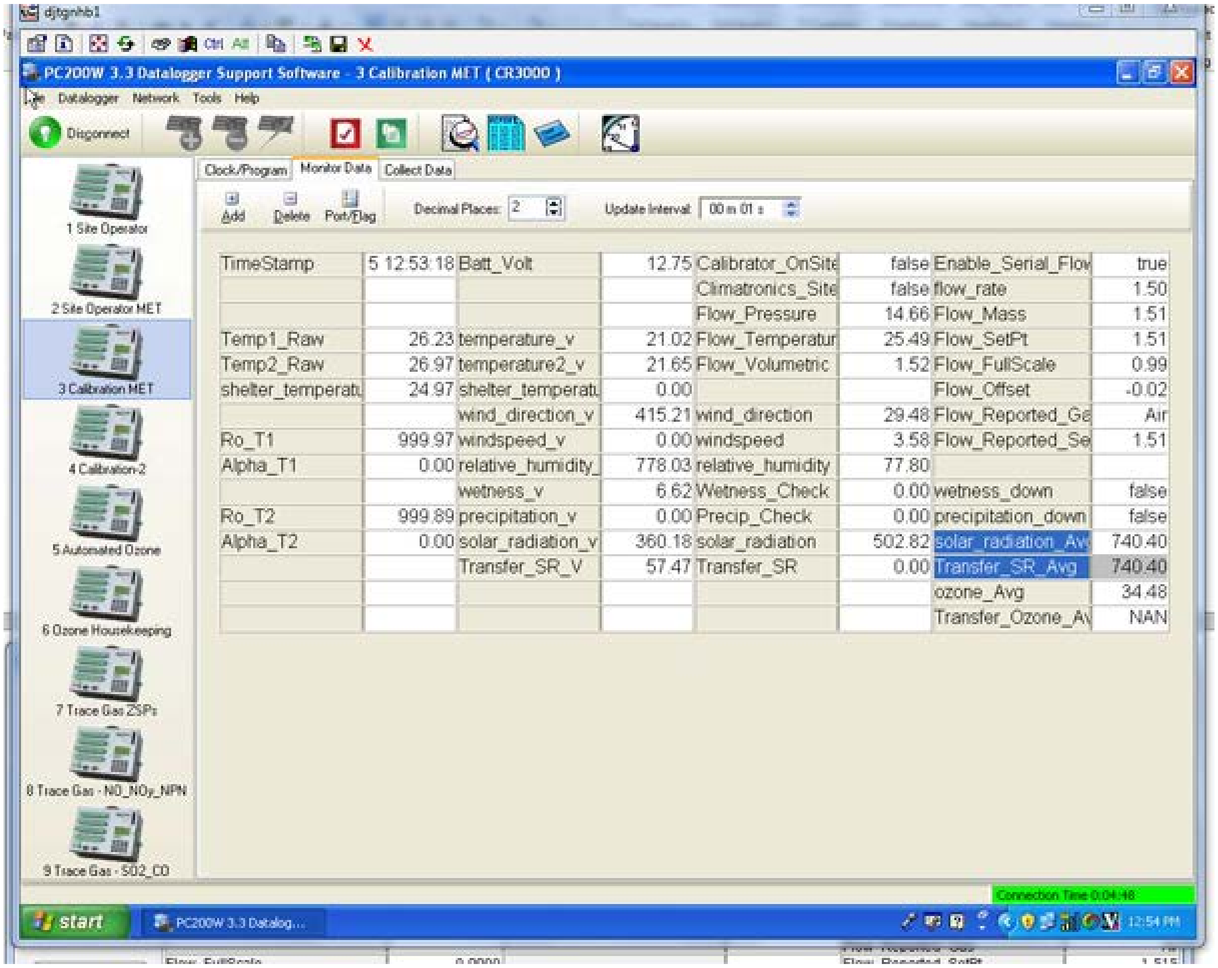
6.6.8 Calibration/Adjustment

- Level and clean the site SR sensor as necessary.
- Remove the site SR sensor translator housing cover. The site SR translator is located on the data logger backplane (Figures 2 and 3, Section II.A.2, Subsection 3.2).
- Remove the two screws that hold the translator PCB card in place.
- Lift and fold the translator card out and down (from the top), out of the housing to expose the gain potentiometer on the card’s backside. Use caution to avoid damaging the solder connection to the BNC bulkhead inside the translator housing (located at bottom left).

Note: *Adjustment should ideally be performed at or above 700W/m^2. If the system does not meet the calibration criteria, then adjust at the highest light levels possible, preferably at mid-day when readings are >400 W/m^2. If daytime values are <400 W/m^2 adjustment, decision is left to the calibrator’s professional discretion. The adjustment potentiometer is a gain potentiometer, so the higher the light level during the time of adjustment, the more accurate the calibration will be at all light levels.*

- Adjust the gain potentiometer screw until the site sensor output is equal to the Corrected Transfer SR sensor value. The site solar radiation instantaneous value *“solar_radiation”* and *“Transfer_SR”* are found in the “3-Calibration” grid (Figure 41); however, the SR transfer value *“Transfer_SR”* displayed should be corrected to Corrected Transfer SR value for the best adjustment. To correct *“Transfer_SR”* to the actual SR value use the following formula: *Corrected Transfer SR = (Transfer SR – Transfer Intercept) / (Transfer Slope) Eq. 1.*

Figure 41. Screen Shot: Evaluating Solar Radiation Measurements



- Following adjustment repeat the audit process. Acquire another 31 five-minute averages and record the results on the *"as left"* section of the SR iForm.

6.7 Site Inventory

6.7.1 Using the current site equipment inventory list included in the calibration folder (Figures 1 and 2), verify that items are present. Note any differences. In addition, verify that a current set of SOP, Health & Safety Plan, and an up-to-date Site Narrative Log are present. Verify the Calibration Results Summary iForm (Figure 42) is complete.

6.7.2 Record the serial number of any equipment found, which normally should, but does not, have a property tag.

6.7.3 Tag and ship any redundant equipment not in use back to Amec Foster Wheeler. If unused equipment with a property ID is onsite but not on the inventory list, make note and tag and return to Amec Foster Wheeler.

Figure 42. Calibration Results Summary Form

Calibration Summary

amec

Site Name	Calibrator	Calibration Date	Data Logger
PAL 190	TYLER WARD	11/19/2013 - 11/20/2013	Campbell 3000 ID:347

Remarks

	As Found				As Left				Remarks
Temperature	Zero °C	Ambient °C	Max Error °C	diff °C	Zero °C	Ambient °C	Max Error °C	diff °C	
Transfer	0.05	30.29							
Temperature	-0.04	30.24	-0.04	-0.09					
Temperature 2/Delta	0.06	30.23	30.23	-0.06					
Shelter Temperature	-0.13	30.07	48.98	-0.36					
Relative Humidity	> 85 %	< 50 %	Other %	%	> 85 %	< 50 %	Other %	%	
Transfer	94.5	17.2	62.9						
Site Sensor	95.8	16.4	62.2						
Solar Radiation	Mean watt/m²	Max watt/m²	Total watt/m²	watt/m²	Mean watt/m²	Max watt/m²	Total watt/m²	watt/m²	Prior to as left check, a new cable was run from the met tower box to the sensor. Previously this new cable had been run from the datalogger to the met tower box. So now the new cable runs from
Transfer	513	620	15120		455	687	13424		
Site Sensor	474	576	14221		445	665	13345		
Wind Direction	North deg	East deg	South deg	West deg	North deg	East deg	South deg	West deg	
Transfer	3	90	180	270	360	90	180	270	
Site Sensor	1.5	92.6	178.7	266.1	0.8	89.3	179.3	268.6	
Windspeed	< 5 m/s	> 5 m/s	Max Error m/s	m/s	< 5 m/s	> 5 m/s	Max Error m/s	m/s	
Transfer	4.096	8.192	4.096		4.096	8.192	4.096		
Site Sensor	4.100	8.190	4.100		4.100	8.190	4.100		
Precipitation	inches	inches	inches	inches	inches	inches	inches	inches	Could not check heater because freeze-it nozzle was missing.
Transfer	0.50								
Site Sensor	0.49								
Wetness	Dry		Wet		Dry		Wet		
Transfer	0.000		1.000		0.000		1.000		
Site Sensor	0.008		1.015		0.008		1.007		
Flow	Nominal lpm	Low lpm	High lpm	lpm	Nominal lpm	Low lpm	High lpm	lpm	Set point was changed prior to as left point.
Transfer	2.964	2.496	3.450						
Site Sensor	3.007	2.507	3.512						
Ozone	Max Error %	Slope	Intercept ppb	r²	Max Error %	Slope	Intercept ppb	r²	L2 leack check = 175mmHg. Prior to ZSP the L3 lamp setting was adjusted from 30.7% to 35.5% and the site analyzers lamp adjusted from 42.3% to 44%. The resulting intensities are recorded in the as
Transfer									
Site Sensor				#DIV/0!					

Site Remarks	DAS Remarks
REVIEWED AK - 12/23/13 MD: 652	[illegible]

6.8 Departure from site

6.8.1 Verify that “Calibrator_OnSite” is set to “false” and all channels are up.

6.8.2 Review the instantaneous unit values of all parameters to ensure all systems are online and operating properly.

6.8.3 Access the internet via the Raven Modem if the site is so equipped to ensure functional communications.

6.8.4 Complete the Site Condition Checklist (Figure 43)

6.8.5 Complete the System Audit Form (Figure 44)

6.8.6 Verify that all iForms and relevant paperwork are complete in entirety.

6.8.7 Note time of departure in log book.

Figure 43. Site Condition Checklist

ite Name: ____________________

ite Location: ____________________

ssessed? (eck for yes)	Structure	Repair needed/comments	Assessed? (check for yes)	Structure	Repair needed/comments
	Shelter:			**Flow Tower:**	
☐	Roof		☐	Base	
☐	Door Hinges		☐	Tower	
☐	Door Stop		☐	Guys	
☐	Floor		☐	Guy anchors[1]	
☐	Cleanliness		☐	Tubing (Teflon or Tygon)	
☐	Counters		☐	Pot head secure	
☐	Wall Panel Yes/No		☐	Swag line	
☐	Fire extinguisher[4]		☐	Tubing ok at hinge	
☐	A/C -		☐		
	MET Tower:			**Ground MET Gear**	
☐	Base		☐	SR Mount Secure	
☐	Tower		☐	SR clean/level	
☐	Guys		☐	TB mount secure/level/clean	
☐	Guy anchors[1]		☐	Wetness sensor secure	
☐	Cross-arm/ North indicator/ Set screws		☐	All sensor wiring tied/protected from weed-eater damage	
☐	Wires neat/wire ties				
☐	Amphenol connectors corrosion free				
☐	Tower rest (down)				

otes:

1. Please inspect guy anchors just below grade to check corrosion
2. Be sure that all sensor wiring is sheathed and/or tied against mounting pole
3. Check that all wiring inside and outside is clean and secure.
4. If fire extinguisher charge is ok, invert extinguisher and tap bottom to mix dry chemicals.

Figure 44. System Audit Form

MACTEC

Systems Audit Form

Site ID: ____________ **Site Location:** ____________
Performed By: ____________
Date: ____________ **Others Present:** ____________

Audit Items	Yes/No	Comment
• Does the site appear to be clean, organized, and well maintained both inside and outside?		
• Does the instrument shelter have adequate working room?		
• Has the Site Condition Checklist been completed?		
• Is the site properly grounded?		
• Does the site appear to be safe and reasonably hazard free?		
• Is a fire extinguisher with current charge present?		
• Is a first aid kit present?		
• Does the site exhibit adequate spacing from nearby features, natural or man-made, that may affect the monitored parameters? *(e.g. tall trees, buildings, steep slopes, hollows, parking lots, etc.)*		
• Is the ground surface surrounding the site natural material? *(e.g. grass, dirt, brush, etc.)*		
• Are the wind speed and direction sensors sited so as to avoid being influenced by any obstructions? *(i.e. WS and WD sensors should be sited on level, open terrain and no closer to any obstruction, natural or man-made, than 10x the height of that obstruction.)*		
• Are the wind speed and wind direction sensors mounted so as to minimize tower effects? *(i.e., WS and WD sensors should be mounted on top of the tower, or on a boom that extends horizontally into the prevailing wind, and spaced >2x the maximum diameter of the tower away from the nearest point on the tower.)*		
• Are the tower and WS/WD sensors plumb?		
• Are the temperature probe inlets pointed north or otherwise positioned to avoid radiated heat sources such as buildings, walls, etc?		
• Are the temperature and RH sensors sited to avoid unnatural conditions? *(i.e. Ground surface below the temperature and RH sensors must not be concrete or asphalt. Steep slopes, ridges, hollows and areas of standing water should be avoided.)*		
• Is the solar radiation sensor plumb and positioned to avoid shading, or any artificial or reflected light sources such as buildings, walls, lamps, etc.?		
• Is the rain gauge plumb and positioned to avoid sheltering effects from buildings, trees, etc?		
• Do the sample inlets have at least a 270 degree arc of unrestricted airflow?		
• Do the sample inlets meet acceptable siting criteria? *(i.e. The sample inlets should be 3-15 meters above ground, >1 m from any major obstruction, and >20 m from trees.)*		
• Does the site have all the required instrument manuals?		
• Are the report forms and site log properly completed and current?		

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1994. Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I. A Field Guide to Environmental Quality Assurance. EPA/600/R-94/038a.

U.S. Environmental Protection Agency (EPA). 2000. Meteorological Monitoring Guidance for Regulatory Modeling Applications. EPA-454/R-99-005.

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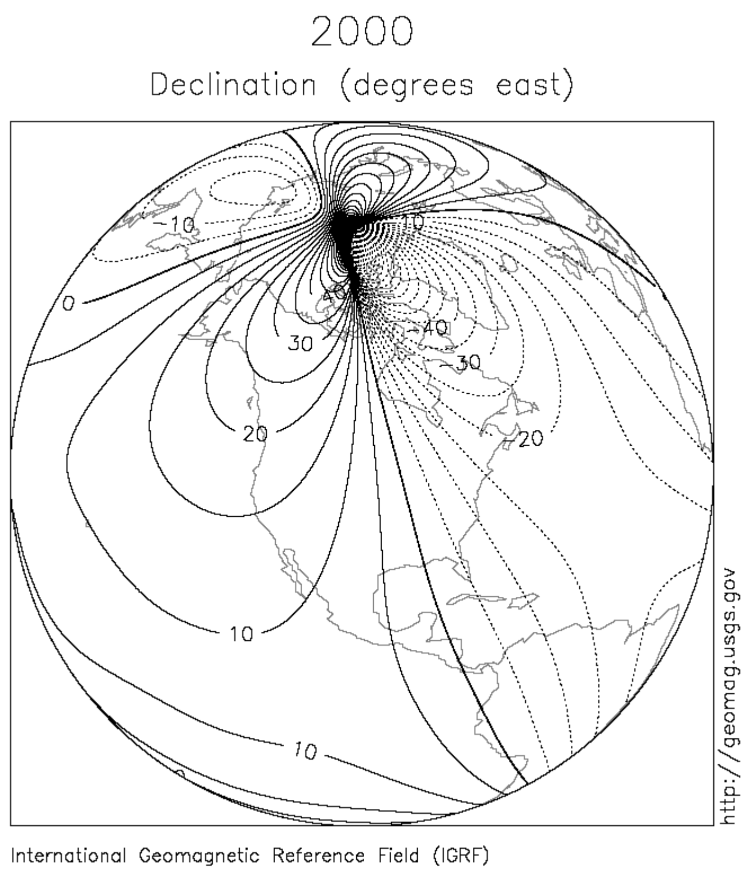
8.0 FIGURES

9.0 APPENDICES

Appendix A – Magnetic Declination Adjustments

Appendix A
Magnetic Declination Adjustments

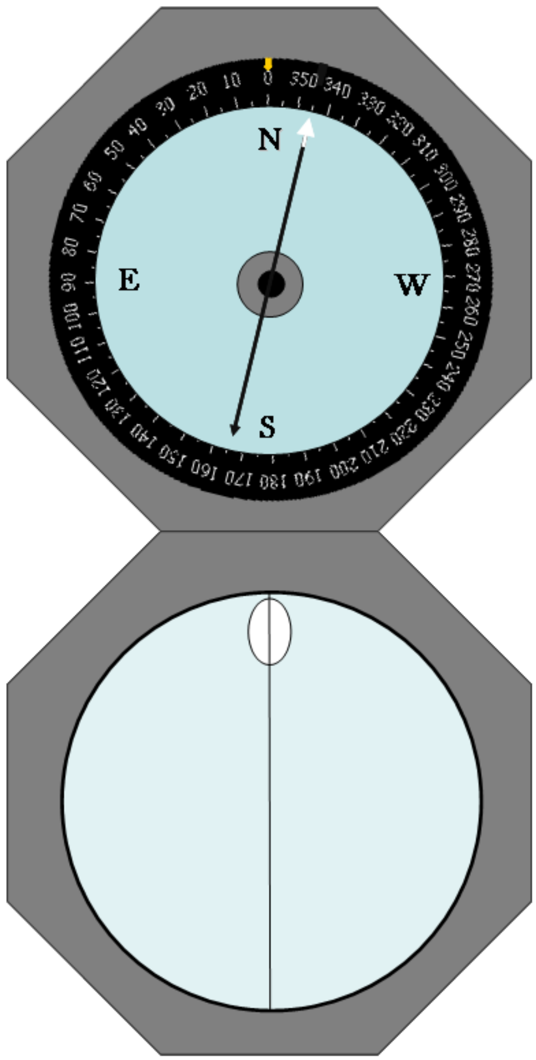
The Earth's magnetic field is produced by complex electric currents generated by the interaction of the planet’s solid iron inner core, the outer core magma and its insulating mantle. The resulting field is complex (see figure below) and can be described by various magnetic dipoles, each with a different intensity and orientation. When a compass needle aligns itself with the magnetic lines of force at a given location, it is actually reacting to the sum of the effects of the dipoles at that location. The difference between the compass reading (magnetic north) and true north (the Earth's northern rotational axis) is called the magnetic declination.



If the compass needle points west of true north, the offset is designated as west declination. If it points east of true north, the offset is designated as east declination.

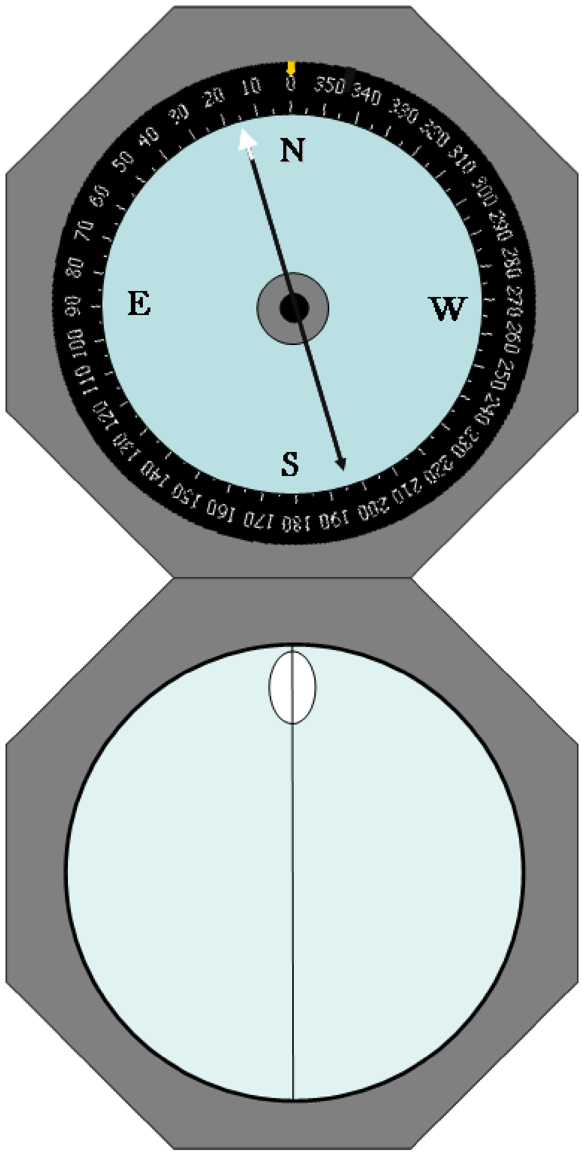
For accurate geographic readings, compass bearings must be adjusted to compensate for magnetic declination. The procedure varies from compass to compass.

For the Brunton compass, CASTNET procedure is to leave the compass ring with the index pin at north on the dial and 0° on the alignment ring and add or subtract according to the site location's known declination. In the example below the index pin is aligned with true north and the compass needle is pointed toward magnetic north at a site with 15° east magnetic declination (counterclockwise | add[‡]):

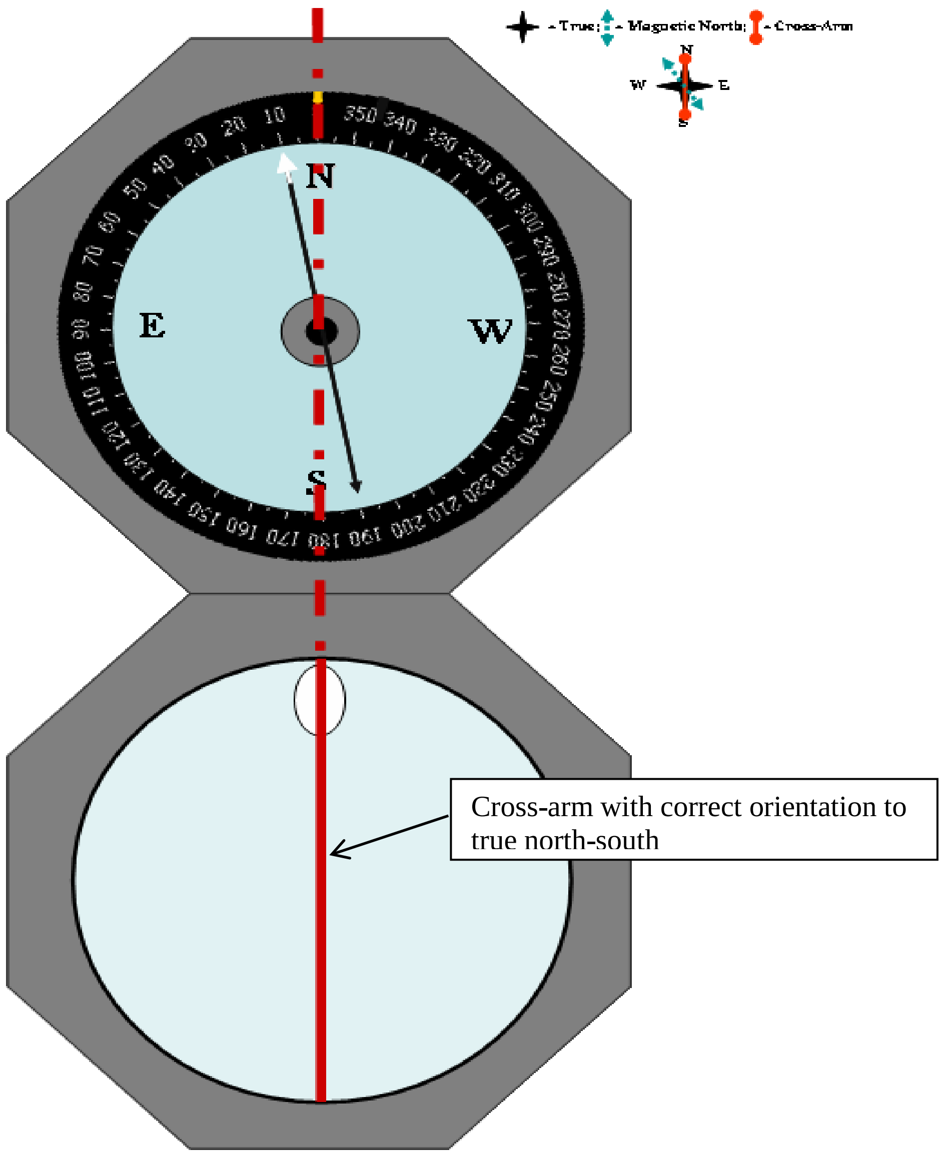


[‡] i.e., **add** to magnetic compass reading to find true (azimuth) geographic direction. In the example provided, magnetic north is at 345° and true north is +15° away at 0°.

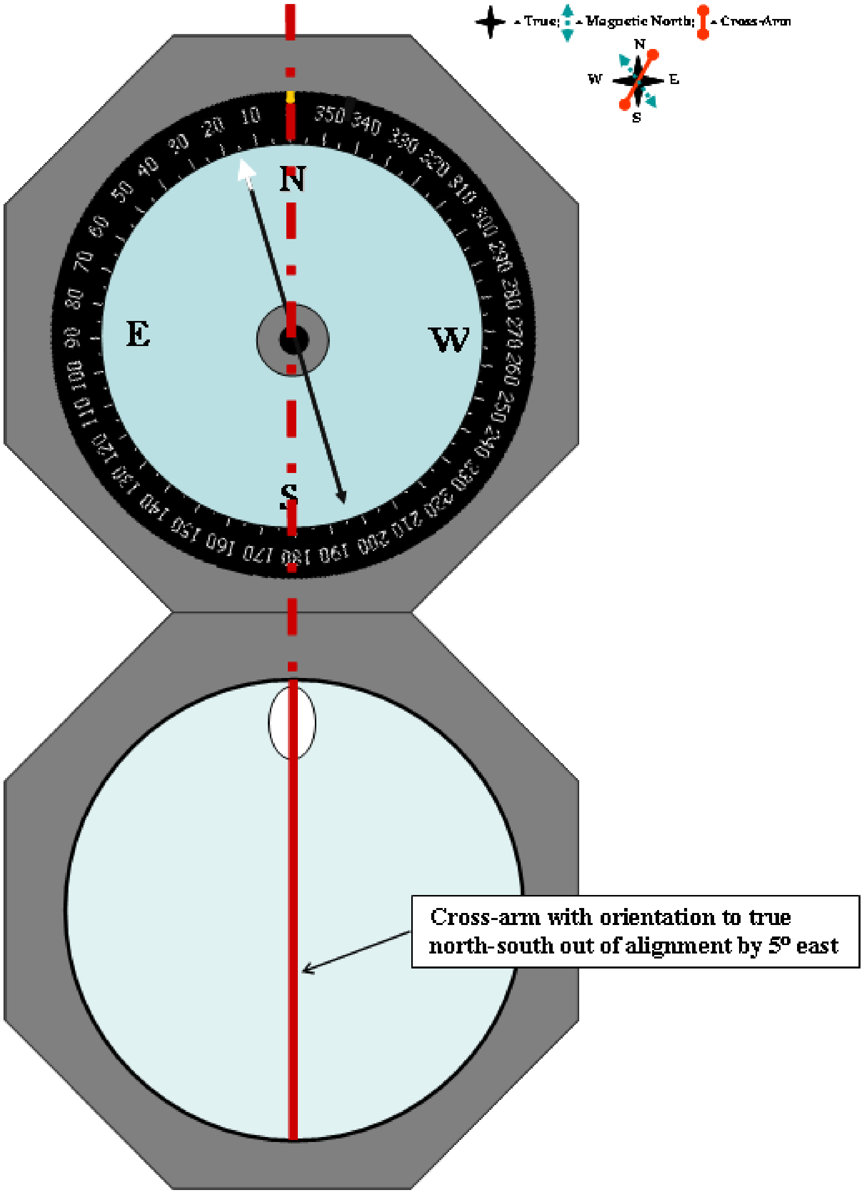
In the next example the index pin is aligned with true north and the compass needle is pointed toward magnetic north at a site with 15° west magnetic declination (clockwise | subtract):



When performing wind direction calibrations, the compass reading will show the expected magnetic declination when the cross-arm is aligned with the sight line on the mirror and if the cross-arm is properly aligned with true north. The cross arm at each CASTNET site should be aligned with true north-south. See the figure below for an example of correct cross-arm alignment at a site with 10° west magnetic declination:



The figure below shows an example of incorrect cross-arm alignment at a site with 10° west magnetic declination. In this example the **cross-arm requires adjustment** 5° toward the west to be properly aligned with true north.



10.0 Attachments

Attachment 1

CR3000: RMY to CR3000 Backplane Wiring Version 4/22/08

Sensor Side					Terminal Block	Logger Side			Misc
Sensor	**Cable Type / TAG**	**Shield**	**Wire Color**	**Function**	**Surge Strip**	**Wire Color**	**Port**	**Block**	**Signal Type**
Wind AQ	Six Conductor w/ 3 Individually Shielded TP Tagged Black		Green	WD Sig +	1	Green	1H	1	SE
		X	Black	WD Ref	2	Green/White*	1 GND	1	
			Red	WS Sig+	3	Red	P1	3	Pulse
		X	Black	WS Sig Ref	4	White / Red	P1 GND	3	
			White	WD EXC+	5	Red / White	VX1	3	Power
		X	Black	EARTH	6	Green/Yellow	G	4	EARTH
Temp 1 (10m)	Four Conductor Tagged Yellow	Do Not Shield	White	Sens +	7	Yellow	2H	1	DIFF
			Green	Sens -	8	White/Yellow	2L	1	
			Red	RTD +	9	Yellow/Red	IX1	3	
			Black	RTD -	10	Yellow/Black	IXR	3	
Blower 1 (10m)	Four Conductor Tagged White		White	CC Status 1	11	Red/Yellow	5V+	4	SE
			Green	CC Status 1	12	Black/Yellow	3H	1	
			Red	15V+	13	Red	NC	N/A	Power
		X	Black	15V GND	14	Black	NC	N/A	
Blower Power Supply					Power Supply	16 GA to MOV's 13-16			Power
Blower 2 (2m)	Four Conductor Tagged Green		Red	15V+	15	Red	NC	N/A	Power
		X	Black	15V GND	16	Black	NC	N/A	
			White	CC Status 1	17	Red/Orange	5V+	4	SE
			Green	CC Status 1	18	Black/Orange	3L	1	
Temp 2 (2m)	Four Conductor Tagged Red	Do Not Shield	White	Sens +	19	Orange	4H	1	DIFF
			Green	Sens -	20	White/Orange	4L	1	
			Red	RTD +	21	Orange/Red	IX2	3	
			Black	RTD -	22	Orange/Black	IXR	3	
RH	Four Conductor Tagged Clear White Wire NC		Green	RH Sig +	23	Gray	5H	1	SE
			WHITE-NC	FUTURE	24	White/Gray	NC	NC	
			Red	RH 12V+	25	White/Red/Black	12V+	4	Power
		X	Black	Common	26	Black	G	4	
Wetness	Four Conductor Tagged Blue		White	Wet Sig +	27	Blue	5L	1	SE
			Green	Wet Ref	28	White/Blue	5 Gnd	1	
			Red	Wet 12V+	29	Red/Blue	12v+	4	Power
		X	Black	Wet 12V Gnd	30	Black/Blue	12V Gnd	4	
Precip	2 or 4 conductor Tagged White		Clear or White	CC 1	31	Lt Blue	P2	3	Pulse
		X	Black	CC 1 Gnd	32	White / Lt Blue	P2 Gnd	3	
SR	RG-58 Coax	N/A	RG-58 Coax w/ BNC to Translator	SR Sig +	Direct to Logger From Translator	Tan	6H	1	DIFF
				SR Sig Ref		White/Tan	6L	1	
				SR Power		Red/Tan*	12V+	4	Power
				Sr Gnd		Black/Tan*	12V Gnd	4	
Shelter Temp	CSI 107 Probe	Not Shielded	Red	Sig +	33 High	Red/Purple	1L	1	SE
			Purple	Sig Gnd	33 Low	Purple/Red	1 Gnd	1	
			Black	Power +	34 High	Black/Purple/Red	VX2	3	Power
			Clear	Power Gnd	34 Low	White/Purple/Black	VX2 Gnd	3	
Flow	2 or 4 conductor Not Tagged			Flow Sig +	35	Purple	10H	2	SE
				Flow Sig Ref	36	White/Purple	10 Gnd	2	
SR Trans	N/A		NC	SR T Sig +	37	Brown	7H	1	DIFF
			NC	SR T Sig Ref	38	White/Brown	7L	1	
Ozone Analog B/U	N/A		NC	B/U O3 Sig +	39	Blue/Pink*	8H	2	DE
			NC	B/U O3 Sig Ref	40	Pink/Blue*	8L	2	
Ozone Trans Analog B/U	N/A		NC	O3 Tran Sig+	41	Purple/Pink*	9H	2	DE
			NC	O3 Tran Ref	42	Pink/Purple*	9L	2	
Communication	Raven Modem		Raven Power Cable	Power	Direct to Logger From Raven Modem	Red	12 VDC+	4	Power
				Power Gnd		Black	12 VDC G	4	
				CAT5e REDt	Direct to 115 Unit	CAT5e RED	115 RJ45	115	Comm
Serial Ozone	DE9 Serial Comm Cable (Female End)		Pin 2	Rx	Direct to Logger From Analyzer Serial Port (Null Modem DE9)	Red*	C1 - Tx	4	Control
			Pin 3	Tx		Orange*	C2 - Rx	4	Control
			Pin 5	Gnd (5)		Green*	G	4	Control
NO Solenoid					43	White/Black	C3	4	Control
Backplane Earth to Grounding Rod via Green 10GA / NO Ground					44	Green 10GA	G Lug		Ground

KEY

Color Code	Device	Stock Number	Identifying Marks
(green)	Ground Clamp	401-006	Green and Yellow
(light yellow)	GDT	Not Yet Assigned	Black w/ Green/Yellow Ground, Marked 110VAC
(cyan)	MOV	401-010	Black w/ Green/Yellow Ground, Marked 12VDC
(light gray)	Terminal	401-005	w/ one terminal per side
(dark gray)	Double Terminal		Gray w/ two terminals per side

Attachment 2

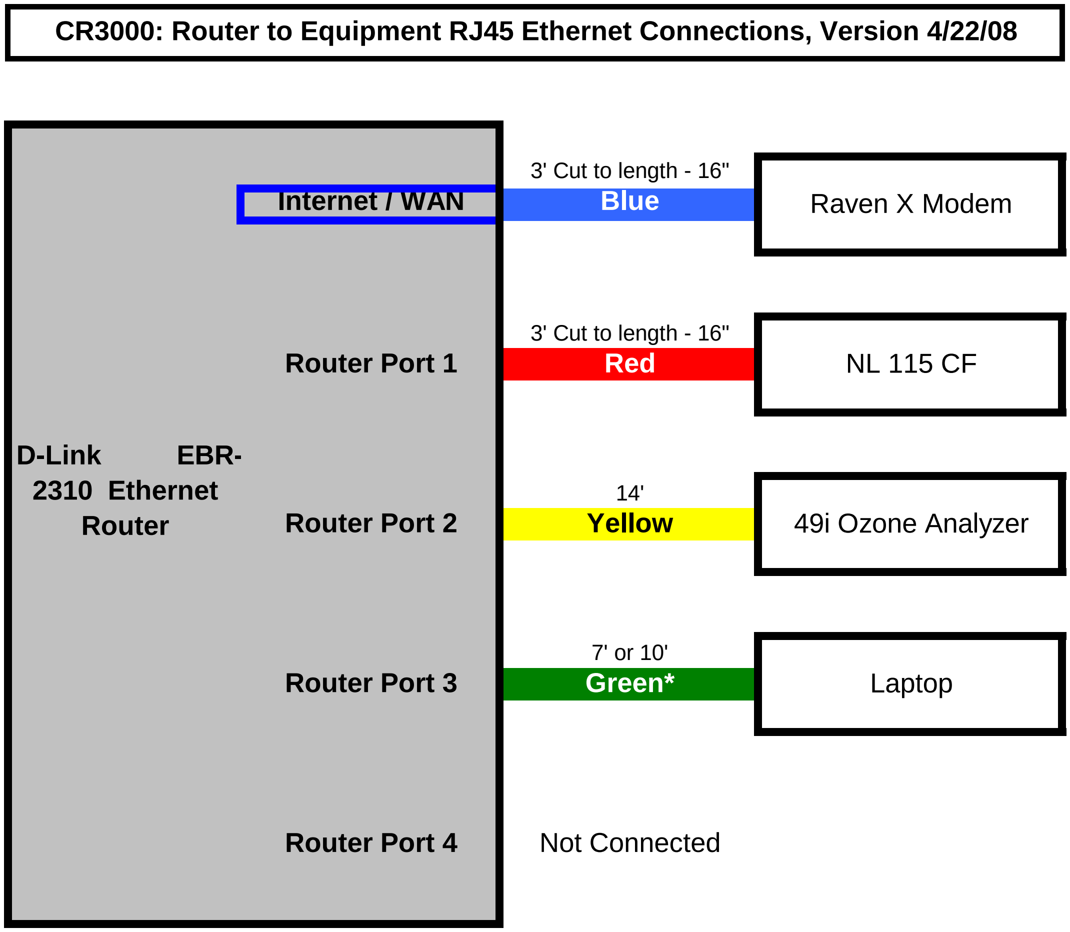
CR3000:RMY Sensor to Met Tower Interface Box Wiring (If So Equipped) Version 4/22/08

From Sensors					Met Tower Interface Terminal Block	To Logger Surge Protection Terminal Strip					
Sensor	Cable Type / TAG	Shield Color	Wire Color	Function / Sensor Mark		Wire Color	Function / Sensor Mark	Shield	Cable Type / TAG	Backplane Terminal	Logger Port
Wind AQ	Six Conductor w/ 3 Individually Shielded TP Tagged Black	Blue	Green	WD Sig +	1	Green	WD Sig +	Blue	Six Conductor w/ 3 Individually Shielded TP Tagged Black	1	1H
			Black	WD Ref	2	Black	WD Ref			2	1 GND
			Bare Wire	Shield	A	Bare Wire	Shield			Ground on 2	N/A
		Red	Red	WS Sig+	3	Red	WS Sig+	Red		3	P1
			Black	WS Sig Ref	4	Black	WS Sig Ref			4	P1 GND
			Bare Wire	Shield	B	Bare Wire	Shield			Ground on 4	N/A
		Green	White	WD EXC+	5	White	WD EXC+	Green		5	VX1
			Black	EARTH	6	Black	EARTH			6	G
			Bare Wire	Shield	C	Bare Wire	Shield			Ground on 6	N/A
Temp 1 (10m)	Four Conductor Tagged Yellow		White	Sens +	7	White	Sens +		Four Conductor Tagged Yellow	7	2H
			Green	Sens -	8	Green	Sens -			8	2L
			Red	RTD +	9	Red	RTD +			9	IX1
			Black	RTD -	10	Black	RTD -			10	IXR
			Bare Wire	Shield	D	Bare Wire	Shield			Ground on 10	N/A
Blower 1 (10m)	Four Conductor Tagged White		White	CC Status 1	11	White	CC Status 1		Four Conductor Tagged Yellow/Black	11	5V+
			Green	CC Status 1	12	Green	CC Status 1			12	3H
			Red	15V+	13	Red	15V+			13	NC
			Black	15V GND	14	Black	15V GND			14	NC
Blower 2 (2m)	Four Conductor Tagged Green		Red	15V+	15	Red	15V+		Four Conductor Tagged Orange/Black	15	NC
			Black	15V GND	16	Black	15V GND			16	NC
			White	CC Status 1	17	White	CC Status 1			17	5V+
			Green	CC Status 1	18	Green	CC Status 1			18	3L
Temp 2 (2m)	Four Conductor Tagged Red		White	Sens +	19	White	Sens +		Four Conductor Tagged Orange	19	4H
			Green	Sens -	20	Green	Sens -			20	4L
			Red	RTD +	21	Red	RTD +			21	IX2
			Black	RTD -	22	Black	RTD -			22	IXR
			Bare Wire	Shield	E	Bare Wire	Shield			Ground on 22	N/A
RH	Four Conductor Tagged Clear: White Wire NC But Intact		Green	RH Sig +	23	Green	RH Sig +		Four Conductor Tagged Clear White Wire NC But Intact	23	5H
			WHITE-NC	FUTURE	24	WHITE-NC	FUTURE			24	12V+
			Red	RH 12V+	25	Red	RH 12V+			25	NC
			Black	Common	26	Black	Common			26	G
			Bare Wire	Shield	F	Bare Wire	Shield			Ground on 26	N/A
Wetness	Four Conductor Tagged Blue		White	Wet Sig +	27	White	Wet Sig +		Four Conductor Tagged Blue	27	5L
			Green	Wet Ref	28	Green	Wet Ref			28	5 Gnd
			Red	Wet 12V+	29	Red	Wet 12V+			29	12v+
			Black	Wet 12V Gnd	30	Black	Wet 12V Gnd			30	12V Gnd
			Bare Wire	Shield	G	Bare Wire	Shield			Ground on 30	N/A
Precip	2 or 4 conductor Tagged White		Clear or White	CC 1	31	Clear or White	CC 1		2 or 4 conductor Tagged White	31	P2
			Black	CC 1 Gnd	32	Black	CC 1 Gnd			32	P2 Gnd
			Bare Wire	Shield	H	Bare Wire	Shield			Ground on 32	N/A
SR	RG-58 Coax	N/A	RG-58 Coax w/ BNC to Translator	SR Sig + SR Sig Ref SR Power Sr Gnd	BNC Barrel Connector (MUST NOT CONTACT GROUND)	RG-58 Coax w/ BNC to Translator	SR Sig + SR Sig Ref SR Power Sr Gnd	N/A	RG-58 Coax	To BNC Port on SR Translator	6H 6L 12V+ 12V Gnd

KEY			
Color Code	Device	Stock Number	Identifying Marks
(gray)	Terminal	401-005	Gray UKK Front 4 Terminal

Shields should be grounded only to Logger Terminal Strip at locations marked X

Attachment 3



*Preferred part number for this cable is Emerson 73-7793-7

III. FIELD MANUAL

A. SITE OPERATORS HANDBOOK

ATTACHMENT 1: THERMO SCIENTIFIC (THERMO) MODEL 43C-TLE ENHANCED TRACE LEVEL SULFUR DIOXIDE (SO_2) ANALYZER

AUTOMATED EQUIVALENT METHOD: EQSA-0486-060

SOP Retired

III. FIELD MANUAL

A. SITE OPERATORS HANDBOOK

ATTACHMENT 2: THERMO SCIENTIFIC (THERMO) MODEL 48C-TLE ENHANCED TRACE LEVEL CARBON MONOXIDE (CO) ANALYZER

AUTOMATED EQUIVALENT METHOD: RFCA-0981-054

SOP Retired

III. FIELD MANUAL

A. SITE OPERATORS HANDBOOK

ATTACHMENT 3: THERMO SCIENTIFIC (THERMO) MODEL 42CY NO/NO_y ANALYZER

SOP Retired

III. FIELD MANUAL

A. SITE OPERATORS HANDBOOK

ATTACHMENT 4: THERMO 146C MULTIGAS DYNAMIC DILUTION SYSTEM

SOP Retired

III. FIELD MANUAL

A. SITE OPERATORS HANDBOOK

ATTACHMENT 5: THERMO SCIENTIFIC (THERMO) MODEL 49*i* UV PHOTOMETRIC OZONE ANALYZER

EPA Designated Equivalent Method Number: EQOA-0880-047

Effective Date: 7-7-16

Reviewed by: Kevin P. Mishoe
Field Operations Manager

Reviewed by: Marcus O. Stewart
QA Manager

Approved by: Holton K. Howell
Project Manager

TABLE OF CONTENTS

Annual Review			
Reviewed by:	Title:	Date:	Signature:

III. A. SITE OPERATORS HANDBOOK
ATTACHMENT 5: THERMO SCIENTIFIC (THERMO) MODEL 49*i* UV PHOTOMETRIC OZONE ANALYZER

EPA Designated Equivalent Method Number: EQOA-0880-047

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide consistent guidance for the operation of the Thermo Scientific (Thermo) Model 49*i* Photometric Ozone (O_3) Analyzer for regulatory monitoring at Clean Air Status and Trends Network (CASTNET) sites.

2.0 SCOPE

This SOP applies to O_3 monitoring compliant with the Code of Federal Regulations, Title 40, Part 58, the guidance in “Quality Assurance Handbook for Air Pollution Measurement Systems”, Volumes I, and II; “Technical Assistance Document Transfer Standards for Calibration of Air Monitoring Analyzers for Ozone” (EPA-600/4-79-056); and “Technical Assistance Document for the Calibration of Ambient Ozone Monitors” (EPA-600/4-79-057) performed at CASTNET sites.

3.0 SUMMARY

The Model 49*i* operation is based on the principle that O_3 molecules absorb ultraviolet (UV) light at a wavelength of 254 nanometers (nm). The degree to which the UV light is absorbed is directly related to the O_3 concentration as described by the Beer-Lambert Law.

An ambient air sample is drawn through a 10-meter high Teflon© inlet. The sample is drawn into the Model 49*i* through the SAMPLE bulkhead and is split into two gas streams, as depicted in Figure 1-1 on page 1-3 of the Thermo instruction manual (May 26, 2006 P/N 102434-00). One gas stream flows through an O_3 scrubber to become the reference gas (I_o). The reference gas then flows to the reference solenoid valve. The sample gas (I) flows directly to the sample solenoid valve. The solenoid valves alternate the reference and sample gas streams between cells A and B every 10 seconds. Longer intervals are also possible. When cell A contains reference gas, cell B contains sample gas and vice versa.

The UV light intensities of each cell are measured by detectors A and B. When the solenoid valves switch the reference and sample gas streams to opposite cells, the light intensities are ignored for several seconds to allow the cells to be flushed. The Model 49*i* calculates the O_3 concentration for each cell and outputs the average concentration to both the front panel display as well as the analog and digital outputs.

4.0 MATERIALS AND SUPPLIES

Campbell Scientific Inc. Model CR3000 Data logger
Thermo Scientific Model 49*i* O_3 Analyzer
Zero air system
Site Narrative Log for appropriate sampling week (and/or other forms as needed)
Writing implement
Site Tool Kit

5.0 REPAIR AND MAINTENANCE

N/A

6.0 PROCEDURE

The O_3 inlet filter isto be replaced every other week and inspected each week and replaced if necessary. Site operators are required to perform additional duties, which include performing manual checks if required.

Page 1-3 of the manual presents the analyzer specifications. Refer to page 3-2 of the instrument manual for a graphic representation of the front panel controls and indicators. The controls and indicators on the front of the Thermo 49*i* analyzer (from left to right) are as follows: Display panel, RUN pushbutton, MENU pushbutton, ⬆ pushbutton, ENTER pushbutton, HELP pushbutton, ⬅ pushbutton, ⬇ pushbutton, and the ➡ pushbutton. Four additional buttons are located just under the screen. These are programmable and at CASTNET sites they are typically configured as: *Temperature, Pressure, Flow, and Intensity (lamp).* The POWER switch is located at the bottom right corner of the front panel.

Refer to page 2-4 of the instrument manual for a graphic representation of the rear panel of the onsite transfer standard. A series of connectors are located on the left side. These are: external accessory (15 pin female), 2 RS-232/485 (9-pin male), I/O expansion (blank cover), Ethernet, power fail relay/digital inputs/analogue voltage outputs (37-pin male), digital outputs (37-pin female), 120 VAC power socket and 2 fuses (3 amp). Pin identifications are available on pp. 3-9 through 3-13 and 7-14 in the manual. To the right of these, items are as follows: from left to right, the cooling fan/filter, Vent and Ozone (top row) bulkhead connectors. These are Teflon fittings connected to same internal manifold. The Ozone port is connected to the sample integrity line that runs to the sample inlet. Below these are the SAMPLE (Teflon, sample input, plugged) and Zero air bulkhead connectors (stainless steel, zero air input). Between these and just below, there is an unidentified Teflon bulkhead connector with a short piece of ¼ inch Teflon tubing to another Teflon bulkhead connector below labeled “IN”.

Refer to page 3-5 of the Model 49*i* instrument manual for the flowchart of the menu-driven software. This flowchart gives a quick reference to all the menus and submenus available to the operator.

6.1 Thermo 49*i* Settings

6.1.1 **Mode Setting** - Mode for the onsite transfer standard should be set on SAMPLE with the O_3 concentration and the time displayed. If not, correct and mark in site log and appropriate calibration or report form. The CR3000 data logger is not capable of running periodic ZPS checks if the onsite transfer standard is left in SERVICE mode. Data communication or program error should be suspected if ZPS checks fail to operate as these are encoded the logger’s program.

6.1.2 **Range Setting** - Press MENU, select RANGE and press ENTER. Select GAS UNITS and press ENTER. CURRENTLY: displays actual setting. SET TO: shows options. The up and down arrows are used to toggle through the options. Set to PPB and save by pressing ENTER. Press the MENU button to return. With the arrows select Range. This should be set at 250 parts per billion (ppb); if not, correct the setting and note in site log and appropriate calibration or report form. Any data recorded in other than the 0.0 to 250 ppb range must be clearly identified.

Note: *Range settings assign a voltage range to a concentration range. This is only relevant when collecting in analogue mode.*

6.1.3 **Averaging Time** - Press MENU twice to return to the main menu, scroll to AVERAGING TIME and press ENTER. Averaging time should be set on 10 seconds; if not, correct the setting and document the observation as described above.

6.1.4 **Voltages** - Press the MENU pushbutton, scroll to DIAGNOSTICS and press ENTER, scroll to VOLTAGES and press ENTER, scroll to INTERFACE BOARD VOLTAGES and press ENTER. Observe the voltage readings on the front panel and document the observation. In particular, please note the "3.3 SUPPLY" reading as it represents the instruments battery voltage.

Note: *Each actuation of the MENU button within the DIAGNOSTICS submenu will move you up one level in the submenu.*

6.1.5 **Temperatures*** - Press the MENU pushbutton, scroll to DIAGNOSTICS and press enter. Scroll to TEMPERATURE and press ENTER. Alternatively you may press run to access the preprogrammed “soft keys” under screen buttons. The leftmost is TEMPS. Observe the temperature readings on the front panel and document. The internal temperature should be between 25 °C and 40 °C. The bench lamp temperature should be between 45 °C and 55 °C. The O_3 lamp temperature should be between 60 °C and 75 C.

6.1.6 **Pressure*** - Press MENU, scroll to DIAGNOSTICS and press ENTER. Scroll to PRESSURE and press ENTER. Alternatively, push the PRESSURE hotkey button under the LCD display. Observe the pressure reading on the display panel and document. If not within limits (400 mm Hg – 1000 mm Hg), corrective action must be taken. A pressure of less than 400 mm Hg indicates a blocked sample line. Document initial and corrected pressure.

6.1.7 **Flow*** - Press MENU, scroll to DIAGNOSTICS and press ENTER. Scroll to FLOW and press ENTER. Alternatively, push the FLOWS hotkey button under the LCD display. Observe the Cell (A and B) flows on the screen and record the values. The 49*i* operates typically at a flow rate of 0.75 liters per minute (LPM) per cell.

Note: *The total flow rate under EPA Designated Equivalent Method Number EQOA-0880-047 must be at least 1.00 LPM and not greater than 3.00 LPM.*
***** *These parameters and others (see Alarms Menu p. 3-72 of the instrument manual) can be programmed to display an alert message if they drift out of a predetermined range.*

The total flow rate is the sum of the Cell A and Cell B flows indicated by the analyzer. This value is not indicated by the analyzer. Either cell exhibiting a flow rate less than or equal to 0.5 LPM is cause for immediate investigation. For normal operation both A and B flow rates should be approximately 0.75 LPM each for a total flow rate of 1.5 LPM. If the flow is unacceptable, corrective action must be taken following a six point audit. Document the initial and corrected flow and recalibrate the machine.

6.1.8 **Cell A/B O_3** - Press MENU, scroll to DIAGNOSTICS and press ENTER. Scroll to CELL A/B O_3 and press ENTER. Observe the readings and document. The two cell readings should average out to the ambient reading.

6.1.9 **Intensity and Noise** - Down the O_3 channel. The noise check will corrupt the measurement. Press MENU, scroll to INSTRUMENT CONTROLS and press ENTER. Scroll to SERVICE MODE and press ENTER. Press ENTER to toggle SERVICE MODE to ON. Press the MENU button twice to return to the main menu. Scroll to SERVICE and press ENTER. Scroll to INTENSITY CHECK and press ENTER. Scroll to INT A SAMPLE GAS and press ENTER. Wait at least sixty seconds for noise to stabilize. Record Cell A Intensity and Noise to the nearest thousand. Press MENU then scroll to INT B SAMPLE GAS. Wait at least sixty seconds for the Noise to stabilize and repeat as before. Sometimes a low frequency condition can be corrected by cleaning the cell tubes. Noise on both cells should be below 4.0 Hz. When done, press the RUN button to return the unit to SAMPLE mode.

6.2 Ozone site configuration

CASTNET sites configured for compliance monitoring feature a separate analyzer used as an onsite transfer standard paired with the site analyzer where the transfer standard is used to generate the concentrations for routine checks. The onsite transfer standard's photometer must first have a 6-day certification and then a 1-day certification every six months by an O_3 transfer standard that is traceable to an EPA standard reference photometer Please see Figure 1.

6.3 Analyzer set up

The transfer and site analyzers need to be plumbed in and turned on for at least an hour before the initial checks are performed. This will allow adequate warm-up. The analyzer will display an alarm message on the front panel until all conditions are within limits. The data logger utilizes Ethernet connections for both the transfer and site analyzers. The site analyzer must be verified via comparison to a certified transfer standard once installed via a 1-day certification procedure.

6.4 Routine Operation and Observations

6.4.1 The following describe routine monitoring:

- Standard local time is used for monitoring and is updated by the data logger.
- Logger controlled zero, precision (60 ppb), and span (225 ppb) checks will be performed each day.
- Span checks must be within ± 7 percent of reference value and zero checks must be ± 1.5 ppb for data to be considered as valid.
- Please refer to Table 1 for measurement quality objectives and actions required when indicators are outside of criteria. Please note that the site operator should only perform adjustments under the guidance of a CASTNET field technician.
- Data are collected via data logger, polled remotely and uploaded to AIRNow every hour.

6.4.2 During each weekly visit, the site operator will perform the following checks:

6.4.2.1 Automatic ZPS checks are performed each day by the data logger. Span checks must be within ± 7 percent of reference value and zero checks must be ± 1.5 ppb. Checks outside of these criteria will alert the site operator to investigate the system and call Amec Foster Wheeler for instructions. Amec Foster Wheeler personnel will guide the site operator through troubleshooting and corrective action. Span checks greater than ±7 percent of reference value or zero checks outside of ± 1.5 ppb are outside of established criteria and data falling between consecutive failed checks are considered invalid. Please refer to Table 1 of this SOP.

6.4.2.2 Physical integrity of the analyzer will be checked and the findings documented.

6.4.2.3 All routine site checks requested on the Site Status Report Form (SSRF) and Site Operator Checklist will be completed.

6.4.2.4 All site activities and observations will be documented in the Site Narrative logbook and SSRF.

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*. 40 CFR 58, Appendix B

U.S. Environmental Protection Agency (EPA). *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)*. 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). *National 8-Hour Primary and Secondary Ambient Air Quality Standards for Ozone.* 40 CFR 50, Appendix I.

U.S. Environmental Protection Agency (EPA). On-Site Meteorological Program Guidance for Regulatory Modeling Applications. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods*. EPA-600/4-77-027a.

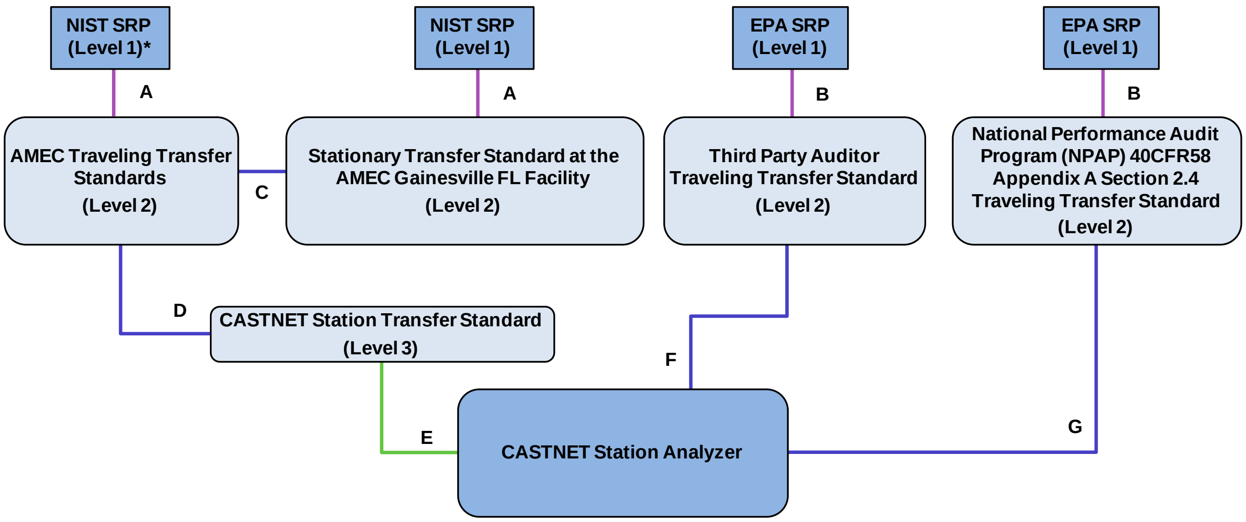
U.S. Environmental Protection Agency (EPA). *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements.* EPA-600/4-82-060.

U.S. Environmental Protection Agency (EPA). Transfer Standards for Calibration of Air Monitoring Analyzers for Ozone, Technical Assistance Document. EPA-600/4-79-056

Thermo Environmental Instruments. *Model 49C UV Photometric Analyzer Instrument Manual*

8.0 TABLES AND FIGURES

Figure 1. Ozone Certification



Legend

A = Annual Reverification
B = Quarterly Reverification
C = Audited ~1/6 weeks
D = Reverification 1/6 months
E = Zero, Span and single Point QC check daily
F = Audited Annually
G = Audited 1/5 years

***Traceability**

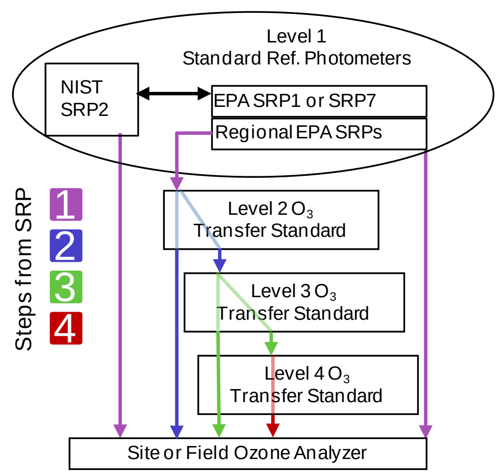


Table 1. Ozone Measurement Quality Objectives

Type of check	Measurement Criteria	Corrective Action[*]		Multi-Point Calibration Criteria
		Field	**Data**	
Zero	≤ ± 1.5 ppb	Perform adjusted calibration	Invalid from the last good check until the next good check or adjusted calibration completed	Between 0.0 and ± 1.5 ppb
Precision/Span	≤ ± 7 percent between supplied and observed concentrations	Contact the field coordinator	Invalid from the last good check until the next good check or adjusted calibration completed	All points on calibration curve within ± 2% of full scale as compared to the best fit straight line linearity error < 5%
Correlation Coefficient				≥ 0.995
Frequency of analyzer checks				
ZSP[**]	One ZSP every day On demand to facilitate trouble shooting Following a multipoint calibration prior to leaving the site			
Calibration	Minimum one multipoint calibration every 6 months As required per QC results When performing the semi-annual multipoint verification, calibration adjustment – if needed - must occur within 24 hours of verification			
General				
Unadjusted calibration does not have to be followed by an adjusted calibration only if all analyzer responses are in a 2 percent of full scale range. **Shelter temperature acceptable range: 20 – 30 degrees C (± 2 degrees C)**				

Notes: [*] Display drifts are frequently due to leaks in the system or lamp degradation/ageing. Verify lamp intensity settings against previously documented values. Perform internal and external leak checks by plugging inlet line in back of the instrument (internal) or tower inlet port (external). A line plug should reduce the internal pressure down to 250 mm Hg or so. Verify external ozone generator pump function and internal pressure using the manual pressure gauge located inside the instrument.

[**] Zero, Span, Precision automated QC check

IV. CALIBRATION LABORATORY
A. STATIONARY TRANSFER STANDARDS (LEVEL 2)
1. OZONE

Effective Date: 10/30/14

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: H. Kemp Howell, Project Manager

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Reviewed by:	Title:	Date:	Signature:
MS	QA Mgr	11/2/15	[signature]

IV.A.1. OZONE

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide consistent guidance for the routine repair, maintenance, and certification of Ozone (O_3) Level 2 stationary transfer standards by Clean Air Status and Trends Network (CASTNET) Field Certification Laboratory personnel. A stationary transfer standard is also called a primary standard in this QAPP.

2.0 SCOPE

This SOP applies to the repair, maintenance, and certification of all Thermo Electron and Thermo Fisher Scientific (Thermo) model 49C PS and Model 49*i* PS, Primary Standard Ultraviolet (UV) Photometric O_3 Calibrators.

3.0 SUMMARY

The CASTNET Field Calibration Laboratory employs four Thermo Primary Standard UV Photometric O_3 Calibrators, two model 49C PS, and two 49i PS. These are sent annually to the EPA Kansas City Science and Technology Center (EPA Region 7) where they are certified against a National Institute of Standards and Technology (NIST) reference photometer. These PS units are used to verify and maintain the accuracy of the O_3 Level 2 transfer standards (Figure 2-11 in QAPP Section 2.0), site O_3 analyzers that have been returned to the calibration lab for repairs or new units being tested for the first time. These units are not plumbed to receive ambient air samples. Figure 1 gives an overview of the maintenance process.

4.0 MATERIALS AND SUPPLIES

Refer to the Thermo 49i PS Manual, Chapter 7 (See Section 7.0, References).

5.0 MAINTENANCE AND CALIBRATION

The following list delineates the steps used in a comprehensive maintenance overhaul. Refer to Ozone Maintenance and Calibration Schedule to determine required maintenance.

5.1 Fan and Fan Filter Cleaning

- Turn off the calibrator and unplug the power cord.
- Remove fan filter holder and clean holder and foam element in soap and water. Use compressed air to dry these parts.
- Use compressed air to flush debris out of fan and internal parts of unit.
- Reinstall fan foam and holder.

5.2 Optical Bench Cleaning (Manual Section 4-2)

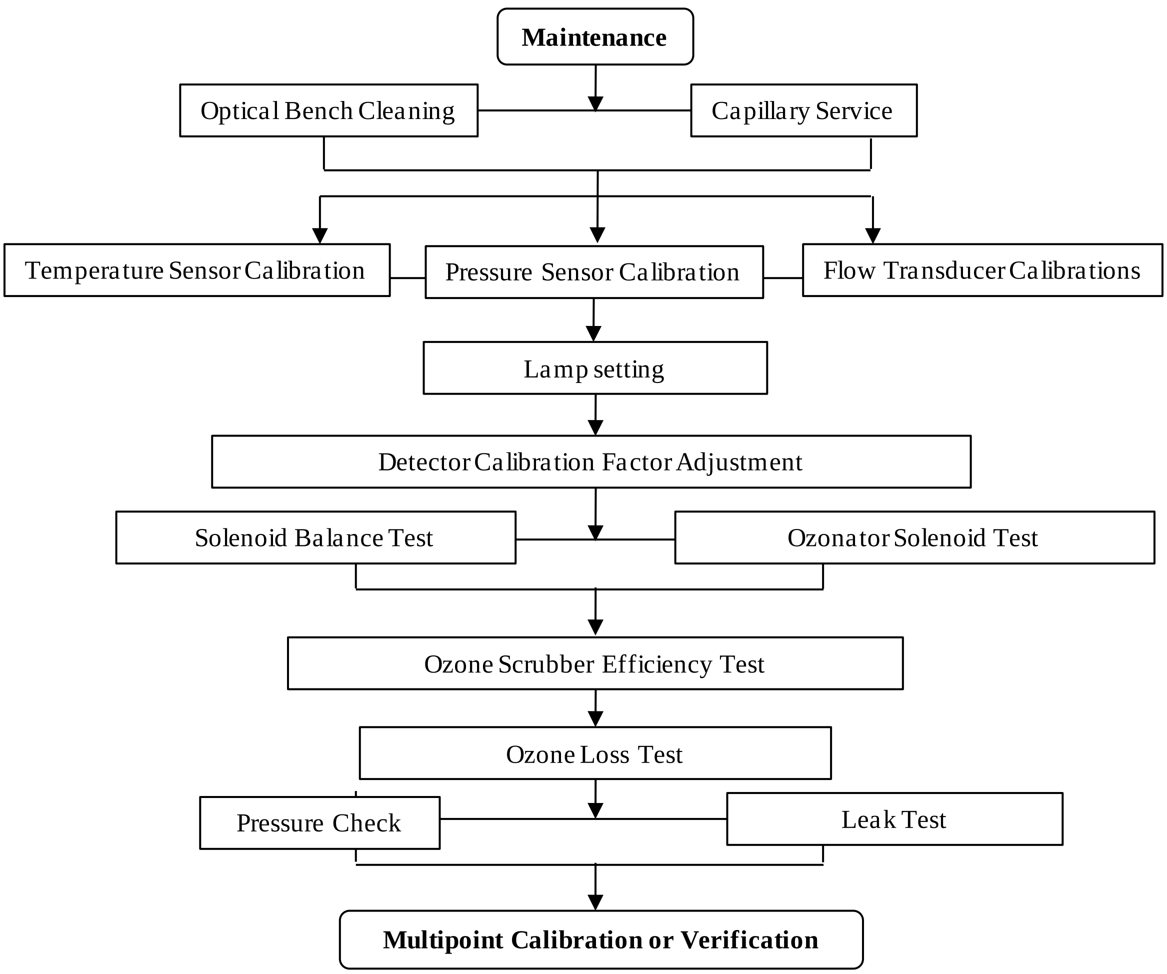
5.2.1 Turn off power, disconnect the power cable, and remove cover.

5.2.2 Loosen the knurled nut around tube and carefully slide out the tube.

5.2.3 Push a piece of lens paper (Kim Wipe) down the tube using a 1/4-inch piece of Teflon tubing so as not to damage the tube. Use a cotton swab to clean the window surfaces through the holes the tube fits into.

5.2.4 Replace the tubes (opposite of removal). Both tubes are identical, so they can be replaced in either position.

Figure 1. Maintenance Overview



5.3 Capillary Service (Manual Section 4-5)

5.3.1 Turn off power, disconnect the power cable, and remove cover.

5.3.2 Remove purple 15 mil capillaries by loosening nuts around the “T” fitting on top of sample pump. Remove capillaries from tubing.

5.3.3 Clear any blockage with a wire less than 0.015-inch OD, or replace.

5.3.4 Replace capillaries.

5.3.5 Repeat steps 2-4 for orange 24 mil capillary upstream of ozone generation chamber if applicable.

5.4 Bench Temperature Sensor Calibration (Manual Sections 6-17 and 3-76)

Note: *The analyzer must be in service mode to perform this adjustment.*

5.4.1 Remove bench thermistor signal cable from the Measurement Interface Board.

5.4.2 Unscrew thermistor from the optical bench.

5.4.3 Reconnect signal cable to Measurement Interface Board.

5.4.4 Place thermistor through foam in an empty insulated thermos with temperature primary standard.

5.4.5 After the readings equilibrate, adjust bench calibration if the deviation is > 2°C.

5.4.6 Press the Main Menu button to display the Main Menu.

5.4.7 Use the down arrow button to scroll to Service and press the enter button to display the Service menu.

5.4.8 Use the down arrow button to scroll to Temperature Calibration and press the enter button to display the Temperature Calibration screen.

5.4.9 Enter corrected temperature standard reading and press ↵ (Enter) to save.

5.5 Pressure Sensor Calibration (Manual Sections 6-32 and 3-72)

The pressure sensor calibration requires a high vacuum pump capable of < 1mmHg (≈1 torr). If such a pump is unavailable, only adjust the pressure span setting.

Note: *The analyzer must be in service mode to perform this adjustment.*

5.5.1 Connect reference pressure sensor and vacuum pump to pressure transducer.

5.5.2 Turn on vacuum pump until reference pressure sensor reads < 1mmHg.

5.5.3 Adjust zero setting if deviation is > 5 mmHg.

5.5.4 Press the Main Menu button to display the Main Menu.

5.5.5 Use the down arrow button to scroll to Service and press the enter button to display the Service menu.

5.5.6 Use the down arrow button to scroll to Pressure Calibration and press the enter button to display the Pressure Calibration screen.

5.5.7 From the zero menu, press enter to set the zero setting.

5.5.8 Turn off vacuum pump and open the relief valve.

5.5.9 After the readings equilibrate, adjust span concentration if deviation > 5mmHg.

5.5.10 Press the menu button to return to the pressure calibration menu.

5.5.11 From the span menu, enter the reference pressure reading and press ↵ (Enter) to save.

5.6 Flow Transducer Calibrations (Manual Sections 6-35 and 3-74)

The flow readings are not used to calculate ozone concentration. Since they are only diagnostic, a precise calibration is not critical.

Note: *The analyzer must be in service mode to perform this adjustment*.

5.6.1 Turn off the instrument sample pump.

5.6.2 Press the Main Menu button to display the Main Menu.

5.6.3 Use the down arrow button to scroll to Service and press the enter button to display the Service menu.

5.6.4 Select Flow A Calibration and then zero.

5.6.5 Press ↵ (Enter) to set the flow zero setting.

5.6.6 Repeat steps 4 and 5 for Flow B.

5.6.7 Connect the reference flow meter to the exhaust bulkhead.

5.6.8 From the Flow A Calibration menu, select Span.

5.6.9 Disconnect the tubing from the cell B flow transducer to the sample pump and cap both cell B pump inlet and transducer output. Leaving either uncapped will produce erroneous readings.

5.6.10 Enter the reference flow meter reading and press ↵ (Enter) to save.

5.6.11 Repeat steps 8 – 10 for Flow B.

5.7 Leak Check (Manual Section 4-7)

5.7.1 Turn off zero air and disconnect the zero air tubing from the primary.

5.7.2 Cap the vent, ozone, and zero air bulkheads. Cap the zero air dump inside the analyzer.

5.7.3 Press the Pressure soft key.

5.7.4 The pressure reading should drop less than 200 mm Hg.

5.7.5 It should take less than 30 seconds from the time the zero air dump is plugged to the time the reading below 200 mm Hg is obtained.

5.8 Adjust Lamp Setting (Manual Section 3-69)

Note: *The analyzer must be in service mode to perform this adjustment*.

5.8.1 Press the Main Menu button to display the Main Menu.

5.8.2 Use the down arrow button to scroll to Service and press the enter button to display the Service menu.

5.8.3 Use the down arrow button to scroll to Lamp Setting and press the enter button to display the Lamp Setting screen.

5.8.4 Use the up or down arrows to increment or decrement the numeric value until both intensities are as close to 100 kHz as possible.

5.8.5 Press the enter button to save the new lamp setting.

5.9 Detector Calibration Factor Adjustment (Manual Section 3-69)

Note: *The analyzer must be in service mode to perform this adjustment.*

5.9.1 Press the Main Menu button to display the Main Menu.

5.9.2 Use the down arrow button to scroll to Service and press the enter button to display the Service menu.

5.9.3 Use the down arrow button to scroll to Detector Calibration and press the enter button to display the Detector Calibration screen.

5.9.4 Verify both detector uncorrected readings are between 90 kHz and 110 kHz.

5.9.5 Press ↵ (Enter) to compute new calibration factors.

5.10 Solenoid Balance and Leak Test (Manual Sections 4-8 and 4-9)

5.10.1 Generate an ozone concentration of approximately 0.5 ppm.

5.10.2 Press the Main Menu button to display the Main Menu.

5.10.3 Use the down arrow button to scroll to Diagnostics and press the enter button to display the Diagnostics menu.

5.10.4 Use the down arrow button to scroll to Cell A/B 0_3 and press the enter button to display the 0_3 PPB screen. This display presents the concentration for each cell.

5.10.5 Once the instrument stabilizes, the average of 10 successive simultaneous readings from each cell should agree within ± 3 percent.

5.10.6 A balanced measurement of better than 3 percent indicates that there are no leaks across the solenoid.

5.10.7 A constant low reading from one cell indicates an imbalance. The imbalance can be caused by a dirty cell, dirty lines to that cell, or by a leaky valve.

5.10.8 To check if the imbalance is caused by a dirty cell, interchange the cells. If the imbalanced side switches, the imbalance is caused by the cell.

5.10.9 Perform the following test to check the solenoid for a leak.

- Remove the solenoid valve that appears to be faulty.
- Connect the solenoid cell test tubing to the test pump. The other end of the tubing will be connected to a tee fitting.
- Cap one open port on the tee fitting.
- Connect a pressure transducer to the open tee fitting port.
- Turn on the test pump.
- After the pressure has stabilized, record the reading as P_C.
- Turn off the test pump.
- Uncap the capped the tee fitting port.
- Connect the open tee fitting port to the common solenoid port.

- Cap the normally open solenoid port.
- Turn on the test pump.
- After the pressure has stabilized, record the pressure reading as P_{NO}.
- Turn off the test pump
- Uncap the normally open solenoid port.
- Cap the normally closed solenoid port.
- Plug the solenoid power line into the appropriate connector on the measurement interface board. Make sure the solenoid is activated.
- After the pressure has stabilized, record the pressure reading as P_{NC}.
- The solenoid is faulty if either P_{NO} or P_{NC} is greater than P_C.

5.10.1 If an imbalance is found, repair and return to step 5.8, adjusting the detector lamp setting

5.11 Pump Pressure Check (Manual Section 3-83)

Note: *The analyzer must be in service mode to perform this test.*

5.11.1 Turn off zero air and disconnect the zero air tubing from the primary.

5.11.2 Cap the vent, ozone, and zero air bulkheads. Cap the zero air dump inside the analyzer.

5.11.3 Press the Main Menu button to display the Main Menu.

5.11.4 Use the down arrow button to scroll to Service and press the enter button to display the Service menu.

5.11.5 Use the down arrow button to scroll to Pressure Check and press the enter button to display the Pressure Check menu.

5.11.6 Use the down arrow button to scroll to Pump Pressure and press the enter button to display the Pump Pressure screen.

5.11.7 The pressure reading should drop below 390 mmHg in less than 20 seconds. This indicates the effectiveness of the sample pump.

5.11.8 After 20 seconds, if the pressure is greater than 390 mmHg or the flow is greater than 0.010 LPM, the words “PUMP PROBLEM DETECTED” appear. Otherwise the words “PUMP OK” appear.
If the pump or pump diaphragm need to be replaced refer to step 5.13.

5.12 Leak Test (Manual Section 4-7)

5.12.1 Refer to step 5.7.

5.13 Sample Pump Maintenance.

5.13.1 Replace the sample pump if, during a leak check, the pressure remains between 200 and 250 mm Hg, the diaphragm is in good condition, and a leak is not suspected. The sample pump may not be strong enough to pull more vacuum.

- Turn off the analyzer and unplug the power cord.
- Remove the cover.

- Unplug power lead of pump from Power Supply Board.
- Loosen fittings and remove all 1/4-inch Teflon lines from pump.
- Remove four screws holding pump bracket to shock mounts and remove pump.
- Install new pump by following the above procedure in reverse.
- Re-install the cover, plug in the power cord, and turn the instrument on.
- Refer to step 5.7 and perform leak test.
- Return to step 5.6, flow transducer calibration.

5.13.2 Sample Pump Diaphragm Removal Procedure

- The sample pump diaphragm may need to be replaced if the pressure exceeds 200 mm Hg and a leak is not suspected.
- Remove the four screws on the top of the sample pump and place the block with the vacuum and pressure ports to one side.
- Remove the screw and collar from the diaphragm and inspect the diaphragm for tears or excessive wear and / or cracking. Replace if necessary.
- The valve body (if the pump is an ASF pump) and the Teflon gasket may need to be replaced as well.
- Reinstall the top block and screws.
- Refer to step 5.7 and perform a leak test.
- Return to step 5.6, flow transducer calibration.

5.14 Pressure Transducer Adjustment (49C-PS) (Manual Section 6-12)

The pressure sensor calibration requires a high vacuum pump capable of < 1mmHg (≈1 torr). If such a pump is unavailable, only adjust the pressure span setting.

Note: *The analyzer must be in service mode to perform this adjustment.*

- From the **Run** screen, choose **Menu** to display the Main menu. Press the ↓ button to move the cursor to **Instrument Control**. Press <**Enter**> to display the **Instrument Control** menu. Press the ↓ button to move the cursor to **Pressure Correction**. Press <**Enter**> to display the pressure reading.
- Adjust the zero potentiometer on the pressure transducer for a reading of 0 mm Hg.
- Disconnect the vacuum pump. After the readings equilibrate, adjust span potentiometer if deviation > 5mmHg.

5.15 Temperature Sensor Adjustment (49C-PS) (Manual Section 6-13)

Note: *The analyzer must be in service mode to perform this adjustment.*

- Remove bench thermistor signal cable from the mother board.
- Unscrew thermistor from the optical bench.
- Reconnect signal cable to mother board.
- Place thermistor through foam in an empty insulated thermos with temperature primary standard.

- After the readings equilibrate, if the deviation is > 2°C, adjust the gain potentiometer on the Analog to Digital Board until the sensor agrees with the primary.

6.0 PROCEDURES

The Thermo model 49C and 49*i* Primary Standards are certified annually by comparison with the NIST Standard Reference Photometer (SRP). All procedures for this comparison are performed under the direction of the NIST SRP operator. An example of a calibration produced by this process is provided in Figure 2.

6.1 Annual Certification Preparation

Prior to the annual certification the following procedures should be performed:

- Check battery voltage (49C-PS only). If it is lower than 3.0 vdc replace;
- Internal pressure regulators should read 10 psi, and instruct technician with NIST to operate unit at this pressure.
- Pack inside of calibrator with foam pieces to reduce jarring during shipment. Be sure to attach tag to unit informing NIST technician to remove packing prior to turning calibrator on. Also include a pre-addressed return FedEx air bill.

7.0 REFERENCES

Thermo Electron Corporation. 1997. *Model 49C UV Photometric Analyzer Instrument Manual*

Thermo Fisher Scientific. 2006. *Model 49i Instruction Manual, UV Photometric O_3 Analyzer Part number 102434-00*

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring.* 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS).* 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1997. *National 8-Hour Primary and Secondary Ambient Air Quality Standards for Ozone.* 40 CFR 50, Appendix I.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods*. EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements*. EPA-600/4-82-060.

U.S. Environmental Protection Agency (EPA). 1979. *Transfer Standards for Calibration of Air Monitoring Analyzers for Ozone, Technical Assistance Document*. EPA-600/4-79-056.

8.0 FIGURES

Figure 2. Example of O_3 EPA Region 7 Calibration Form

Standard Reference Photometer #000380
Calibration Report

Calibrating Institute:	US_EPA REGION 7	**Date:**	7-Feb-08
Operator:	US_EPA	**Start Time:**	12:15
Instrument:	SRP 13 Cell Length=89.45	**End Time:**	13:15
Comment:	Verification of TECO 49i-ps- S/N 0801827200 - using Se	**Filename:**	c0207004.xls

Calibrated Instrument:	Guest#1	**Calibration Results**	**Value**	**Standard Uncertainty**
Owner:	MACTEC			
Contact:	Dan Lucas/ Kent Brakefield	**Slope**	1.00590	0.00066
Make:	TECO	**Intercept**	-0.19849	0.19914
Model:	49i-ps	**Covariance**		-1.7642E-07
Serial Number:	801827200	**Res Std Dev**	0.24594	

Calibration Parameters: Raw Saved;Dark Count On (4)
Air Flow Rate: 7.0 l/min
Lamp Intensity Range: 0.0 to 50.0 %
Number Conc. Points: 6 **Points/Concentration:** 10
Conditioning: 53.0 % for 2 minutes

Calibration	**SRP 13**		**Guest#1**		**Guest#1**	
Data Points	**Result**	**Std. Dev**	**Result**	**Std. Dev**	**Predicted**	**Residual**
Dark Count 1	9					
Dark Count 2	12					
1	496.9	0.8	499.9	0.3	499.62	0.32
2	398.2	0.3	400.0	0.1	400.39	-0.39
3	298.4	0.3	300.0	0.1	299.98	0.04
4	199.2	0.3	200.0	0.1	200.18	-0.15
5	99.5	0.7	100.0	0.4	99.84	0.14
6	0.2	0.1	0.1	0.1	0.01	0.04

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IV. CALIBRATION LABORATORY
A. PRIMARY STANDARD
2. BIOS FLOW METER

Effective Date: 10/30/14

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, Project QA Manager

Approved by: Holton K. Howell, Project Manager

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Reviewed by:	Title:	Date:	Signature:
MS	QA Mgr	11/2/15	

IV.A.2. BIOS FLOW METER

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide consistent guidance for repair, maintenance, and certification of the Bios Flow Meter to Clean Air Status and Trends Network (CASTNET) Field Certification Laboratory personnel.

2.0 SCOPE

This SOP applies to the repair, maintenance, and certification of all Bios Flow Meters administered by the CASTNET Field Certification Laboratory.

3.0 SUMMARY

The Bios Flow meters administered by the CASTNET Field Certification Laboratory are leak tested and recharged on a quarterly basis. Each meter is returned to the manufacturer annually for routine maintenance and certification.

4.0 MATERIALS

Bios Model DCL-MH DC-Lite Flow Meter and Bios DryCal NEXUS flow cell, or
Bios Model Definer 220
Bios 12 volts direct current (VDC) charger or
Bios Air PRO 4000D charger
Latex flow tubing

5.0 SAFETY

As with all electronic equipment, take precautions to avoid electric shock.

6.0 PROCEDURES

The Bios Primary Air Flow Meter (Bios) is returned to the manufacturer annually for routine cleaning, maintenance, calibration, and certification (see sample factory certificates in Figures 1 and 2).

6.1 Repair and Maintenance

All repairs and adjustments are performed by the manufacturer.
When not in use, store in a clean, dry environment with the inlet/outlet caps installed. Every quarter, fully charge the battery pack, and perform a leak test.

6.2 Charging the Battery

Before using your Bios, be sure that the battery system has been fully charged to ensure that the unit will perform to specifications and maintain proper operation for the required time period.

The Bios is equipped with a battery indicator that displays battery charge. When the battery indicator on the display is empty, the unit will continue to operate for a short period of time before shutting itself off.

6.3 To Charge the Bios:

6.3.1 Connect only the appropriate 12VDC charger, provided with the Bios flow meter, into a standard wall outlet. Optionally, one station of the BIOS AirPro 4000D multi-station charger may be used.

6.3.2 Insert the charger barrel plug. The unit will indicate that it is charging. Full charge takes 8 to 12 hours, and the unit can charge while being used.

6.3.3 The Definer 220 will indicate charging status on its LCD readout. To view the actual charging status of the DC Lite during the charging period, disconnect the battery charger and wait 3 to 5 minutes. When the indicator is solid black the battery is fully charged.

Note: *The unit may be charged for an indefinite time period without causing battery damage.*

6.4 Battery Maintenance:

Lead-acid batteries will not exhibit the “memory effect” common to nickel-cadmium batteries. A lead acid battery may be charged for an indefinite time period without damage. Return unit to the manufacturer for repair if battery damage is suspected.

6.5 Long-Term Storage:

Long-term storage without charging can damage the battery pack; therefore, if the Bios cannot be left charging continuously, it should be charged at least every 3 months.

6.6 Leak-Test Check Procedure (DC-Lite/NEXUS)

The DC-Lite has a built-in quality assurance self-test feature to verify proper integrity and operation of the DC-Lite flow cell (see the DC-Lite manual). When the NEXUS is introduced into the flow stream, the NEXUS represents additional opportunities for leakage. We recommend that the NEXUS flow path be included in the leak test process.

The leak test for the DC-Lite and NEXUS combination is very similar to the leak test defined in the DC-Lite manual with only a small modification. Connect tubing from the NEXUS to either the inlet or outlet of the DC-Lite and connect the leak test fitting to the remaining NEXUS air boss. Make sure the electronic cable is disconnected.

To initiate the leak test:

6.6.1 Connect either the DC-Lite inlet or outlet to the NEXUS with tubing and then place the leak test tubing accessory (short piece of tubing with red cap) over the remaining NEXUS air boss. The low flow range DC-Lite (DCL500) requires a tubing adapter to connect to the larger NEXUS air boss.

6.6.2 After the tubing connections have been made, from the DC-Lite key pad, press and hold the **<Stop>** button while pressing the **<On>** button. The DC-Lite display will read:

Leak Test Invert Push Read

Note: *If the DC-Lite is already "ON", press and hold the* ***<Stop>*** *button while pressing the* ***<Hard Reset>*** *button on the back of the DC-Lite unit.*

6.6.3 Invert the DC-Lite so the piston moves to the top of the cell. While the piston is resting at the top of the cell press the **<Read>** button and the internal valve will close. Return the DC-Lite to an upright position and it will time the descent of the piston.

Note: *The test may take as long as 15-20 minutes. Observe the location of the piston to ensure that it is at the top of the cell when the test begins.*

If the test is completed successfully, the display will read:

Test OK Push Read

6.6.4 Press the **<Read>** button as directed and the internal valve will open and the piston will fall.

6.6.5 Repeat the test with the leak test tubing accessory connected to air boss not connected to the NEXUS.

Note: *If the unit fails the leak-test, the display will read message below. Check connections to ensure no setup failure has occurred and if not, return to manufacturer for repair:*

Maintenance Reqd Push Read

6.7 Leak Test Procedure (Definer 220)

The Definer Leak Test is designed only to verify the internal integrity of the instrument and alert you to an internal leak. We recommend performing the Leak Test only as an intermediate quality control check or whenever the integrity of the instrument is questioned due to misuse or accidental damage.

Please note that a leak test is not a substitute for a comprehensive examination of the unit's overall performance and it does not ensure that the Definer is operating accurately.

- Invert the Definer and allow the piston to travel to the top.
- Cap the port under test using the Bios supplied leak test cap. Leave the other port uncapped.
- Press Enter on the control panel while the unit is still inverted.
- Return the unit upright. The leak test will progress.

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*. 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)*. 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods.* EPA-600/4-77-027a.

Bios International Corporation. 2002. DryCal DC-Lite Manual

8.0 FIGURES

Figure 1 Sample Certification

BIOS

BIOS International Corporation • 10 Park Place, Butler, NJ 07405 USA
Phone: (973) 492-8400 • Fax: (973) 492-8270 • www.biosint.com

calibration certificate

DRYCAL NEXUS TEMPERATURE AND PRESSURE SENSOR CALIBRATION

The DryCal Lite is a true primary *volumetric* flow standard. A separate calibration certificate is supplied with the flow measuring cell(s). Temperature and pressure corrections are then applied by the Nexus to obtain *standardized* flow readings. The temperature and pressure transducers are calibrated against NIST traceable standards to obtain the standardized readings.

BIOS International certifies that the following DryCal Nexus has been calibrated against the following standards:

- Ambient temperature using precision thermometer 21 °C
- Nexus Temperature reading 21 °C

Calibration Standard	Telatemp 4400T		Serial No. 300907	
Date of Calibration	03/21/2000	Date Due	03/21/2001	NIST No. 811/260178

- Ambient pressure using precision pressure indicator 751 mm Hg
- Nexus pressure reading 751 mm Hg

Calibration Standard	Druck DPI 740		Serial No. 431/98-09	
Date of Calibration	10/31/2000	Date Due	10/31/2001	NIST No. E2828 822/249620

All calibrations performed in accordance with ANSI/NCSL Z540-1-1994

Serial Number 1023 Nexus Air # 00587

By Machek Pankow Date 7/17/01

Machek Pankow

1 of 1

Figure 2 Sample Certification

BIOS

BIOS International Corporation • 10 Park Place, Butler, NJ 07405 USA
Phone: (973) 492-8400 • Fax: (973) 492-8270 • www.biosint.com

AS SHIPPED FLOW DATA:

Product DCL-MH

Serial No. 1153 20k Air #00579 → EPA # 000307

Date 7/26/01

Laboratory Environment:

Temperature Ambient: 21.04°C

Pressure Ambient: 749.9 mmHg

Humidity Ambient: 54 %

Instrument Reading ml/min	Lab Standard Reading ml/min	Lab Standard Unit #	Deviation Percentage	Allowable Deviation	Condition Shipped
200.7	200	1002	0.35	1.00%	in tolerance
503.6	500.15	1003	0.69	1.00%	in tolerance
2014	2002	1001	0.60	1.00%	in tolerance
5026	5000.5	1001	0.51	1.00%	in tolerance
17040	17015	1001	0.15	1.00%	in tolerance

Notes:

By: Sonia Otero (signature)
Sonia Otero

Date: 7/26/01

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IV. CERTIFICATION LABORATORY
A. PRIMARY STANDARDS
3. EPPLEY PYRANOMETER

Effective Date: 11-10-11

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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MS	QA Mgr	11/2/15	[signature]

IV.A.3. EPPLEY PYRANOMETER

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance for repair, maintenance, and certification of the Eppley pyranometer to Clean Air Status and Trends Network (CASTNET) Field Calibration Laboratory personnel.

2.0 SCOPE

This SOP applies to the repair, maintenance, and certification of all Eppley pyranometers administered by the CASTNET Field Calibration Laboratory.

3.0 SUMMARY

Eppley precision pyranometers administered by the CASTNET Field Calibration Laboratory are checked for level, moisture control, translator card adjustment, and cleanliness biweekly. Each unit is returned to the manufacturer annually for maintenance and certification.

4.0 MATERIALS AND SUPPLIES

Eppley Model PSP Precision Spectral Pyranometer
Electronically matched Translator Card
Desiccant (mesh grade 48)
Soft, lint-free cloth
Screwdriver

5.0 REPAIR AND MAINTENANCE

All repairs and adjustments are performed by the manufacturer.

Inspect the pyranometer twice a week for being level, silica gel condition, and wipe clean the hemisphere daily. (Figure 1 gives the characteristics of the Eppley Model PSP.)

Note: *Record all maintenance in the logbook in the CASTNET shelter*.

5.1 Leveling the pyranometer

A circular spirit level is located on the base ring (Figure 1) of the pyranometer and can be viewed through the hole in the radiation shield. Adjust the three leveling screws on the base ring of the pyranometer to center the level's bubble in the bull's eye ring.

5.2 Changing the silica gel

The desiccator is installed in the side case of the pyranometer and should be replaced whenever the silica gel drying agent is pinkish in color. To remove desiccator, unscrew the silver ring using a small pair of pliers. Separate the small black vial from silver ring and replace the silica gel with fresh product. Re-assemble in reverse order.

5.3 Lens Cleaning

With a clean, dry, lint-free soft cloth, very gently clean the glass hemisphere of the pyranometer.

6.0 PROCEDURES

Eppley PSP is returned annually to the manufacturer for routine maintenance, calibration, and certification. Upon receipt following annual certification the correct sensitivity constant must be entered into the solar radiation calibration data-logger. Figure 2 is a sample annual calibration certification from the manufacturer.

7.0 REFERENCES

The Eppley Laboratory, Inc., Model PSP Radiometer Sensor Manual.

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*. 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)*. 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods*. EPA-600/4-77-027a.

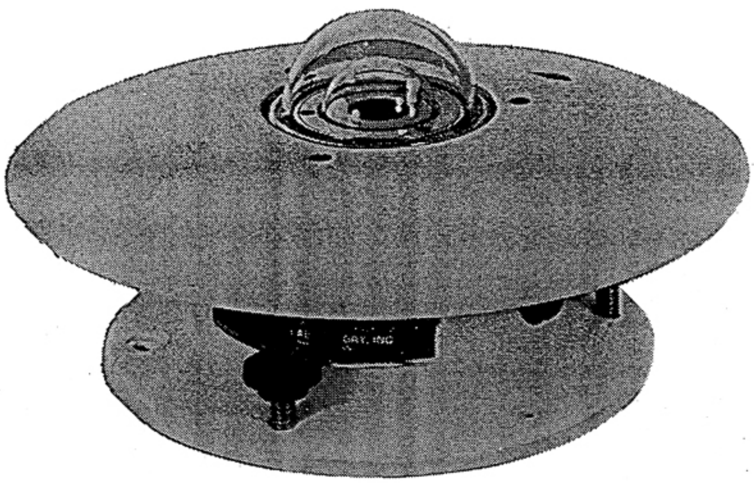
U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements*. EPA-600/4-82-060.

8.0 FIGURES

Figure 1 Eppley Model PSP Characteristics

EPPLEY PRECISION PYRANOMETER

Model PSP



INSTRUMENT CHARACTERISTICS

Sensitivity	9 microvolts per watt meter^{-2} approx.
Impedance	650 ohms approx.
Receiver	circular 1 cm^{-2}, coated with Parsons' black optical lacquer
Temperature dependance	$\pm$ 1 per cent over ambient temperature range -20 to +40°C (temperature compensation of sensitivity can be supplied over other ranges at additional charge
Linearity	$\pm$ 0.5 per cent from 0 to 2800 watts m^{-2}
Response time	1 second (i/e signal)
Cosine	$\pm$ 1 per cent from normalization 0-70° zenith angle $\pm$ 3 per cent 70-80° zenith angle
Orientation	no effect on instrument performance
Mechanical vibration	tested up to 20g's without damage
Calibration	integrating hemisphere (approx. 700 watts/meter ambient temperature +25°C): calibration reference Eppley primary standards
Readout	reproducing the World Radiation Reference

Fig. 1

Figure 2. Sample Calibration Certification

THE EPPLEY LABORATORY, INC.
12 Sheffield Ave., P.O. Box 419, Newport, RI 02840 USA
Telephone: 401-847-1020 Fax: 401-847-1031

EPLAB
Scientific Instruments
for Precision Measurements
Since 1917

STANDARDIZATION OF EPPLEY PRECISION SPECTRAL PYRANOMETER Model PSP

Serial Number: 26385F3

Resistance: 613 Ω at 23 °C
Temperature Compensation Range: -20 to 40 °C

This radiometer has been compared with Standard Precision Spectral Pyranometer, Serial Number 21231F3 in Eppley's Integrating Hemisphere under radiation intensities of approximately 700 watts meter^{-2} (roughly one-half a solar constant). The adopted calibration temperature is 25 °C.

As a result of a series of comparisons, it has been found to have a sensitivity of:

7.84 x 10^{-6} volts/watts meter^{-2}

5.47 millivolts/cal cm^{-2} min^{-1}

The calculation of this constant is based on the fact that the relationship between radiation intensity and emf is rectilinear to intensities of 1400 watts meter^{-2}. This radiometer is linear to within ± 0.5% up to this intensity.

The calibration of this instrument is traceable to standard self-calibrating cavity pyrheliometers in terms of the Systems Internationale des Unites (SI units), which participated in the Eighth International Pyrheliometric Comparisons (IPC VIII) at Davos, Switzerland in October 1995.

Useful conversion facts: 1 cal cm^{-2} min^{-1} = 697.3 watts meter^{-2}
1 BTU/ft^{2}-hr^{-1} = 3.153 watts meter^{-2}

Shipped to:
Environmental Science
Newberry, FL

Date of Test: June 30, 1999

In Charge of Test: R.T. Freeman

S.O. Number: 57564
Date: July 7, 1999

Reviewed by: Thomas D Kirk

Remarks:

IV. CERTIFICATION LABORATORY
A PRIMARY STANDARDS
4. THERMOMETERS TRACEABLE TO THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

Effective Date: 11-10-11

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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IV. A. 4. THERMOMETERS TRACEABLE TO THE NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY (NIST)

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance to Clean Air Status and Trends Network (CASTNET) Field Equipment Calibration Laboratory technicians in the maintenance and handling of liquid in glass thermometers with certification traceable to the National Institute of Standards and Technology (NIST).

2.0 SCOPE

This SOP applies to the maintenance and handling of NIST traceable thermometers administered by the CASTNET Field Equipment Calibration Laboratory.

3.0 SUMMARY

See Sections 5.0 and 6.0.

4.0 MATERIALS AND SUPPLIES

Liquid in glass thermometer(s) certified for the appropriate temperature range(s).

5.0 REPAIR AND MAINTENANCE

Before each use, inspect the column to ensure that there is no mercury separation. If separation is observed, eliminate it prior to use by shaking, heating, or cooling the thermometer.

6.0 PROCEDURES

NIST thermometers are returned to the manufacturer annually for calibration and certification. All primary standard thermometers are certified as traceable to the NIST. Separate thermometers are certified for each of 6 different temperature ranges. See Figures 1-6 for sample certifications.

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring.* 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS).* 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods*. EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements*. EPA-600/4-82-060.

8.0 FIGURES

Figure 1: Sample Certificate

Brooklyn Thermometer Company Inc.

FARMINGDALE, N.Y. 11735

Factory Certificate

Liquid In Glass Thermometer

Marked: 91581 ✓

Range: -1 to 1°C in 0.01° Divisions

Immersion: 4"

Catalog Number: 22291-D4-FC

Tested For: QST Environmental P.O. #95086-310

Temperature	Thermometer Reading	Correction
0°C	-0.001	+0.001

REFERENCE NIST TEST NO. 259980-98

This thermometer has been tested by comparison with standards certified by the National Institute of Standards & Technology (formerly NBS). For applicable accuracy tolerance and factors affecting its use refer to N.B.S. Monograph 150. If the correction is + the true temperature is higher than the thermometer reading; if the correction is - the true temperature is lower than the thermometer reading. All temperatures are based on the ITS-90. If the ice point is included, a subsequent change in its reading will change all other readings by the same amount. Calibration per MIL-STD-45662A.

Brooklyn Thermometer Company Inc.
per P. R. Teichert

January 28, 1999 P. R. Teichert

Figure 2: Sample Certificate

Brooklyn Thermometer Company Inc.

FARMINGDALE, N.Y. 11735

Factory Certificate

Liquid In Glass Thermometer

Marked: 91591✓

Range: -1 to 11°C in 0.01° Divisions

Immersion: 4"

Catalog Number: 22626-D4-FC

Tested For: QST Environmental P.O. #95086-310

Temperature	Thermometer Reading	Correction
5°C	4.985	+0.015

REFERENCE NIST TEST NO. 214868

This thermometer has been tested by comparison with standards certified by the National Institute of Standards & Technology (formerly NBS). For applicable accuracy tolerance and factors affecting its use refer to N.B.S. Monograph 150. If the correction is + the true temperature is higher than the thermometer reading; if the correction is - the true temperature is lower than the thermometer reading. All temperatures are based on the ITS-90. If the ice point is included, a subsequent change in its reading will change all other readings by the same amount. Calibration per MIL-STD-45662A.

Brooklyn Thermometer Company Inc.

per P. R. Teichert

January 28, 1999

Figure 3: Sample Certificate

Brooklyn Thermometer Company Inc.

FARMINGDALE, N.Y. 11735

Factory Certificate

Liquid In Glass Thermometer

Marked: 91551 ✓

Range: 9 to 21°C in 0.01° Divisions

Immersion: 4"

Catalog Number: 22628-D4-FC

Tested For: QST Environmental P.O. #95086-310

Temperature	Thermometer Reading	Correction
10°C	10.000	0.000
20°C	20.000	0.000

REFERENCE NIST TEST NO. 199114

This thermometer has been tested by comparison with standards certified by the National Institute of Standards & Technology (formerly NBS). For applicable accuracy tolerance and factors affecting its use refer to N.B.S. Monograph 150. If the correction is + the true temperature is higher than the thermometer reading; if the correction is - the true temperature is lower than the thermometer reading. All temperatures are based on the ITS-90. If the ice point is included, a subsequent change in its reading will change all other readings by the same amount. Calibration per MIL-STD-45662A.

Brooklyn Thermometer Company Inc.

per P. R. Teichert

January 28, 1999 P. R. Teichert

Figure 4: Sample Certificate

Brooklyn Thermometer Company Inc.

FARMINGDALE, N.Y. 11735

Factory Certificate

Liquid In Glass Thermometer

Marked: 91552 ✓

Range: 19 to 31°C in 0.01° Divisions

Immersion: 4"

Catalog Number: 22630-D4-FC

Tested For: QST Environmental P.O. #95086-310

Temperature	Thermometer Reading	Correction
20°C	19.990	+0.010
30°C	30.009	-0.009

REFERENCE NIST TEST NO. 213426

This thermometer has been tested by comparison with standards certified by the National Institute of Standards & Technology (formerly NBS). For applicable accuracy tolerance and factors affecting its use refer to N.B.S. Monograph 150. If the correction is + the true temperature is higher than the thermometer reading; if the correction is - the true temperature is lower than the thermometer reading. All temperatures are based on the ITS-90. If the ice point is included, a subsequent change in its reading will change all other readings by the same amount. Calibration per MIL-STD-45662A.

Brooklyn Thermometer Company Inc.

per

P. R. Teichert

January 28, 1999

Figure 5: Sample Certificate

Brooklyn Thermometer Company Inc.

FARMINGDALE, N.Y. 11735

Factory Certificate

Liquid In Glass Thermometer

Marked: 91553 ✓

Range: 29 to 41°C in 0.01° Divisions

Immersion: 4"

Catalog Number: 22632-D4-FC

Tested For: QST Environmental P.O. #95086-310

Temperature	Thermometer Reading	Correction
30°C	29.999	+0.001
40°C	40.000	0.000

REFERENCE NIST TEST NO. 203537

This thermometer has been tested by comparison with standards certified by the National Institute of Standards & Technology (formerly NBS). For applicable accuracy tolerance and factors affecting its use refer to N.B.S. Monograph 150. If the correction is + the true temperature is higher than the thermometer reading; if the correction is - the true temperature is lower than the thermometer reading. All temperatures are based on the ITS-90. If the ice point is included, a subsequent change in its reading will change all other readings by the same amount. Calibration per MIL-STD-45662A.

Brooklyn Thermometer Company Inc.

per

January 28, 1999 P. R. Teichert

Figure 6: Sample Certificate

Brooklyn Thermometer Company Inc.

FARMINGDALE, N.Y. 11735

Factory Certificate

Liquid In Glass Thermometer

Marked: 91554

Range: 39 to 51°C in 0.01° Divisions

Immersion: 4"

Catalog Number: 22634-D4-FC

Tested For: QST Environmental P.O.#95086-310

Temperature	Thermometer Reading	Correction
40°C	39.990	+0.010
50°C	50.009	-0.009

REFERENCE NIST TEST NO. 227121

This thermometer has been tested by comparison with standards certified by the National Institute of Standards & Technology (formerly NBS). For applicable accuracy tolerance and factors affecting its use refer to N.B.S. Monograph 150. If the correction is + the true temperature is higher than the thermometer reading; if the correction is - the true temperature is lower than the thermometer reading. All temperatures are based on the ITS-90. If the ice point is included, a subsequent change in its reading will change all other readings by the same amount. Calibration per MIL-STD-45662A.

Brooklyn Thermometer Company Inc.

per

P. R. Teichert

January 28, 1999

IV. CERTIFICATION LABORATORY
A. PRIMARY STANDARDS
5. VAPORTRON H-100L PRECISION RELATIVE HUMIDITY LAB

Effective Date: 11-10-11

Reviewed by: Kevin P. Mishoe, Field Operations Manager — [signature]

Reviewed by: Marcus O. Stewart, Project QA Manager — [signature]

Approved by: Holton K. Howell, Project Manager — [signature]

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IV.A.5. VAPORTRON H-100L PRECISION RELATIVE HUMIDITY LAB

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide consistent guidance for maintenance and handling of the Vaportron H-100L Precision Relative Humidity Lab to Clean Air Status and Trends Network (CASTNET) Field Calibration Laboratory personnel.

2.0 SCOPE

This SOP applies to the maintenance and handling of Vaportron H-100L Precision Relative Humidity Lab units administered by the CASTNET Field Calibration Laboratory.

3.0 SUMMARY

The Vaportron's internal water reservoir is emptied and refilled routinely every 1 to 6 weeks and is returned to the manufacturer annually for routine maintenance and certification.

4.0 MATERIALS

Vaportron Model H-100L Precision Relative Humidity Lab
Distilled water
Desiccant - spherical indicating silica gel, mesh grade 48

5.0 SAFETY

Electrical components inside the machine are an electrocution hazard. Take necessary precautions, such as wearing an antistatic wristband and gloves, while working inside of the machine.

6.0 PROCEDURE

The Vaportron H-100L Precision Humidity is returned to the manufacturer annually for routine maintenance, cleaning, calibration, and certification.

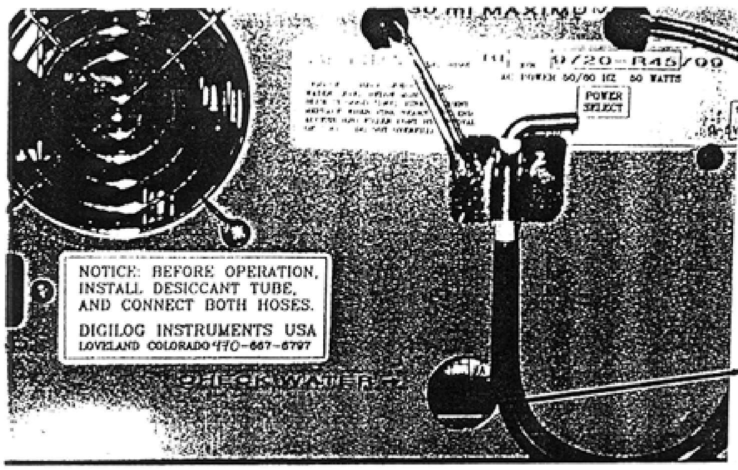
6.1 Water Reservoir Check and Water Service Procedure

The Vaportron internal vapor saturator/water reservoir is designed for long service between re-fills. Depending on the amount of use, the normal refill of water should last from 4 to 6 weeks to only 1 week for continuous use or heavy cycling from high to low relative humidity (RH) levels.

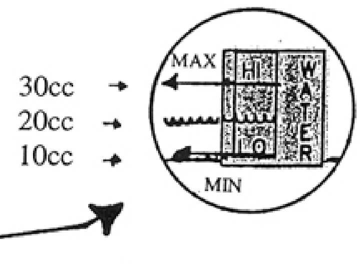
To check the water level, remove the desiccant cartridge and look into the large window near the left desiccant hanger hook (Figure 1). Use the small inspection lamp as supplied in the service kit. If necessary, tilt the Vaportron chassis fore/aft or left/right about 20 degrees. This can help to visually locate the water level.

The water level must be between the lower and upper red lines on the fill level decal. **NEVER ADD MORE THAN 30 CC OF WATER**. Use distilled water, if available. Use clean tap water (or bottled water) if distilled water is not available. The blunt-needled syringe from the service kit should be used for easiest fill. Always reinstall the small red cap after adding water.

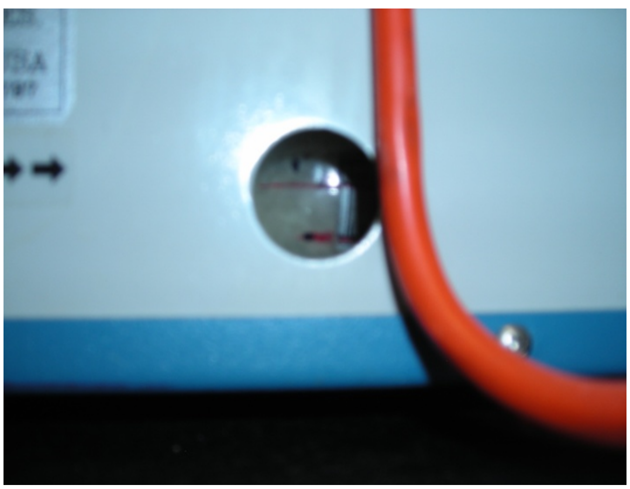
Figure 1 Water Gauge Window

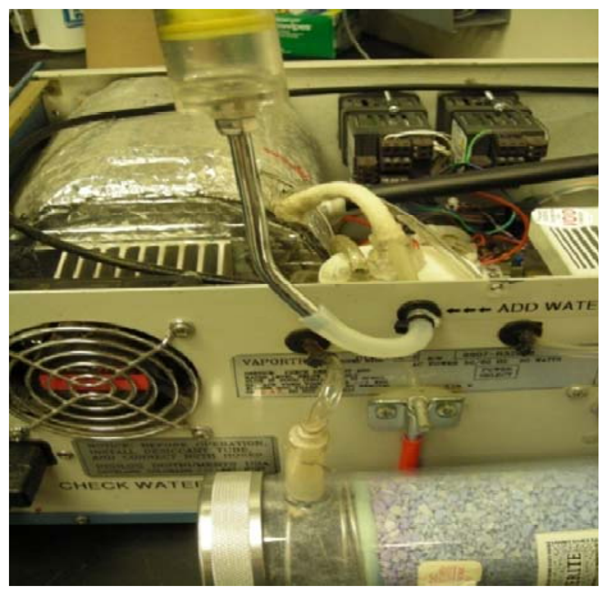


Water Gauge Window Location



Gauge Decal Detail





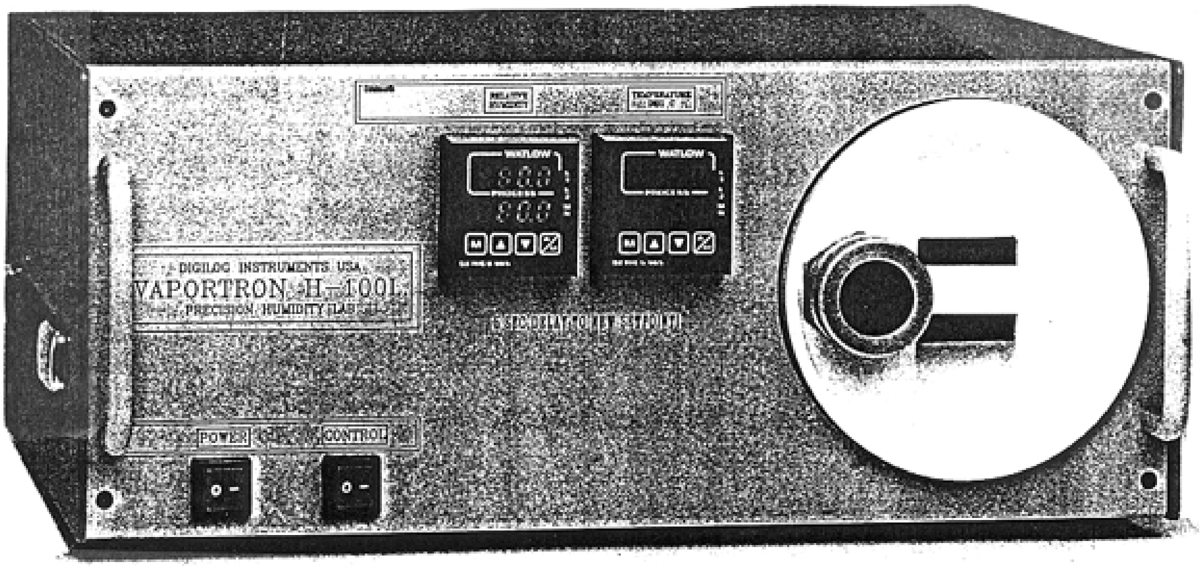
6.2 Desiccant/Drier Cartridge Service

The plastic desiccator tube holds enough material to run the Vaportron typically for 1 month (Figure 2). The drier material gradually turns from dark blue when dry to pink or grey-white when depleted. Normally, a sharp contrast is seen when using granular calcium sulfate material between the depleted and fresh section (depletion is from left to right from back view).

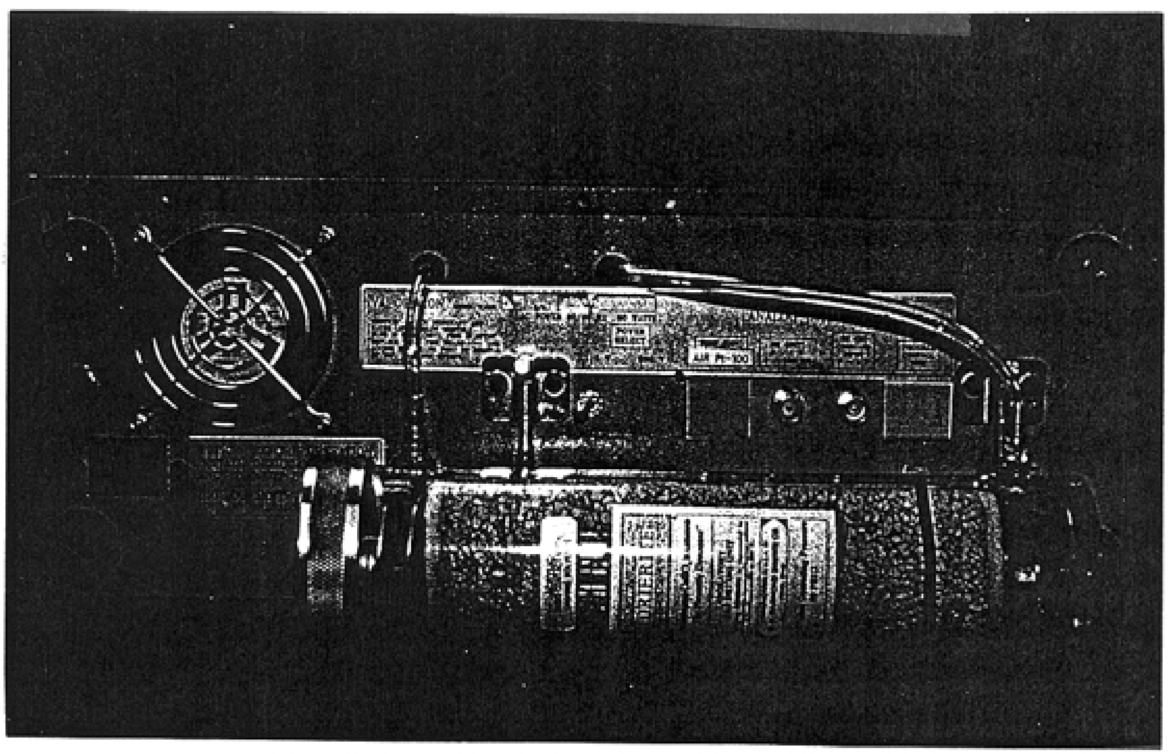
For Vaportrons with an external sample loop option, the desiccator tube is normally filled with spherical indicating silica gel. The silica dries the air by a mechanical method as opposed to chemical and is less "dusty". This allows longer use of chilled mirrors before mirror contamination occurs. The factory advises changing the desiccant at 1 inch to left of the red line when using the silica gel-filled drier cartridges. The properly reinstalled cartridge is shown in Figure 3.

Figure 2 Installing drier cartridge

Figure 3 Vaportron front and rear panels



VAPORTRON H-100BL FRONT PANEL



REAR PANEL WITH DESICCANT CARTRIDGE CORRECTLY INSTALLED

7.0 REFERENCES

Digilog Instruments. 1997. *Vaportron H-100L Precision Relative Humidity Lab Provisory Users Guide*

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring.* 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS).* 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems*, *Vol. II*, *Ambient Air Specific Methods*. EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements*. EPA-600/4-82-060.

8.0 ATTACHMENTS

8.1 The Factory ASTM Calibration Reference System

Each Vaportron reference sensor is calibrated against the Laboratory ASTM multiple point saturated salt chambers. The salt chambers are operated in accordance with Salt/Hydrate literature in ASTM 1991, E 104-85. The values of Greenspan, L., 1977 #81A [National Bureau of Standards (NBS)/National Institute for Standards and Technology (NIST), Journal of Research] are used.

The following salt/hydrate types are used:

Salt Type	RH Value at 25°C	STD Deviation at 25°C
Lithium-Chloride	11.4	0.27
Magnesium-Chloride	32.7	0.16
Potassium-Nitrate	48.2	0.21 (est)
Sodium-Bromide	57.6	0.40
Sodium-Chloride	75.3	0.12
Potassium-Chloride	84.3	0.26
Potassium-Sulfate	97.3	0.45

Note: °C = degrees Celsius.

The performance of the reference sensor supplied in the Vaportron has been recorded at each of these points, and a certificate of accuracy is shipped with each chamber system. Figure 4 is a sample factory calibration certification. Figure 5 is a flow diagram representing the Vaportron traceability, and certification frequency.

To qualify for use in a Vaportron unit, each sensor must have a less than 1% average error when calibrated over this range and no single point can exceed 1.5% RH.

The sensor is calibrated at a mid-level RH value of 20 to 50% RH using a GEI Model 1500 (or better) Chilled Mirror Hygrometer. The hygrometer supports an approximate 1% RH accuracy in this range. This comparison allows NIST/NBS traceability for the systems.

Other salt/hydrate values are available to extend the comparison coverage in a given area or to gain more points at the dry end. A “zero” point check is also available at an RH level of 0.4% RH.

ATTACHMENT A
Sample Factory Calibration Certification

DIGILOG INSTRUMENTS
7617 JOEL PLACE LOVELAND, CO 80537 USA
(970) 667-6797 PHONE
(970) 667-8559 FAX

DIGILOG INSTRUMENTS A.S.T.M / N.I.S.T. CALIBRATION DATA DOCUMENT

Date 5/5/97 Customer ESP / SEALED UNIT PARTS CO.

Instrument Type VAISALA HMP-35AC Orig Cal ✓ Re-Cal___

Unit(s) Serial # H-100 BL - 9719 - V484 ØØ43

Special Comments on test STD FACTORY CROSS check

As Found Test Data: Below -

****

A.S.T.M Test Point Values Listed Below (%RH) all points at 25.0 deg C

11.4%-----32.8%-----48.2%-----57.7%-----75.3%-----84.2%-----97.1%

11.6 33.0 48.5 58.0 76.0 84.5 96.8

Instrument Test Point Values Listed Above
Deviation (difference) Listed Below

+Ø.2 +Ø.2 +Ø.3 +Ø.3 +Ø.7 +Ø.3 -Ø.3

Average Error from 7 test points listed +Ø.33 Max +Ø.7 Min -Ø.3
Nominal time at value is 30 min for 11-58%, 1 hr for 75% and 84%, and 2-4 hours for 97% RH. Instrument Temp reading 25.0 +/- 0.2

****

* Note, the ASTM method is in compliance with ASTM publication #E 104-85 of 1985. The RH values are from L. Greenspan; 1977, NBS Journal of Research. The standard deviation of the seven reference values is 0.276 % RH.

****

N.I.S.T. METHOD TEST DATA (at 24.0 C chamber temp) *

Generator Test Value RH	Dew point	N.I.S.T. Traced Reference RH	Dew point	Deviation RH %
10.0	-9.Ø	9.5	-9Ø	-Ø.5
20.0	-0.3 C	19.8	-Ø.2	-Ø.2
30.0	5.4 C	30.0	5.45	Ø.Ø
50.0	12.9 C	5Ø.2	12.95	+Ø.2
75.0	19.3 C	74.8	19.25	-Ø.2

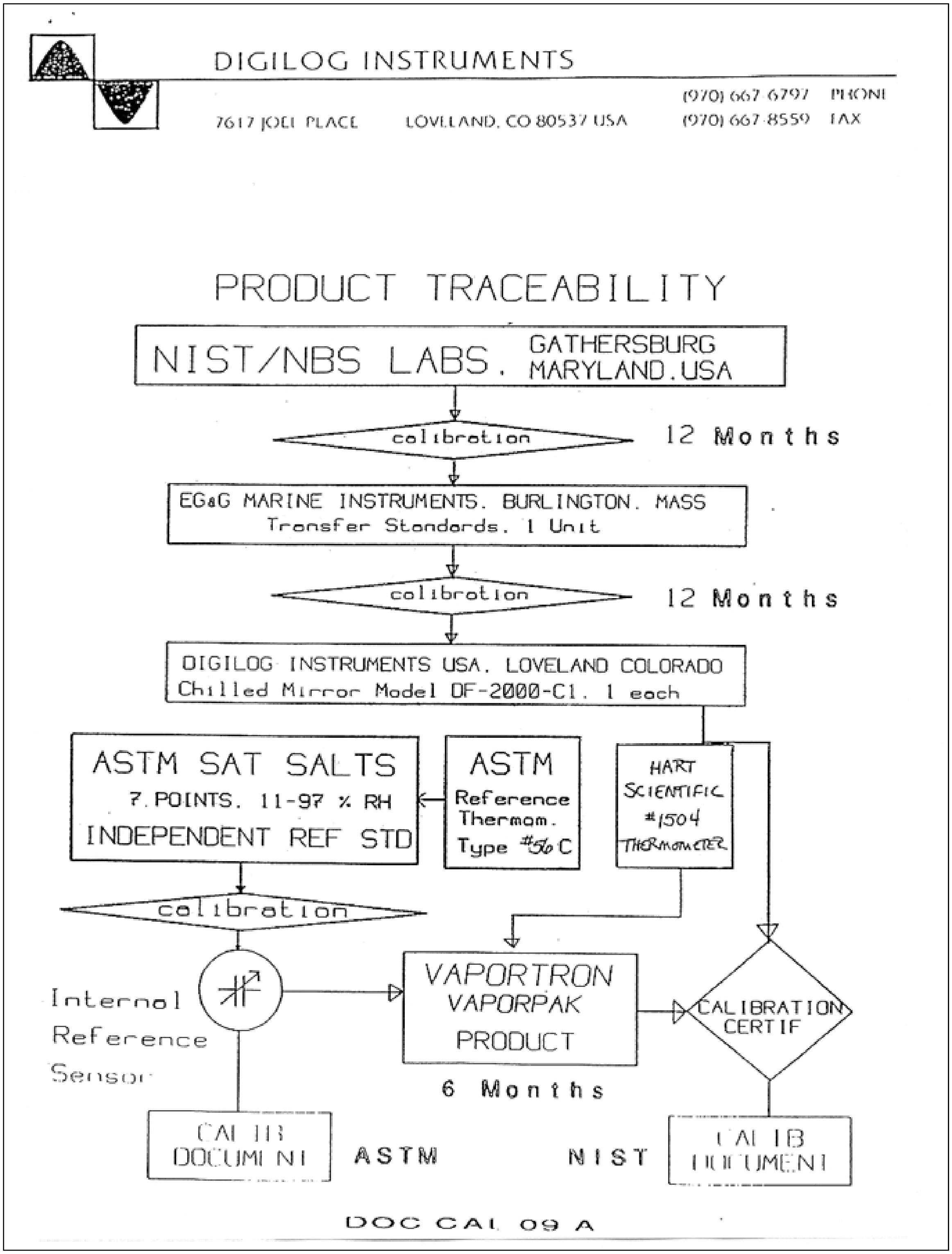
SEE NIST CERT SHEET

****

Tests Performed By (Calibration Technician): [signature]

* UNP Display verified AT 24.0 °C
By ASTM Glass method #68C
S/N H1 w/exp accuracy +/- Ø.2 °C

ATTACHMENT B
Vaportron Traceability



IV. CERTIFICATION LABORATORY
A. PRIMARY STANDARDS
6. FLUKE MULTIMETER 8060A

Effective Date: 10/30/14

Reviewed by: Kevin P. Mishoe
Field Operations Manager

Reviewed by: Marcus O. Stewart
Project QA Manager

Approved by: Holton K. Howell
Project Manager

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MS	QA mgr	11/2/15	

IV.A.6. FLUKE MULTIMETER 8060A

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide consistent guidance for maintenance and handling of the Fluke Multimeter 8060A to Clean Air Status and Trends Network (CASTNET) Field Equipment Calibration Laboratory personnel.

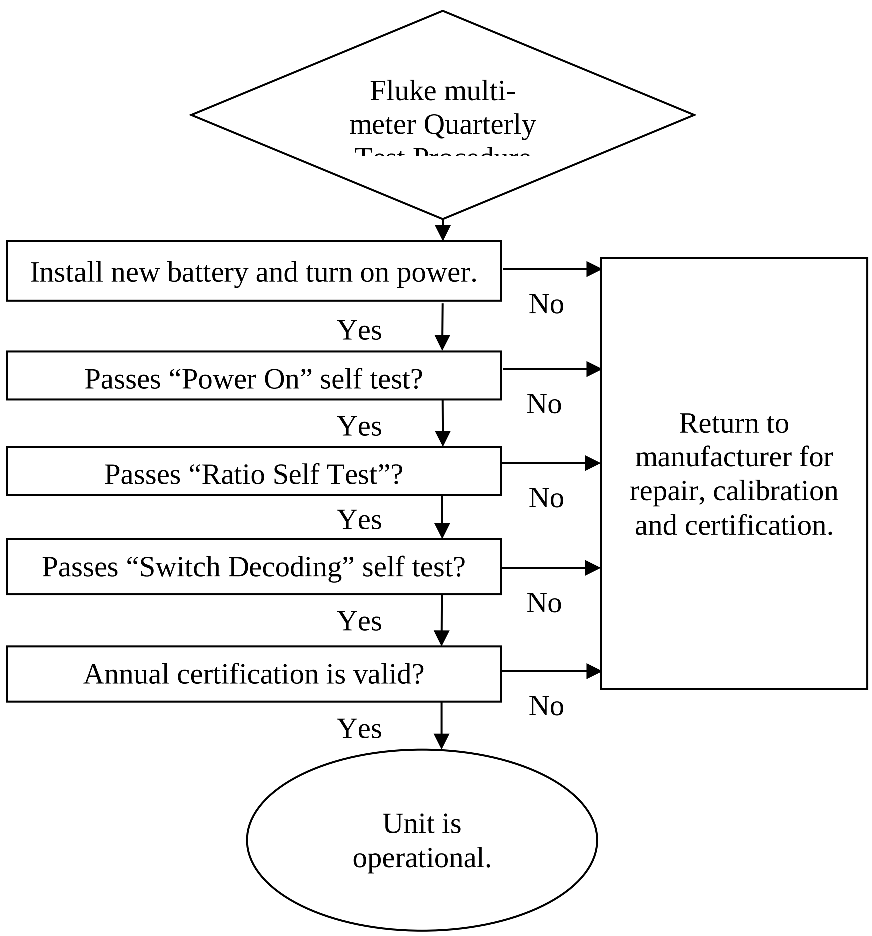
2.0 SCOPE

This SOP applies to the maintenance and handling of all the Fluke Multimeter 8060A units administered by the CASTNET Field Calibration Laboratory.

3.0 SUMMARY

Fluke Model 8060A multi-meters are calibrated and certified annually or following repair by the manufacturer. Repairs are conducted only by the manufacturer. Battery and fuse maintenance is performed as needed. Self tests are documented quarterly. See Figure 1.

Figure 1 Quarterly Test Procedure



4.0 MATERIALS

Fluke Model 8060A Multi-meter
9-Volt (V) battery, if needed
Fluke Model A81 battery Eliminator, if needed

5.0 SAFETY

Use standard precautions when using the 120 VAC power adapter with the Fluke 8060A. To avoid possible electrical shock, turn the unit off and remove leads prior to battery or fuse replacement.

6.0 PROCEDURES

6.1 Repair

All repairs and adjustments are performed by the manufacturer.

6.2 Maintenance

6.2.1 Replace the internal 9-V battery when indicated by the meter. Replace fuse as necessary.

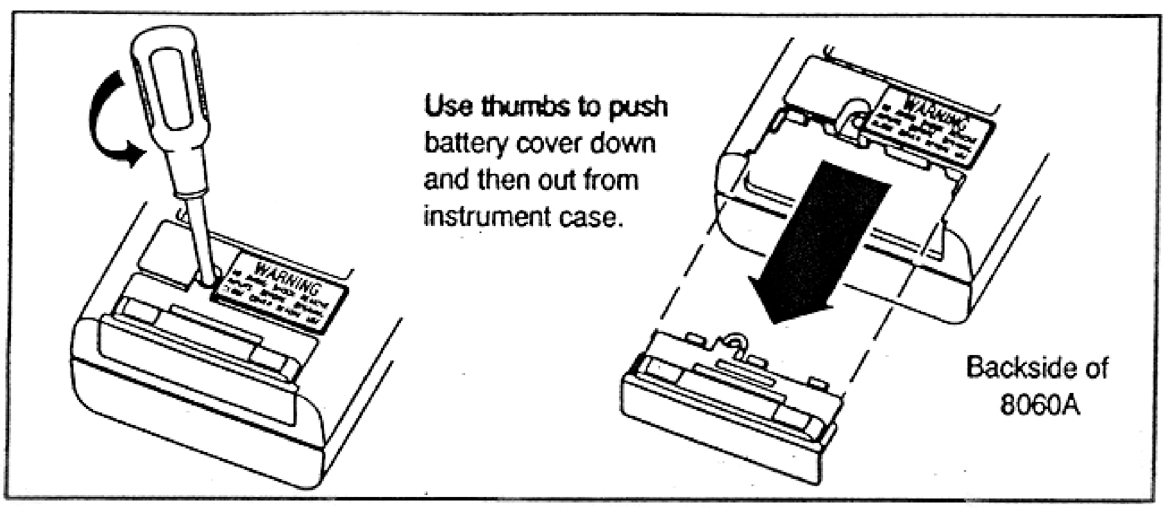
6.2.2 Perform and document self test quarterly.

6.3 Battery Installation or Replacement

When the battery has exhausted about 80% of its useful life, the **BT** indicator will appear at the far left of the display. The 8060A also may be operated from a standard AC power line outlet when used with the optional A81 Battery Eliminator (refer to Chapter 7 of the Manufacturer's Instruction Manual for a description). Use the following procedure to install or replace the battery. See Figure 2 for details.

WARNING: To avoid electrical shock, turn off the instrument and remove the test leads and any input signals before replacing the battery.

Figure 2 Fluke 8060A battery replacement



6.3.1 Set the 8060A power switch to **Off**.

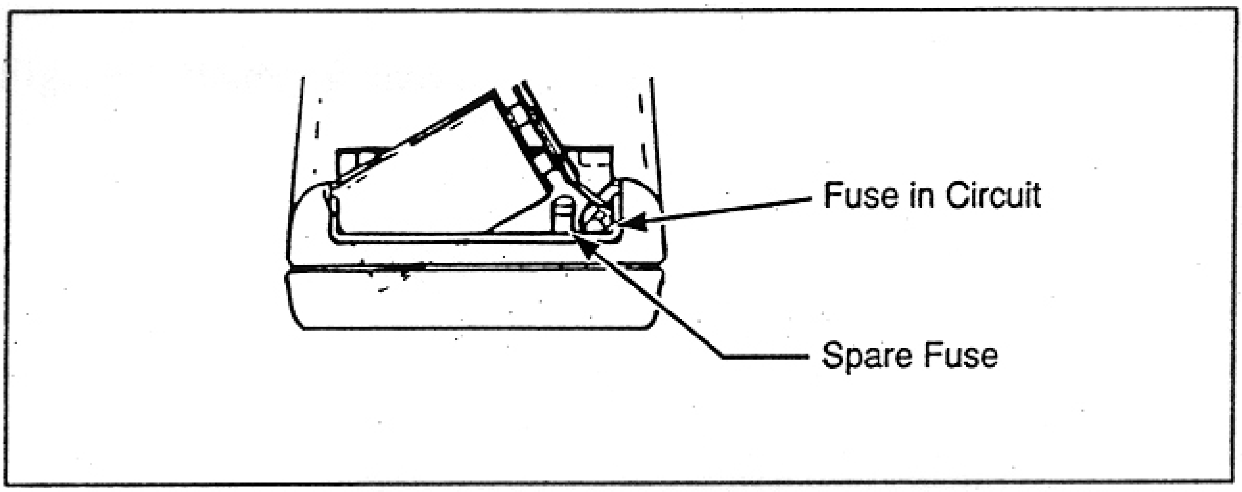
6.3.2 Remove test leads from external connections and from the 8060A input terminals.

6.3.3 Turn the instrument over and remove screw from battery cover as shown in Figure 2.

6.3.4 Use your thumbs to push off the battery cover as shown in Figure 2.

6.3.5 Slide the battery out of the compartment as shown in Figure 3.

Figure 3: Fluke 8060A fuse replacement



6.3.6 Carefully pull the battery clip free from the battery terminals (if replacing the battery) and attach the new battery.

6.3.7 Slide the battery and its leads into the compartment, slide the cover into place, and install the screw.

6.4 Fuse replacement

6.4.1 With battery compartment cover removed, pull fuse ribbon to free fuse from terminals.

6.4.2 Remove and discard fuse. Refer to Figures 2 and 3 for details.

6.4.3 Place fuse ribbon between fuse terminals and push new fuse into terminals.

6.5 Self-Tests

6.5.1 Perform the Ratio and Switch Decoding self-test once each calendar quarter. Document and file the results of the test.

6.5.2 The 8060A offers three self-tests: power-on self-test, ratio self-test, and switch decoding self-test. The power-on self-test is automatically performed whenever the instrument is turned on. It is described in Chapters 2 and 4 of the Manufacturer’s Instruction Manual. The other two tests function as follows:

6.6 Ratio Self-Test

6.6.1 The ratio self-test is an operating mode of the 8060A in which the reference voltage for the analog/digital (a/d) converter is applied to the a/d converter during both the integrate and the read periods. If the instrument is functioning properly, the display should read 10000 ±10 counts (the decimal point location depends on the range, and does not affect the number of counts).

6.6.2 To select the ratio self-test, select a voltage or current function. Hold down the →←))))) button while you turn on the instrument. After the power-on self-test has been completed (the display is .8.8.8.8), release the →←))))) button. The instrument should now be in the ratio self-test mode. To cancel the ratio self test, press the →←))))) button or turn off the instrument.

6.6.3 A proper ratio self-test count indicates that the a/d converter is working properly. If the count deviates more than 10 counts from 10000, the probable causes are as follows (in order of probability) a/d converter in U3, leakage around or failure of C16, 18, Z3, R8, or the power supply. U3, C16, C18, Z3, and R8 are locations on the main printed circuit board.

6.7 Switch Decoding Self-Test

6.7.1 To select the switch decoding self-test, hold down the **REL** button while you turn on the instrument. After the power-on self-test has been completed (the display is .8.8.8.8), release the **REL** button. The instrument should now indicate the switch decoding. To cancel the switch decoding self-test, turn off the instrument.

6.7.2 The switch decoding self-test indicates how the software in the microcomputer interprets the configuration of the eight switches and four push buttons. Each function or range that may be selected corresponds to a number that appears in one of the digit positions on the display (see the table below). Notice that if no range is selected, the microcomputer assumes the 200 (μA, mV, Σ) range is selected. See Table 1 for details.

Table 1 Switch de-coding self test display results

Range	Display Digit 0*
200 (μA, mV, or Σ)	0 (default if no range selected)
2	1
20	2
200	3
2000	4
Push Button	**Display Digit 1***
none	0
REL	1
→←))))	2
dB	4
Hz	8
Function	**Display Digit 3***
AC voltage	1
DC voltage	2
AC current	3
DC current	4
Resistance	5
Conductance	6
Diode Test	7

*Display digits are numbered 0 through 4 from right (LSD) to left (MSD).

6.7.3 In some cases, it may be helpful to know that the microcomputer scans the switches in order from SW5 to SW8 (there is no input for switch SW4, the default range). The microcomputer assumes the first range switch detected as being pushed in is the desired range. For example, if you press in both the 200V and 1000V switches while in dc voltage, the microcomputer assumes you want the 200V range. There are two exceptions: diode test and conductance. If the microcomputer detects that the 2 kΣ switch is selected, it checks for the 20 kΣ switch (indicating diode test selection). If the microcomputer detects the 200 kΣ switch is selected, it checks for the MΣ switch (indicating conductance selection).

6.7.4 Also during the switch decoding self-test, the continuity indicator (the long bar across the top of the display) indicates the state of the continuity/frequency comparator. When the voltage at U3-4 (CM-) is less than at U3-3 (CM+), the continuity indicator is off. You can use this feature to check the comparator when troubleshooting the continuity or the frequency functions. R9 controls the setting of the comparator offset.

6.8 Calibration

All Fluke Multi-meters are returned to the manufacturer annually for calibration and certification. See Attachment A for example of Annual Certificate of Calibration.

7.0 REFERENCES

Fluke Multi-meter 8060A Operation Manual

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring.* 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS).* 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods*. EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements*. EPA-600/4-82-060.

8.0 ATTACHMENTS

Attachment A – Certificate of Annual Calibration

ATTACHMENT A
Certificate of Annual Calibration

ISO 9001

Certificate of Calibration

FLUKE

Dallas Support Center
2104 Hutton Drive, Ste. 112
Carrollton, TX 75006-6807 USA
Phone: (972) 406 1000
Fax :(972) 406 1072

CalNet®

Manufacturer: FLUKE
Model: 8060A
Description: TRUE RMS MULTIMETER
Asset Number: 4170710
Serial Number: 4170710

NODN# 04489

The Fluke Corporation, ISO Certification No. U0018, certifies that the instrument identified above was calibrated in accordance with applicable Fluke calibration procedures. Its calibration processes are ISO-9001 controlled and are designed to certify that the instrument was within its published specifications at the time of calibration.

The measurement standards and instruments used during the calibration of this instrument are traceable to the United States National Institute of Standards and Technology (NIST), natural physical constants, consensus standards, or by ratio type measurements.

CALIBRATION INFORMATION

Cal Date:	15-Jan-2001	**Temperature:**	22°C	**Calibration Report Number:**	588707-4170710
Next Cal Due:	15-Jan-2002	**Humidity**	33 %	**Technician#**	88341
Remarks:				**Technician:**	Tom Rudy

Calibration Procedure: FLUKE 8060A: (1 YEAR) CAL VER (BELOW S/N 6820XXX) **Revision:** 1.3

STANDARDS USED FOR CALIBRATION

Asset	Manufacturer	Model	Description	Cal Date	Due Date
L102	FLUKE	5700A SERIES 2	CALIBRATOR	09-Nov-2000	09-Nov-2001

End of Report

IV. CERTIFICATION LABORATORY
A. PRIMARY STANDARDS
7. RELATIVE HUMIDITY SATURATED AQUEOUS SALT SOLUTIONS

Effective Date: 11-10-11

Reviewed by: Kevin P. Mishoe
Field Operations Manager

Reviewed by: Marcus O. Stewart
QA Manager

Approved by: Holton K. Howell
Project Manager

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Annual Review			
Reviewed by:	Title:	Date:	Signature:
MS	QA Mgr	10/30/12	[signature]
MS	QAM	10/30/14	[signature]
MS	QA Mgr	11/2/15	[signature]

IV. A. 7. RELATIVE HUMIDITY SATURATED AQUEOUS SALT SOLUTIONS

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide consistent guidance for the preparation, maintenance, and handling of the Relative Humidity Saturated Aqueous Salt Solutions to Clean Air Status and Trends Network (CASTNET) Field Certification Laboratory personnel.

2.0 SCOPE

This SOP applies to the preparation, maintenance, and handling of all Relative Humidity Saturated Aqueous Salt Solutions prepared and administeredby CASTNET Field Equipment Certification Laboratory personnel.

3.0 SUMMARY

The saturated aqueous salt solutions are prepared as needed according to the American Society for Testing and Materials (ASTM) Standard number 104-85 (See Figure 1). The solutions are maintained as per the ASTM Standard and verified with a calibration hygrometer at least every 6 months.

4.0 MATERIALS AND SUPPLIES

ASTM Standard 104 or this SOP
Calibrated hygrometer
Nalgene® Screw-capped bottles
Deionized water
Reagent Grade Salts:
 Magnesium Chloride
 Magnesium Nitrate
 Sodium Chloride
 Potassium Nitrate

5.0 REPAIR AND MAINTENANCE

Stir the aqueous salt solutions before each use.
Maintain the proper water level, by adding deionized (DI) water.
Check the salt solution immediately following preparation and stabilization and every 6 months thereafter with a calibrated hygrometer.

6.0 CERTIFICATION PROCEDURES

This is an ASTM standard (E104-85); if the verification of the aqueous salt solution using a calibrated hygrometer fails, the solution is remade. Figure 1 is a copy of the applicable ASTM standard.

7.0 REFERENCES

American Society for Testing and Materials (ASTM). 1985. *ASTM Book of Standards, Vol. 11.03* E 104-85.

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring.* 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS).* 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods*. EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements*. EPA-600/4-82-060.

8.0 FIGURES

Figure 1: Standard Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions (Page 1 of 3)

Designation: E 104 – 85

Standard Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions[1]

This standard is issued under the fixed designation E 104; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice describes two methods for generating constant relative humidity (rh) environments in relatively small containers.

1.2 This practice is applicable for obtaining constant relative humidities ranging from dryness to near saturation at temperatures spanning from 0 to 50°C.

1.3 This practice is applicable for closed systems such as environmental conditioning containers and for the calibration of hygrometers.

1.4 This practice is not recommended for the generation of continuous (flowing) streams of constant humidity unless precautionary criteria are followed to ensure source stability. (See Section 9.)

1.5 **Caution**—Both saturated salt solutions and sulfuric acid-water solutions are extremely corrosive, and care should be taken in their preparation and handling.

1.6 *This standard may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of whoever uses this standard to consult and establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.* (For more specific safety precautionary information see 1.5 and 10.1.)

2. Referenced Documents

2.1 *ASTM Standards:*

D 1193 Specification for Reagent Water[2]

D 4023 Definitions of Terms Relating to Humidity Measurements[3]

E 126 Test Method for Inspection and Verification of Hydrometers[4]

2.2 *Other Document:*

DIN50008 "Konstantklimate uber waBerigen Losungen" (Constant Climates Over Aqueous Solutions).
Part 1: Saturated Salt and Glycerol Solutions.
Part 2: Sulfuric Acid Solutions. (1981)[5]

3. Definitions

3.1 *non-hygroscopic material*—material which neither absorbs nor retains water vapor.

3.2 For definitions of other terms used in this practice refer to Definitions D 4023.

4. Summary of Practice

4.1 Standard value relative humidity environments are generated using selected aqueous saturated salt solutions or various strength sulfuric acid-water systems.

5. Significance and Use

5.1 Standard value relative humidity environments are important for conditioning materials in shelf-life studies or in the testing of mechanical properties such as dimensional stability and strength. Relative humidity is also an important operating variable for the calibration of many species of measuring instruments.

6. Interferences

6.1 Temperature regulation of any solution-head space environment to ±0.1°C is essential for realizing generated relative humidity values within ±0.5 % (expected).

6.2 *Sulfuric Acid*—Water systems are strongly hygroscopic and can substantially change value by absorption and desorption if stored in an open container. Only freshly prepared solutions, or solutions which values have been independently tested for strength should be used.

6.3 Some aqueous saturated salt solutions change composition following preparation by hydrolysis or by reaction with environmental components (for example, carbon dioxide absorption by alkaline materials). These solutions should be freshly prepared on each occasion of use.

7. Apparatus

7.1 *Container*—The container, including a cover or lid which can be secured airtight, should be made of corrosion resistant, non-hygroscopic material such as glass. A metal or plastic container is acceptable if the solution is retained in a dish or tray made of appropriate material. Refer also to 9.2 for size restrictions.

7.2 *Hydrometers*—One or more hydrometers may be used to test sulfuric acid solution densities for the range of humidities concerned. The hydrometer(s) should have a minimum scale division of 0.001 gm/cm^3. (Refer to Test Method E 126.)

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[1] This practice is under the jurisdiction of ASTM Committee D-22 on Sampling and Analysis of Atmospheres and is the direct responsibility of Subcommittee D22.11 on Meteorology.
Current edition approved Feb. 22, 1985. Published June 1985.

[2] *Annual Book of ASTM Standards*, Vol 11.01.

[3] *Annual Book of ASTM Standards*, Vol 11.03.

[4] *Annual Book of ASTM Standards*, Vol 14.03.

[5] Published by Deutsches Institut für Normung, 4-10 Burggrzfenstrasse Postfach 1107, D-1000 Berlin, Federal Republic of Germany. Also available from ANSI Publication Office, New York, NY.

Figure 1: Standard Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions (Page 2 of 3)

8. Reagents and Materials

8.1 *Purity of Reagents*—Reagent grade chemicals shall be used for preparation of all standard solutions. Unless otherwise indicated, it is intended that all reagents conform to the specifications of the Committee on Analytical Reagents of the American Chemical Society where such specifications are available.[6] Other grades may be used, provided it is first ascertained that the reagent is of sufficiently high purity to permit its use without lessening the accuracy of the determination.

8.1.1 Saturated salt solutions may be prepared using either amorphous or hydrated reagents (that is, reagents containing water of crystallization). Hydrated reagents are often preferred to amorphous forms for their solvating characteristics.

8.2 *Purity of Water*—Reagent water produced by distillation, or by ion exchange, or reverse osmosis followed by distillation shall be used. See Specification D 1193.

9. Technical Precautions

9.1 Although a container capable of airtight closure is described in Section 7, it may be desirable to have a vent under certain conditions of test or with some kinds of containers (changes in pressure may produce undesirable cracks in some types of containers). The vent should be as small as practical to minimize loss of desired equilibrium conditions when in use.

9.2 The container should be small to minimize the influence of any temperature variations acting upon the container and contents. A maximum proportion of 25 cm^3 volume/cm^2 of solution surface area is suggested, and overall container headspace volume should be no larger than necessary to confine a stored item.

9.3 Measurement accuracy is strongly dependent on the ability to achieve and maintain temperature stability during actual use of any solution system. Temperature instability of ±0.1°C can cause corresponding instabilities in generated values of relative humidity of ±0.5 %.

9.4 The compatibility of any constant relative humidity system used for instrument calibration testing should be confirmed by reference to the instrument manufacturer's instructions.

9.5 Important considerations leading to stability should include (but are not necessarily limited to) the following:

9.5.1 Elimination of leakage paths.

9.5.2 Elimination of heat sources or heat sinks, or both, for temperature stability.

9.5.3 Limiting flow rate to preclude source carry-over.

[6] "Reagent Chemicals, American Chemical Society Specifications," Am. Chemical Soc., Washington, DC. For suggestions on the testing of reagents not listed by the American Chemical Society, see "Reagent Chemicals and Standards," by Joseph Rosin, D. Van Nostrand Co., Inc., New York, NY, and the "United States Pharmacopeia."

10. Preparations of Aqueous Solutions

10.1 Caution—Saturated salt-water systems and sulfuric acid solutions should be regarded as hazardous materials. Refer to 1.6 for guidelines.

10.2 *Saturated Salt-Water Systems:*

10.2.1 Select a salt of characteristic value from Annex A1.

NOTE —The reference document by Greenspan[7] contains information on many other saturated salt solutions which may be used. These additional systems, however, are less accurately or less completely defined in value. Also, some may only be used when freshly prepared (to limit the influence of chemical instability such as hydrolysis or acid gas absorption). The salts listed in Annex A1 can be used for a year or more.

10.2.2 Place a quantity of the selected salt in the bottom of a container or an insert tray to a depth of about 4 cm for low rh salts, or to a depth of about 1.5 cm for high rh salts.

10.2.3 Add water in about 2-mL increments, stirring well after each addition, until the salt can absorb no more water as evidenced by free liquid. Although a saturated solution system is defined when any excess quantity of undissolved solute is present, it is preferred to keep the excess liquid present to a minimum for ease in handling and for minimal impact on stability should temperature variations occur.

10.2.4 Close the container and allow 1 h for temperature stabilization.

10.2.5 The container may be used as a reservoir from which quantities of slush can be transferred for use, or the entire container may be used for conditioning tests.

10.3 *Sulfuric Acid-Water Solutions:*

10.3.1 Determine the acid concentration corresponding to the desired relative humidity value from Annex A2, interpolating as necessary.

10.3.2 Measure sufficient working quantities of sulfuric acid reagent and reagent water so that, when mixed in proper proportion, a sufficient depth of liquid is available for proper floatation of a test hydrometer. (See Section 9.)

10.3.3 Measure solution density after the sulfuric acid-water solution has cooled following mixing. Refer to Annex A2 for desired values.

10.3.4 Store the prepared mixture in a container with a tight-fitting lid. Check solution density before each occasion of use.

11. Precision and Bias

11.1 Under ideal conditions, the bias (accuracy) of the sources generated by this practice are equal to the uncertainty figures associated with each source value, as stated in the Annex tables. In actual use, lack of temperature equilibrium (±0.5°C) and other functional losses can reduce the bias statement to ±2.5 %. Precision is ±0.5 % rh.

[7] Greenspan, L., "Humidity Fixed Points of Binary Saturated Aqueous Solutions," *Journal of Research*, National Institute of Standards and Technology, Vol. 81A, 1977, pp. 89–96.

Figure 1: Standard Practice for Maintaining Constant Relative Humidity by Means of Aqueous Solutions (Page 3 of 3)

E 104

ANNEXES

(Mandatory Information)

A1.1 EQUILIBRIUM RELATIVE HUMIDITY VALUES FOR SELECTED SATURATED AQUEOUS SALT SOLUTIONS

Temperature (°C)	Lithium Chloride[A] LiCl, %	Potassium Acetate[A] CH_3COOK	Magnesium Chloride[A] $MgCl_2 \cdot 6H_2O$, %	Potassium Carbonate[A] K_2CO_3, %	Magnesium Nitrate[A] $Mg(NO_3)_2 \cdot 6H_2O$, %	Sodium Chloride[A] NaCl, %	Potassium Chloride[A] KCl, %	Barium Chloride[B] $BaCl_2 \cdot H_2O$, %	Potassium Nitrate[A] KNO_3, %	Potassium Sulfate[A] K_2SO_4, %
0	11.2 ± 0.5	...	33.7 ± 0.3	43.1 ± 0.7	60.4 ± 0.6	75.5 ± 0.3	88.6 ± 0.5	...	96.3 ± 2.9	98.8 ± 2.1
5	11.3 ± 0.5	...	33.6 ± 0.3	43.1 ± 0.5	58.9 ± 0.4	75.7 ± 0.3	87.7 ± 0.5	93 ± 2	96.3 ± 2.1	98.5 ± 0.9
10	11.3 ± 0.4	23.4 ± 0.5	33.5 ± 0.2	43.1 ± 0.4	57.4 ± 0.3	75.7 ± 0.2	86.8 ± 0.4	93 ± 2	96.0 ± 1.4	98.2 ± 0.8
15	11.3 ± 0.4	23.4 ± 0.3	33.3 ± 0.2	43.2 ± 0.3	55.9 ± 0.3	75.6 ± 0.2	85.9 ± 0.3	92 ± 2	95.4 ± 1.0	97.9 ± 0.6
20	11.3 ± 0.3	23.1 ± 0.3	33.1 ± 0.2	43.2 ± 0.3	54.4 ± 0.2	75.5 ± 0.1	85.1 ± 0.3	91 ± 2	94.6 ± 0.7	97.6 ± 0.5
25	11.3 ± 0.3	22.5 ± 0.3	32.8 ± 0.2	43.2 ± 0.4	52.9 ± 0.2	75.3 ± 0.1	84.3 ± 0.3	90 ± 2	93.6 ± 0.6	97.3 ± 0.5
30	11.3 ± 0.2	21.6 ± 0.5	32.4 ± 0.1	43.2 ± 0.5	51.4 ± 0.2	75.1 ± 0.1	83.6 ± 0.3	89 ± 2	92.3 ± 0.6	97.0 ± 0.4
35	11.3 ± 0.2	...	32.1 ± 0.1	...	49.9 ± 0.3	74.9 ± 0.1	83.0 ± 0.3	88 ± 2	90.8 ± 0.8	96.7 ± 0.4
40	11.2 ± 0.2	...	31.6 ± 0.1	...	48.4 ± 0.4	74.7 ± 0.1	82.3 ± 0.3	87 ± 2	89.0 ± 1.2	96.4 ± 0.4
45	11.2 ± 0.2	...	31.1 ± 0.1	...	46.9 ± 0.5	74.5 ± 0.2	81.7 ± 0.3	...	87.0 ± 1.8	96.1 ± 0.4
50	11.1 ± 0.2	...	30.5 ± 0.1	...	45.4 ± 0.6	74.4 ± 0.2	81.2 ± 0.3	...	84.8 ± 2.5	95.8 ± 0.5

[A] See "Humidity Fixed Points of Binary Saturated Aqueous Solutions," by L. Greenspan. Published in the *Journal of Research* by the National Institute of Standards and Technology, Vol 81A, 1977, pp. 89–96.
[B] See the German standard, DIN 50008, Constant Climates Over Aqueous Solutions, (referenced in 2.2).

A2. EQUILIBRIUM RELATIVE HUMIDITY VALUES FOR SULFURIC ACID-WATER SOLUTIONS

NOTE—The values shown in this table are stated with an uncertainty of ±1 % rh.

Weight % H_2SO_4	Density, g/mL at 20°C	Density, g/mL at 23°C	Density, g/mL at 25 %	Equilibrium Relative Humidity in % at t°C			
				5°C	23°C	25°C	50°C
5	10 317	10 307	10 300	98	98	98	98
10	10 661	10 648	10 640	96	96	96	96
15	11 020	11 005	10 994	92	92	92	93
20	11 394	11 376	11 365	88	88	88	89
25	11 783	11 764	11 750	82	82	82	83
30	12 185	12 164	12 150	74	75	75	77
35	12 599	12 577	12 563	65	66	67	69
40	13 028	13 005	12 991	54	56	57	59
45	13 476	13 452	13 437	43	46	46	49
50	13 591	13 972	13 911	32	35	35	38
55	14 453	14 428	14 412	23	25	25	28
60	14 983	14 957	14 940	14	16	16	19
65	15 533	15 507	15 490	8	9	9	11
70	16 105	16 077	16 059	4	4	5	6

IV. CERTIFICATION LABORATORY
B. TRANSFER STANDARDS
1. CALIBRATION EQUIPMENT AND SPARE PARTS BOXES

Effective Date: 11-10-11

Reviewed by: Kevin P. Mishoe, Field Operations Manager [signature]

Reviewed by: Marcus O. Stewart, QA Manager [signature]

Approved by: H. Kemp Howell, Project Manager [signature]

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Annual Review			
Reviewed by:	Title:	Date:	Signature:
MS	QA Mgr	10/30/13	[signature]
MS	QA Mgr	10/30/14	[signature]
MS	QA Mgr	11/2/15	[signature]

IV. B. 1. CALIBRATION EQUIPMENT AND SPARE PARTS BOXES

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide consistent guidance, for the maintenance and handling of the Calibration Equipment and Spare Parts Boxes to Clean Air Status and Trends Network (CASTNET) Field Calibration Laboratory personnel.

2.0 SCOPE

This SOP applies to the maintenance and handling of Calibration Equipment and Spare Parts Boxes units administered by the CASTNET Field Calibration Laboratory.

3.0 SUMMARY

When Calibration and Spare Parts Boxes are returned from the field, their inventories are verified and replenished. All necessary service and repair of equipment is performed prior to restocking. Inventory lists for both equipment and consumable items are updated and verified. Problems are reported to the Property Manager and Field Operations Coordinator as appropriate.

Four sets of boxes are maintained complete and ready for CASTNET field use at a given time (3 active, 1 spare). Calibration boxes are due for return on a 6-week cycle primarily due to the calibration frequency requirements for the MACTEC transfer standards (every 6 weeks).

4.0 MATERIALS AND SUPPLIES

Calibration Box
Calibration Box Inventory Form
Spare Parts Box
Spare Parts Box A or B forms
Spare Parts Box Equipment Inventory List
Status Tags (yellow)

5.0 REPAIR AND MAINTENANCE

N/A

6.0 PROCEDURES

6.1 Calibration Box

Upon receipt of the calibration box from the field, check the Calibration Box Inventory Form to ensure that all the transfer equipment has returned from the field. Report any missing equipment to the Property Manager and Field Operations Coordinator.

6.1.1 Complete post-calibration of the transfer equipment that receives in-house certification, rather than annual factory certification; and record the results on the proper forms. If the post-calibrations are within transfer equipment acceptance criteria, use the post-calibration as a pre-calibration for the next deployment. Repair any transfer equipment that fails a post-calibration and recalibrate. Or, remove the transfer equipment from service and replace it with a properly working calibrated transfer standard.

6.1.2 After the post- or pre-calibrations of the transfer equipment are completed, repack, restock, and inventory the box using the Calibration Box Inventory Form (Figure 1).

6.1.3 Give a copy of the new Calibration Box Inventory Form to the Property Manager for review. After review, the Property Manager updates the equipment inventory list on the property database.

6.1.4 After the Property Manager finalizes the Calibration Box Inventory Form, secure the calibration box and tag with a green tag showing that it is field ready.

6.2 Spare Parts Box

6.2.1 Upon receipt of the spare parts box(es) from the field, use Spare Parts Box A or B forms (Figure 2), to perform a checkout of the Spare Parts Box Equipment and equipment calibration forms. Inspect the condition of all parts (used or unused) and replace as necessary with tested and tagged parts. EPA numbered sensors are accompanied by complete calibration forms.

6.2.2 Update the Spare Parts Box Equipment Inventory List and equipment calibration forms as necessary when replacing equipment.

6.2.3 Give a copy of the updated Spare Parts Box Equipment Inventory List to the Property Manager for review. After review, the Property Manager updates the equipment inventory list on the property database.

6.2.4 After the Property Manager finalizes the equipment property list, lock the spare parts box and tag with a green tag showing that it is field ready.

6.3 Consumable Items

The consumable material log is updated based on the First In, First Out (FIFO) principle. As such, this log is not necessarily updated each time a calibration or spare parts box is processed. It is rather, updated as items are “consumed” from the storage area per FIFO.

7.0 REFERENCES

AMEC E&I, Inc. (AMEC). 2011. *Clean Air Status and Trends Network (CASTNET) Quality Assurance Project Plan, Revision* 8.0. Prepared for U.S. Environmental Protection Agency (EPA), Washington, DC. Contract No. EP-W-09-028. Gainesville, FL.

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*. 40 CFR 58, Appendix B.

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U.S. Environmental Protection Agency (EPA). 1997. *National 8-Hour Primary and Secondary Ambient Air Quality Standards for Ozone*. 40 CFR 50, Appendix I.

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U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

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U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements*. EPA-600/4-82-060.

U.S. Environmental Protection Agency (EPA). 1979. *Transfer Standards for Calibration of Air Monitoring Analyzers for Ozone, Technical Assistance Document.* EPA-600/4-79-056.

8.0 FIGURES

Figure 1: Calibration Box Inventory Form (Page 1 of 2)

Cal Box #

Issued To:

Date Out

Inventoried By:

Date:

NDDN / EPA #	AIR #	Issued	Qty	Unit	Description	Recal Date
		X	1	Each	Fluke Multimeter with Clip-On and Point Leads	
		X	1	Each	Datel Voltage Calibrator with Banana Leads	
		X	1	Each	Test Assy for Campbell CR3000	
		X	1	Each	O3 Power Cord, Signal Cable, Etc.	
		X	1	Each	Disposable Camera with Instructions	
		X	1	Each	Digital Camera with Battery, Memory and A/C Charger/Adapter	
		X	1	Each	Tripod for Digital Camera with Camera Mount	
		X	1	Each	Brunton Pocket Transit, Transit Clamp and Ball & Socket Tripod	
		X	1	Each	RMY Synchronus Drive, High & Low Motors, 1.2 A A/C Adapter	
		X	1	Each	RMY WD Compass with Tail Bracket and Large Clip	
		X	1	Each	RMY Vane Torque Gauge	
		X	1	Each	RMY Propeller Torque Wheel with Screws	
		X	1	Each	Speed Square for Climatronics Wind Direction	
		X	1	Each	Rotronics GTL Relative Humidity Transfer	
		X	1	Each	S-503 Humidity Calibrator	
		X	1	Each	Desiccant, DI H2O and Syringe for RH Calibrator	
		X	1	Each	Li-Cor Solar Radiation Pyranometer	
		X	1	Each	RMY SRTranslator with Power Supply and Signal Cable	
		X	1	Each	75' SR Coaxial Cable with Barrel Connector	
		X	1	Each	Eutechnics RTD Temperature Transfer and Probe	
		X	2	Each	Thermos with Styrofoam Inserts	
		X	2	Each	Stir Bars, Straight	
		X	1	Each	Stir Plate w/Cord	
		X	1	Each	Coffee Pot with Cord	
		X	1	Each	Graduated Cylinder, 250mL	
		X	1	Each	Separatory Filter, 250mL	
		X	1	Each	Decade Box with Mini-RCA Jack	
		X	6	Each	9 Volt Battery	
		X	4	Each	AA Cell Battery	
		X	1	Each	50' Grounded Extension Cord	
		X	1	Each	6 Outlet Grounded Power Strip	
		X	1	Can	LPS Spray	
		X	1	Can	Contact Restorer	
		X	1	Can	Ultra Jet Compressed Air	
		X	2	Can	Freez-It	
		X	10	Each	Yellow Pre-Printed Tags	
		X	1	Bag	8" and 11" Ty-Wraps	
		X			Rubber Bands, Asst.	
		X			Plastic Bags, Asst.	
		X	1	Each	Safety Vest	

NOTES:

Figure 1: Calibration Box Inventory Form (Page 2 of 2)

Ozone and Flow

Issued To:
Date:

Ozone Transfer # ______ EPA # ____________ **Cal Date Due** __________

Power Cord	√
8 feet of 1/4-inch Sample Line	√
Signal Cable (49C or 49i)	√
Balston Filter	√
Exhaust Line	√
1/4 T Nuts, Plugs and Caps	√

Flow Transfer # ______

Nexus	EPA/Air # ____________	**Cal Date Due** __________
Bios 20K	EPA/Air # ____________	**Cal Date Due** __________
Bios 40K	EPA/Air # ____________	**Cal Date Due** __________
Bios Medium/High	EPA/Air # ____________	**Cal Date Due** __________

Power Supply	√
Communication Cable	√
Tubing and Adaptors	√
30 feet of 1/4-inch Flow Tubing	√
White, Male QC	√

Inventoried By __________

Date __________

NOTE:

Figure 2: Spare Parts Inventory Forms (Page 1 of 5)

CASTNet

Spare Parts A

SENT TO: ____________________

DATE SENT OUT: ____________________

DATE RETURNED: ____________________

MACTEC Part Number	Description	EPA #	Qty	Unit	In Box	Used/Site
	Signal Connector for 49C		1	each	✓	
	Power Cable		1	each	✓	
201-025	KNF pump kit		1	each	✓	
201-026/201-026A	ASF pump kit & diaphragms		1-2	each	✓	
501-001	QC Fitting, (female white ring)		1	each	✓	
901-007	Thomas Pump Diaphragm		6	each	✓	
501-004	QC Fitting, (female bulkhead, black)		1	each	✓	
701-034A	Canister O-Ring		8	each	✓	
901-018	Pump Rebuild Kit, Thomas		2	each	✓	
1001-011	Balston filter		2	each	✓	
101-030	Rotronics RH Sensor Bushing		1	each	✓	
501-036	3/8-inch Kynar Union		3	each	✓	
with union	3/8-inch Kynar Nut		6	each	✓	
501-032	3/8X1/4-inch Kynar Adaptor		2	each	✓	
801-022	12 vdc Pwer Supply		1	each	✓	
801-029	Hourmeter with Cord		1	each	✓	
	Nose Cone Assembly (Heavy)		2	each	✓	
801-007	Gordos Relays (silver or white)		1	each	✓	
1001-003	Prop		1	each	✓	
	RMY Wind AQ Mod for Campbell		1	each	✓	
	Fuses (.25, .50, 1, 2, 3, 5, 7, 100ma RH, TECO 49C 1.25)		3	each	✓	
	Fuse 12vdc ps (1, 8A)		2	each	✓	
101-036	Rotronics SS RH Filter		3	each	✓	
201-024	Vaisala RH Filter (long and short)		2	each	✓	

Figure 2: Spare Parts Inventory Forms (Page 2 of 5)

CASTNet

MACTEC Part Number	Description	EPA #	Qty	Unit	In Box	Used/Site
101-037	Rotronics RH O-Ring		3	each	✓	
	Assorted Spade Lugs & Terminals		1	Many	✓	
	Set of Screws for Sensors		1	set	✓	
501-016	3/8-inch SS Nut		2	each	✓	
501-023	3/8-inch SS Ferrule		5	each	✓	
301-028A	Tipping Bucket Clip		6	each	✓	
901-019	Bulls Eye Level		2	each	✓	
101-010	Prop Nut, with end cut off		3	each	✓	
101-019	Wind Speed Bearing (nosecone)		2	each	✓	
101-026	Wind Direction Pot		1	each	✓	
401-059	B&C Connector		2	each	✓	
401-058	Barrel Connector		2	each	✓	
101-075	Rotronics RH Sield Adapter Clip		2	each	✓	
101-020	Wind Direction Bearing		2	each	✓	
	Nuts and Ferrules, Assorted, Metal & Plastic				✓	
401-032	#2 Spade Lugs		50	each	✓	
301-025	Vaisala Clip		2	each	✓	
Bin D16	RMY Wetness Sensor		1	each	✓	
701-077	4-Cond. Signal Cable (100 FT sections)		200	feet	✓	
	RMY Temp Probe (Campbell Mod)		1	each	✓	
	RMY Temp Probe (Campbell Mod)		1	each	✓	
	Temp External Adaptors		2	each	✓	
	Rotronic RH Probe		1	each	✓	None in stock - install Vaisala
	Vaisala RH probe		1	each	✓	
301-034	Tipping Bucket Assy Mechanism		1	each	✓	
301-015	Tipping Bucket Thermostat		1	each	✓	
101-002	RMY 12 vdc Blower Motor		2	each	✓	
801-063	0-5 lpm Flow Rotometer		1	each	✓	

Figure 2: Spare Parts Inventory Forms (Page 3 of 5)

CASTNet

MACTEC Part Number	Description	EPA #	Qty	Unit	In Box	Used/Site
	RMY Solor Radiation Sensor		1	each	✓	
	RMY Solor Radiation Translator		1	each	✓	
	Mass Flow Controller w/PS-Display		1	each	✓	
1001-044	1/4-inch Teflon Tubing		100	ft	✓	
701-021	Filter Holder w/Side Tap		1	each	✓	
1001-043A	3/8-inch Teflon Tubing		50	ft	✓	
1001-031	Plastic Wind Vane		1	each	✓	

NOTES: ___

Inventoried By: dme

Date: ___

Figure 2: Spare Parts Inventory Forms (Page 4 of 5)

CASTNet

SPARE PARTS KIT
OZONE

SENT TO: ______________
DATE SENT OUT: ______________
DATE RETURNED: ______________

TECO SPARE PARTS INVENTORY

Packing Location	MACTEC Part # / Locate	Description	Qty	Units	Check List SENT	Check List RETURNED	Used
R1 Box 1 A	201-011	MAIN Power Supply (49-9)	1	each	✓		
R1 Box 1 B	201-009	Lamp Power Supply (8596)	1	each	✓		
R1 Box 1 C		Solenoid Assembly (conditioned)	1	each	✓		
R1 Box 1 D	201-033	3-Way Solenoid, Teflon 24 vdc	1	each	✓		
R1 Box 1 E	201-027	Ozone Cooling Fan	1	each	✓		
R1 Box 1F	201-021	PC Board Lamp Heater	1	each	✓		
R2 Box 2 A	201-013	Ozonator PS (49-14) (w/Memory match)	1	each	✓		
R2 Box 2 B	201-101	Air Scrubber w/ Teflon Tubing Connector	1	each	✓		
R2 Box 2 C	201-032	Pressure Transducer	1	each	✓		
R2 Box 2 D	201-020	Detector	2	each	✓		
R2 Box 2 E Bag 1	201-052A	Ozone lamp Gasket	1	each	✓		
R2 Box 2 E Bag 2		Filter Holder (modified filter wrench)	2	each	✓		
R2 Box 2 E Bag 3	201-055 & 201-056	Orfice, Silver and Blue/Violet	2	each	✓		
R2 Box 2 E Bag 4	201-036	Orfice O-Ring	2	each	✓		
R2 Box 2 E Bag 5	201-060	Frequency Adjustment Screws	1	each	✓		
R2 Box 2 E Bag 6	201-035	Latex Tubing	4	each	✓		
R2 Box 2 E Bag 7	201-066	Sample Pump Bumper Feet	1	each	✓		
R2 Box 2 F	201-050	Photometer lamp, (brown cord)	1	each	✓		
R2 Box 2 G	201-052A	Ozonator Lamp, (black cord)	1	each	✓		
R2 Box 2 H		Circuit Boards (49-1 to 49-7) (tested set)	1	each	✓		
R3 Box 3 A	801-020B	UPS Battery (charged)	1	each	✓		
R3 Box 3 B		ASF Sample Pump with Fittings (49-103)	1	each	✓		

Notes/Comments: ______________

Inventoried By: ______________
Date: ______________

Page 1 of 1

Figure 2: Spare Parts Inventory Forms (Page 5 of 5)

CASTNet

SPARE PARTS KIT B

SENT TO: ____________________

DATE SENT OUT: ____________________

DATE RETURNED: ____________________

Packing Location	MACTEC Part # / Locate	Description	EPA #	Qty	Units	Check List SENT	Check List RETURNED	Used
R1 Box 1A		Wind F-460 Translator - calibrated		1	each	✓		
R1 Box 1B		Li-Cor Solar Radiation Sensor - calibrated		1	each	✓		
		Solar Radiation Translator - calibrated		1	each	✓		
R1 Box 1C		RH Sensor - calibrated		1	each	✓		
		RH Translator - calibrated		1	each	✓		
R1 Box 1D		Temperature Translator - calibrated		1	each	✓		
		Temperature Sensor T1 - calibrated		1	each	✓		
		Temperature Sensor T2 - calibrated		1	each	✓		
R1 Box 1E		Extender Card (Get from Mike Beadles)		1	each	✓		
R1 Box 1F	301-011	Blower (with wires soldered on)		1	each	✓		
R1 Box 2A	1001-015	Wind Speed Cups		1	each	✓		
R2 A		Wind Direction Sensor - calibrated		1	each	✓		
R2 B		Wind Speed Sensor - calibrated		4	each	✓		
R3 Box 1A	301-008	RH Filter		3	each	✓		
R3 Box 1B	901-019	Bulls Eye Level		1	each	✓		
R3 Box 1C	301-023	RH Clip		2	each	✓		
R3 Box 1D		Assorted Screws and Set Screws		1	set	✓		
R3 Box 1E	301-004	Sensor Bearings		4	each	✓		
R3 Box 1F		Wind Direction Sensor Fuse (pico) Green		2	each	✓		
		Wind Direction Sensor Resistor (Blue)		2				
R3 Box 1G	301-021	Sensor Snap Rings		4	each	✓		
R3 Box 1H	301-005A	Wind Direction Pot		1	each	✓		
R3 Box 1I	301-001	Sensor Spacers		4	each	✓		
R3 Box 1J		F-460 Cable		1	each	✓		
R3 Box 2A	301-019	Sensor Heater		2	each	✓		
R3 Box 2B	301-017	Sensor "Y" Thermostat		1	each	✓		
R3 Box 2C	301-009	Temperature Trailer Connector Plugs		2	set	✓		

NOTES/COMMENTS: ____________________

Inventoried By____________________ Date____________________

Climatronics Spare Parts Inventory Kit 1B

Page 1 of 1

IV. CALIBRATION LABORATORY
B. TRANSFER STANDARDS
2. DATEL VOLTAGE SOURCE (350A)

Effective Date: 10/30/14

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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Annual Review			
Reviewed by:	Title:	Date:	Signature:
MS	QA Mgr	11/2/15	

IV. B. 2. DATEL VOLTAGE SOURCE (350A)

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance for the maintenance and handling of the Datel Voltage Source (350A) to Clean Air Status and Trends Network (CASTNET) Field Calibration Laboratory personnel.

2.0 SCOPE

This SOP applies to the maintenance and handling of Datel Voltage Source (350A) units administered by the CASTNET Field Equipment Calibration Laboratory.

3.0 SUMMARY

Each unit is recertified according to the procedure described in Section 6.0 at least every six months.

4.0 MATERIALS AND SUPPLIES

4.1 Fluke Multimeter
4.2 Data Acquisition System (DAS) Calibration Form

5.0 REPAIR AND MAINTENANCE

5.1 All repairs are performed by the manufacturer.
5.2 Replace the 9-volt (V) battery when the unit's **Low Batt** arrow is lit.

6.0 PROCEDURES

6.1 Obtain certified Fluke multimeter traceable to National Institute of Standards and Technology (NIST).
6.2 Connect output of Datel voltage source (+ / -) to the test jacks of the multimeter (+ / -). Maintain proper polarity.
6.3 Obtain a data logger calibration iForm (Figure 1) and record the serial number of the voltage source and the serial number of the Fluke on the DAS Calibration Form. The Fluke should be recorded as the Primary DAS.
6.4 With the Fluke set to the range of DCV 2 V, increment the Datel from 0.0000 to 1.0000. The Datel should be set to the 1.2 V range. Record the results.
6.5 If the Datel is not within ±0.3 millivolts at the set point (Fluke is actual voltage), then adjust the Datel (Figure 2) and repeat the certification.
6.6 Switch the Datel to 12 V DC range and check the output with the Fluke at 1.000 V, 2.000 V, 3.000 V, 4.000 V, 5.000 V and 10.000 V.

6.7 Reverse the polarity switch on the Datel and check the output of the Fluke for a negative response.

6.8 Record any necessary maintenance or adjustments on form.

6.9 Attach the completed DAS Calibration Form to the instrument.

6.10 Sign and date the form

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*. 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)*. 40 CFR 58, Appendix A.

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U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods*. EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements.* EPA-600/4-82-060.

8.0 FIGURES

Figure 1: Data Logger Calibration iForm

MACTEC — Data Logger Calibration

Site Name	Calibrator	Calibration Date	iForms Ver.
BVL130	AQS	9/6/2011	1.4.0

Datalogger	As Found	As Left
ID #	000424	
Mfg./Model	Campbell 3000	

MultiMeter	
ID #	04623
Mfg.	Fluke
Cert. Date	10/8/2010

Voltage Source	
ID #	04626
Model	Datel DVC-350A
Cert. Date	8/24/2011

Data Logger Signal Accuracy

Voltage Source Output	Digital MultiMeter Reading	Datalogger Reading As Found: Voltage	Diff	Max Channel	Diff	As Left: Voltage	Max Channel
0.0000	0.0000	-0.0003	-0.0003	wdir			
0.1000	0.1000	0.0999	-0.0001	flow			
0.2000	0.2000	0.1997	-0.0003	wetness			
0.3000	0.3000	0.2999	-0.0001	flow			
0.4000	0.4000	0.3997	-0.0003	wetness			
0.5000	0.5000	0.4997	-0.0003	wetness			
0.6000	0.6000	0.5999	-0.0001	flow			
0.7000	0.7000	0.6998	-0.0002	flow			
0.8000	0.8000	0.7998	-0.0002	wetness			
0.9000	0.9000	0.8997	-0.0003	flow			
1.0000	1.0000	0.9997	-0.0003	flow			

	With Charger	Without Charger
Backup Battery Volatge		
Climatronics Mainframe Power Supply Voltage	(+)	(-)
	As Found	As Left
Status Switches		
Channels Changed		

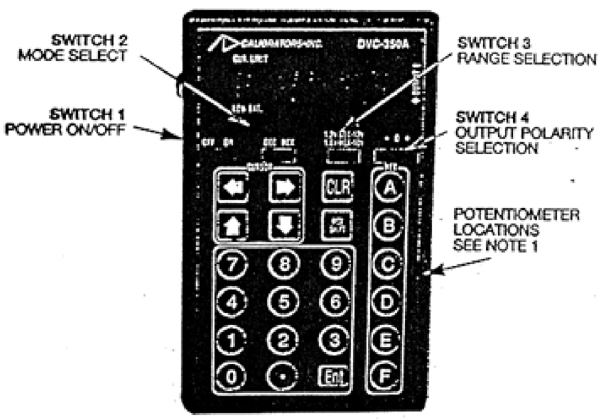
Remarks:

Reviewed By: S. Ismail   Date: 10/17/11

Figure 2: Calibration Procedure -- Page from Datel Manual

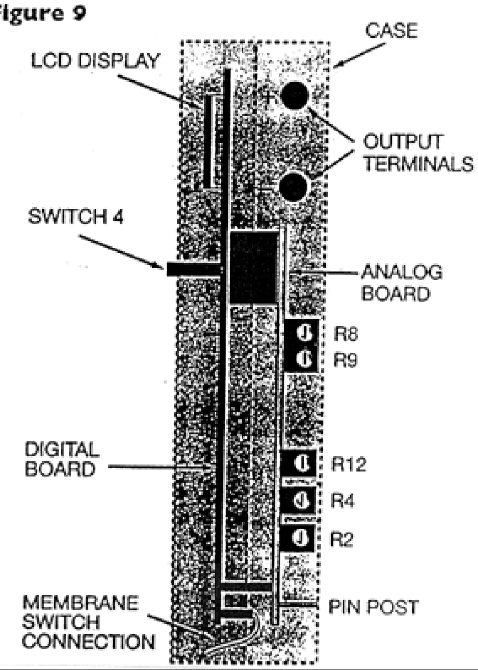
CALIBRATION PROCEDURE

Figure 8



NOTE 1:THE USER MUST OPEN THE CASE TO ACCESS THE POTENTIOMETERS.
1) REMOVE THE FOUR SCREWS LOCATED ON THE BACK OF THE CASE
2) REMOVE THE THREE SCREWS LOCATED INSIDE OF THE CASE
3) LIFT INTERNAL SUB-ASSEMBLIES SLIGHTLY UPWARDS TO ACCESS POTENTIOMETERS.

Figure 9



The DVC-350A hand-held voltage calibrator is designed for field and laboratory use. therefore, recalibration is not frequently required. However, due to normal component aging and unforeseen physical stresses and shock, vibration and temperature, cycles during field and laboratory use. the precision of the instrument should be checked every 6 months. If the accuracy of the instrument is not within specification, recalibration is needed.

RECALIBRATION EQUIPMENT:

Use any standard digital voltmeter with a resolution of ±10 microvolts (uV) and overall known accuracy of 0.001% or better. Due to its unique design, the DVC-350A requires an exceptionally short "warm up" time of 5 seconds before starting recalibration.

1) ZEROING THE INTERNAL REFERENCE DAC

1.1 DVC-350A switch settings (see figure 8).
SWITCH 1 (POWER):ON   SWITCH 2 (MODE):DEC
SWITCH 3 (RANGE):12V   SWITCH 4 (POLARITY):+
1.2 Press the CLR key to clear the display.
1.3 Connect a Volt Meter's positive (+) lead to the DVC-350A's PIN POST terminal (see figure 9). Connect the meters negative (-) lead to the DVC-350A's negative output terminal.
1.4 Adjust R2 (see figure 9), until the meter reads 0 volts ± 10 microvolts.

2) ZEROING THE OUTPUT

2.1 Same switch settings as step 1.1
2.2 Connect the volt meters Positive (+) lead to the DVC-350A's Positive (+) output terminal and adjust R12 until the output reads 0, ±50 microvolts.

3) +12 VOLT OUTPUT FULL-SCALE ADJUSTMENT

3.1 Same switch settings as step 1.1
3.2 Enter 12.000 via the DVC-350A keyboard.
3.3 Adjust R8 until the voltmeter reads +12 volts dc, ±100 microvolts (+11.9999 to +12.0001).

4) +1.2 VOLT OUTPUT FULL-SCALE ADJUSTMENT

4.1 Move the Range SWITCH (3) to the 1.2V dc scale.
4.2 Adjust R9 until the voltmeter reads +1.2000V dc,+10 microvolts.

5) HEX MODE OUTPUT FULL-SCALE ADJUSTMENT

5.1 Move the MODE SWITCH (2) to the"HEX" position.
5.2 Enter FFF via the keyboard.
5.3 Move the RANGE SWITCH (3) to the "10V" position.
5.4 Adjust R4 until the voltmeter reads +9.99756 dc, ±100 microvolts (+9.99746V to 9.99766V dc).

IV. CALIBRATION LABORATORY
B. TRANSFER STANDARDS
3. OZONE ANALYZER

Effective Date: 10/30/14

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, Project QA Manager

Approved by: H. Kemp Howell, Project Manager

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Annual Review			
Reviewed by:	Title:	Date:	Signature:
MS	QA mgr	11/2/15	[signature]

IV.B.3. THERMO-FISHER MODEL 49*i* ANALYZER

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance for the maintenance and handling of the Thermo Ozone (O_3) Monitors Model 49*i* used as transfer standards to Clean Air Status and Trends Network (CASTNET) Field Calibration Laboratory personnel.

2.0 SCOPE

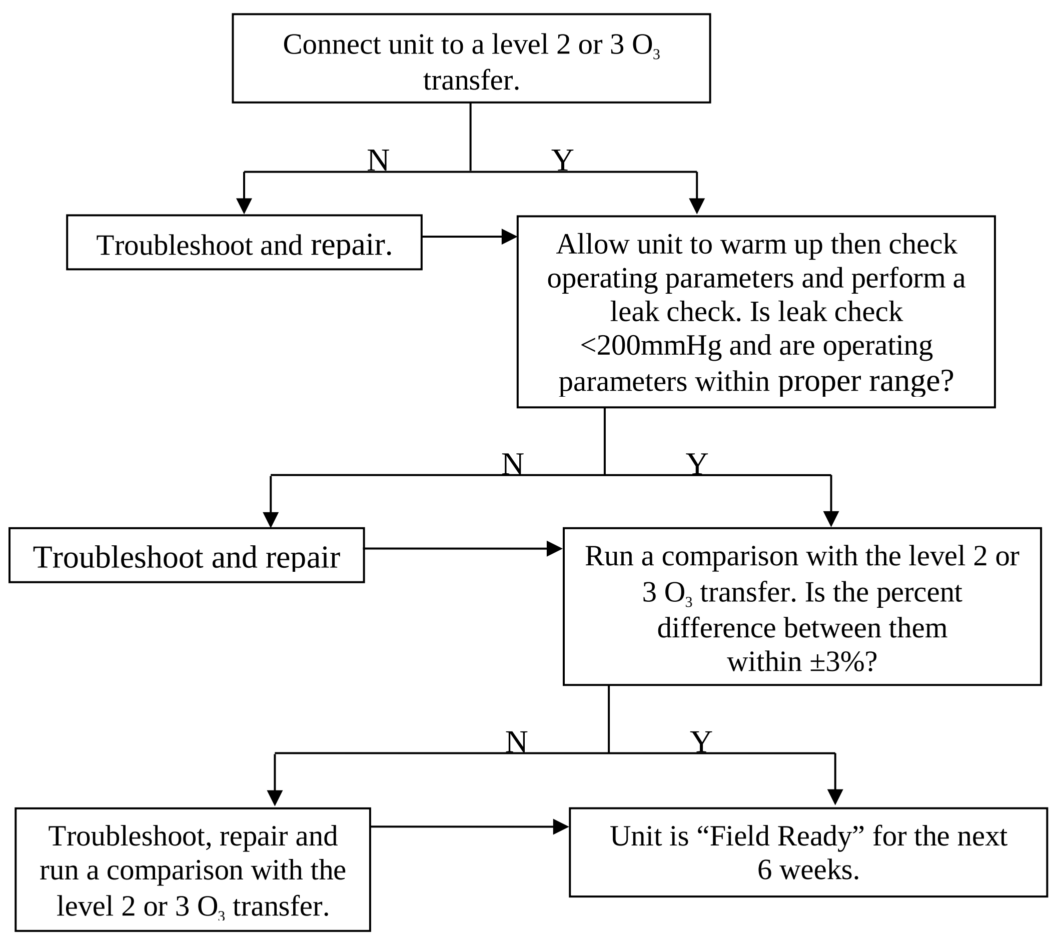
This SOP applies to the maintenance and handling of Thermo O_3 Monitors Model 49i units administered by the CASTNET Field Calibration laboratory.

3.0 SUMMARY

CASTNET O_3 transfer standards are calibrated and certified prior to installation at a remote monitoring site. See Figure 1.

Note: *Procedures for traveling transfer standards are discussed in III.6.12.*

Figure 1. O_3 Transfer



4.0 MATERIALS AND SUPPLIES

Thermo Model 49*i* O_3 Analyzer
Short ¼” exhaust tube
Local primary O_3 standard (PS) with ¼” Teflon sample line
Data logger
Computer
¼” T Kynar plug
Maintenance Form
Writing implement
Multimeter with clip leads
I/O Terminal Board (Thermo pn102888) with 6 foot 2-cond cable
Kimwipes
Compressed air blower

5.0 SAFETY

Always use a third ground wire on all instruments.

Always unplug the analyzer when servicing or replacing parts.

If it is mandatory to work inside an analyzer while it is in operation, use extreme caution to avoid contact with high voltages. The analyzer has a 110 VAC power supply. Refer to the manufacturer's instruction manual and know the precise locations of the VAC components before working on the instrument.

Avoid electrical contact with jewelry. Remove rings, watches, bracelets, and necklaces to prevent electrical burns.

6.0 CERTIFICATION PROCEDURE OF STANDARDS

All ozone analyzers used as transfer standards are calibrated and certified in accordance with the EPA document titled “Transfer Standards for Calibration of Air Monitoring Analyzers for Ozone”, EPA-545/B-10-001. Initial certification requires 6 comparison runs between transfer and PS that include 6 concentrations including zero and 85 percent to 95 percent of upper range. This procedure is to be performed on 6 separate days over a period no longer than 14 days. Ongoing recertification requires one new comparison, performed as described above, on a single day twice per calendar quarter.

The transfer standards are calibrated, and certified before and after each field calibration trip, and at a minimum of once every 6 weeks. A record of the most recent six calibrations of the transfer standard is kept as part of the certification process. The average of the six slopes and the average of the six intercepts are used as the correction factor for the transfer standard. Transfer standard certifications and traceability documents are maintained in the network coordination center files. See Attachment A for an example of a 6-day certification of an ozone transfer standard.

6.1 Calibrating the Detector, Model 49i

6.1.1 Allow the instrument to warm up for approximately 1 hour, sampling ONLY zero air. Transfer should NEVER sample ambient room air. (Check to see if desiccant or charcoal canisters in the zero air system are due to be changed.)

6.1.2 Connect the output of the Thermo 49PS primary to the sample inlet of the sampler (transfer).

6.1.3 Connect an Ethernet cable to the back of 49i model analyzers.

6.1.4 Using the laptop connected to the CR3000 data logger, determine which primary standard is being used, 2 or 3, and ensure that page is selected. Only two (2) analyzers can be attached to single primary standard at any time. The data logger has a program built into it that runs a full audit or calibration on an analyzer. However, the instrument must be set up in the program for it to run and record the data properly.

6.1.5 For a 49i analyzer, certain parameters need to entered and enabled. For instance, if using PS1, its page should already have the PS slope and intercept entered into the program. Check to make sure these agree with the sticker on the PS, as well as all other parameters match the PS being used. Under Analyzer 1, the parameters of iSeries, SerialNum, Comport and IP_Addr need to be adjusted to match the machine being hooked up. For a 49i, the iSeries parameter should read “true”. If it does not say “true”, double click on the box and double click again to change the logic statement. The serial number of the Transfer Analyzer should be input into the parameter labeled SerialNum. Double click inside the box, type in the serial number and then hit enter to save it. The Comport parameter should read “TCP”. If it does not say “TCP”, double click inside the box, type in TCP and then hit enter to save it. The IP address of the Transfer Analyzer should be entered into the IP_Addr parameter. This can be found in the machine by going into the Menu, down to Instrument Controls, down to Communications and then to TCP/IP Settings. Record this IP address into the table, inputting similar to the serial number. Repeat for all analyzers being calibrated.

It is important to make sure that unique IP addresses are entered for each analyzer connected to the logger.

6.1.6 To begin an audit of a transfer machine, set "CalStart" under the PS parameters to "true". The data-logger will then perform and record an automatic six level audit that takes approximately 2 hours to run. A report can be generated through an Access script loaded on to the Loggernet computer which can be accessed from any of the other computers in the shop.

6.2 Adjusting the levels

6.2.1 If the transfer was found to be out of criteria (more than ± 3% of target), it is necessary to perform a full calibration. To do so, connect the transfer as in steps 1 through 5, if not already connected. Once the parameters are adjusted for the particular analyzer set the "CalAdjust" parameter to "true" under the appropriate analyzer's setting. Next set the "CalStart" parameter to "true". This performs an automatic sequence that adjusts the Background and Coefficient variables. A report can be generated through an Access script loaded on to the Loggernet computer which can be accessed from any of the other computers in the shop.

Below are equations to check the accuracy of the analyzers.

Correct the PS averages to actual (observed average minus the y-intercept and divided by the slope generated when the PS was certified).

$$actual = \left(\frac{average\ reading - \text{intercept}}{slope} \right)$$

Calculate percent differences (*%Δ)* and perform a regression analysis of the transfer averages versus the 49PS values.

$$\%\Delta = \left(\frac{unknown - known}{known} \right) \times 100$$

6.2.2 After 6 days, calculate the average for all 6 days from the printed reports.

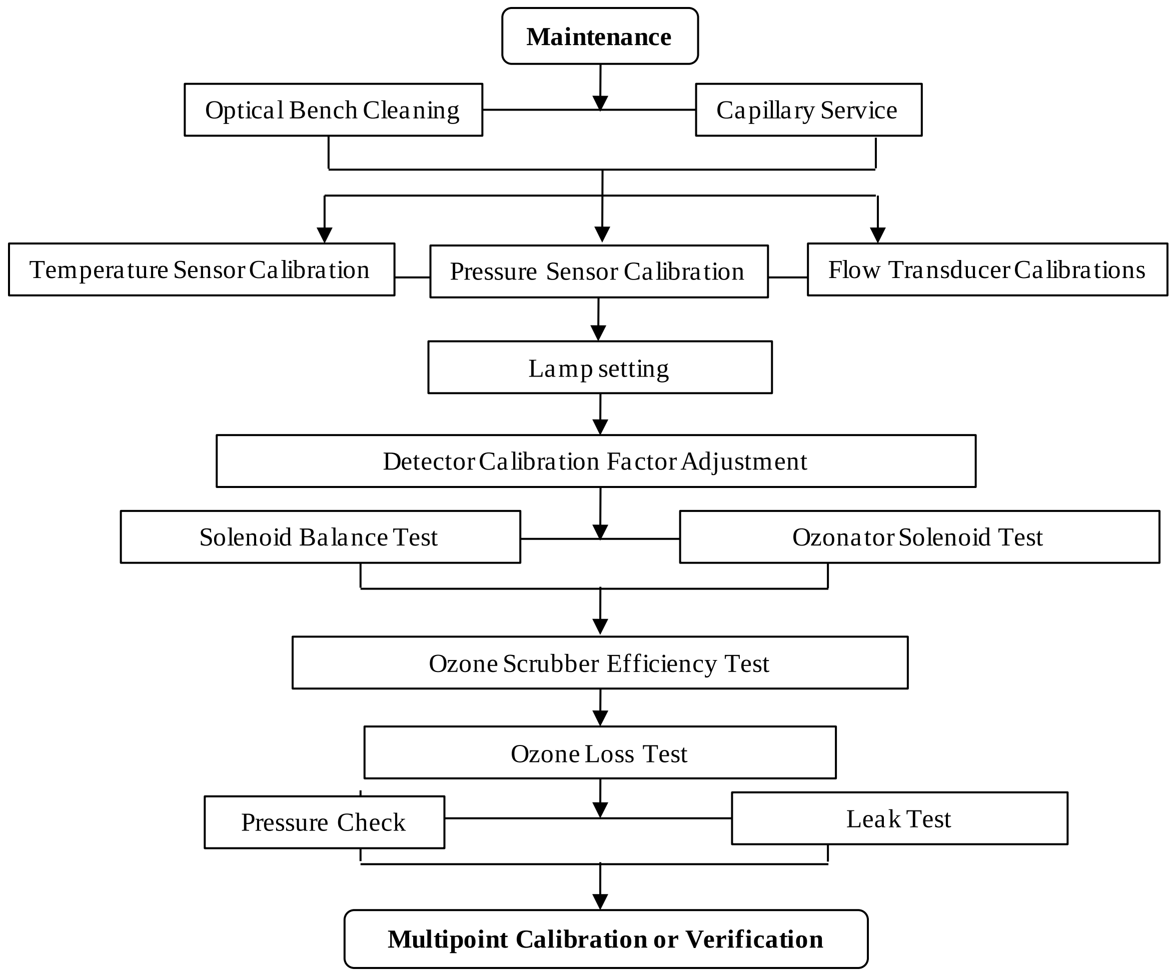
6.3 Repair and Maintenance

See Chapter 7 in the Thermo Manufacturer's Manuals for repair procedures for both models.

7.0 MAINTENANCE AND CALIBRATION

Perform any detector audits or post calibrations prior to beginning the following procedure. The following list is the comprehensive maintenance overhaul. Refer to Ozone Maintenance and Calibration Schedule to determine required maintenance. Please see Figure 2 for an overview of the maintenance process.

Figure 2. Maintenance Overview



7.1 Optical Bench Cleaning (Manual Section 5-2)

7.1.1 Turn off power, disconnect the power cable and remove cover.

7.1.2 Loosen the knurled nut around tube and carefully slide out the tube.

7.1.3 Push a piece of lens paper (Kim Wipe) down the tube using a 1/4-inch piece of Teflon tubing so as not to damage the tube. Use a cotton swab to clean the window surfaces through the holes the tube fits into.

7.1.4 Replace the tubes (opposite of removal). Both tubes are identical, so they can be replaced in either position.

7.2 Capillary Service (Manual Section 5-5)

7.2.1 Turn off power, disconnect the power cable, and remove cover.

7.2.2 Remove purple 15 mil capillaries by loosening nuts around the Tee fitting on top of sample pump. Remove capillaries from tubing.

7.2.3 Clear any blockage with a wire less than 0.015-inch OD, or replace.

7.2.4 Replace capillaries (opposite of removal).

7.2.5 Repeat steps 2-4 for orange 24 mil capillary upstream of ozone generation chamber if applicable.

7.3 Bench Temperature Sensor Calibration (Manual Sections 7-26 and 3-92)

Note: *The analyzer must be in service mode to perform this adjustment.*

7.3.1 Remove bench thermistor signal cable from the Measurement Interface Board.

7.3.2 Unscrew thermistor from the optical bench.

7.3.3 Reconnect signal cable to Measurement Interface Board.

7.3.4 Place thermistor through foam in an empty insulated thermos with temperature primary standard.

7.3.5 After the readings equilibrate, adjust bench calibration if the deviation is > 2°C.

7.3.6 Press the Main Menu button to display the Main Menu.

7.3.7 Use the down arrow button to scroll to Service and press the enter button to display the Service menu.

7.3.8 Use the down arrow button to scroll to Temperature Calibration and press the enter button to display the Temperature Calibration screen.

7.3.9 Enter corrected temperature standard reading and press ↵ (Enter) to save.

7.4 Pressure Sensor Calibration (Manual Sections 7-34 and 3-88)

The pressure sensor calibration requires a high vacuum pump capable of < 1mmHg (≈1 torr). If such a pump is unavailable, only adjust the pressure span setting.

Note: *The analyzer must be in service mode to perform this adjustment.*

7.4.1 Connect reference pressure sensor and vacuum pump to pressure transducer.

7.4.2 Turn on vacuum pump until reference pressure sensor reads < 1mmHg.

7.4.3 Adjust zero setting if deviation is > 5 mmHg.

7.4.4 Press the Main Menu button to display the Main Menu.

7.4.5 Use the down arrow button to scroll to Service and press the enter button to display the Service menu.

7.4.6 Use the down arrow button to scroll to Pressure Calibration and press the enter button to display the Pressure Calibration screen.

7.4.7 From the zero menu, press enter to set the zero setting.

7.4.8 Turn off vacuum pump and open the relief valve.

7.4.9 After the readings equilibrate, adjust span concentration if deviation > 5mmHg.

7.4.10 Press the menu button to return to the pressure calibration menu.

7.4.11 From the span menu, enter the reference pressure reading and press ↵ (Enter) to save.

7.5 Flow Transducer Calibrations (Manual Sections 7-37 and 3-90)

The flow readings are not used to calculate ozone concentration. Since they are only diagnostic, a precise calibration is not critical.

Note: *The analyzer must be in service mode to perform this adjustment*.

7.5.1 Turn off the instrument sample pump.

7.5.2 Press the Main Menu button to display the Main Menu.

7.5.3 Use the down arrow button to scroll to Service and press the enter button to display the Service menu.

7.5.4 Select Flow A Calibration and then zero.

7.5.5 Press ↵ (Enter) to set the flow zero setting.

7.5.6 Repeat steps 4 and 5 for Flow B.

7.5.7 Connect the reference flow meter to the sample bulkhead.

7.5.8 From the Flow A Calibration menu, select Span.

7.5.9 Disconnect the tubing from the cell B flow transducer to the sample pump and cap both cell B pump inlet and transducer output. Leaving either uncapped will produce erroneous readings.

7.5.10 Enter the reference flow meter reading and press ↵ (Enter) to save.

7.5.11 Repeat steps 8 – 10 for Flow B.

7.6 Leak Check (Manual Section 5-7)

7.6.1 Turn off zero air and disconnect the zero air tubing from the primary.

7.6.2 Cap the sample inlet bulkhead.

7.6.3 Press the Pressure soft key.

7.6.4 The pressure reading should drop less than 200 mm Hg.

7.6.5 It should take less than 30 seconds from the time the zero air dump is plugged to the time the reading below 200 mm Hg is obtained

7.7 Adjust Lamp Setting (Manual Section 3-85)

Note: *The analyzer must be in service mode to perform this adjustment*.

7.7.1 Press the Main Menu button to display the Main Menu.

7.7.2 Use the down arrow button to scroll to Service and press the enter button to display the Service menu.

7.7.3 Use the down arrow button to scroll to Lamp Setting and press the enter button to display the Lamp Setting screen.

7.7.4 Use the up or down arrows to increment or decrement the numeric value until both intensities are as close to 100 kHz as possible.

7.7.5 Press the enter button to save the new lamp setting.

7.8 Detector Calibration Factor Adjustment (Manual Section 3-86)

Note: *The analyzer must be in service mode to perform this adjustment.*

7.8.1 Connect zero air to the sample bulkhead connector.

7.8.2 Press the Main Menu button to display the Main Menu.

7.8.3 Use the down arrow button to scroll to Service and press the enter button to display the Service menu.

7.8.4 Use the down arrow button to scroll to Detector Calibration and press the enter button to display the Detector Calibration screen.

7.8.5 Verify both detector uncorrected readings are between 90 kHz and 110 kHz.

7.8.6 Press ↵ (Enter) to compute new calibration factors.

7.9 Solenoid Balance and Leak Test (Manual Sections 5-8 and 5-9)

7.9.1 Generate an ozone concentration of approximately 0.5 ppm and connect to the sample bulkhead connector.

7.9.2 Press the Main Menu button to display the Main Menu.

7.9.3 Use the down arrow button to scroll to Diagnostics and press the enter button to display the Diagnostics menu.

7.9.4 Use the down arrow button to scroll to Cell A/B O_3 and press the enter button to display the O_3 PPB screen. This display presents the concentration for each cell.

7.9.5 Once the instrument stabilizes, the average of 10 successive simultaneous readings from each cell should agree within ± 3 percent.

7.9.6 A balanced measurement of better than 3 percent indicates that there are no leaks across the solenoid.

7.9.7 A constant low reading from one cell indicates an imbalance. The imbalance can be caused by a dirty cell, dirty lines to that cell, or by a leaky valve.

7.9.8 To check if the imbalance is caused by a dirty cell, interchange the cells. If the imbalanced side switches, the imbalance is caused by the cell.

7.9.9 To check if the imbalance is caused by dirty lines to a cell, perform the ozone loss test.

7.9.10 To check the solenoid for a leak perform the following test.

- Remove the solenoid valve that appears to be faulty.

- Connect the solenoid cell test tubing to the test pump. The other end of the tubing will be connected to a tee fitting.
- Cap one open port on the tee fitting.
- Connect a pressure transducer to the open tee fitting port.
- Turn on the test pump.
- After the pressure has stabilized, record the reading as P_C.
- Turn off the test pump.
- Uncap the capped the tee fitting port.
- Connect the open tee fitting port to the common solenoid port.
- Cap the normally open solenoid port.
- Turn on the test pump.
- After the pressure has stabilized, record the pressure reading as P_{NO}.
- Turn off the test pump
- Uncap the normally open solenoid port.
- Cap the normally closed solenoid port.
- Plug the solenoid power line into the appropriate connector on the measurement interface board. Make sure the solenoid is activated.
- After the pressure has stabilized, record the pressure reading as P_{NC}.
- The solenoid is faulty if either P_{NO} or P_{NC} is greater than P_C.

7.9.11 If an imbalance is found, repair and return to step 3, adjusting the detector lamp setting

7.10 Ozone Scrubber Efficiency Test (Manual Section 5-10)

To obtain accurate results using this test, it is critical to measure all readings precisely. In most cases, the entire range of the instrument is represented by 500-600 Hz. Make sure the instrument has sufficiently warmed up and the cover is on. Any limitations in ambient temperature control, test zone concentration, intensity stability, or temperature and pressure measurements should be understood when evaluating the test results.

Note: *The analyzer must be in service mode to perform this test.*

7.10.1 Generate an ozone concentration of approximately 0.5 ppm and connect to the sample bulkhead connector. The exact concentration is not important, but the accuracy of this test is directly affected by how accurately the test concentration is known.

7.10.2 Press the Main Menu button to display the Main Menu.

7.10.3 Use the down arrow button to scroll to Service and press the enter button to display the Service menu.

7.10.4 Use the down arrow button to scroll to Intensity Check and press the enter button to display the Intensity Check menu.

7.10.5 Press the enter button to display the Int A Reference Gas screen.

7.10.6 When the frequency stabilizes, record the frequency to the nearest 5 Hz as FREQ 1.

7.10.7 Press the menu button to return to the Intensity Check menu and select Int A Sample Gas.

7.10.8 When the frequency stabilizes, record the frequency to the nearest 5 Hz as FREQ 2.

7.10.9 Press the Pressure soft key and record as P.

7.10.10 Press the Temperature soft key and record as T.

7.10.11 The approximate efficiency is given as follows:

$$\% \text{ Efficiency} = \frac{\frac{(273 + T)}{P} \frac{10^6}{KL} \frac{760}{273} \ln \frac{FREQ2}{FREQ1}}{C} \times 100\%$$

7.10.12 Repeat steps 5-11 for Cell B (choose Int B Reference Gas).

7.10.13 If the analyzer passed the balance test of the “Solenoid Balance and Leak Test” performed previously and the measured efficiency is low, replace the ozone scrubber.

7.11 Ozone Loss Test (Manual Section 4-4)

Only perform as necessary as indicated by the results of the Solenoid Balance and Leak Test.

7.11.1 With the instrument running, generate an ozone concentration of approximately 0.5 ppm and connect to the sample bulkhead connector. The internal generator can be used since concentration will be measured later.

7.11.2 Using a certified ozone detector, measure the concentration at the test instrument sample bulkhead as C, the inlet of cell A as Ca_{IN}, the exhaust of cell A as Ca_{OUT}, the inlet of cell B as Cb_{IN} and the exhaust of cell B as Cb_{OUT}.

7.11.3 The percent ozone loss is given as follows:

$$1 - \frac{C^a_{IN} + C^a_{OUT} + C^b_{IN} + C^b_{OUT}}{4C} \times 100\%$$

7.12 Pump Pressure Check (Manual Section 3-83)

Note: *The analyzer must be in service mode to perform this test.*

7.12.1 Press the Main Menu button to display the Main Menu.

7.12.2 Use the down arrow button to scroll to Service and press the enter button to display the Service menu.

7.12.3 Use the down arrow button to scroll to Pressure Check and press the enter button to display the Pressure Check menu.

7.12.4 Use the down arrow button to scroll to Pump Pressure and press the enter button to display the Pump Pressure screen.

7.12.5 The pressure reading should drop below 390 mmHg in less than 20 seconds. This indicates the effectiveness of the sample pump.

7.12.6 After 20 seconds, if the pressure is greater than 390 mmHg or the flow is greater than 0.010 LPM, the words “PUMP PROBLEM DETECTED” appear. Otherwise the words “PUMP OK” appear.

7.13 Leak Test (Manual Section 5-7)

7.13.1 Plug the sample inlet port.

7.13.2 Press the Pressure soft key.

7.13.3 The pressure reading should drop less than 200 mm Hg.

7.13.4 It should take less than 30 seconds from the time the sample inlet port is plugged to the time the reading below 200 mm Hg is obtained.

7.13.5 Continue only for instruments with ozone generators.

7.13.6 Plug the vent port, ozone port, zero air port, and the integrity/cal gas outlet port on the tee fitting.

7.13.7 Press the ► button to return to the home screen.

7.13.8 Press the ► button to activate zero mode.

7.13.9 Press the Pressure soft key.

7.13.10 The pressure reading should drop less than 200 mm Hg.

7.13.11 It should take less than 30 seconds from the time the sample inlet port is plugged to the time the reading below 200 mm Hg is obtained.

7.13.12 Lift the lid and remove any packing material used for shipping. Inspect interior for obvious damage (i.e., broken fittings, cracked tubing and loose parts) and repair if necessary.

7.13.13 Remove cell chambers and clean with a Kimwipe and compressed air. Replace cells in their previous positions (***Note:*** *Do not interchange cell positions as this affects frequency values. Work on only one cell at a time.*) Excessive debris inside cells may be indicative of deterioration of the 3-way valves.

7.13.14 Connect the sample port to one of the three level 2 or 3 ozone transfer standards. Add a short exhaust line and check and other connections (i.e., in/out loop, exhaust) are properly attached for a tight connection.

7.13.15 Turn the unit on. (It must be connected to a running level 2 or 3 ozone transfer standard before operating). Allow to warm up for at least one hour.

7.13.16 Perform a leak check. To do so turn the unit off, remove the sample tubing and install a Kynar plug. Turn the unit on and wait for it to reboot. Press the **Pres** soft key. Note the pressure on the front of analyzer – it should drop to below 200 mmHg for a good leak check. Turn the unit off and replace the sample line before turning on again. A pressure drop above 200 mmHg may indicate a leak in the system or a weak sample pump and requires investigation prior to sampling.

7.13.17 Check intensity and noise levels. With unit in **Service Mode** press **Menu**, **Service** and **Lamp Setting**. If necessary, adjust the intensities (also known as frequencies) to around 100,000 Hertz. Record the lamp percentage on the Maintenance Form. While in the **Service** menu, toggle down to **Intensity Check**, press **enter**, press **enter** again on **Int A Reference Gas** or **Int A Sample Gas**. Record the intensity and noise level. Allow at least one minute for the noise level to stabilize. It should be below 4.0 and not ramp above that level. Press **Menu** once and then press **enter** on **Int B Reference Gas** or **Int B Reference Sample** to obtain the intensity and noise level for cell B. Press the **Run** button to return to sample mode.

7.13.18 Check the temperature, flows and ambient pressure by pressing the "soft" keys (**Temp**, **Flow**, and **Pres** respectively) which are located directly under the display screen (Figure 3). Record their values on the Maintenance Form.

Figure 3. Model 49i Soft keys.

7.13.19 Set voltage output. In the **Main Menu**, choose **Instrument Controls**, **I/O Configuration** then **Analog Output Config**. Select **All Current Channels**, **Select Range** and use the cursor to select **0-1V** and press **enter** to save.

7.13.20 Calibrate analog output. Attach I/O Terminal board (Thermo pn102888) to Analog Voltage Output port in back of the analyzer (Figure 4). Connect the certified multi-meter's positive wire to terminal #20 and the negative wire to terminal #21 respectively on the I/O terminal board. Set the multi-meter to read to three decimal places. Return to **Main Menu** and scroll the cursor down to **Service**. Choose **Analog Output Calibration**, **Voltage Channel 1**, **Calibrate Zero**. Use the cursor to increment or decrement the numeric value and produce 0.000 VDC as indicated by the multi-meter.. Press **Enter** to save when multi-meter reads 0.000. Record the value and exact voltage on the Maintenance Form. Return to **Analog Out Cal** menu, choose **Calibrate Full Scale**, and use cursor to increment or decrement the numeric value to produce 1.000 VDC indicated by the multi-meter. Press **Enter** to save when multi-meter reads 1.000. Record the value and exact voltage on the Maintenance Form.

Figure 4. Model 49i analog output calibration.

7.13.21 Take the unit out of **Service Mode**. Press **Run**, **Main Menu**, **Instrument Controls**, **Service Mode**, **Enter** and then **Run** again.

8.0 REFERENCES

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9.0 ATTACHMENTS

Attachment A – Example Ozone Detection Calibration Report

Attachment B – Certification Procedures for CASTNET Traveling Transfer Standards

ATTACHMENT A
Example Ozone Detection Calibration Report

MACTEC

Ozone Detector Calibration Report

Analyzer	
ID Number	000375
Beginning Bkg	0.1
Beginning Coef	1.016
Ending Bkg	0.1
Ending Coef	1.016

Calibrator	
ID Number	000122
Slope	0.989899993
Intercept	0.041889999

Technician	
Start Time	11/11/09 11:51
End Time	11/11/09 13:45

Setting	Zero			450 PPB		
Reading	Calibrator	Actual	Analyzer	Calibrator	Actual	Analyzer
1	0.0	0.0	0.2	449.0	453.5	454.2
2	0.0	0.0	0.1	449.0	453.5	454.1
3	0.0	0.0	-0.3	449.0	453.5	454.2
4	0.0	0.0	-0.1	449.0	453.5	454.3
5	0.0	0.0	0.1	449.0	453.5	454.1
6	0.0	0.0	0.4	449.0	453.5	453.9
7	0.0	0.0	-0.1	449.0	453.5	454.0
8	0.0	0.0	-0.2	449.0	453.5	454.2
9	0.0	0.0	-0.3	449.0	453.5	453.2
10	0.0	0.0	0.1	449.0	453.5	453.9
Average	0.0	0.0	0.0	449.0	453.5	454.0
Difference			0.0 PPB			0.11 %
Linearized			-0.4			453.3
Final Diff			-0.4 PPB			-0.04 %

Setting	300 PPB			200 PPB		
Reading	Calibrator	Actual	Analyzer	Calibrator	Actual	Analyzer
1	299.0	302.0	303.2	199.0	201.0	201.8
2	299.0	302.0	303.0	200.0	202.0	201.9
3	300.0	303.0	303.1	199.0	201.0	201.8
4	299.0	302.0	303.2	199.0	201.0	201.3
5	299.0	302.0	303.3	200.0	202.0	201.7
6	300.0	303.0	303.3	199.0	201.0	202.1
7	299.0	302.0	303.2	199.0	201.0	201.5
8	299.0	302.0	303.0	199.0	201.0	201.4
9	299.0	302.0	302.8	199.0	201.0	201.7
10	299.0	302.0	303.2	199.0	201.0	201.8
Average	299.2	302.2	303.1	199.2	201.2	201.7
Difference			0.30 %			0.25 %
Linearized			302.5			201.2
Final Diff			0.10 %			0.00 %

Setting	90 PPB			60 PPB		
Reading	Calibrator	Actual	Analyzer	Calibrator	Actual	Analyzer
1	89.0	89.9	90.9	60.0	60.6	61.4
2	89.0	89.9	90.7	59.0	59.6	61.1
3	90.0	90.9	91.3	60.0	60.6	61.0
4	89.0	89.9	90.8	60.0	60.6	60.6
5	89.0	89.9	90.8	59.0	59.6	60.9
6	90.0	90.9	90.9	60.0	60.6	60.8
7	89.0	89.9	90.6	60.0	60.6	61.1
8	89.0	89.9	91.0	60.0	60.6	61.0
9	89.0	89.9	90.6	60.0	60.6	60.7
10	89.0	89.9	90.8	60.0	60.6	60.7
Average	89.2	90.1	90.8	59.8	60.4	60.9
Difference			0.78 %			0.83 %
Linearized			90.4			60.5
Final Diff			0.33 %			0.17 %

Linear Regression	
Slope	1.0008315
Intercept	0.36 PPB
Correlation	0.9999988

Signature *Mactec Employee*

ATTACHMENT B
Certification Procedures for CASTNET Traveling Transfer Standards

CASTNET sites that are configured for compliance monitoring are most often configured with a site analyzer without an onboard ozone generator paired with a separate analyzer equipped with both a photometer and an onboard ozone generator. The analyzer with the onboard ozone generator is used as an onsite transfer standard to generate the ozone concentrations for routine checks. The transfer standard's photometer must first have a 6-day certification and then a 1-day certification every six months by an O_3 transfer standard that is traceable to an EPA standard reference photometer (SRP).

SRP are considered Level 1 standards. Any commercial analyzer designated as a reference or equivalent method compared with a Level 1 standard is considered a Level 2 standard. Initial verification of the site transfer standards will be performed at the CASTNET field equipment laboratory using its Level 2 standards, giving the site transfers Level 3 authority when installed at a site configured with a separate analyzer for compliance monitoring.

In order to maintain Level 3 authority for the site transfer standards, the traveling transfer standards must have Level 2 authority. To accomplish this authority traveling transfer standards are shipped to an SRP operated by the National Institute of Standards and Technology once per year.

In addition to sending traveling transfer standards to an SRP annually, after each calibration trip, the traveling transfer standards will be compared to the Level 2 standards in the CASTNET field equipment laboratory as a quality control check. However, the comparison will be a quality control check only; the traveling transfer standards will not be adjusted. If a problem is found based on these checks or a major repair is required due to mechanical failure or shipping damage, the traveling standard will be returned to an SRP for verification before it is redeployed to the field.

IV. CALIBRATION LABORATORY
B. TRANSFER STANDARDS
4. BIOS PRIMARY AIR FLOW METER

Effective Date: 11-10-17

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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Annual Review			
Reviewed by:	Title:	Date:	Signature:
MS	QA Mgr	10/30/12	[signature]
MS	QA Mgr	10/30/14	[signature]
MS	QA Mgr	11/2/15	[signature]

IV.B.4. BIOS PRIMARY AIR FLOW METER

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance for the maintenance and handling of the BIOS Definer 220 and BIOS DryCal Primary Air Flow Meters to Clean Air Status and Trends Network (CASTNET) Field Calibration Laboratory personnel.

2.0 SCOPE

This SOP applies to the maintenance and handling of BIOS Air Flow Meters administered by the CASTNET Field Calibration Laboratory.

3.0 SUMMARY

The BIOS Definer 220 and BIOS DryCal DC-Lite Flow Meter with NEXUS Data/ Communication Module [both referred to as mass flow meters (MFM)] are recharged and leak tested at least quarterly by laboratory personnel. Repairs and certifications are performed by the manufacturer.

4.0 MATERIALS AND SUPPLIES

MFM
Battery charger
Lead-acid batteries

5.0 REPAIR AND MAINTENANCE

All repairs and adjustments are performed by the manufacturer.

When not in use, store in a clean, dry environment with the inlet/outlet caps installed. Every quarter, fully charge the battery pack, and perform a leak test.

5.1 Charging the Battery

Before using your MFM, be sure that the battery system has been fully charged to ensure that the unit will perform to specifications and maintain proper operation for the required time period.

The MFM is equipped with a battery indicator that shows battery charge at three levels. When the battery indicator on the display is empty, the unit will continue to operate for a short period of time before shutting itself off.

5.2 Charging the MFM

5.2.1 Connect the appropriate BIOS 12VDC charger, which was provided with the MFM, into a standard wall outlet. Optionally, one station of the BIOS AirPro 4000D multi-station charger may be used.

5.2.2 Insert the charger barrel plug into the charging jack. Full charge takes 8 to 12 hours. The unit can charge while being used.

5.2.3 The Definer 220 will indicate charging status on its LCD readout. To view the actual charging status of the DC Lite during the charging period, disconnect the battery charger and wait 3 to 5 minutes. When the indicator is solid black, the battery is fully charged.

5.3 Battery Maintenance and Storage

5.3.1 Battery Maintenance:
Lead-acid batteries will not exhibit the "memory effect" common to nickel-cadmium batteries. A lead acid battery may be charged for an indefinite time period without damage.

5.3.2 Long-Term Storage:
Long-term storage without charging can damage the battery pack; therefore, if the DC-Lite cannot be left charging continuously, it should be charged at least every 3 months.

5.4 Leak-Test Check Procedure (DC-Lite/NEXUS)

The DC-Lite has a built-in quality assurance self-test feature to verify proper integrity and operation of the DC-Lite flow cell (see the DC-Lite Manual). When the NEXUS is introduced into the flow stream, the NEXUS represents additional opportunities for leakage. We recommend that the NEXUS flow path be included in the leak test process.

The leak test for the DC-Lite and NEXUS combination is very similar to the leak test defined in the DC-Lite Manual with only a small modification. Connect tubing from the NEXUS to either the inlet or outlet of the DC-Lite and connect the leak test fitting to the remaining NEXUS air boss. Make sure the electronic cable is disconnected.
To initiate the leak test:

5.4.1 Connect either the DC-Lite inlet or outlet to the NEXUS with tubing and then place the leak test tubing accessory (short piece of tubing with red cap) over the remaining NEXUS air boss. The low flow range DC-Lite (DCL500) requires a tubing adapter to connect to the larger NEXUS air boss.

5.4.2 After the tubing connections have been made, from the DC-Lite key pad, press and hold the **<Stop>** button while pressing the **<On>** button. The DC-Lite display will read:

Leak Test Invert & Push Read

***Note**: If the DC-Lite is already "ON", press and hold the* **<Stop>** *button while pressing the* **<Hard Reset>** *button on the back of the DC-Lite unit.*

5.4.3 Invert the DC-Lite so the piston moves to the top of the cell. While the piston is resting at the top of the cell press the **<Read>** button and the internal valve will close. Return the DC-Lite to an upright position and it will time the descent of the piston.

***Note:** The test may take as long as 15-20 minutes. Observe the location of the piston to ensure that it is at the top of the cell when the test begins.*

If the test is completed successfully, the display will read:

Test OK Push Read

5.4.4 Press the **<Read>** button as directed and the internal valve will open and the piston will fall.

5.4.5 Repeat the test with the leak test tubing accessory connected to air boss not connected to the NEXUS.

***Note:** If the unit fails the leak-test, the display will read*:

Maintenance Reqd Push Read

5.5 Leak Test Procedure (Definer 220)

The Definer Leak Test is designed only to verify the internal integrity of the instrument and alert you to an internal leak. We recommend performing the Leak Test only as an intermediate quality control check or whenever the integrity of the instrument is questioned due to misuse or accidental damage.

Please note that a leak test is not a substitute for a comprehensive examination of the unit's overall performance and it does not ensure that the Definer is operating accurately.

- Invert the Definer and allow the piston to travel to the top.
- Cap the port under test using the Bios supplied leak test cap. Leave the other port uncapped.
- Press Enter on the control panel while the unit is still inverted.
- Return the unit upright. The leak test will progress.

6.0 PROCEDURES

The BIOS Primary Air Flow Meter is returned to the manufacturer annually for routine cleaning, maintenance, calibration, and certification (Figures 1 and 2 show Sample Factory Certificates).

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring.* 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)*. 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods*. EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements.* EPA-600/4-82-060.

Bios International Corporation. 2002. *DryCal® DC-Lite Manual*

8.0 FIGURES

Figure 1. Sample Calibration Certificate

BIOS

BIOS International Corporation • 10 Park Place, Butler, NJ 07405 USA
Phone: (973) 492-8400 • Fax: (973) 492-8270 • www.biosint.com

calibration certificate

DRYCAL NEXUS TEMPERATURE AND PRESSURE SENSOR CALIBRATION

The DryCal Lite is a true primary *volumetric* flow standard. A separate calibration certificate is supplied with the flow measuring cell(s). Temperature and pressure corrections are then applied by the Nexus to obtain *standardized* flow readings. The temperature and pressure transducers are calibrated against NIST traceable standards to obtain the standardized readings.

BIOS International certifies that the following DryCal Nexus has been calibrated against the following standards:

- Ambient temperature using precision thermometer 21 °C
- Nexus Temperature reading 21 °C

Calibration Standard	Telatemp 4400T		Serial No. 300907	
Date of Calibration	03/21/2000	Date Due	03/21/2001	NIST No. 811/260178

- Ambient pressure using precision pressure indicator 751 mm Hg
- Nexus pressure reading 751 mm Hg

Calibration Standard	Druck DPI 740		Serial No. 431/98-09	
Date of Calibration	10/31/2000	Date Due	10/31/2001	NIST No. E2828 822/249620

All calibrations performed in accordance with ANSI/NCSL Z540-1-1994

Nexus
Air #
00587

Serial Number 1023

By Machek Pankow
Machek Pankow

Date 7/17/01

1 of 1

Figure 2. Sample Performance Certificate

BIOS

BIOS International Corporation • 10 Park Place, Butler, NJ 07405 USA
Phone: (973) 492-8400 • Fax: (973) 492-8270 • www.biosint.com

AS SHIPPED FLOW DATA:

Product DCL-MH

Serial No. 1153 20k Air #00579 → EPA # 000307

Date 7/26/01

Laboratory Environment:

Temperature Ambient: 21.04°C

Pressure Ambient: 749.9 mmHg

Humidity Ambient: 54 %

Instrument Reading ml/min	Lab Standard Reading ml/min	Lab Standard Unit #	Deviation Percentage	Allowable Deviation	Condition Shipped
200.7	200	1002	0.35	1.00%	in tolerance
503.6	500.15	1003	0.69	1.00%	in tolerance
2014	2002	1001	0.60	1.00%	in tolerance
5026	5000.5	1001	0.51	1.00%	in tolerance
17040	17015	1001	0.15	1.00%	in tolerance

Notes:

By: Sonia Otero
Sonia Otero

Date: 7/26/01

Page 2 of 2

IV. CALIBRATION LABORATORY
B. TRANSFER STANDARDS
5. EUTECHNICS MODEL 4600 AND EXTECH MODEL 407907 PLATINUM RESISTANCE TEMPERATURE DEVICES

Effective Date: 10/30/14

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, Project QA Manager

Approved by: Holton K. Howell, Project Manager

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Reviewed by:	Title:	Date:	Signature:
MS	QA Mgr	11/2/15	

IV.B.5. EUTECHNICS MODEL 4600 AND HY-CAL BA500AUCXI PLATINUM RESISTANCE TEMPERATURE DEVICES

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance for the maintenance and handling of the Eutechnics Model 4600 and Extech Model 407907 platinum Resistance Temperature Devices (RTD) to Clean Air Status and Trends Network (CASTNET) Field Calibration Laboratory personnel.

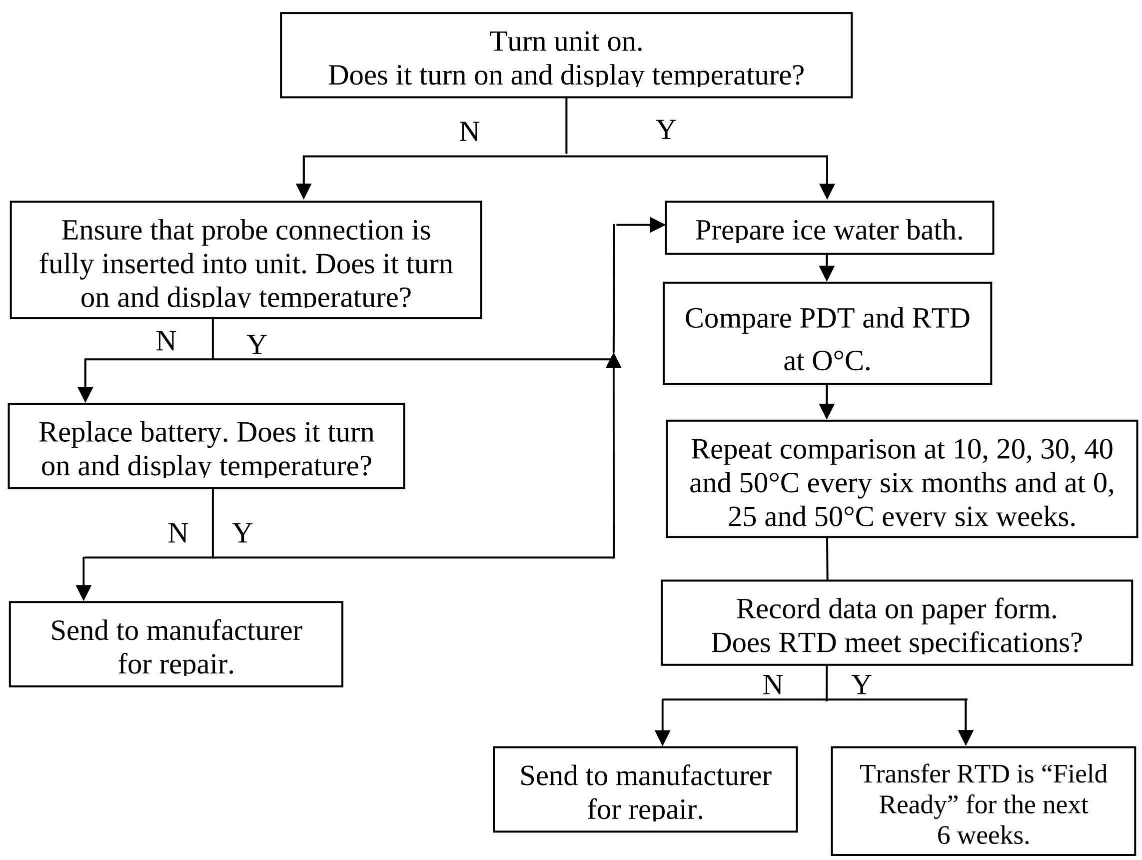
2.0 SCOPE

This SOP applies to the maintenance and handling of Eutechnics Model 4600 and Extech Model 407907 platinum RTD units administered by the CASTNET Field Equipment Calibration Laboratory.

3.0 SUMMARY

Transfer platinum RTD units used in field calibration activities are certified at a minimum of once every 6 weeks via comparison with an independently certified NIST traceable Dostmann Model P600 platinum RTD. See Figure 1.

Figure 1. RTD Transfer certification, maintenance and repair process



4.0 MATERIALS AND SUPPLIES

Dostmann P600 temperature probe and meter with NIST traceable certification
EUTECHNICS 4600 RTD Temperature transfer or
EXTECH 407907 Temperature transfer
RTD Calibration form
Stir plate
Stirring magnet
Device to heat water to 50˚C
Large syringe
Crushed ice
Water
Insulated vessel with fitted lid large enough to accommodate temperature probes
9-Volt battery

5.0 SAFETY

Exercise standard laboratory precautions when handling electrical heating appliances and hot water.

6.0 PROCEDURES

6.1 Certification

6.1.1 Heat approximately one half liter of water to at least 50˚C.

6.1.2 Obtain the correction factor chart for the Dostmann NIST RTD being used to certify the transfer RTD(s). Verify that the Dostmann display unit displays the proper calibration code for the probe attached to it.

6.1.3 Record the serial number and correction factors for the Dostmann NIST traceable handheld display on an RTD Calibration form. See attachment A.

6.1.4 The Eutechnics RTD or Extech RTD needs only to be turned on to read and display values on its screen. Ensure it is reading in °C and recording to two decimal places.

6.1.5 Place a stir bar, finely crushed ice and water in the insulated vessel and place on the stir plate.

6.1.6 Turn the stir plate on and verify active stirring of the bath water.

6.1.7 Place the foam lid in the vessel and insert the Dostmann probe and the transfer probe through the lid to immerse to a depth of 3 to 4 inches. None of the probes should be touching each other or the sides of the Thermos (Figure 2).

Figure 2. Transfer certification apparatus

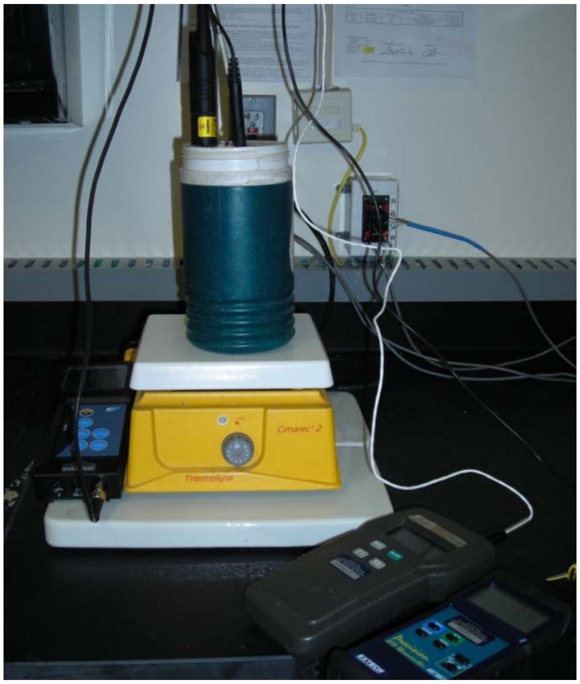


Figure 3. Dostmann probe (left), Eutechnics transfer probe (middle) and Extech probe (right) immersed in stirring bath. More than one temperature transfer device may be certified simultaneously.

6.1.8 Allow the RTDs to stabilize and then record the Dostmann output at the 0ºC target temperature. Simultaneously record the transfer probe measurement to two decimal places. If more than one transfer is being certified, use separate RTD Calibration forms for each and record the Dostmann output on each form. Correct the Dostmann measured reading using its NIST traceable certification correction factors.

6.1.9 Repeat the above procedure to obtain five measurements at 0ºC, simultaneously recording the Dostmann and each transfer probe measurement. Correct each value measured with the Dostmann unit.

6.1.10 Using a syringe to mix hot and room temperature water make stirring baths at 10°C, 20°C, 30°C, 40°C, and 50°C, ±1ºC.

6.1.11 Repeat the procedure to obtain five total measurements from each unit at each temperature target.

6.1.12 Average the five measurements of each unit at each target temperature and record on the calibration form.

6.1.13 Using the NIST traceable certification form values calculate and record the corrected average temperature for the Dostmann measurements.

6.1.14 Calculate the difference between the Dostmann and the transfer RTD in units of °C and record on the form. The RTD must be within ±0.3° of the Dostmann RTD to meet specification.

6.1.15 Calculate the slope, intercept, and correlation coefficient for the NIST RTD and record on the form.

6.1.16 Sign and date the form and have a qualified technician or supervisor review it. Secure the form to the RTD.

6.2 Repair

All repairs and adjustments are performed by the manufacturer.

6.3 Maintenance

6.3.1 Replace the 9-volt (V) alkaline battery as needed.

6.3.2 Turn the unit over onto its face and remove the battery door at the bottom of the case.

6.3.3 Pry the old battery out from the mounting terminals using thumb and/or forefinger.

6.3.4 When putting in the new 9-V battery, be sure that the terminals line up and snap firmly into the terminal on the circuit board.

Note: *The unit will not be damaged if you accidentally try to put the battery in backwards. Replace the battery door.*

Note: *A 9V lithium battery may be used to extend the battery life.*

6.3.5 Insert probe connector, ensure a good connection and remove.

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*. 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)*. 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods.* EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements.* EPA-600/4-82-060.

8.0 ATTACHMENTS

Attachment A – Sample Temperature Calibration Form

ATTACHMENT A
Sample Temperature Calibration Form

MACTEC Temperature

Site Name	Calibrator	Calibration Date	Data Logger	iForms Ver.
BVL130	AQS	9/6/2011	Campbell 3000 ID:424	1.4.0

	9 Meter (T1)		2 Meter (T2)	
	As Found	As Left	As Found	As Left
ID #	06690		06685	
Description	RTD		RTD	
Manufacturer	R.M. Young		R.M. Young	
Model	43347		43347	
R_o	1000.56		1000.37	
Alpha	0.00375		0.00375	
Translator Type				

Transfer Standard					
ID #	06843				
Manufacturer	Eutechnics				
Model	4600				
Date of Last Cert.	6/15/2011				
Correction Factors					
0°	10°	20°	30°	40°	50°
0.15	0.14	-0.11	0.00	-0.12	-0.06

As Found RTD (°C)			Temperature Data Logger Output: Temperature (9m) Output				Temperature 2 (2m) Output				Delta T.	Shelter Temperature	
Uncorrected Temp. (°C)	Correction Factor	Corrected Temp. (°C)	Raw Temp. (°C)	Corrected Temp. (°C)	Raw Diff (°C)	Corrected Diff (°C)	Raw Temp. (°C)	Corrected Temp. (°C)	Raw Diff (°C)	Corrected Diff (°C)	Diff (°C)	Temp. (°C)	Diff (°C)
-0.03	0.15	0.12	0.28	0.13	0.16	0.01	0.19	0.09	0.07	-0.03	0.04	-0.02	-0.14
10.41	0.14	10.55	10.65	10.49	0.10	-0.06	10.56	10.46	0.01	-0.09	0.04	10.32	-0.23
20.85	-0.11	20.74	21.01	20.85	0.27	0.11	20.99	20.88	0.25	0.14	-0.03	20.67	-0.07
30.28	0.00	30.28	30.44	30.27	0.16	-0.01	30.35	30.24	0.07	-0.04	0.03	29.93	-0.35
40.17	-0.12	40.05	40.26	40.09	0.21	0.04	40.20	40.09	0.15	0.04	0.00	39.64	-0.41
49.29	-0.06	49.23	49.27	49.09	0.04	-0.14	49.22	49.10	-0.01	-0.13	-0.01	48.77	-0.46

Remarks

Reviewed By: Selma Vail   Date: 10/17/11

IV. CALIBRATION LABORATORY
B. TRANSFER STANDARDS
6. R.M. YOUNG SYNCHRONOUS MOTOR MODEL 18802

Effective Date: 11-10-11

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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MS	QA Mgr	10/30/12	[signature]
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MS	QA Mgr	11/2/15	[signature]

IV. B. 6. R.M. YOUNG SYNCHRONOUS MOTOR MODEL 18802

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance for maintenance and handling of the R.M. Young Synchronous Motor Model 18802 to Clean Air Status and Trends Network (CASTNET) Field Calibration Laboratory personnel.

2.0 SCOPE

This SOP applies to the maintenance and handling of R.M. Young Synchronous Motor Model 18802 units administered by the CASTNET Field Calibration laboratory.

3.0 SUMMARY

The synchronous motors are used to calibrate wind speed systems onsite and in the laboratory by mathematically relating shaft rotation frequency to wind speed.

4.0 MATERIALS AND SUPPLIES

R.M. Young Synchronous Motor Model 18802
9-volt (V) batteries

5.0 REPAIR AND MAINTENANCE

5.1 Repair

All repairs and adjustments are performed by the manufacturer when necessary.

5.2 Maintenance

5.2.1 Check all cables for cuts or breaks before each use.

5.2.2 Check the batteries before each calibration trip.

5.2.3 Replace the two 9-V internal batteries when the motor stops and alerts the user on the display.

6.0 CALIBRATION/CERTIFICATION PROCEDURE

The R.M. Young Synchronous Motor is returned to the factory annually for calibration and certification. See Figure 1 for a sample certification form.

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1998a. Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring. 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS). 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. On-Site Meteorological Program Guidance for Regulatory Modeling Applications. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods. EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements. EPA-600/4-82-060.

8.0 FIGURES

Figure 1: Sample Certification Form

YOUNG

METEOROLOGICAL INSTRUMENTS

Certificate of Calibration and Testing

Test Unit:
Model: 18802 Serial Number: CA 01965
Description: Anemometer Drive - 200 to 15,000 Rpm
- Comprised of Models 18820A Control Unit & 18830A Motor Assembly

R.M. Young Company certifies that the above equipment has been inspected and calibrated using standards whose accuracies are traceable to the National Institute of Standards and Technologies (NIST).

Nominal Motor Rpm	27106D Output Frequency Hz (1)	Calculated Rpm (2)	Indicated Rpm (3)
300	50	300	300
2700	450	2700	2700
5100	850	5100	5100
7500	1250	7500	7500
10,200	1700	10200	10200
12,600	2100	12600	12600
15,000	2500	15000	15000
☐ Clockwise and Counterclockwise rotation verified			

(1) Measured frequency output of RM Young Model 27106D standard anemometer attached to motor shaft
(2) 27106D produces 10 pulses per revolution of the anemometer shaft
(3) Indicated on the Control Unit LCD display

*Indicates out of tolerance

Traceable frequency meter used in calibration DP4863

Date of inspection 2/18/99

Tested By K. Ellis

R.M. Young Company 2801 Aero-Park Drive, Traverse City, Michigan 49686 U.S.A.
TEL: (616) 946-3980 FAX: (616) 946-4772

IV. CALIBRATION LABORATORY
B. TRANSFER STANDARDS
7. BRUNTON POCKET TRANSIT

Effective Date: 11-10-11

Reviewed by: Kevin P. Mishoe, Field Operations Manager [signature]

Reviewed by: Marcus O. Stewart, QA Manager [signature]

Approved by: Holton K. Howell, Project Manager [signature]

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MS	QA mgr	10/30/1-	[signature]
MS	QA mgr	10/30/14	[signature]
MS	QA Mgr	1/2/15	[signature]

IV. B. 7. BRUNTON POCKET TRANSIT

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance for maintenance and handling of the Brunton Pocket Transit to Clean Air Status and Trends Network (CASTNET) Field Equipment Calibration Laboratory personnel.

2.0 SCOPE

This SOP applies to the maintenance and handling of Brunton Pocket Transit units administered by the CASTNET Field Calibration laboratory.

3.0 SUMMARY

See Sections 5.0 and 6.0.

4.0 MATERIALS AND SUPPLIES

Soft dry cloth

5.0 REPAIR AND MAINTENANCE

5.1 Repair

Any necessary repairs and adjustments are performed by the manufacturer at the factory when needed.

5.2 Maintenance

Clean the case, mirror, and glass with a soft, dry, cloth, as needed. When not in use store the unit in the leather transit case.

6.0 CALIBRATION/CERTIFICATION PROCEDURES

The Brunton Pocket Transit is returned to the factory annually for calibration and certification. See Figure 1 for a sample certification.

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*. 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)*. 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems*, Vol. I, Principles. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods*. EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements*. EPA-600/4-82-060.

8.0 FIGURES

Figure 1: Sample Certification Form

NDDN# 00984

The Brunton Company

Riverton, Wyoming 82501
Phone (307) 856-6559

Certificate Of Calibration

SOLD TO	
Name	QST ENVIRONMENTAL
Address	404 SW 140TH TERRACE
Address	
City, State, Zip	NEWBERRY, FL. 32669-3000

Purchase Order No. 87282-310	Brunton Invoice No. 127495
Your Part No. F5008	Brunton Part No. F5008
Quantity 1	Brunton Lot No. 15060
Description POCKET TRANSIT, SERIAL # 028814	

Calibration traceable to the National Institute of Standards and Technology in accordance with Mil- STD- 45662A has been acccomplished on the instrument listed below by comparison with standards maintained by The Brunton Co. The accuracy and stability of all standards maintained by The Brunton Co. are traceable to national standards maintained by the National Institute of Standards and Technology in Wahington, D.C. and Boulder, Co. Complete record of all work performed is maintained by The Brunton Co. and is available for inspection upon request.

This Unit has been calibrated to Lietz TM10E serial number 30937 traceable to N.B.S. no. 738 227675 this 6TH Day of OCT. 1998.

Signed : [signature]
QUALITY CONTROL MANAGER

FORMS\BRUNTON\CERTANL.FOR

IV. CALIBRATION LABORATORY
B. TRANSFER STANDARDS
8. ROTRONIC HYGROMETER MODEL A1

Effective Date: 11-10-11

Reviewed by: Mark G. Hodges, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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MS	QA Mgr	10/30/12	[signature]
MS	QA Mgr	10/30/14	[signature]
MS	QA Mgr	1/2/15	[signature]

IV. B. 8. ROTRONIC HYGROMETER MODEL A1

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide consistent guidance for maintenance and handling of the Rotronic Hygrometer Model A1 to Clean Air Status and Trends Network (CASTNET) Field Calibration Laboratory personnel.

2.0 SCOPE

This SOP applies to the maintenance and handling of Rotronic Hygrometer Model A1 units administered by the CASTNET Field Calibration laboratory.

3.0 SUMMARY

CASTNET hygrometer transfer standards are calibrated, and certified at a minimum of once every 6 months.

4.0 MATERIALS AND SUPPLIES

Rotronic Hygrometer Model A1
Vaportron H-100L Humidity Lab
Aqueous Saturated salts (Note: Use only as a last resort)
Kimwipes®
RH iForm
9-volt battery

5.0 REPAIR AND MAINTENANCE

5.1 Repair

All repairs and adjustments are performed by the manufacturer.

5.2 Maintenance

5.2.1 Replace the 9-V battery when needed.

5.2.2 Clean the dust filter prior to each calibration/certification procedure: Cleaning should be done <u>without</u> removing the filter from the probe.

5.2.2.1 Gently wipe the filter with a solution of water and mild detergent.

5.2.2.2 If cleaning does not remove most of the stains, the filter should be replaced. To do this, unscrew the filter from the probe. When removing the filter, make sure that the sensors are not damaged. The humidity sensor is sometimes mistaken for a "white paper tag." Do not remove from the probe!

5.2.2.3 Before putting on a new dust filter, check the alignment of both sensors with the probe. The wires that connect the sensors to the probe are very thin and bend easily. If this happens, correct the alignment by holding the sensor <u>very gently</u> with a pair of small flat-nosed pliers. Do not use sharp pliers or tweezers as this could puncture the sensor. Do not pull on the sensor.

6.0 CALIBRATION /CERTIFICATION PROCEDURE

6.1 Rotronic A1 Transfer Sensor Using the Vaportron H-100L Series Precision Humidity Lab

6.1.1 Check the desiccant cartridge located on back of unit; the indicating silica gel must be a blue color above the red line on the cartridge. If the indicating silica gel is pink at or below the red line on the cartridge, refer to the Vaportron Manual for instructions on changing indicating silica gel.

6.1.2 Check the water level by lifting up on cap end of cartridge and looking into the large window near the left desiccant hanger hook (See Figure 1). Use a small flashlight to locate the water level. The water level must be between the lower and upper red lines on the fill level decal. If water level is not between lines, refer to the Vaportron Section (IV.A.5) of these Standard Operating Procedures (SOP) for instructions on water level service procedure.

6.1.3 Switch on **Power** (lower left). Both **RH LCD** (center top) and **Temperature** display should come on and read the approximate room conditions.

6.1.4 Set the **Temperature** display using the up or down arrows to 22.5°C.

6.1.5 Set the **RH LCD** display using the up or down arrows to the first point of 5.0 % RH.

6.1.6 Replace the white chamber access door (right side) with the clear access door which has a black strain relief port. Insert the Rotronic A1 probe so approximately 3.5 inches of the probe is inside the Vaportron chamber. **Lightly** tighten the port fitting to hold the probe securely in the chamber. Bend the hand-held part of the unit down to rest on the counter top.

6.1.7 Turn the unit on and check that the battery condition is greater than 50%; if not, replace the battery. Obtain a Temperature/ Relative Humidity Data Form (See Figure 2 which is a completed sample form) and record the serial number of the sensor.

6.1.8 Switch on **Control**. A faint, high-pitched sound should indicate proper operation of the air circulator fan inside the chamber. The Vaportron displays should begin to ramp toward the values that were set. Normally, the RH and temperature readings will stabilize within 2 to 5 minutes.

6.1.9 Allow the A1 sensor to equilibrate for 1 hour at the set point, and then record the output from the Vaportron RH controller and Rotronic A1 on the calibration form.

6.1.10 Set the **RH LCD** display using the up arrow to the next point of 25.0% RH and repeat step number 9.

6.1.11 Repeat step number 10 for set points of: 50.0%, 75.0%, and 95.0%.

6.1.12 After completion of the final set point, loosen the black port fitting on the door and remove the A1 sensor, and then remove the clear door from chamber.

6.1.13 Install the white chamber access door with yellow port plug in place. Set the **RH LCD** display using the down arrow to 50.0 % RH. Let the unit run for 5 minutes at this setting.

6.1.14 Switch off **Control** and then switch off **Power** (lower left).

6.1.15 Check that the calibration form is completed. (NOTE: Be sure to calculate slope and intercept.) Then, see Calibration Lab Manager for review of the calibration form

6.1.16 After review, place the form and sensor in a plastic bag and put them in the appropriate calibration box or on the “ready to ship” shelf.

6.2 **Rotronic Model Al Sensor Using Aqueous Saturated Salts** [Use aqueous salts for calibration/certification only as a last resort]

6.2.1 Turn the unit on and check that the battery condition is greater than 50%; if not, replace the battery. Obtain a Temperature/Relative Humidity Data form (See Figure 3 which is a completed sample form) and record the serial number of the sensor.

6.2.2 Carefully remove the filter cap from the sensor. Using a Climatronics sensor support cap, insert the Rotronic A1 probe approximately 1.25 inches into the rubber grommet (just above sensor inlet screens). Starting with Silica Gel (0.0%) gently screw Climatronics sensor support cap and sensor, into the opening of the bottle (use great caution not to bump or contaminate the sensor tip when inserting in bottle). Place the bottle/sensor into the blue bottle caddy.

6.2.3 Allow the Rotronic A1 sensor to equilibrate for 1 hour at the set point and record its output on the Temperature/Relative Humidity Data Form.

6.2.4 Repeat steps 2 and 3 for salt solutions of: $MgCl_2$ (32.8%), $Mg(NO_3)_2$ (52.9%), NaCl (75.3%), and KNO_3 (93.6%). Lightly swirl the solution of deionized (DI) water and salt, being careful not to get salt solution into the bottle neck. If salt solution gets in the bottleneck, clean with a Kimwipe® before inserting the probe.

6.2.5 After the completion of the final point, remove the A1 sensor from the bottle and wipe the sensor housing with a clean Kimwipe®.

6.2.6 Check to see that the calibration form is completed. (NOTE: be sure to calculate slope and intercept.) See Calibration Laboratory Manager for review of the calibration form. After review, place the form and sensor in a plastic bag and put them in the appropriate calibration box or on the “ready to ship” shelf.

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*. 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)*. 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

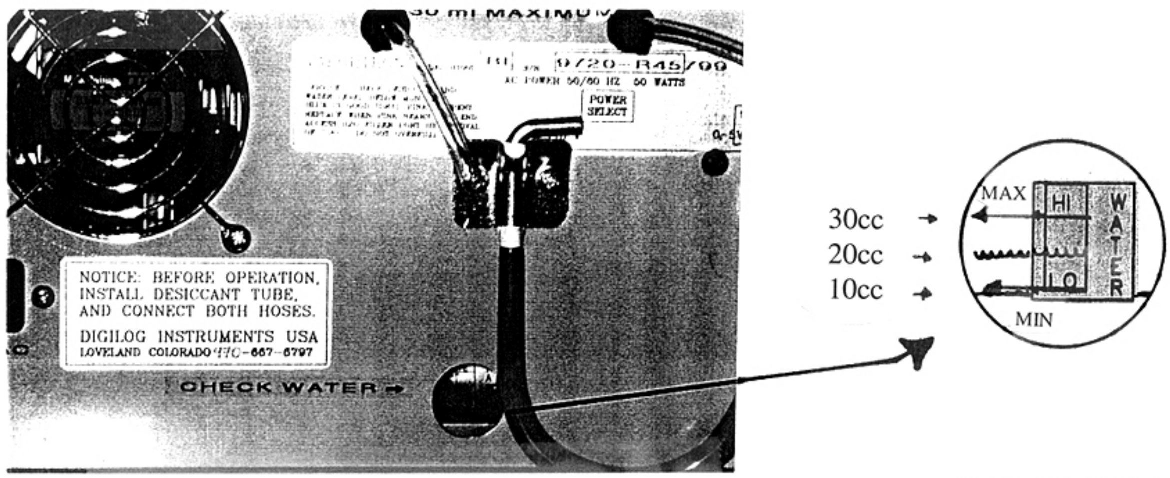
U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems*, Vol. I, Principles. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods.* EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements*. EPA-600/4-82-060.

8.0 FIGURES

Figure 1: Water Gauge Window



Water Gauge Window Location

Gauge Decal Detail

Figure 2: Sample Temperature/Relative Humidity Data Form Using Vaportron

Example

Environmental Science & Engineering, Inc. — **TEMPERATURE/RELATIVE HUMIDITY DATA FORM**

Site Name/Number: ESE-Test Site Location: Gainesville, FL

DSM 3260 S/N: NA DSM 3260L S/N: NA

TEMPERATURE	10-m Sensor S/N: NA 2-m Sensor S/N: ↓	Translator S/N: Air # Rotronics GTL
RTD S/N: N/A	Temp. Zero: NA Temp. Span: ↓	ΔTemp. Zero: NA ΔTemp. Span: ↓

~~THERMOMETER~~ Vaportron READING (°C)		~~DAS~~ GTL TEMPERATURE OUTPUT			DAS ΔTEMPERATURE OUTPUT		
Uncorrected	Corrected	3260 Voltage	3260L Voltage	Temp. (°C)	3260 Voltage	3260L Voltage	Temp (°C)
25.01°C	25.00°C	NA	NA	24.7	N/A		

RELATIVE HUMIDITY	Sensor S/N: Air # 00123 Transfer S/N: Air # 00662 Rotronics GTL	Translator S/N: N/A Translator Zero/Span: N/A

GTL	SALT	EQUIVALENT RELATIVE HUMIDITY Vaportron	DAS OUTPUT		
			3260 Voltage	3260L Voltage	% Rel. Hum.
4.6%	NA	5.0%	N/A		
32.1%	↓	32.8%			
51.9%		52.9%			
75.2%		75.3%			
93.7%		93.6%			

Remarks: Battery ≈ 75%
Set Time One hour

Slope = 1.0068
int = −0.7732
r² = 0.9999

Performed by: [signature] Date: 4-1-99 Calibrated: ☐
Reviewed by: ______ Date: ______ Audited: ☒

Figure 3: Sample Temperature/Relative Humidity Data Form Using Salts

Environmental Science & Engineering, Inc. A BACTEC Company

TEMPERATURE/RELATIVE HUMIDITY DATA FORM

Site Name/Number: ESE - Test   Site Location: Gainesville, FL

DSM 3260 S/N: NA   DSM 3260L S/N: NA

TEMPERATURE	10-m Sensor S/N:	Translator S/N:
	2-m Sensor S/N:	
RTD S/N:	Temp. Zero:	ΔTemp. Zero:
	Temp. Span:	ΔTemp. Span:

THERMOMETER READING (°C)		DAS TEMPERATURE OUTPUT			DAS ΔTEMPERATURE OUTPUT		
Uncorrected	Corrected	3260 Voltage	3260L Voltage	Temp. (°C)	3260 Voltage	3260L Voltage	Temp. (°C)
			NA				

RELATIVE HUMIDITY	Sensor S/N: Air 000123	Translator S/N: NA
	Transfer S/N: Salts / Rotronics GTL	Translator Zero/Span: NA

GTL	SALT	EQUIVALENT RELATIVE HUMIDITY	DAS OUTPUT		
			3260 Voltage	3260L Voltage	% Rel. Hum.
2.7%	Silica Gel	0.0%			
32.9%	$MgCl_2$	32.8%		NA	
53.1%	$Mg(NO_3)_2$	52.9%			
76.6%	NaCl	75.3%			
93.5%	KNO_3	93.6%			

Remarks: Battery ≈ 75%
Set Time 1hr

Slope = 0.9791
int = 1.9028
r^2 = 0.9997

Performed by: [signature]   Date: 4-2-99   Calibrated: ☐
Reviewed by: Date: Audited: ☒

IV. CERTIFICATION LABORATORY
B. TRANSFER STANDARDS
9. R.M. YOUNG SOLAR RADIATION TRANSFER SYSTEM

Effective Date: 10/30/14

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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Reviewed by:	Title:	Date:	Signature:
MS	QAMGR	11/2/15	

IV. B. 9. R.M. YOUNG SOLAR RADIATION TRANSFER SYSTEM

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance for maintenance and handling of the R.M. Young Solar Radiation Transfer System to Clean Air Status and Trends Network (CASTNET) Field Calibration Laboratory personnel.

2.0 SCOPE

This SOP applies to the maintenance and handling of R.M. Young Solar Radiation Transfer System units administered by the CASTNET Field Equipment Calibration Laboratory.

3.0 SUMMARY

R.M. Young solar radiation systems are calibrated upon receipt and at the request of field technicians. Repairs and maintenance are performed as necessary.

4.0 MATERIALS AND SUPPLIES

Li-Cor Model LI-2000SA Pyranometer (transfer standard)
Eppley Precision Spectral Pyranometer (certified primary standard)
Fluke Multimeter and cable
Light source
Huxseflux Model LP02 Pyranometer (certified primary standard)
Tool kit including screwdriver, soldering flux, soldering iron, and wire cutters

5.0 REPAIR AND MAINTENANCE

5.1 Repair

5.1.1 Testing the Photodiode

5.1.1.1 Connect the Fluke multimeter using the double banana-style cable with BNC connector on the other end.

5.1.1.2 Insert the double banana-style cable into the µAmp (A) and common receptacles on the multimeter.

5.1.1.3 Connect the BNC end of the cable to the Li-Cor sensor BNC connection (use a barrel connector as a union).

5.1.1.4 Set the multimeter for Amps (A), DC, and 200 µA.

5.1.1.5 Shine a flashlight or other light source directly on the sensor. The multimeter readout should be at least 35 µA. If there is little or no response, repair the sensor as follows:

5.1.2 Replacing the Photodiode

5.1.2.1 Remove the back of the sensor housing. Unscrew the small set screw near the top of the sensor housing to release the sensor eye inside. Cut off the old photodiode.

5.1.2.2 Strip approximately 1/2 inch of insulation from the cable end. Unwrap the shield and wind it into a single strand. Strip approximately 1/8 inch of plastic covering on central wire. Slip a 2-inch piece of shrink-wrap onto cable.

5.1.2.3 Bend the terminals on the new sensor eye at approximately 1/4 inch. Solder the shield to the terminal marked with the black dot. Solder the central wire to the other terminal. Be sure the wires do not touch. Move the heat shrink as close to the new sensor as possible and heat it so that it tightens around the cable.

5.1.2.4 Test the new sensor eye with the multimeter as described in Section 5.1.1.

5.1.2.5 Install old (or new) insulating ring on the new photodiode. Insert photodiode pin legs into miniature PC board. Solder and snip excess. The pin leg closest to the tab on the rim of the photodiode housing is the shield. Solder the woven wire of the coaxial cable to the trace in continuity with this pin. Solder the signal (core wire) of the coaxial cable to the trace in continuity to the other pin.

5.1.2.6 Clean the housing inside first, being sure not to touch the surface of the new sensor eye with your fingers. Insert the new photodiode.

5.1.2.7 Be sure the new photodiode is flush with the inside surface of the housing and then tighten the set screw.

5.1.2.8 Seal the back cover of the housing with silicone sealant before screwing it back on. Put a dab of sealant in the set screw hole as well.

5.1.2.9 Retest with the multimeter as described in 5.1.1 above.

5.2 Maintenance

Routinely clean the sensor housing. Inspect the 75-foot cable for damage. Repair if necessary.

5.3 Retire housing when lens becomes crazed, cracked, or chipped.

6.0 PROCEDURES

6.1 Calibration/Certification

6.1.1 Install the Li-Cor sensor on the solar radiation sensor stand outside the solar radiation test facility. Ensure that it is level.

6.1.2 Run the 75-foot cable supplied with the transfer unit through the PVC elbow opening in the shelter wall to connect it to the translator box on one of the stations on the bench.

6.1.3 Connect the translator box to one of the stations inside the shelter.

6.1.4 Allow the transfer to operate for at least 1 full day. Be sure to wipe dew and dust from the lens of each primary transfer every morning. Record data on a sunny day with high solar radiation values if possible.

6.1.5 Record the identification (ID) number of the primary sensor and data logger.

6.1.6 Total the columns of the primary and the transfer using the values from the early morning (values ~ 0 watts) until the evening when the values return to ~ 0.

6.1.7 Average the totals of each column by the number of hourly averages being used.

6.1.8 Calculate the percent differences between the primary and transfer for the total averages and the hour at which the highest hourly averages occurred.

6.1.9 Perform a linear regression on the two columns. If the slope falls between .95 and 1.05 and the intercept falls between ±10, the unit will not require recalibration prior to being used again in the field. If the unit does not meet the above specifications, recalibrate as follows.

6.1.9.1 Unscrew the translator card from the box and expose the voltage adjustment potentiometer on the back side of the card.

6.1.9.2 Compare the transfer's values against the primary's values during the day at moderate light levels and at peak solar radiation levels. Adjust the transfer's voltage adjustment potentiometer as necessary.

6.1.9.3 Calculate the percent differences between the two units and perform a linear regression as outlined in steps 6.1.7 through 6.1.9.

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*. 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)*. 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications.* EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles.* EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods.* EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements*. EPA-600/4-82-060.

Li-Cor, Inc., *Environmental Division. LI-200SA Pyranometer Sensor Manual*.

8.0 FIGURES

Figure 1: Solar Radiation Data Form

MACTEC

Solar Radiation

Site Name	Calibrator	Calibration Date	Data Logger
BVL130	AQS	9/6/2011	Campbell 3000 ID:424

	Sensor As Found	Sensor As Left
ID #	04612	
Description	Pyronometer	
Manufacturer	LiCor	
Model	Li-200	
Translator ID #	06627	
Manufacturer	Climatronics	
Zero		
Span		

iForms Ver.	1.4.0
Transfer Standard	
ID #	06533
Manufacturer	LiCor
Model	Li-200
Date of Last Cert.	9/2/2011
Slope	1.03800
Intercept	-3.33440
Translator ID #	06321

As Found

Time	Transfer W/m²	Sensor W/m²	Time	Transfer W/m²	Sensor W/m²	Time	Transfer W/m²	Sensor W/m²
10:55	859	856	12:00	890	890	14:05	733	733
11:00	863	860	12:05	888	887	14:10	722	722
11:05	866	864	12:10	888	888	14:15	712	712
11:10	869	867	12:15	888	887	14:20	699	698
11:15	877	875	12:20	880	880	14:25	688	688
11:20	880	878	12:25	876	875	14:30	677	677
11:25	884	883	12:30	876	875	14:35	663	663
11:30	886	885	12:35	868	868			
11:35	886	887	12:40	865	864			
11:40	893	892	12:45	857	857			
11:45	892	891	12:50	852	852			
11:50	890	889	12:55	846	846			
11:55	890	889	13:00	840	839			

As Found					As Left				
Transfer		Sensor		% Diff	Transfer		Sensor		% Diff
Total	27643	Total	27617	-0.1%	Total		Total		
Adj. Max.	864	Max	892	3.3%	Adj. Max.		Max		
Adj. Average	810.2	Average	836.9	3.3%	Adj. Average		Average		

Remarks

Reviewed By: [signature] Date: 10/17/11

IV. CALIBRATION LABORATORY
B. TRANSFER STANDARDS
10. PORTABLE HUMIDITY GENERATORS

Effective Date: 11-10-11

Reviewed by: Kevin P. Mishoe, Field Operations Manager — [signature]

Reviewed by: Marcus O. Stewart, Project QA Manager — [signature]

Approved by: Holton K. Howell, Project Manager — [signature]

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MS	QA Mgr	10/30/12	[signature]
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MS	QA Mgr	11/2/15	[signature]

IV.B.10. RELATIVE HUMIDITY: BUCK RESEARCH INSTRUMENTS VAPORPAK MODEL H-31, RENSE INSTRUMENTS MODEL S-503

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide consistent guidance for the preparation, maintenance, and handling of the Buck Research Instruments Vaporpak Model H-31 and Rense Instruments Model S-503 to Clean Air Status and Trends Network (CASTNET) Field Certification Laboratory personnel.

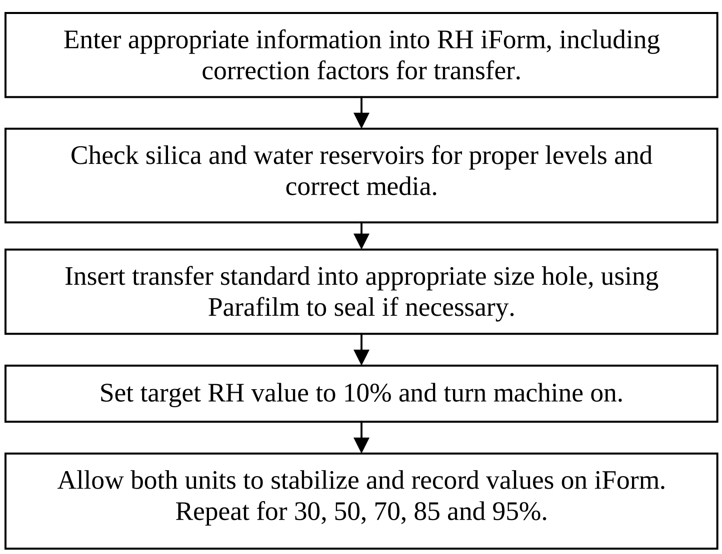
2.0 SCOPE

This SOP applies to the preparation, maintenance, and handling of all Buck Research Instruments Vaporpak Model H-31and all Rense Instruments Model S-503 administered by CASTNET Field Equipment Certification Laboratory personnel.

3.0 SUMMARY

The portable humidity generators are calibrated and serviced by the manufacturer once per year and verified with a hygrometer at least every 6 weeks. Typically, these portable humidity generators are not used as a transfer instrument, but are certified as such to provide a redundant transfer instrument in the event of transfer hygrometer failure.

Figure 1. Calibration of Portable Humidity Generators



Note: Return setting to 50% after completion and allow to stabilize to reduce the risk of damage to machine by excess moisture in the chamber.

4.0 MATERIALS

Rense Instruments Model SA-503 and User’s Manual
Calibrated hygrometer certified using Primary Standard
Nalgene Screw-capped bottles
Deionized (DI) water
Fresh Drier-Rite desiccant (Vaporpak) or Fresh silica gel desiccant (S-503)
Rubber stopper and/or Parafilm (to seal access ports)
RH iForm

5.0 SAFETY

Exercise standard laboratory precautions when handling powered equipment.

6.0 PROCEDURES

The proper amounts of DI water and fresh desiccant should be maintained when in operation. The unit should be packed and transported for use in the field according to the manufacturer's instrument manual.

The instrument should be able to produce stable values between 20 percent and 100 percent relative humidity (RH).

6.1 Rense Instruments Model S-503

6.1.1 Note in the “remarks” section of the iForm (Figure 2) that the unit is a full calibration of Rense Instrument Model S-503. Record the ID of the S-503 in the site instrument ID field.

Figure 2. Relative Humidity Generator Certification iForm

MACTEC — Relative Humidity

Site Name	Calibrator	Calibration Date	Data Logger	iForms Ver.
MEC099	JLN	6/14/2010	Campbell 3000 ID:355	1.3.1.0

	RH Sensor As Found	RH Sensor As Left
ID #		
Description		
Manufacturer	Rotronics	Rotronics
Model	MP-101-A	MP-101-A
Translator ID #		
Manufacturer		
Zero		
Span		

Humidity Chamber	
ID #	000537
Manufacturer	VaporPak
Model	S-503
Date of Last Cert.	4/14/2010

Transfer Standard					
ID #	08567				
Manufacturer	Rotronics				
Model	GTL				
Date of Last Cert.	5/19/2010				
Correction Factors					
10%	30%	50%	70%	85%	95%
1.02	0.40	0.80	0.53	0.62	0.78

As Found — Relative Humidity Datalogger Output

Portable Hygrometer	Correction Factor	Equivalent Relative Humidity	Datalogger Output % Relative Humidity	Datalogger Output Diff

As Left — Relative Humidity Datalogger Output

Portable Hygrometer	Correction Factor	Equivalent Relative Humidity	Datalogger Output % Relative Humidity	Datalogger Output Diff
10.0%	1.02%	11.02%	9.20%	-1.8%
30.0%	0.4%	30.40%	32.10%	1.7%
50.0%	0.8%	50.80%	50.90%	0.1%
70.0%	0.53%	70.53%	68.90%	-1.6%
85.0%	0.62%	85.62%	85.60%	0.0%
95.0%	0.78%	95.78%	93.77%	-2.0%

Remarks
Calibration of Portable Humidity Generator Rense Instruments Model S-503, ID# 000537

Reviewed By: ____________ Date: ____________

6.1.2 Enter the correction factors for the transfer Hygrometer into the iForm.

6.1.3 Remove the clear port plugs on the top of the S-503 to verify proper water level and desiccant condition (Figure 3). Add new desiccant and DI water as necessary.

Figure 3. Inspect desiccant and water reservoirs for proper media levels

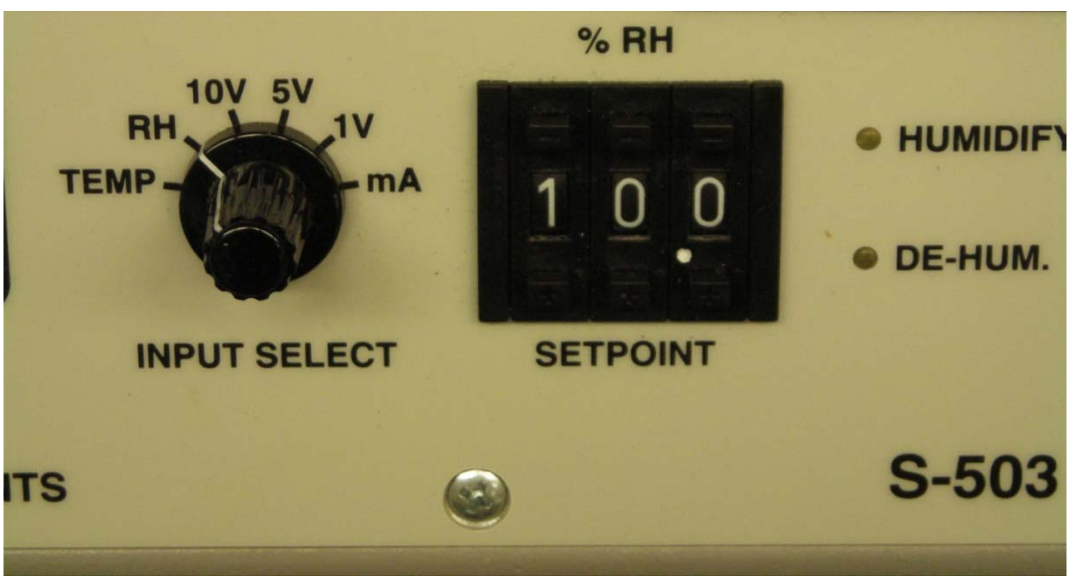
6.1.4 Seal all open ports on the top panel of the instrument using the provided plugs.

6.1.5 Insert your portable hygrometer in the top of the S-503 as shown in Figure 4. If necessary use a single layer of ParaFilm to ensure an airtight seal.

Figure 4. Rense Instruments s-503 Humidity Calibrator

6.1.6 Set the target RH value to 10% using the pushbutton potentiometer, Figure 5.

Figure 5. Adjust push button setting to 10% and ensure dial is set to RH



6.1.7 Turn the set switch to RH.

6.1.8 Plug the S-503 into an outlet and turn the power switch on.

6.1.9 Allow both units to fully stabilize. Record the test data on the RH iForm. Record the S-503 display in the DAS column and the Certified Transfer display in the Transfer column.

6.1.10 Repeat the procedure outlined above for RH values of approximately 30%, 50%, 70%, 85% and 95%. Adjustments should be made from low to high RH values.

6.1.11 Upon completion return the RH set-point to 50% and allow it to stabilize.

6.1.12 Print two copies of the humidity generator calibration. One will remain with the S-503 along with the transfer certification, the other will be filed in the instrument file along with the transfer certification.

6.2 Calibration Criteria

6.2.1 If the unit in question tests within five percent at each point tested it may be used as a backup transfer in the event the regular transfer fails.

6.2.2 If the unit in question tests within ten percent at each point tested it may be used as a backup transfer in the event the regular transfer fails, however the unit must receive post calibration upon return to the lab to validate performance and accuracy.

6.2.3 Otherwise the unit must be returned to the manufacturer for repair.

6.2.4 Figure 2 depicts a completed certification form.

6.3 Three point periodic check.

Between full audits performed at six-month intervals, a three point check may be performed in lieu of a full audit to assess the validity of the previous full six point performance audit. This check must be performed every six weeks at a minimum.

6.3.1 Using the same procedure as for a full six point biannual audit, test the humidity generator at the following points: 10%, 50% and 95%.

6.3.2 Document the results (Figure 6) just as for the full audit and print two copies of the check form.

Figure 6. RH Translator Humidity Generator – 6-Week Update Form

MACTEC — Relative Humidity

Site Name	Calibrator	Calibration Date	Data Logger	iForms Ver.
MEC099	JLN	6/14/2010	Campbell 3000 ID:355	1.3.1.0

	RH Sensor As Found	RH Sensor As Left
ID #		
Description		
Manufacturer	Rotronics	Rotronics
Model	MP-101-A	MP-101-A
Translator ID #		
Manufacturer		
Zero		
Span		

Humidity Chamber	
ID #	000537
Manufacturer	VaporPak
Model	S-503
Date of Last Cert.	4/14/2010

Transfer Standard					
ID #	08567				
Manufacturer	Rotronics				
Model	GTL				
Date of Last Cert.	5/19/2010				
Correction Factors					
10%	30%	50%	70%	85%	95%
1.02	0.40	0.80	0.53	0.62	0.78

As Found — Relative Humidity Datalogger Output

Portable Hygrometer	Correction Factor	Equivalent Relative Humidity	Datalogger Output % Relative Humidity	Datalogger Output Diff

As Left — Relative Humidity Datalogger Output

Portable Hygrometer	Correction Factor	Equivalent Relative Humidity	Datalogger Output % Relative Humidity	Datalogger Output Diff
10.0%	1.02%	11.02%	9.20%	-1.8%
50.0%	0.8%	50.80%	49.70%	-1.1%
95.0%	0.78%	95.78%	92.36%	-3.4%

Remarks
SIX WEEK Calibration UPDATE of Portable Humidity Generator Rense Instruments Model S-503, ID# 000537

Reviewed By: ____________ Date: ____________

6.3.3 File one copy in the instrument file, and attach one copy to the original certification.

6.3.4 If the unit is found to not meet specification, return to the manufacturer for repair.

7.0 REFERENCES

American Society for Testing and Materials (ASTM). 1985. *ASTM Book of Standards, Vol. 11.03* E 104-85.

Rense Instruments BV. 2008. *S-503 series User's Manual* ©2008. www.renseinstruments.com

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring.* 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS).* 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I*, *Principles*. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II*, *Ambient Air Specific Methods*. EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements*. EPA-600/4-82-060.

8.0 ATTACHMENTS

This SOP does not contain attachments.

IV. CERTIFICATION LABORATORY
B. TRANSFER STANDARDS
11. MANNIX TESTING & MEASUREMENT MODEL EB833 DIGITAL ALTIMETER & BAROMETER

Effective Date: 11-10-11

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, Project QA Manager

Approved by: Holton K. Howell, Project Manager

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IV.B.11. MANNIX TESTING & MEASUREMENT MODEL EB33 DIGITAL ALTIMETER & BAROMETER

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide consistent guidance for the calibration of the Mannix Testing & Measurement Model EB833 Digital Altimeter & Barometer.

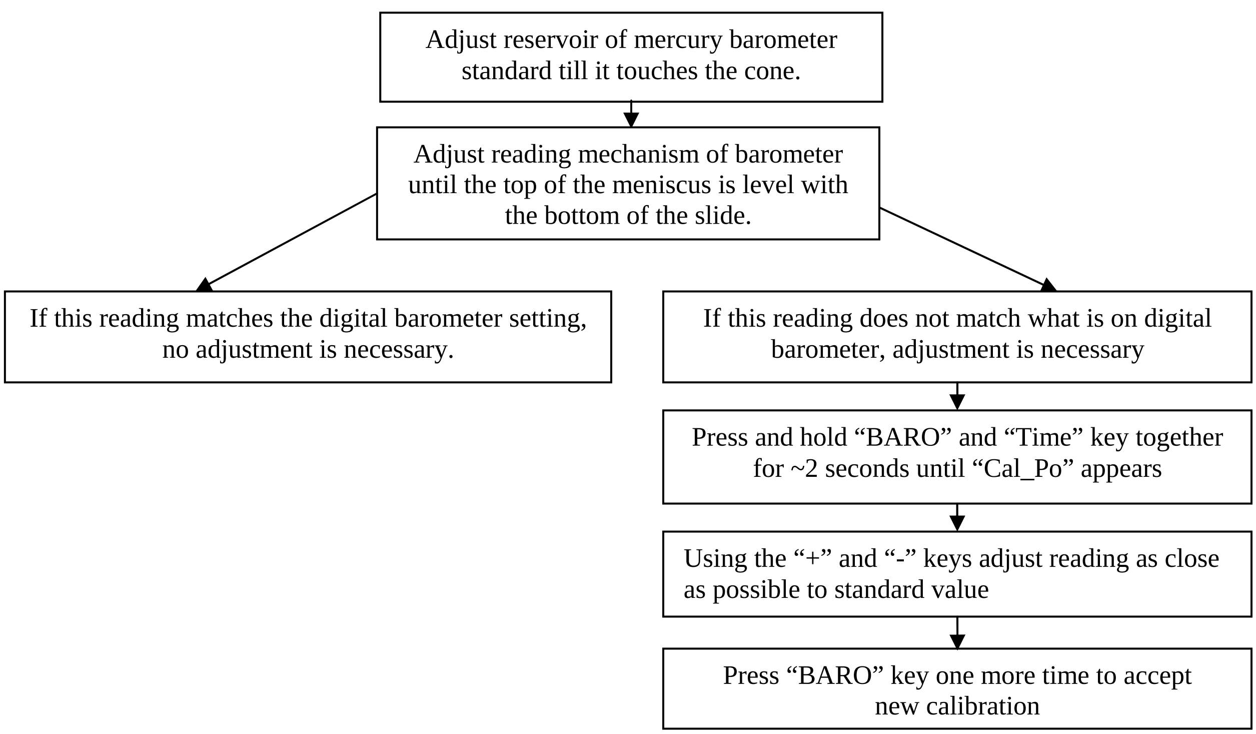
2.0 SCOPE

The Mannix EB833 is used in the field to facilitate the calibration of continuous gas analyzers.

3.0 SUMMARY

The Mannix Testing & Measurement Model EB833 Digital Altimeter & Barometer can be calibrated using a certified mercury barometer. This is accomplished by reading the certified mercury barometer standard and adjusting the settings on the digital unit.

Figure 1. Calibration of Mannix Digital Barometer



4.0 MATERIALS

EUTECHNICS 4600 RTD or HY-CAL BA500AUCXI RTD
National Institute of Standards and Technology (NIST) Certified Princo Model 453 Barometer
Princo Model 453 Barometer Manual
Princo Model 453 Barometer Certificate
Mannix Testing & Measurement Model EB833 Digital Altimeter & Barometer
Mannix Testing & Measurement Model EB833 Digital Altimeter & Barometer Manual

5.0 SAFETY

Replace battery as necessary.

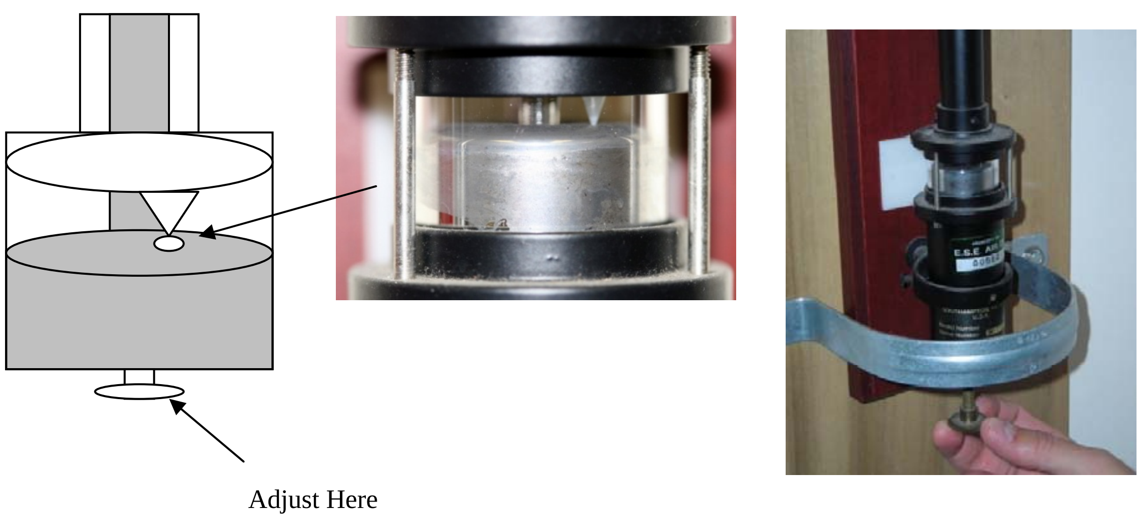
6.0 PROCEDURE

Calibration of this instrument is necessary to ensure the proper calibration of field trace gas instruments. Refer to the Princo manual and Figures 2 and 3 of this SOP for operation of the Princo Barometer. Refer to page 10 of the Mannix Testing & Measurement Model EB833 Digital Altimeter & Barometer Manual for more information regarding calibration of the digital instrument.

6.1 Configuring the Princo Barometer

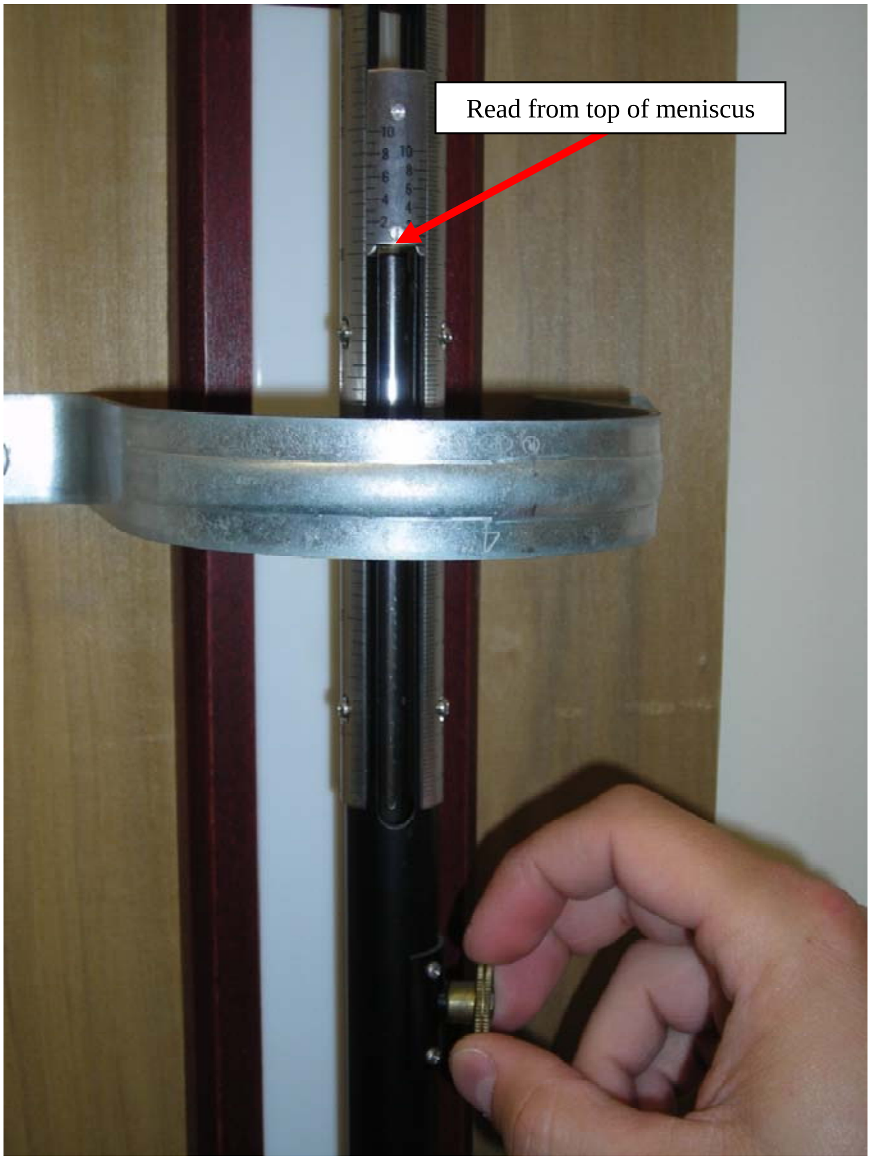
6.1.1 To begin, the mercury in the reservoir at the bottom of the barometer must be touching the small white cone, making a very small dimple in the mercury. To adjust, slowly turn the dial on the bottom of the reservoir until the mercury touches the cone. Refer to Figure 2.

Figure 2. Adjust dial at bottom of barometer so mercury just touches the point of the triangle



6.1.2 To read the barometer, adjust the dial on the side of the barometer to move the indicator up and down (Figure 3). The bottom of the indicator should be just “touching” the top of the meniscus of the mercury. The side of the barometer has numbers marking the hundreds, tens and ones of the barometric reading and the numbers on the indicator slide show the tenths of the reading. Ensure that you are taking the reading at eye level. When the indicator is at the meniscus, observe where the lines from the side of the barometer match up with those of the indicator lines. This will give the value of the current barometric reading.

Figure 3. Adjusting and reading the mercury meniscus from the top of the bubble



6.2 Adjusting the Digital Barometer to the Princo

6.2.1 To input the reading found on the Princo standard, make sure the digital barometer is in the barometric mode by hitting the “BARO” soft key button. Next, hold down the “BARO” and “TIME” keys together for about 2 seconds (Figure 4). “CAL Po” will display on the screen and the current pressure reading will flash. Press either the "+" or "-" keys to adjust the display reading to that found on the Princo barometer (Figure 5). Press the “BARO” key once again to accept the new reading.

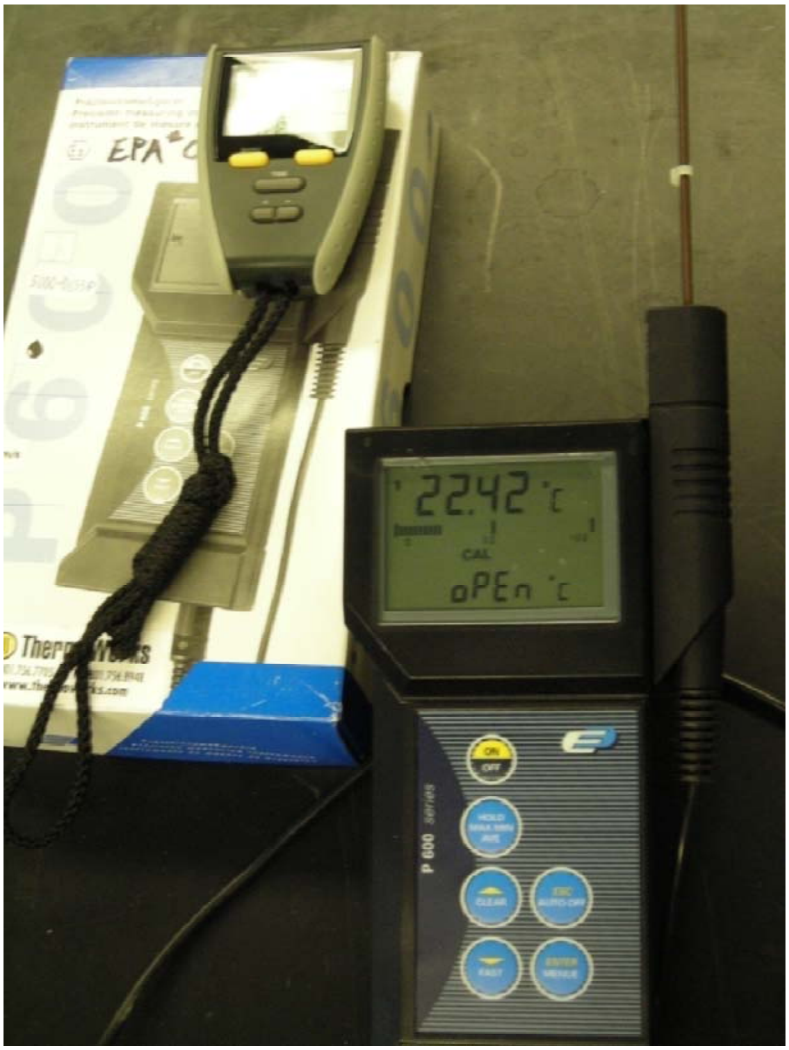
Figure 4. Press Baro and Time together for 2 seconds to start calibration

Figure 5. Press “+” or “-” to adjust the pressure reading up and down

6.3 Calibration of Temperature on Digital Barometer

The temperature of the Digital Barometer cannot be adjusted, so a simple check against a temperature transfer standard is sufficient. Place the devices next to each other and allow for stabilization, ~ 20 minutes, and record values (Figure 6). When the application calls for it, an adjustment can be added to account for any difference in the RTD and barometer readings.

Figure 6. Place digital barometer next to RTD to check temperature accuracy



7.0 REFERENCES

Mannix Testing & Measurement Eb833 Altimeter and Barometer Manual Princo Model 453 Barometer Manual

8.0 ATTACHMENTS

This SOP does not contain attachments.

IV. CALIBRATION LABORATORY
C. SITE INSTRUMENTATION
1. FIELD EQUIPMENT SIGN-IN AND SIGN-OUT

Effective Date: 11-10-11

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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IV. C. 1. FIELD EQUIPMENT SIGN-IN AND SIGN-OUT

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance for field equipment sign-in and sign-out to Clean Air Status and Trends Network (CASTNET) Field Calibration Laboratory personnel.

2.0 SCOPE

This SOP applies to field equipment sign-in and sign-out for the CASTNET Field Calibration Laboratory.

3.0 SUMMARY

All CASTNET field equipment is treated such that their current location or intended destination is documented at all times.

4.0 MATERIALS AND SUPPLIES

CASTNET II Receiving/Sign-In Log
CASTNET II Shipping/Sign-Out Log
Networked computer with access to the CASTNET Data Management Application (CDMSA)

5.0 REPAIR AND MAINTENANCE

N/A

6.0 PROCEDURE

6.1 Field Equipment Sign-In

Sign-in all equipment received from the field in the "CASTNET II Receiving Sign-In Log" (Figure 1). If the system is tagged for post-calibration, note that in the **Action** column of the sign-in log.

6.1.1 Any equipment requiring post-calibration is given to a Calibration Laboratory Technician for a complete post-calibration test.

6.1.2 Testing of equipment requiring post-calibration includes:

6.1.2.1 <u>Do not make</u> adjustments or changes to the piece of equipment before post-calibration.

6.1.2.2 All normal calibration test points will be tested and recorded on the proper form with additional test points for relative humidity and wind direction (see III.A. Figures 6-15).

6.1.2.3 If the post-calibration tag indicates a problem point, obtain additional test points at and around this area.

6.1.2.4 After testing of post-calibrated equipment, the form must be reviewed by the Calibration Laboratory Manager or the Field Operations Coordinator.

6.1.3 Upon completion, give post-calibration forms to the Field Operations Coordinator along with the Post Calibration Request (Figure 3) tag for final review and for filing in the proper site file.

6.1.4 After the post-calibration form is reviewed and filed, move the equipment to the repair area for repair/rebuild and calibration.

6.2 Field Equipment Sign-Out

Sign-out all CASTNET equipment either being shipped or hand-carried to a site in the "CASTNET II Shipping/Sign-Out Log" (Figure 2). Pay particular attention to the equipment serial number and its destination. This information will be required when the equipment inventory database is updated.

6.2.1 Equipment Sign-Out and Shipping Procedure: to a Site
If a CASTNET monitoring site requires an equipment shipment, an electronic Equipment Request Form (ERF) must first be generated from the CDMSA.

If item has an EPA or a CASTNET ID number:

1. Enter equipment ID in Sign-Out Log Book.
    a. The six digit EPA ID is written in the third column from the left.
    b. The five digit CASTNET number is written in the fourth column.
2. Pack securely in appropriate sized box using adequate packing material.
3. Include a pre-printed FedEx return air bill that has the AMEC address and correct project number on it.
    a. Write the site name and number on the "Company" line.
    b. Include a pre-printed yellow tag with site and equipment filled in. (This tag will be returned with the equipment).
4. Find ERF form in CASTNET database.
    a. Enter equipment ID # in appropriate line under Sent column.
    b. Add equipment type in Comments.
    c. Type Project number and Requested Mode of Shipment.
    d. Fill in Date and Initials (person filling out ERF form).
    e. Save and print.
5. Attach the ERF to the box.
6. Take the box to the shipping trailer. Leave it for the regular shipping person or ship it yourself (use the FedEx computer that is the leftmost of the three computers in the shipping trailer).
7. Remove the ERF and affix the tracking number portion of the FedEx shipping label to a place on the form such that information is not obscured.
8. Adhere the FedEx shipping label to the box.

9. File the ERF in the SHIPPING drawer (top drawer in Deborah's office) in the folder with the appropriate site ID.

If the item does not have a CASTNET or EPA number:

1. Pack appropriately. There will be no return air-bill or yellow tag.
2. Attach ERF if provided and continue with step 5) above.
3. If there is no ERF, write the site ID and shipping method on the box or on the "Shipping Request" form.
4. Continue with above steps 5), 7), and 8) above.

6.2.2 Equipment Sign-Out and Shipping Procedure: to a Vendor

If item has an EPA or a CASTNET ID number:

1. Enter equipment ID in Repair Log Book.
   a. Write the date item is shipped.
   b. Leave the "Date Rt'd" column blank.
   c. Enter the vendor's name, then the item description.
   d. Enter the equipment's serial number provided by the manufacturer.
   e. Write the EPA or CASTNET number next.
   f. Most vendors will provide an RMA # or RA # to put on the box and the authorization letter. Also enter this number in the log book.
   g. The PO # may be available at time of shipping, but most likely not. If available, enter this number in the log book.
2. Pack well in appropriate sized box with adequate packing material.
3. Include a signed copy of the authorization letter inside the box and a signed copy in a see-through packing slip sleeve to be adhered to the outside of the box.
4. Take the box to the shipping trailer. Leave it for the regular shipping person or ship it yourself (use the FedEx computer that is the leftmost of the three computers in the shipping trailer).
5. Adhere the FedEx shipping label to the box.
6. Put the box in the shelter outside the trailer's roll up door.

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*. 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)*. 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1997. *National 8-Hour Primary and Secondary Ambient Air Quality Standards for Ozone*. 40 CFR 50, Appendix I.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods*. EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements*. EPA-600/4-82-060.

U.S. Environmental Protection Agency (EPA). 1979. *Transfer Standards for Calibration of Air Monitoring Analyzers for Ozone, Technical Assistance Document*. EPA-600/4-79-056.

8.0 FIGURES

Figure 1: CASTNET II Receiving/Sign-In Log

EXAMPLE

CASTNET II RECEIVING/SIGN IN LOG

UPDATE ON COMPUTER	NAME	EPA NUMBER	NDDN NUMBER	SENT FROM LOCATION	DATE IN	DESCRIPTION	ACTION
✓	Deborah		04063	571	10/15/01	RM4 SR frame	
✓	"		04261	"	"	Rotronics RH sensor	[illegible]
✓	"		03049	"	"	RM4 wetness sensor	"
✓	"		03002	EOH	"	LapTop	
✓	"		*04588		10/17/01	RM4 Wetness	*New ID #. old tag #03049 damaged
✓	"		04489	C. Nagle	10/18/01	DVM	Returned
✓	"		04557	"	"	Compass	"
✓	"		04625	"	"	DATEL	"
✓	"		02990	EOH	10/23/01	Dell computer (laptop)	
✓	"		04321	303	"	rm4 temp probe	
✓	"		04320	"	"	"	
✓	"		04409	"	"	Wind AQ	w/vane & horizontal
✓	"		04353	"	"	Prosine invertor	
✓	"	666386		"	"	Gerber laser	

Note: For Figures 1 and 2:

Update on Computer	= Indicates whether equipment inventory database was updated.
Name	= Name of individual receiving/shipping the item.
EPA Number	= Tracking number supplied by the EPA.
NDDN Number	= Tracking number supplied by AMEC E&I, Inc.
Sent From Location/ Location Sent	= Name of location from/to which the item was sent. May be a monitoring site (site ID number), a field technician (name or initials) or a designated calibration kit.
Date In/Out	= Date received/shipped.
Description	= Short description of item.
Action	= Primarily describes post-calibration requests. May also provide other explanation of why item was sent.
Mode of Shipping	= Shipping company or field technician.
Reason	= Brief explanation of why item was sent.

Figure 2: CASTNET II Shipping/Sign-Out Log

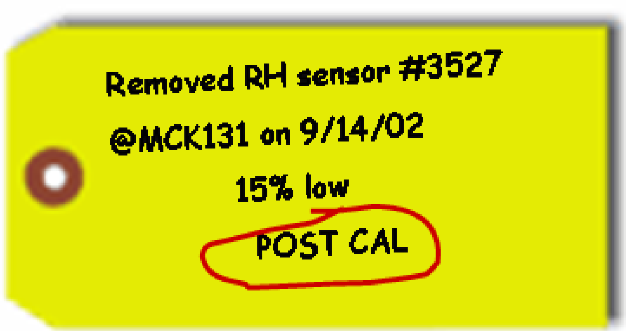
EXAMPLE

CASTNET II SHIPPING/SIGN OUT LOG

UPDATE ON COMPUTER	NAME	EPA NUMBER	NDDN NUMBER	LOCATION SENT	DATE OUT	DESCRIPTION	MODE OF SHIPPING	REASON
✓	Deborah		00492	706	10/2/01	O'Haus triple beam	Fedx ON	
✓	"		04627	EOH	"	DATEL	Carry	
✓	"		04630	EOH	"	Fluke	"	
✓	"		*02762	Retire 10 #	10/3/01	10-M tower		*New 10# 04585
✓	"		03462	Retire tower	"	"		
✓	"		04192	156	10/9/01	LI-COR sensor	FedxON	
✓	"		04540	"	"	RMY SR trans	"	
✓	Mike		03419	Mitch Grove 4	10/10/01	RMY monitor AQ	Fed Ex	Maint.
✓	"		03297	"	"	"	"	"
✓	Deborah		02671	Sandy/ARS	"	"	"	"
✓	"		04354	"	"	"	"	"
✓	"		00889	"	"	Clim WSP	"	"
✓	"	000098		cal Box #1	"	Nexus		Flow kit #3
✓	"		04654	cal Box #1	"	20K		"

Figure 3: Post-Calibration Request Tag

EXAMPLE



IV. CALIBRATION LABORATORY
C. SITE INSTRUMENTATION
2. OZONE MONITORS

Effective Date: 1-30-15

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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IV. C. 2. OZONE MONITORS

1.0 PURPOSE

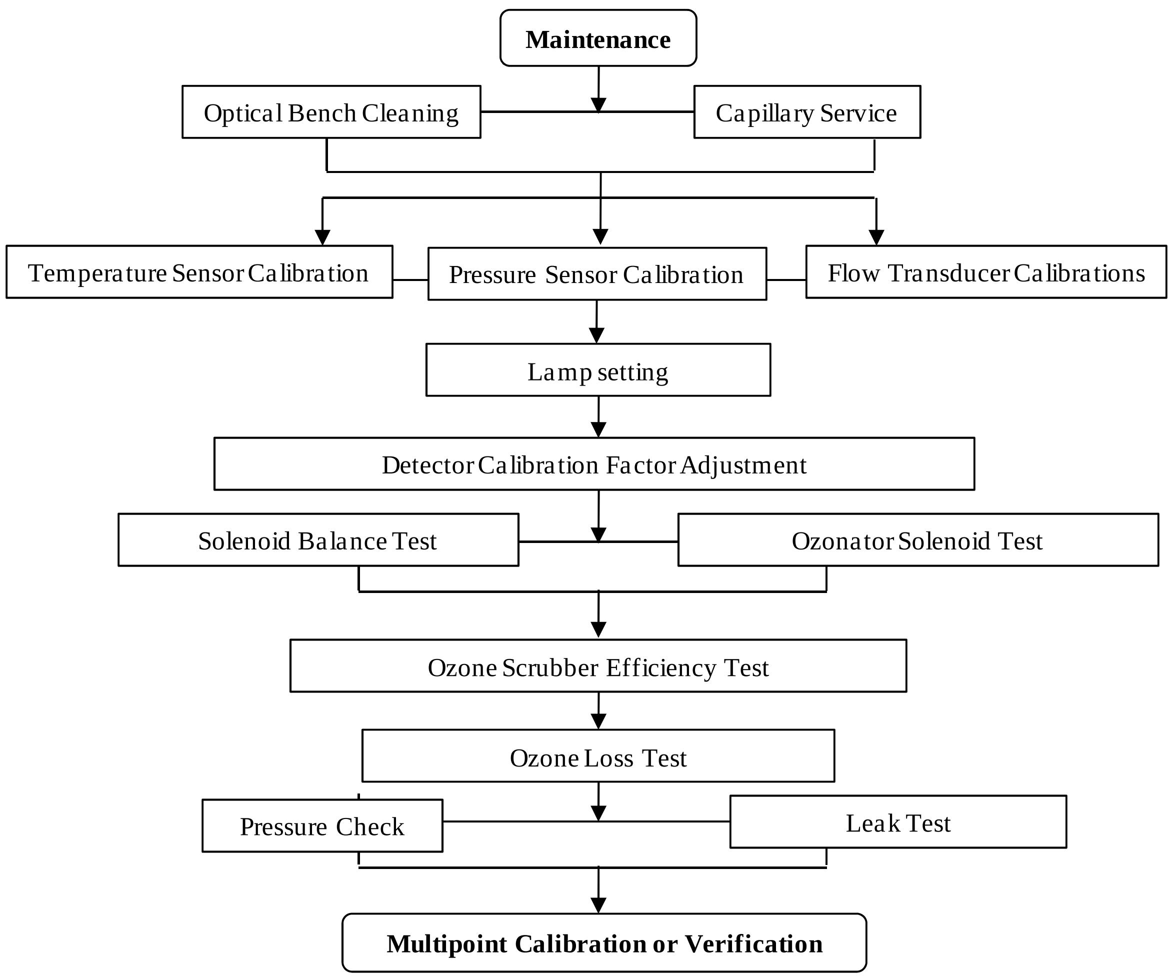
The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance for maintenance and handling of the Thermo Fisher Scientific (Thermo) Ozone (O_3) monitors to Clean Air Status and Trends Network (CASTNET) Field Calibration Laboratory personnel.

2.0 SCOPE

This SOP applies to the maintenance and handling of Thermo O_3 monitors administered by the CASTNET Field Calibration Laboratory.

3.0 SUMMARY

CASTNET field equipment technicians repair and calibrate O_3 monitors during the routine calibration visits, at the request the site operator, upon receipt from the manufacturer, prior to use in the field, or otherwise as needed.



4.0 MATERIALS AND SUPPLIES

Thermo Models 49*i* O_3 Analyzers
Multimeter
Kimwipes
Compressed air blower
Insulated screwdriver
Teflon tape

5.0 MAINTENANCE AND CALIBRATION

Perform any detector audits or post calibrations prior to beginning the following procedure. The following list is the comprehensive maintenance overhaul. Refer to Ozone Maintenance and Calibration Schedule to determine required maintenance.

5.1 Optical Bench Cleaning (Manual Section 5-2)

5.1.1 Turn off power, disconnect the power cable, and remove cover.

5.1.2 Loosen the knurled nut around tube and carefully slide out the tube.

5.1.3 Push a piece of lens paper (Kim Wipe) down the tube using a 1/4-inch piece of Teflon tubing so as not to damage the tube. Use a cotton swab to clean the window surfaces through the holes the tube fits into.

5.1.4 Replace the tubes (opposite of removal). Both tubes are identical, so they can be replaced in either position.

5.2 Capillary Service (Manual Section 5-5)

5.2.1 Turn off power, disconnect the power cable, and remove cover.

5.2.2 Remove purple 15 mil capillaries by loosening nuts around the Tee fitting on top of sample pump. Remove capillaries from tubing.

5.2.3 Clear any blockage with a wire less than 0.015-inch OD, or replace.

5.2.4 Replace capillaries (opposite of removal).

5.2.5 Repeat steps 2-4 for orange 24 mil capillary upstream of ozone generation chamber if applicable.

5.3 Bench Temperature Sensor Calibration (Manual Section 7-26, 3-92)

Note: *The analyzer must be in service mode to perform this adjustment.*

5.3.1 Remove bench thermistor signal cable from the Measurement Interface Board.

5.3.2 Unscrew thermistor from the optical bench.

5.3.3 Reconnect signal cable to Measurement Interface Board.

5.3.4 Place thermistor through foam in an empty insulated thermos with temperature primary standard.

5.3.5 After the readings equilibrate, adjust bench calibration if the deviation is > 2°C.

5.3.6 Press the Main Menu button to display the Main Menu.

5.3.7 Use the down arrow button to scroll to Service and press the enter button to display the Service menu.

5.3.8 Use the down arrow button to scroll to Temperature Calibration and press the enter button to display the Temperature Calibration screen.

5.3.9 Enter corrected temperature standard reading and press ↵ (Enter) to save.

5.4 Pressure Sensor Calibration (Manual Section 7-34, 3-88)

The pressure sensor calibration requires a high vacuum pump capable of < 1mmHg (≈1 torr). If such a pump is unavailable, only adjust the pressure span setting.

Note: *The analyzer must be in service mode to perform this adjustment.*

5.4.1 Connect reference pressure sensor and vacuum pump to pressure transducer.

5.4.2 Turn on vacuum pump until reference pressure sensor reads < 1mmHg.

5.4.3 Adjust zero setting if deviation is > 5 mmHg.

5.4.4 Press the Main Menu button to display the Main Menu.

5.4.5 Use the down arrow button to scroll to Service and press the enter button to display the Service menu.

5.4.6 Use the down arrow button to scroll to Pressure Calibration and press the enter button to display the Pressure Calibration screen.

5.4.7 From the zero menu, press enter to set the zero setting.

5.4.8 Turn off vacuum pump and open the relief valve.

5.4.9 After the readings equilibrate, adjust span concentration if deviation > 5mmHg.

5.4.10 Press the menu button to return to the pressure calibration menu.

5.4.11 From the span menu, enter the reference pressure reading and press ↵ (Enter) to save.

5.5 Flow Transducer Calibrations (Manual Section 7-37, 3-90)

The flow readings are not used to calculate ozone concentration. Since they are only diagnostic, a precise calibration is not critical.

Note: *The analyzer must be in service mode to perform this adjustment*.

5.5.1 Turn off the instrument sample pump.

5.5.2 Press the Main Menu button to display the Main Menu.

5.5.3 Use the down arrow button to scroll to Service and press the enter button to display the Service menu.

5.5.4 Select Flow A Calibration and then zero.

5.5.5 Press ↵ (Enter) to set the flow zero setting.

5.5.6 Repeat steps 4 and 5 for Flow B.

5.5.7 Connect the reference flow meter to the sample bulkhead.

5.5.8 From the Flow A Calibration menu, select Span.

5.5.9 Disconnect the tubing from the cell B flow transducer to the sample pump and cap both cell B pump inlet and transducer output. Leaving either uncapped will produce erroneous readings.

5.5.10 Enter the reference flow meter reading and press ↵ (Enter) to save.

5.5.11 Repeat steps 8 – 10 for Flow B.

5.6 Leak Check (Manual Section 5-7)

5.6.1 Turn off zero air and disconnect the zero air tubing from the primary.

5.6.2 Cap the sample inlet bulkhead.

5.6.3 Press the Pressure soft key.

5.6.4 The pressure reading should drop less than 200 mm Hg. \

5.6.5 It should take less than 30 seconds from the time the zero air dump is plugged to the time the reading below 200 mm Hg is obtained

5.7 Adjust Lamp Setting (Manual Section 3-85)

Note: *The analyzer must be in service mode to perform this adjustment*.

5.7.1 Press the Main Menu button to display the Main Menu.

5.7.2 Use the down arrow button to scroll to Service and press the enter button to display the Service menu.

5.7.3 Use the down arrow button to scroll to Lamp Setting and press the enter button to display the Lamp Setting screen.

5.7.4 Use the up or down arrows to increment or decrement the numeric value until both intensities are as close to 100 kHz as possible.

5.7.5 Press the enter button to save the new lamp setting.

5.8 Detector Calibration Factor Adjustment (Manual Section 3-86)

Note: *The analyzer must be in service mode to perform this adjustment.*

5.8.1 Connect zero air to the sample bulkhead connector.

5.8.2 Press the Main Menu button to display the Main Menu.

5.8.3 Use the down arrow button to scroll to Service and press the enter button to display the Service menu.

5.8.4 Use the down arrow button to scroll to Detector Calibration and press the enter button to display the Detector Calibration screen.

5.8.5 Verify both detector uncorrected readings are between 90 kHz and 110 kHz.

5.8.6 Press ↵ (Enter) to compute new calibration factors.

5.9 Solenoid Balance and Leak Test (Manual Section 5-8, 5-9)

5.9.1 Generate an ozone concentration of approximately 0.5 ppm and connect to the sample bulkhead connector.

5.9.2 Press the Main Menu button to display the Main Menu.

5.9.3 Use the down arrow button to scroll to Diagnostics and press the enter button to display the Diagnostics menu.

5.9.4 Use the down arrow button to scroll to Cell A/B O_3 and press the enter button to display the O_3 PPB screen. This display presents the concentration for each cell.

5.9.5 Once the instrument stabilizes, the average of 10 successive simultaneous readings from each cell should agree within ± 3 percent.

5.9.6 A balanced measurement of better than 3 percent indicates that there are no leaks across the solenoid.

5.9.7 A constant low reading from one cell indicates an imbalance. The imbalance can be caused by a dirty cell, dirty lines to that cell, or by a leaky valve.

5.9.8 To check if the imbalance is caused by a dirty cell, interchange the cells. If the imbalanced side switches, the imbalance is caused by the cell.

5.9.9 To check if the imbalance is caused by dirty lines to a cell, perform the ozone loss test.

5.9.10 To check the solenoid for a leak perform the following test.

- Remove the solenoid valve that appears to be faulty.
- Connect the solenoid cell test tubing to the test pump. The other end of the tubing will be connected to a tee fitting.
- Cap one open port on the tee fitting.
- Connect a pressure transducer to the open tee fitting port.
- Turn on the test pump.
- After the pressure has stabilized, record the reading as P_C.
- Turn off the test pump.
- Uncap the capped the tee fitting port.
- Connect the open tee fitting port to the common solenoid port.
- Cap the normally open solenoid port.
- Turn on the test pump.
- After the pressure has stabilized, record the pressure reading as P_{NO}.
- Turn off the test pump
- Uncap the normally open solenoid port.
- Cap the normally closed solenoid port.
- Plug the solenoid power line into the appropriate connector on the measurement interface board. Make sure the solenoid is activated.

- After the pressure has stabilized, record the pressure reading as P_{NC}.
- The solenoid is faulty if either P_{NO} or P_{NC} is greater than P_C.

5.9.11 If an imbalance is found, repair and return to step 3, adjusting the detector lamp setting

5.10 Ozone Scrubber Efficiency Test (Manual Section 5-10)

To obtain accurate results using this test, it is critical to measure all readings precisely. In most cases, the entire range of the instrument is represented by 500-600 Hz. Make sure the instrument has sufficiently warmed up and the cover is on. Any limitations in ambient temperature control, test zone concentration, intensity stability, or temperature and pressure measurements should be understood when evaluating the test results.

Note: *The analyzer must be in service mode to perform this test.*

5.10.1 Generate an ozone concentration of approximately 0.5 ppm and connect to the sample bulkhead connector. The exact concentration is not important, but the accuracy of this test is directly affected by how accurately the test concentration is known.

5.10.2 Press the Main Menu button to display the Main Menu.

5.10.3 Use the down arrow button to scroll to Service and press the enter button to display the Service menu.

5.10.4 Use the down arrow button to scroll to Intensity Check and press the enter button to display the Intensity Check menu.

5.10.5 Press the enter button to display the Int A Reference Gas screen.

5.10.6 When the frequency stabilizes, record the frequency to the nearest 5 Hz as FREQ 1.

5.10.7 Press the menu button to return to the Intensity Check menu and select Int A Sample Gas.

5.10.8 When the frequency stabilizes, record the frequency to the nearest 5 Hz as FREQ 2.

5.10.9 Press the Pressure soft key and record as P.

5.10.10 Press the Temperature soft key and record as T.

5.10.11 The approximate efficiency is given as follows:

$$\% \text{ Efficiency} = \frac{\dfrac{(273 + T)}{P} \dfrac{10^6}{KL} \dfrac{760}{273} \ln \dfrac{FREQ2}{FREQ1}}{C} \times 100\%$$

5.10.12 Repeat steps 5-11 for Cell B (choose Int B Reference Gas).

5.10.13 If the analyzer passed the balance test of the “Solenoid Balance and Leak Test” performed previously and the measured efficiency is low, replace the ozone scrubber.

5.11 Ozone Loss Test (Manual Section 4-4)

Only performed as necessary as indicated by the results of the Solenoid Balance and Leak Test.

5.11.1 With the instrument running, generate an ozone concentration of approximately 0.5 ppm and connect to the sample bulkhead connector. The internal generator can be used since concentration will be measured later.

5.11.2 Using a certified ozone detector, measure the concentration at the test instrument sample bulkhead as C, the inlet of cell A as Ca_{IN}, the exhaust of cell A as Ca_{OUT}, the inlet of cell B as Cb_{IN} and the exhaust of cell B as Cb_{OUT}.

5.11.3 The percent ozone loss is given as follows:

$$1-\frac{C_{IN}^{a}+C_{OUT}^{a}+C_{IN}^{b}+C_{OUT}^{b}}{4C} \text{ x } 100\%$$

5.12 Pump Pressure Check (Manual Section 3-83)

Note: *The analyzer must be in service mode to perform this test.*

5.12.1 Press the Main Menu button to display the Main Menu.

5.12.2 Use the down arrow button to scroll to Service and press the enter button to display the Service menu.

5.12.3 Use the down arrow button to scroll to Pressure Check and press the enter button to display the Pressure Check menu.

5.12.4 Use the down arrow button to scroll to Pump Pressure and press the enter button to display the Pump Pressure screen.

5.12.5 The pressure reading should drop below 390 mmHg in less than 20 seconds. This indicates the effectiveness of the sample pump.

5.12.6 After 20 seconds, if the pressure is greater than 390 mmHg or the flow is greater than 0.010 LPM, the words “PUMP PROBLEM DETECTED” appear. Otherwise the words “PUMP OK” appear.

5.13 Leak Test (Manual Section 5-7)

5.13.1 Plug the sample inlet port.

5.13.2 Press the Pressure soft key.

5.13.3 The pressure reading should drop less than 200 mm Hg.

5.13.4 It should take less than 30 seconds from the time the sample inlet port is plugged to the time the reading below 200 mm Hg is obtained.

5.13.5 Continue only for instruments with ozone generators.

5.13.6 Plug the vent port, ozone port, zero air port, and the integrity/cal gas outlet port on the tee fitting.

5.13.7 Press the ▶ button to return to the home screen.

5.13.8 Press the ▶ button to activate zero mode.

5.13.9 Press the Pressure soft key.

5.13.10 The pressure reading should drop less than 200 mm Hg.

5.13.11 It should take less than 30 seconds from the time the sample inlet port is plugged to the time the reading below 200 mm Hg is obtained.

5.14 Repair

See Chapter 7 in the Thermo Manufacturer's Manual for repair procedures for all models.
5.14.1.1

6.0 CALIBRATION PROCEDURE

6.1 Calibrating the Detector, Model 49i

Allow the instrument to warm up for approximately 1 hour. Check to see if desiccant or charcoal canisters in the zero air system are due to be changed.

6.1.1 Connect the output of the Thermo 49PS primary to the sample inlet of the site analyzer.

6.1.2 Connect an Ethernet cable to the back of 49i model analyzers.

6.1.3 Using the laptop connected to the CR3000 datalogger, determine which primary standard is being used, 1, 2 or 3, and ensure that page is selected. Only three (3) analyzers can be attached to single primary standard at any time. The datalogger has a program built into it that runs a full audit or calibration on an analyzer. However, the instrument must be set up in the program for it to run and record the data properly.

Under each Primary Standard page, three analyzers can be set up. PS1is associated with Analyzer 1,Analyzer 2, and Analyzer 3. PS2 is associated with Analyzer 4, Analyzer 5, and Analyzer 6. PS3 is associated with Analyzer 7, Analyzer 8, and Analyzer 9. All parameters are the same on each page, but their values change depending on the analyzers being used.

6.1.4 For a 49i analyzer, certain parameters need to entered and enabled. For instance, if using PS1, its page should already have the PS slope and intercept entered into the program. Check to make sure these agree with the sticker on the PS, as well as all other parameters match the PS being used. Under Analyzer 1, the parameters of iSeries, SerialNum, Comport and IP_Addr need to be adjusted to match the machine being hooked up. For a 49i, the iSeries parameter should read "true". If it does not say "true", double click on the box and double click again to change the logic statement. The serial number of the machine should be input into the parameter labeled SerialNum. Double click inside the box, type in the serial number and then hit enter to save it. The Comport parameter should read "TCP". If it does not say "TCP", double click inside the box, type in TCP and then hit enter to save it. The IP address of the machine should be entered into the IP_Addr parameter. This can be found in the machine by going into the Menu, down to Instrument Controls, down to Communications and then to TCP/IP Settings. Record this

IP address into the table, inputting similar to the serial number. Repeat for all analyzers being calibrated.

It is important to make sure that unique IP addresses are entered for each analyzer connected to the logger.

6.1.5 To begin an audit of a transfer machine, select the CalStart under the PS parameters and change the logic to "true". This will begin a sequence that cycles through all six target levels automatically. The sequence takes approximately 2 hours to run. A report can be generated through an Access script loaded on to the Loggernet computer which can be accessed from any of the other computers in the shop.

6.2 Adjusting the levels

6.2.1 If the was analyzer is found to be out of criteria, it is necessary to perform a full calibration. To do so, connect the transfer as in steps 1 through 5, if not already connected. Once the parameters are adjusted for the particular analyzer, first, turn the CalAdjust parameter to "true" under the appropriate analyzer's setting. Next, turn on the CalStart parameter to "true". This performs an automatic sequence that adjusts the Background and Coefficient variables. A report can be generated through an Access script loaded on to the Loggernet computer which can be accessed from any of the other computers in the shop.

Below are equations to check the accuracy of the analyzers.

Correct the PS averages to actual (observed average minus the y-intercept and divided by the slope generated when the PS was certified).

$$actual = \left(\frac{average\ reading - intercept}{slope} \right)$$

Calculate percent differences (*%Δ)* and perform a regression analysis of the transfer averages versus the 49PS values.

$$\%\Delta = \left(\frac{unknown - known}{known} \right) \times 100$$

Note: *After completing the calibration, place the calibration form, and O_3 a**nalyz**er on the "ready to ship" shelf.*

7.0 REFERENCES

Thermo Electron Corporation. 1997. Model 49C UV Photometric Analyzer Instrument Manual

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring.* 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)*. 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1997. *National 8-Hour Primary and Secondary Ambient Air Quality Standards for Ozone*. 40 CFR 50, Appendix I.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications.* EPA-450/4-87-013.

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U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements.* EPA-600/4-82-060.

U.S. Environmental Protection Agency (EPA). 1979. *Transfer Standards for Calibration of Air Monitoring Analyzers for Ozone, Technical Assistance Document.* EPA-600/4-79-056.

IV. CALIBRATION LABORATORY
C. SITE INSTRUMENTATION
3. MASS FLOW CONTROLLER

Effective Date: 11-10-11

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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IV.C.3. MASS FLOW CONTROLLER

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance for maintenance and handling of all mass flow control (MFC) units to Clean Air Status and Trends Network (CASTNET) Field Calibration Laboratory personnel.

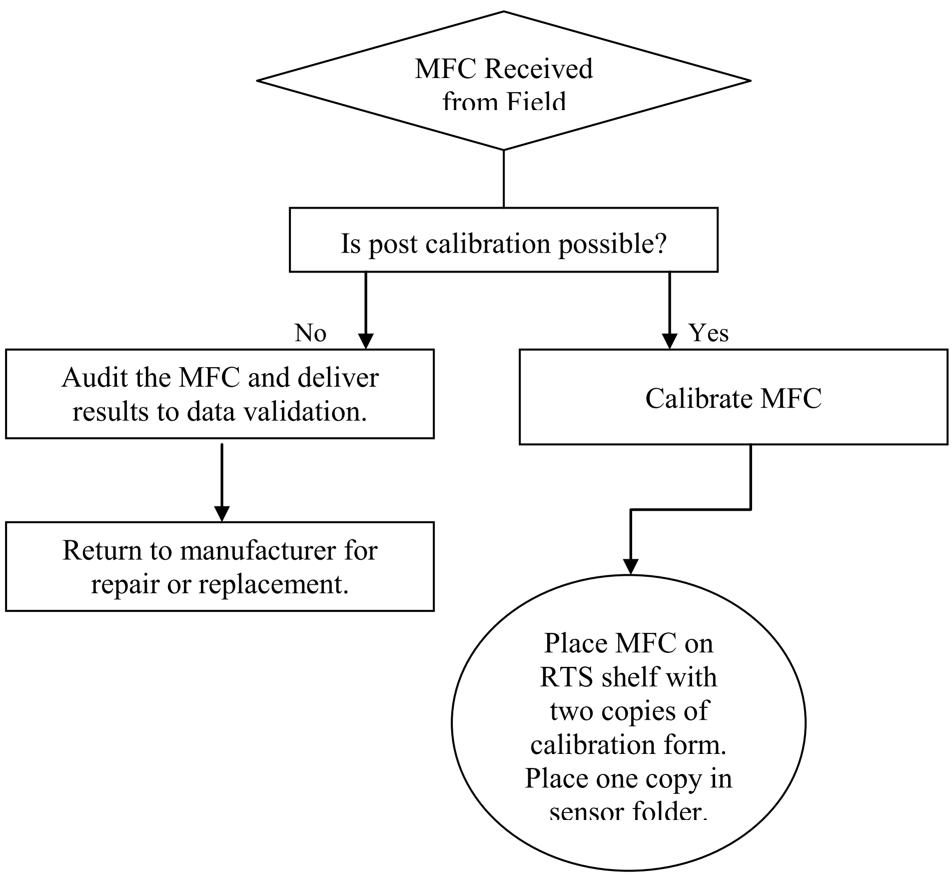
2.0 SCOPE

This SOP applies to the maintenance and handling of MFC units administered by the CASTNET Field Calibration Laboratory.

3.0 SUMMARY

All mass flow control systems are inspected and calibrated prior to site installation according to the procedure listed in Section 6.0. Upon receipt of MFC system from the field post calibration should always be attempted and the results documented and delivered to data validation.

Figure 1. Summary of Procedure



4.0 MATERIALS AND SUPPLIES

Lowflow [0.01 liters per minute (Lpm)-30.0 Lpm] MFC and display/power supply
BIOS DryCal DC-Lite mass flow meter (MFM)
BIOS DryCal Nexus data logger/communications module or
BIOS Definer MFM
Balston filter
Latex flow tubing
Certified Voltmeter digital (DMM or DVM)

Figure 2. DC-Lite (left) and Nexus (right) flow calibration standard

Figure 3. Definer flow calibration standard

5.0 SAFETY

MFC power supplies operate on 120 VAC power. Precautions should be taken to avoid electrocution. Always unplug an MFC power supply prior to removing cover.

6.0 REPAIR AND MAINTENANCE

6.1 Repair

Mass flow control systems consist of a mass flow controller and a regulated, adjustable power supply with voltage display. Power supply and display may be separate or integrate as one unit. The power supply voltage output controls the MFC valve and thus the flow rate setting of the mass flow controller. The power supply output voltage is adjustable via a potentiometer on the power supply unit. Mass flow controllers are always calibrated with their associated power supply. MFC's are returned to the manufacturer for repair, MFC power supplies however are replaced if defective and the system is then recalibrated. If it is an integrated unit, the unit is returned to the manufacturer.

6.2 Maintenance

Clean the inlet screen and inspect the o-ring when performing a bench calibration. Replace the o-ring if necessary.

6.3 Calibration / Post-Calibration

6.3.1 Allow the MFM and the MFC to warm up for at least 30 minutes. Make sure DC-Lite and Nexus are properly connected with the supplied cable. Use a silicone tube to connect the OUTLET port of the DC-Lite to the Nexus. Leave the INLET port of the DC-Lite open to atmosphere. See Figure 2 for photograph of plumbing.

6.3.2 Install a Balston filter on the inlet side of the mass flow controller. Using silicone tubing connect the remaining Nexus port to the Balston filter.

6.3.3 Connect a regulated vacuum source such as standard diaphragm pump to the remaining port on the Nexus.
Note: *If using a Definer, connect flow tubing to the upper port.*

6.3.4 Attach a certified voltmeter to the voltage output terminals on the MFC display/power supply.

6.3.5 With the vacuum pump off record the MFC display. Adjust to zero if necessary. Notice the voltage output under conditions of no flow.

6.3.6 Switch the MFC to full **OPEN** and adjust the needle valves wide open to allow full flow through the system, and switch the MFC to **AUTO** to check that it can control flow. If it can, switch the MFC back to full **OPEN**, and adjust the flow throughout the rest of the calibration with the needle valves.

6.3.7 Adjust the flow (with the needle valves) so that the MFC display shows the expected level of flow at which the instrument will be used [e.g., 1.50 Lpm for CASTNET eastern sites; 3.00 Lpm for CASTNET western sites).

6.3.8 Measure this flow through the DC Lite/Nexus, obtaining an average of five good runs. Correct this average to standard temperature and pressure (STP) to get actual flow (as described in step 9) and compare with the MFC display. If the actual flow differs from the MFC reading by more than 5%, the MFC span should be adjusted (refer to the MFC manufacturer's manual for this procedure). If the MFC display is within 5% of actual flow, continue with the calibration.

6.3.9 Generate a range of flows around the expected flow setting for that instrument. For MFCs to be used at 1.5 Lpm, for example, do respective flows at 0.75, 1.00, 1.25, 1.50, 1.75, 2.00, and 2.25 Lpm. At each level of flow, record the MFC display, the voltage output, and the MFM measurement (average of five good runs) on the Mass Flow Data Form (Figure 4).

Figure 4. Example - Flow Calibration Form

MACTEC

Flow

Site Name	Calibrator	Calibration Date	Data Logger	iForms Ver.
MACTEC	DME	1/25/2010	Campbell 3000 ID:355	1.3.2.1

	Mass Flow Controller		MFC Display	
	As Found	As Left	As Found	As Left
ID #		000560		
Description		MFC		
Manufacturer		Alicat		
Model		-MC_10SLPM-D-PCV6		
Serial #		50732.00		
Full Scale		0.988		
Zero		-0.024	1.5 lpm	3.0 lpm
Pot. Setting		1.501	Estimate: 1.000	2.000
Rotameter				
Pump Max Flow				

Transfer Mass Flow Meter	
ID #	
Manufacturer	
Model	
Date of Last Cert.	
Data Module	
ID #	BIOS
Manufacturer	BIOS
Model	Dry Cal Nexus
Date of Last Cert.	12/11/2009

	Transfer Flow		Site MFC	Voltage	Flow lpm	% Diff
	Display	STP	Display			
Pump Off (Zero Value)		0.000				
Leak Check						
Exisiting Flow						
Adjusted Zero Value		0.000				
Adjusted Leak Check						
Pot. Setting						
Pot. Setting						
Pot. Setting						
Flow As Left (Unadj.)						

		Transfer Flow		Site MFC	Voltage	Flow lpm	% Diff	Corrected	Corrected
		Display	STP	Display				Flow	% Diff
Pump Off (Zero Value)			0.000						
Leak Check									
Set Point	1.000		0.991	1.00	1.000			0.988	-0.3%
Set Point	1.250		1.241	1.25	1.250			1.241	0.0%
Set Point	1.500		1.493	1.50	1.500			1.493	0.0%
Set Point	1.750		1.745	1.75	1.749			1.745	0.0%
Set Point	2.000		1.996	2.00	1.999			1.998	0.1%
Set Point	2.250		2.248	2.25	2.248			2.250	0.1%
Set Point	2.500		2.502	2.50	2.499			2.504	0.1%
Set Point	2.750		2.757	2.75	2.747			2.755	-0.1%
Set Point	3.000		3.007	3.00	2.999			3.009	0.1%
Set Point	3.250		3.258	3.25	3.246			3.259	0.0%
Set Point	3.500		3.517	3.50	3.497			3.513	-0.1%
Post Calibration			1.500	1.50	1.501			1.494	-0.4%

Remarks
P=100 DP=12000 For 3 lpm set point=2.983 STP=2.9999 voltage=2.981

Reviewed By: ____________________ Date: ____________

6.3.10 Record the ambient barometric pressure (P) in inches and temperature (T) in degrees Celsius (°C) in the room. Correct each DC Lite/Nexus measurement to STP with the following formula:

$$STP\ flow\ (LPM) = DC - Lite / Nexus\ flow\ (LPM) * \frac{P * 298}{29.92 * (T + 273)}$$

6.3.11 Perform a linear regression on the STP flow (independent variable) vs. the MFC display reading (dependent variable). Record the y intercept, slope, and correlation coefficient. Calculate the MFC display for whatever actual flow the instrument is to monitor (i.e., 1.5 Lpm for CASTNET eastern sites).

y = mx + b

(where m = slope, b = y intercept, and x = STP flow)

6.3.12 If the MFC is being calibrated to be sent to a site, divide all the voltage output values by 5 (as the 3260 does onsite), and perform a linear regression on actual flow versus this corrected voltage. Record the y intercept, slope, and correlation coefficient. Calculate the DSM setting for full scale and zero:

$$Full\ scale = \frac{(1.00 - b)}{m}$$

$$Zero = \frac{(0.00 - b)}{m}$$

6.3.13 Set the MFC to the calculate set point and measure this flow through the MFM, obtaining an average of five good runs. If the actual flow differs from the desired reading by more than 3%, then MFC must be re-calibrated.

6.3.14 After completing the calibration, place the calibration form and MFC in a plastic bag and put on the "ready to ship" shelf.

7.0 REFERENCES

BIOS International Corporation. 2001. *DryCal® DC-Lite Manual,* http://www.biosint.com/pdfs/lite_man_b.PDF.

BIOS International Corporation. 2001. *Operating Instructions DryCal® Nexus DC-Lite Accessory model DCNS* http://www.biosint.com/pdfs/nexus_nss_man.PDF

BIOS International Corporation. 2001. *Operating Instructions DryCal® Nexus DC-Lite Accessory model DCNL* http://www.biosint.com/pdfs/nexus_nsl_man.PDF

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U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods.* EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements*. EPA-600/4-82-060.

8.0 ATTACHMENTS

This SOP does not contain attachments.

IV. CALIBRATION LABORATORY
C. SITE INSTRUMENTATION
4. WETNESS SENSOR

Effective Date: 11-10-11

Reviewed by: Kevin P. Mishoe
Field Operations Manager

Reviewed by: Marcus O. Stewart
Project QA Manager

Approved by: Holton K. Howell
Project Manager

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IV. C. 4. WETNESS SENSOR

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance for maintenance and handling of the wetness sensor to Clean Air Status and Trends Network (CASTNET) Field Calibration Laboratory personnel.

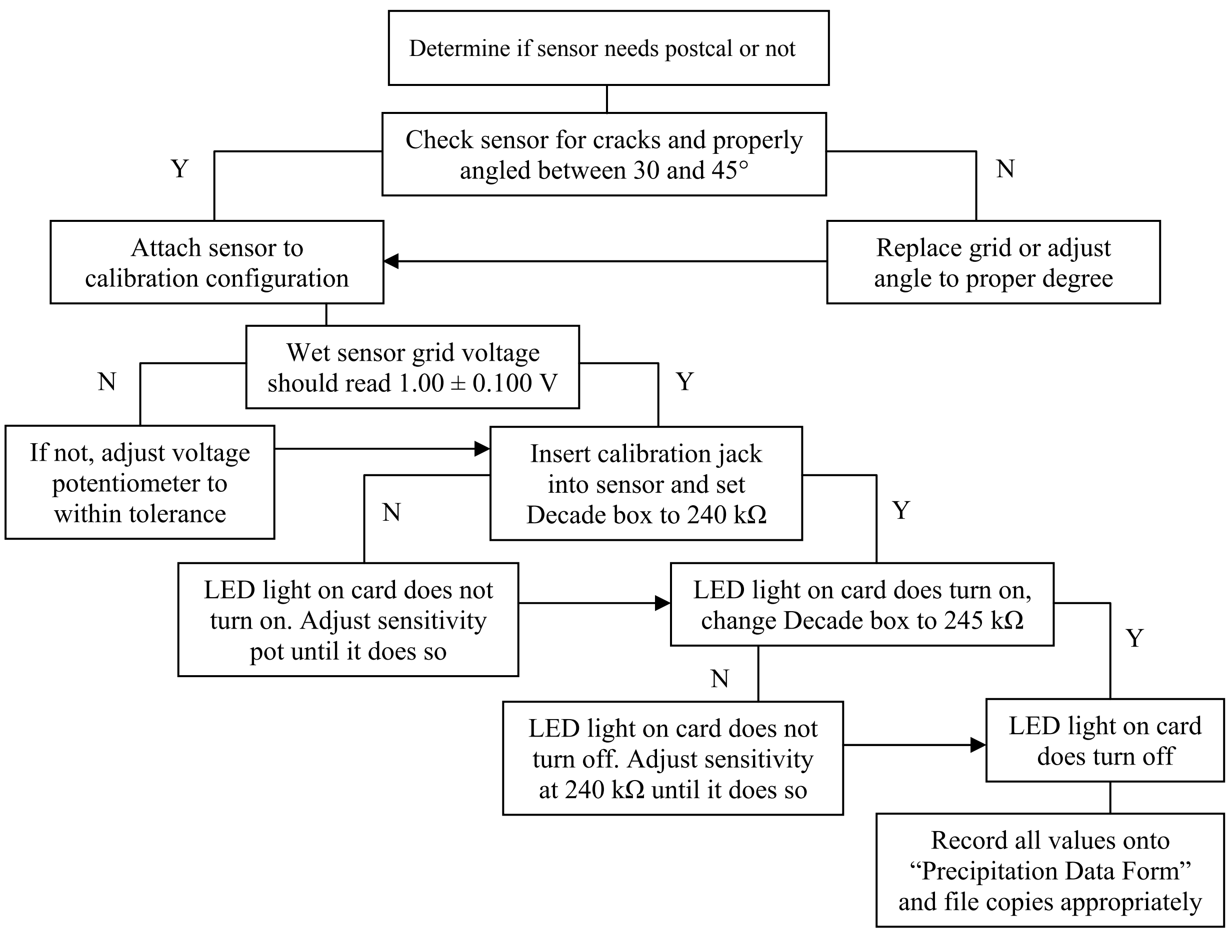
2.0 SCOPE

This SOP applies to the maintenance and handling of wetness sensor units administered by the CASTNET Field Calibration Laboratory.

3.0 SUMMARY

All wetness sensors received from the field are post calibrated if necessary, inspected, cleaned, repaired if needed, and then calibrated. Test jacks allowing application of a standard resistance will be permanently installed on all new wetness sensors prior to use in the field.

Figure 1. Wetness Sensor Calibration Procedures



4.0 MATERIALS

Wetness sensor grid
Integrated circuit (IC) chips
Electronics tool kit including:
Soldering tool
Solder
Screwdriver
Wire cutters

5.0 SAFETY

5.1.1 When working with the soldering iron, it is recommended to wear gloves to avoid getting burned. Electricity and water are present together while performing the calibration, so care should be taken to avoid electrocution.

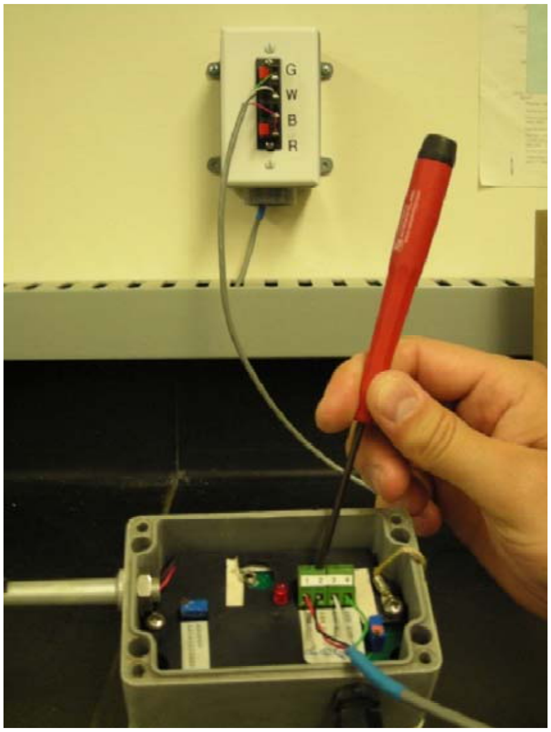
6.0 PROCEDURE

6.1 Post Calibration/Calibration

6.1.1 Voltage Calibration

6.1.2 Connect wetness sensor to the CR3000 calibration station as shown in Figure 2. Attachment A provides a wiring diagram for the RM Young Wetness probe.

Figure 2. Wiring sensor to wall jacks



6.1.3 Wet the grid Figure 3. The red light on the card should come on and register 1.000 ± 0.10 V on the PC200 laptop screen (Figure 4). (Adjust the voltage potentiometer if necessary, only during calibration, not post calibrations). Ensure that the calibration jack is **<u>not</u>** plugged in. Record voltage at ON and OFF on a “Precipitation Data Form” (Figure 5).

Grid wet should be	~	1.0000 V.
OFF (dry) should be	~	0.0000 V.

Figure 3. Wet sensor grid and observe output voltage

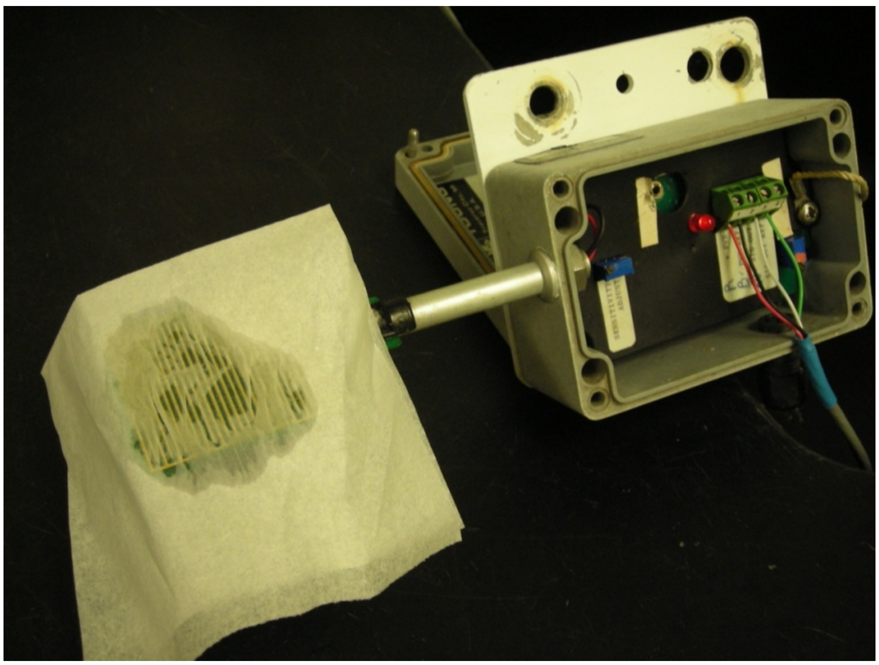


Figure 4. Computer screen shot

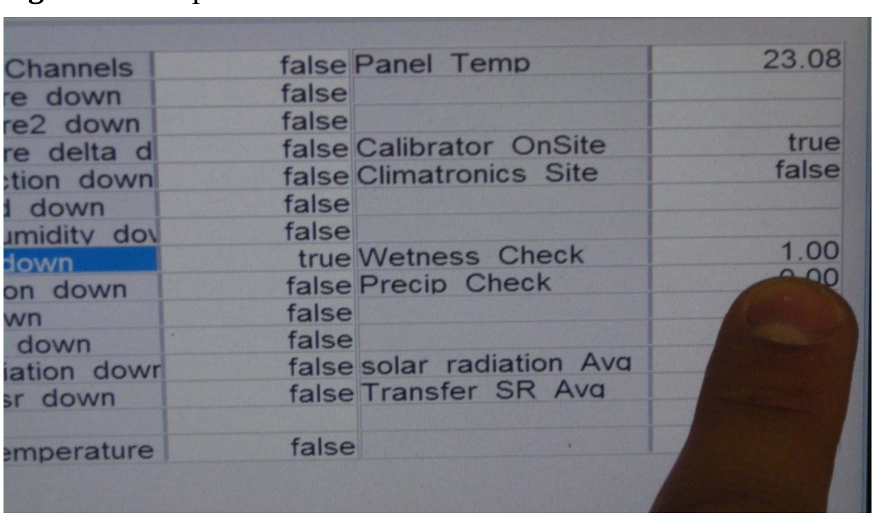
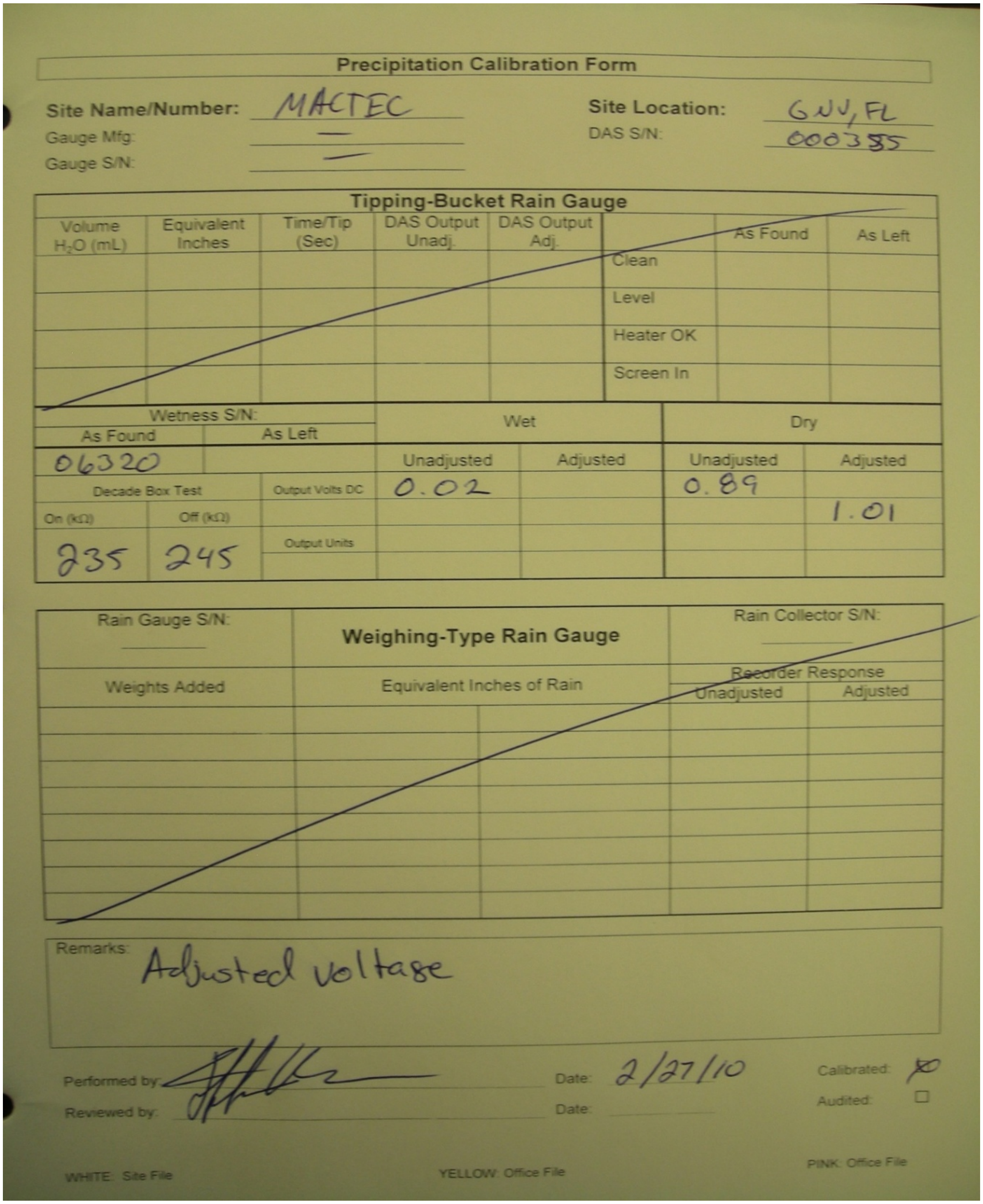


Figure 5. Precipitation record sheet for wetness sensors



Precipitation Calibration Form

Site Name/Number: MACTEC
Gauge Mfg: —
Gauge S/N: —

Site Location: GNV, FL
DAS S/N: 000385

Tipping-Bucket Rain Gauge

Volume H_2O (mL)	Equivalent Inches	Time/Tip (Sec)	DAS Output Unadj.	DAS Output Adj.		As Found	As Left
					Clean		
					Level		
					Heater OK		
					Screen In		

Wetness S/N:			Wet		Dry	
As Found	As Left					
06320			Unadjusted	Adjusted	Unadjusted	Adjusted
Decade Box Test		Output Volts DC	0.02		0.89	
On (kΩ)	Off (kΩ)					1.01
235	245	Output Units				

Weighing-Type Rain Gauge

Rain Gauge S/N:		Rain Collector S/N:	
Weights Added	Equivalent Inches of Rain	Recorder Response	
		Unadjusted	Adjusted

Remarks: Adjusted voltage

Performed by: [signature] Date: 2/27/10 Calibrated: ☒
Reviewed by: Date: Audited: ☐

WHITE: Site File YELLOW: Office File PINK: Office File

6.2 Sensitivity Calibration

6.2.1 During a post calibration, push the test jack from the decade box into the test jack socket. Beginning at least 4 kΩ above the final value, decrease the resistance in 1 kΩ intervals until the sensor turns on. Record the highest resistance at which the sensor remains on. Likewise, Beginning at least 4 kΩ below the final value, increase the resistance in 1 kΩ intervals until the sensor turns off. Record the lowest resistance at which the sensor remains off.

6.2.2 For calibration, set the decade box to 240 kΩ and adjust the sensitivity potentiometer as shown in Figure 6, (the light should come on) as seen in Figure 7. Set the decade box to 235 kΩ (the light should remain on). Then set the decade box to 245 kΩ (the light should go off).

Figure 6. Using a decade box to test sensitivity

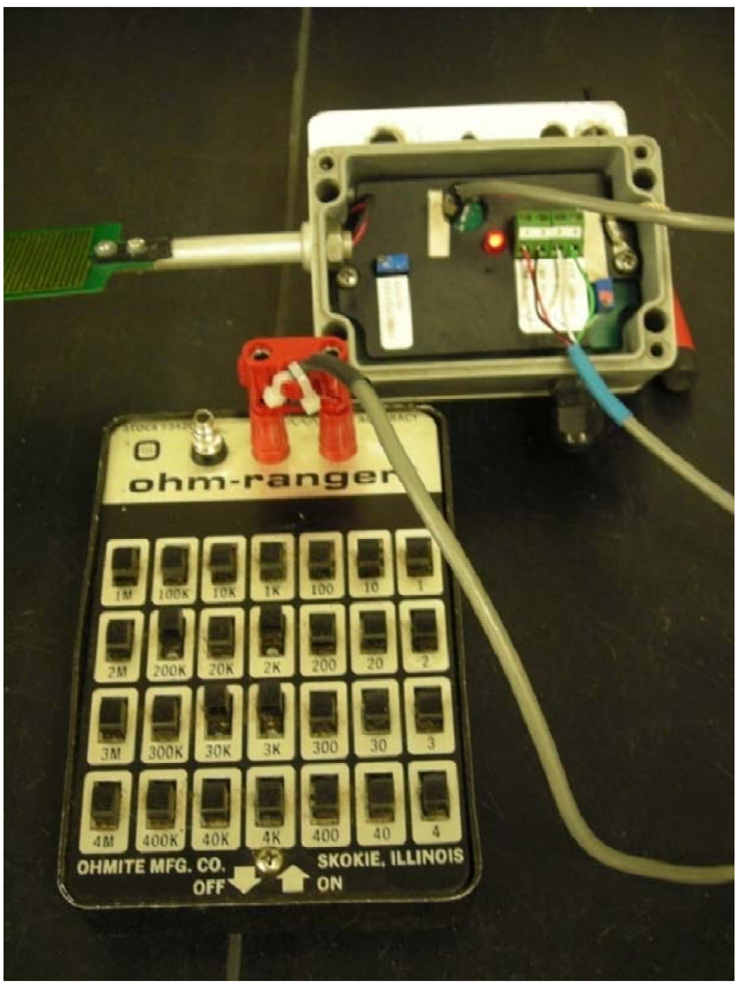
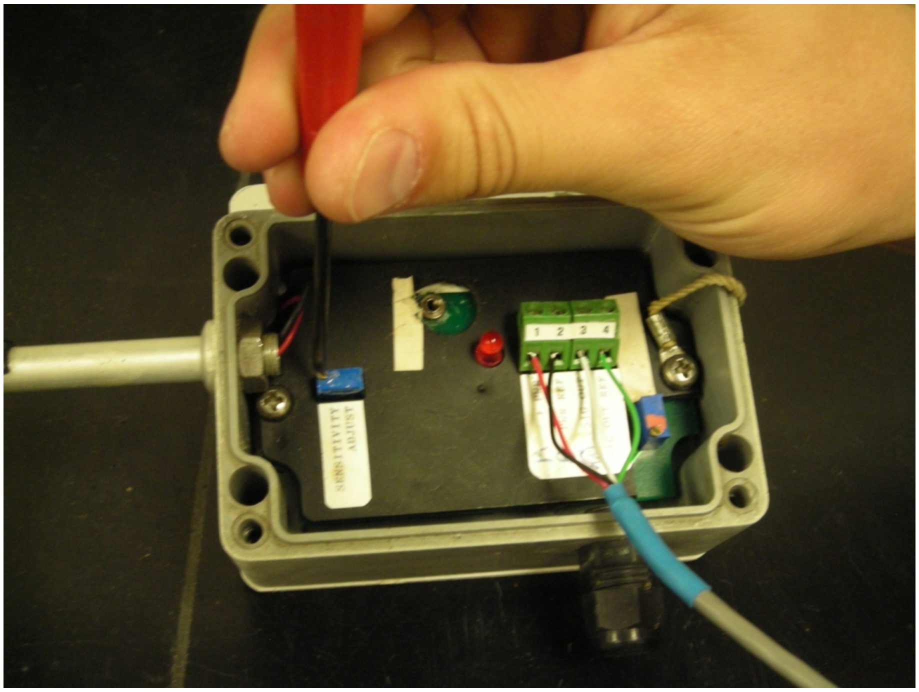


Figure 7. Adjusting sensitivity potentiometer



6.2.3 If calibrated, document results, all repair, and maintenance actions on calibration form. Attach two copies of the calibration form to the sensor and place it on the "Ready to Ship" shelf. Place a third calibration form copy in the sensor file.

6.2.4 If post-calibration, document results on calibration form and place calibration form in sensor file and deliver copy to data validation group. Then perform repair, maintenance and calibration of sensor.

6.3 Maintenance and Repair

6.3.1 Clean and inspect the sensor grid. Adjust the grid angle to between 30° and 45° with respect to the top edge of the sensor box.

6.3.2 Clean and inspect all solder joints and wire connections.

6.3.3 Clean and inspect the box lid seal and replace if necessary, see 6.3.4 for details.

6.3.4 Replace damaged grid by removing the screws attached to the base of the grid, which secures the grid to the support arm. Unsolder the circuit board wires from the base of the grid. Install a new grid using the reverse of this procedure. Before replacing the screws to secure the grid, add silicon sealant underneath the grid at the end of the arm to waterproof the wires and prevent insects from entering the sensor.

6.3.5 To replace damaged or failing IC chips, remove the circuit board from the box by taking out the retainer screws on either side of the board. Flip the board over to locate the IC chips and with a chip lifter, remove the defective piece. Pay close attention to which chip performs what function. Chips labeled with LM1830N control the sensitivity, while chips labeled with LM2902N control the voltage. It is also important to pay attention to the outline on the circuit board which will show which direction the new chips should be installed, indicated by a notch on one side of the chip.

- Seal translator box with silicon sealant where the arm enters the box and also around the base of the grid where it attaches to the arm
- Remove old lid seal with small screwdriver or needle nose pliers. Place a small amount of vacuum grease on a few points of the new seal and press down into box lid.

6.3.6 Installing a Test Jack

- Disconnect wires from grid to board.
  Note: *It will be necessary to remove the nut from the grid arm to unscrew one side of the sensor card from the box. When reinstalling the grid arm, set at a 45º angle to the box top.*
- Solder a short red wire (about 2 inches long) from the "sensor +" to the single tab on top of the jack.
- Solder a short black wire to the "sensor return" on the card. Solder the other end of the short black wire and the black wire from the grid to the bottom tab of the jack.
- Solder the red wire from the grid to the top tab on the side of the jack with two tabs.

  Note: *Use the heat sink on the jack tabs when soldering wires, as plastic on the jack melts easily. In addition, ensure that the calibration jack hole in the faceplate is large enough for the jack to fit properly.*

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring.* 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS).* 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications.* EPA-450/4-87-013.

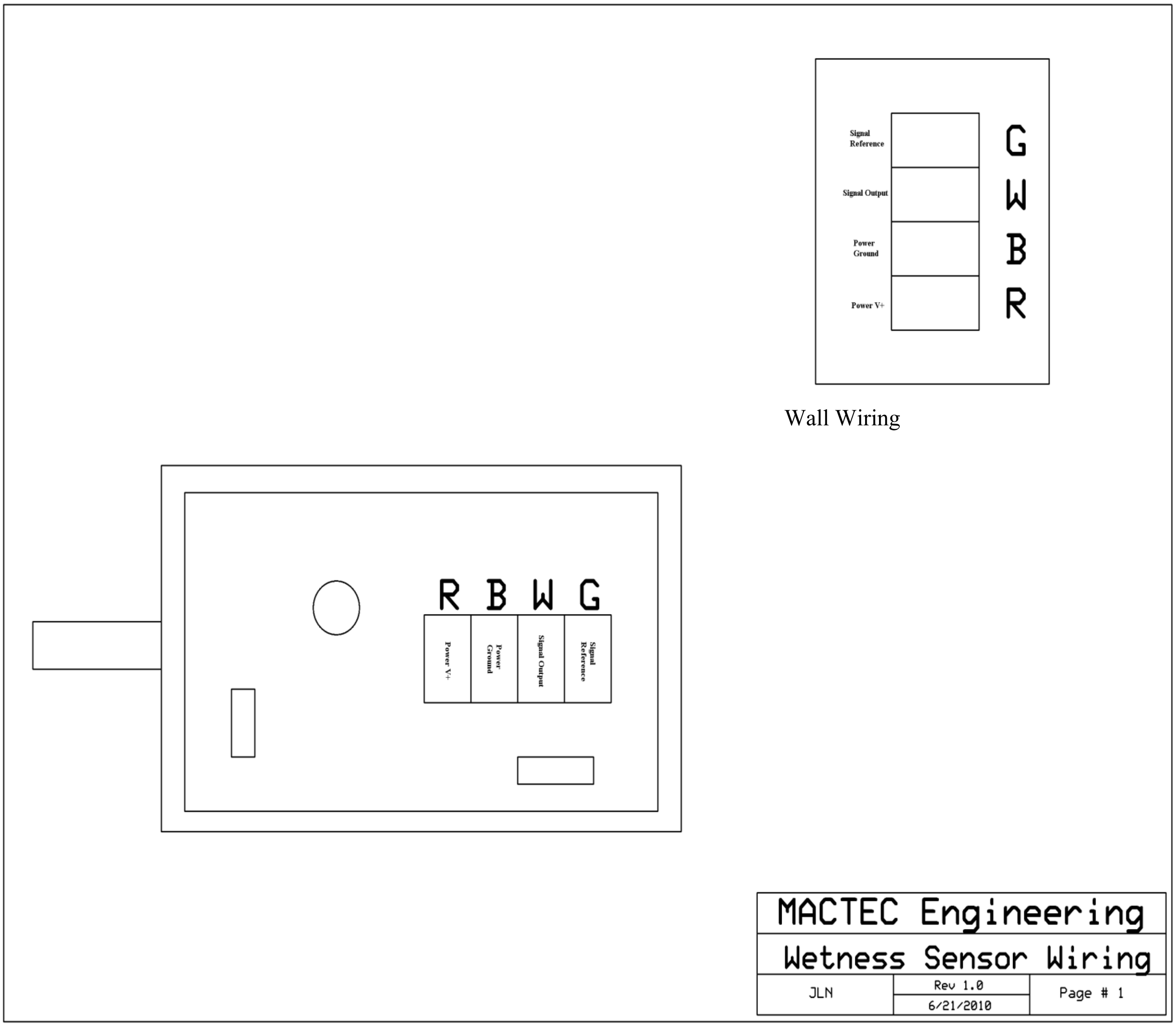
U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods.* EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements.* EPA-600/4-82-060.

8.0 ATTACHMENTS

Attachment A: Wetness sensor card wiring diagram



IV. CALIBRATION LABORATORY
C. SITE INSTRUMENTATION
5. TIPPING BUCKET RAIN GAUGE

Effective Date: 11-10-11

Reviewed by: Kevin P. Mishoe, Field Operations Manager — [signature]

Reviewed by: Marcus O. Stewart, Project QA Manager — [signature]

Approved by: Holton K. Howell, Project Manager — [signature]

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Reviewed by:	Title:	Date:	Signature:
MS	QA Mgr	10/30/12	[signature]
MS	QA Mgr	10/31/14	[signature]
MS	QA Mgr	11/2/15	[signature]

IV.C.5. TIPPING BUCKET RAIN GAUGE

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance for maintenance and handling of the tipping bucket rain gauge to Clean Air Status and Trends Network (CASTNET) Field Calibration Laboratory personnel.

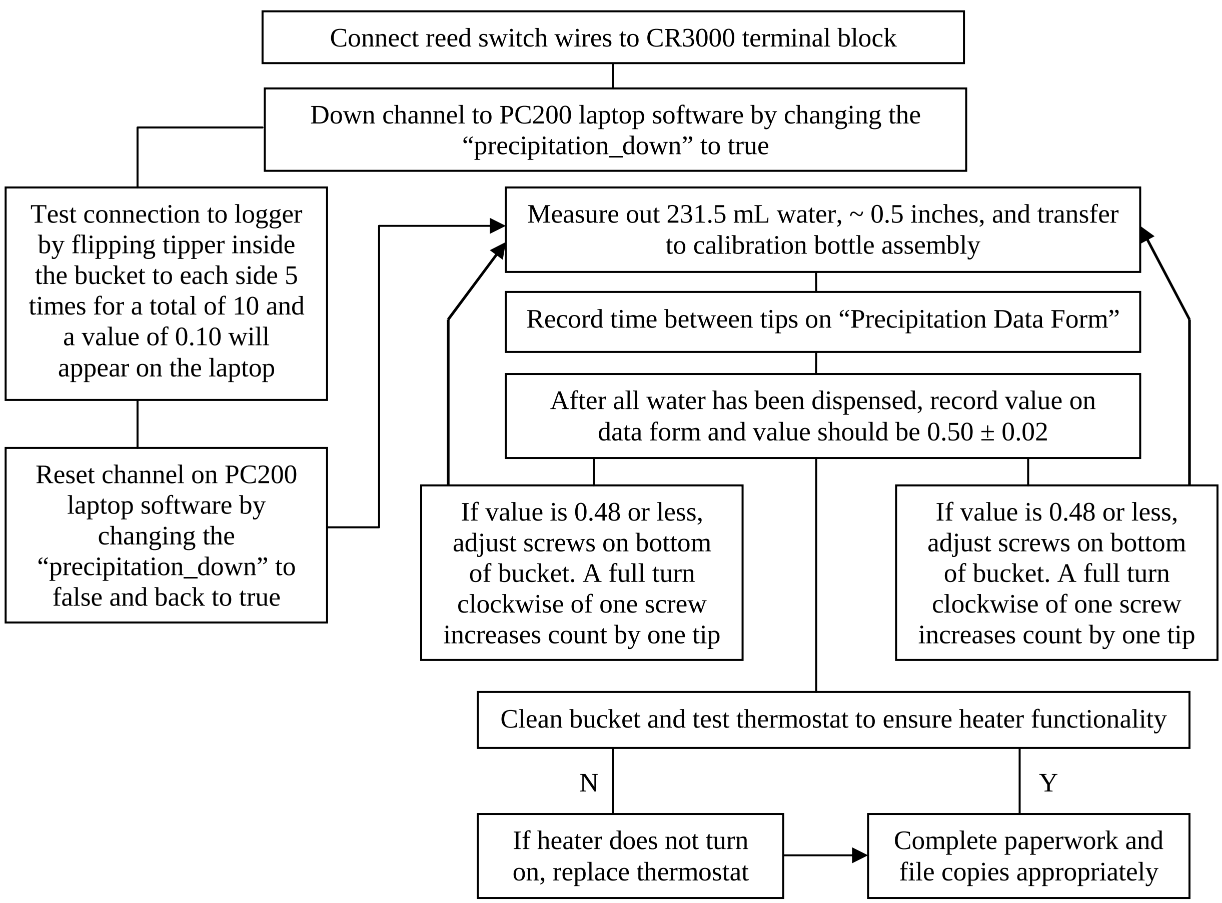
2.0 SCOPE

This SOP applies to the maintenance and handling of tipping bucket rain gauge units administered by the CASTNET Field Calibration Laboratory.

3.0 SUMMARY

All tipping bucket rain gauge units are calibrated prior to shipment, after repair, or upon receipt from the manufacturer.

Figure 1. Calibration of Tipping Bucket Rain Gauge



4.0 MATERIALS

Texas Electronics Model 525I or Climatronics Model 100508 tipping bucket rain gauge
Data logger
Cleaning materials
Multimeter
Graduated cylinder and separatory funnel both capable of measuring 231.5 milliliters water
Replacement reed switch
Freeze spray
Tool kit

5.0 SAFETY

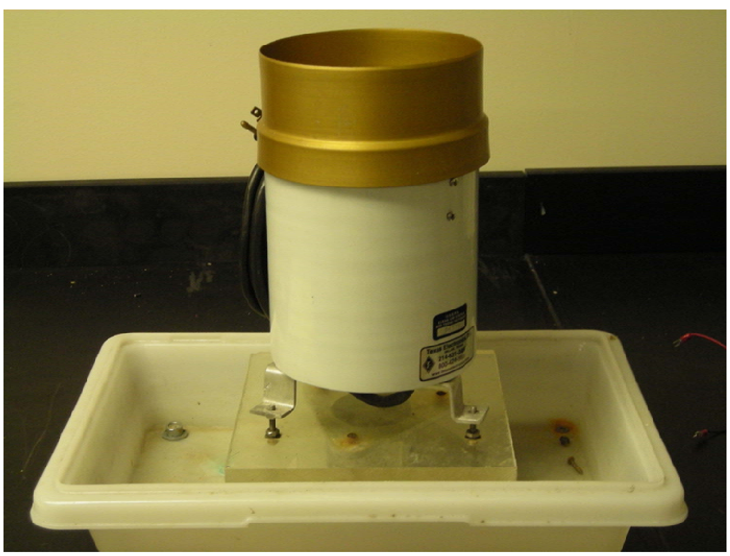
The calibration and maintenance of the tipping bucket rain gauge requires work around water and electricity. Necessary precautions, such as wearing gloves, need to be taken to ensure electrocution is avoided. When removing the heater jacket from the funnel, a sharp blade knife is best used to remove the residual sealant. Caution should be taken while handling the knife.

6.0 PROCEDURES

6.1 Post Calibration/Calibration

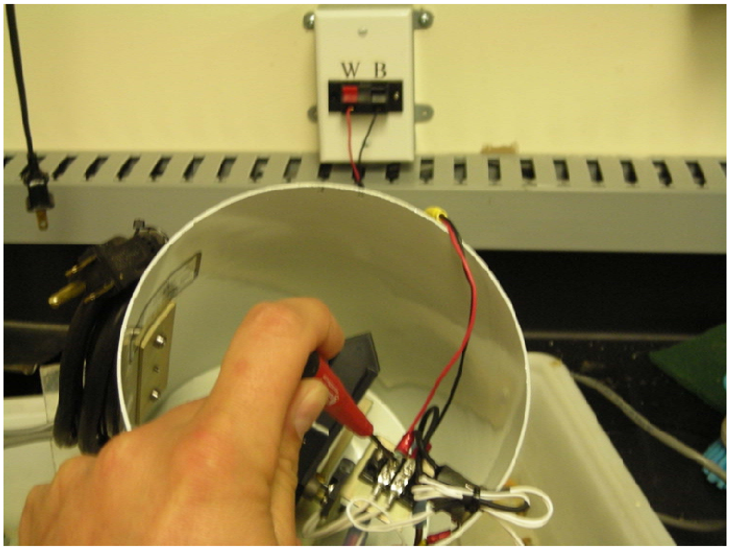
6.1.1 Place the tipping bucket rain gauge in the white pan next to the sink at the calibration station, Figure 2.

Figure 2. Place tipping bucket on platform in white catch bin



6.1.2 Remove the funnel and attach the proximity switch wires to the terminal block on the wall labeled “tipping bucket signal” and inside the bucket on the terminal strip, Figure 3. Check to ensure bucket is level using the bull’s-eye level under the tipping mechanism.

Figure 3. Use wires from wall jack to wire into tipping bucket



6.1.3 “Down” the precip channel on the PC200 software, Figure 4, on the laptop located by the datalogger by double clicking on the “false” value and double clicking again to change the value to true. Rotate the rocker arm assembly to each side five times, Figure 5. This will give a 10-count total, or .10, for the manual check that will show up on the far right hand column of the PC200 program to the right of Precip Check.

Figure 4. Down precipitation channel to test wiring connection

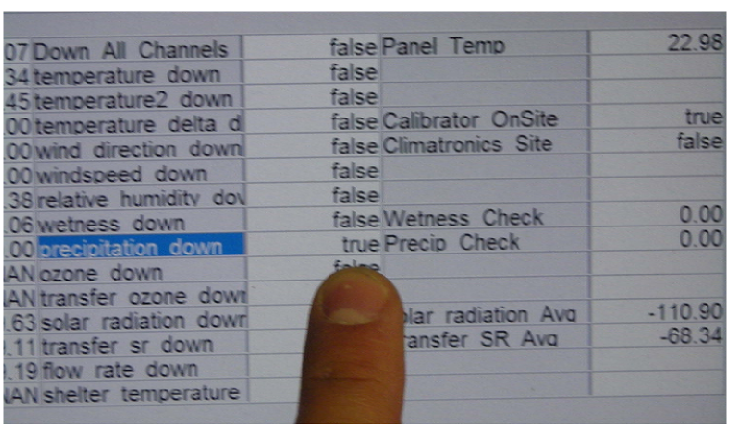
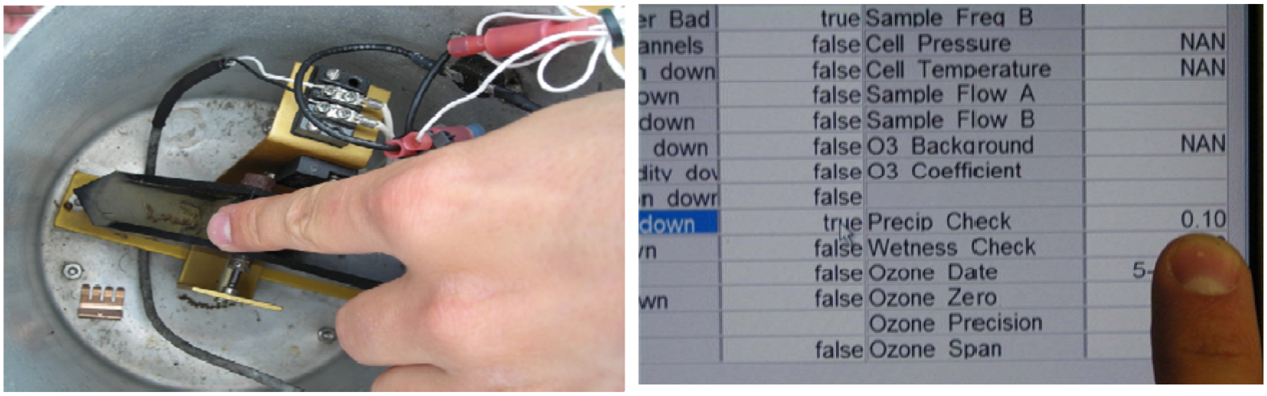
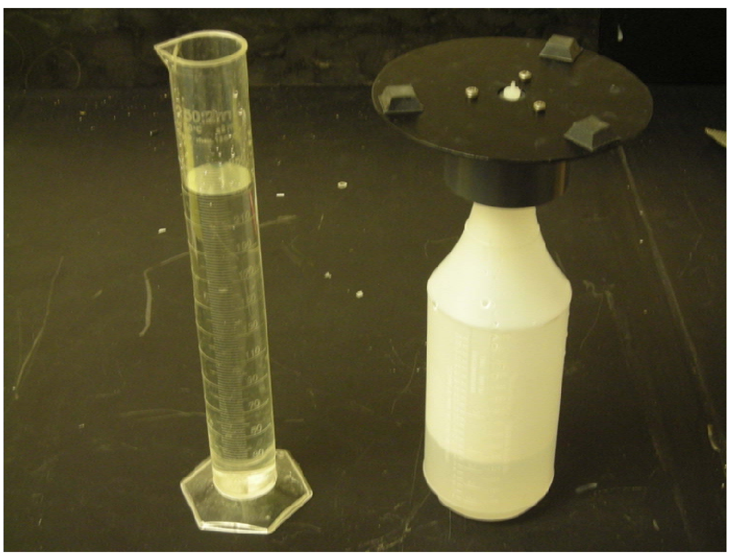


Figure 5. Tip mechanism 10 times and check for accuracy on PC200 screen



6.1.4 Measure 231.5 ml of water into a graduated cylinder and transfer to calibration funnel, Figure 6. (This will equal .5 inch of rain.)

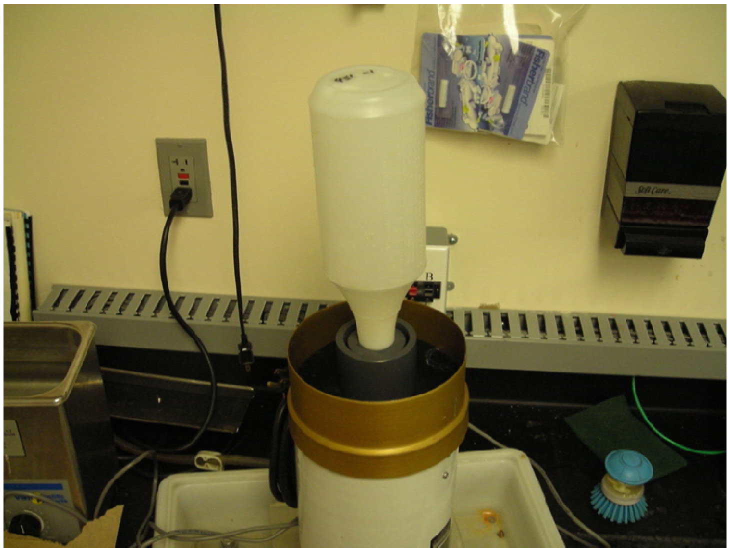
Figure 6. Measure 231.5 ml of water into a graduated cylinder and transfer to calibration funnel



6.1.5 Pour the water into the calibration funnel.

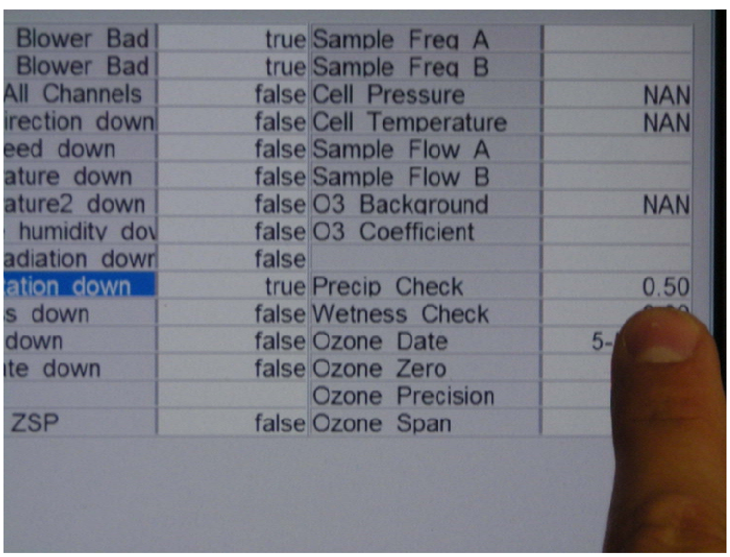
6.1.6 Reset the Precip Check value by toggling the precip_down value from false back to true. Then, quickly flip the calibration funnel over the precipitation bucket funnel and allow water to begin to drip, Figure 7. As the tipping bucket rocker arm assembly rotates, count the intervals in seconds. Each interval should be approximately 9-12 seconds with a 1second difference between each side. For instance, one side tips at 11 seconds, the other side should tip between 10 and 12 seconds. Allow the calibration funnel to dispense the 231.5-ml of water.

Figure 7. Flip calibration funnel on top of tipping bucket lid and allow all water to dispense



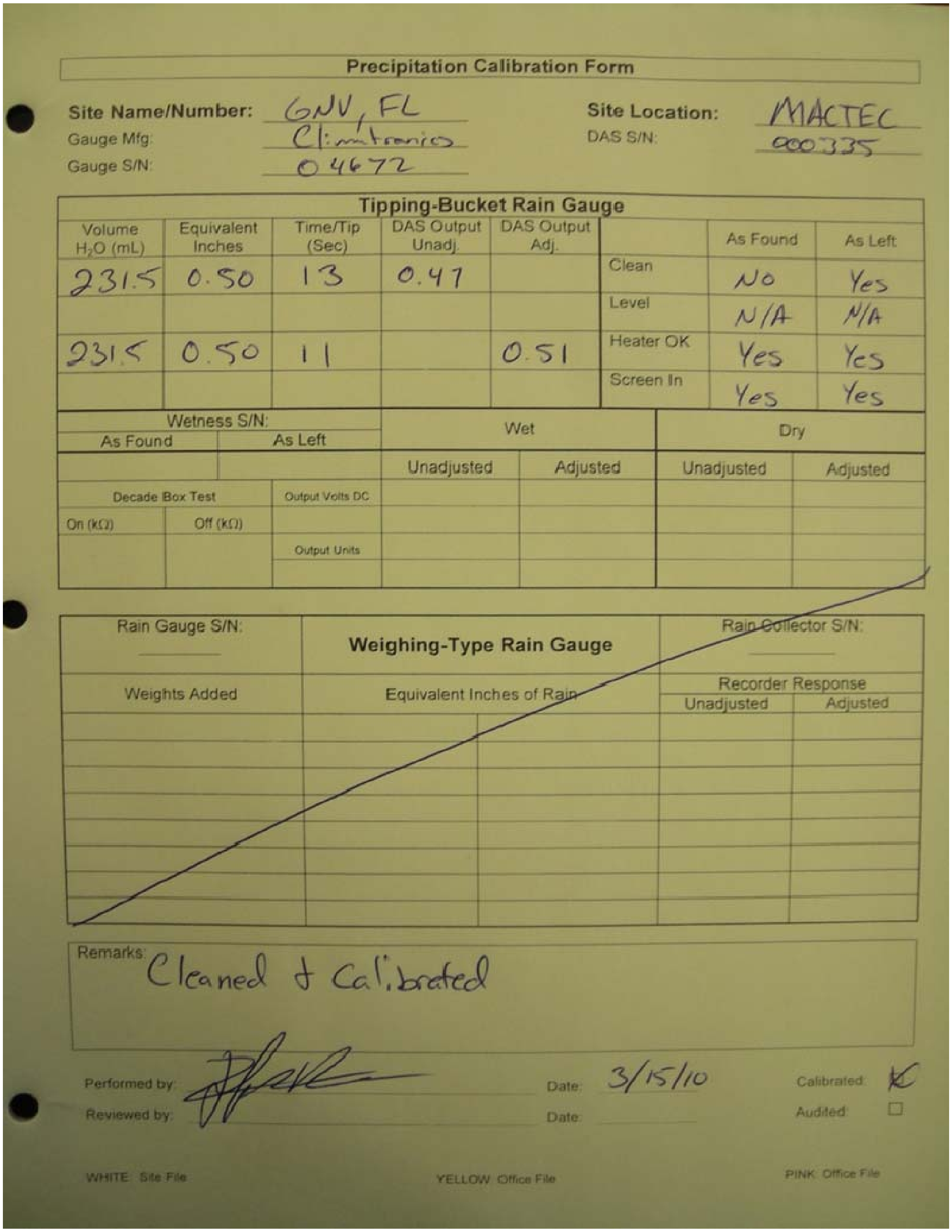
6.1.7 When the water is dispensed, record the value to the right of the Precip Check label, Figure 8.

Figure 8. After dispensing is complete, locate "Precip_Check" on PC200 screen



6.1.8 A total of 0.50 ± 0.02, should be achieved, record on Precipitation Cal Form, Figure 9.

Figure 9. Record "Precip_Check" findings on precipitation calibration form



Precipitation Calibration Form

Site Name/Number: GNV, FL
Gauge Mfg: Climatronics
Gauge S/N: 04672
Site Location: MACTEC
DAS S/N: 000335

Tipping-Bucket Rain Gauge

Volume H_2O (mL)	Equivalent Inches	Time/Tip (Sec)	DAS Output Unadj.	DAS Output Adj.		As Found	As Left
231.5	0.50	13	0.47		Clean	No	Yes
					Level	N/A	N/A
231.5	0.50	11		0.51	Heater OK	Yes	Yes
					Screen In	Yes	Yes

Wetness S/N: As Found	As Left	Wet Unadjusted	Wet Adjusted	Dry Unadjusted	Dry Adjusted
Decade Box Test On (kΩ)	Off (kΩ)	Output Volts DC / Output Units			

Weighing-Type Rain Gauge

Rain Gauge S/N: | Rain Collector S/N:

Weights Added	Equivalent Inches of Rain		Recorder Response Unadjusted	Recorder Response Adjusted

Remarks: Cleaned & Calibrated

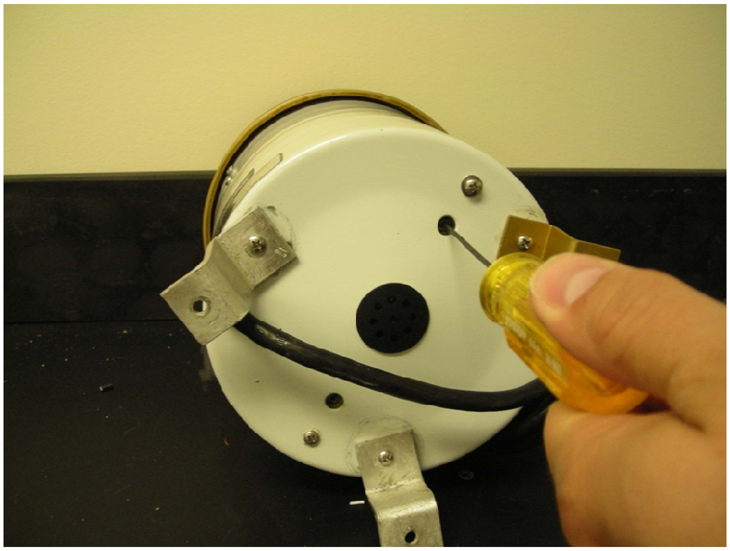
Performed by: [signature] Date: 3/15/10 Calibrated: ☒
Reviewed by: Date: Audited: ☐

WHITE: Site File YELLOW: Office File PINK: Office File

***Note**: Do not perform these next steps during a post calibration procedure.*

6.1.9 For averages totaling more than 0.52, a counter-clockwise adjustment of the rocker arm stops must be made. Rotate the screws counter-clockwise to correct, Figure 10. One turn of both screws (360^o) will equal 2 tips (Each screw will affect the adjustment 1 tip). Both screws should be adjusted by the same amount of turns.

Figure 10. If needed, adjust screws on bottom of bucket to increase or decrease tips



6.1.10 For averages totaling less than 0.48, a clock-wise adjustment must be made. A clockwise rotation of either rocker arm stop of 360° equals 1 tip.

6.1.11 Repeat steps 4 through 11; when 0.50 ± 0.02 is achieved, the unit is calibrated.

6.1.12 If calibration, document results, all repair, and maintenance actions on calibration form. Attach two copies of the calibration form to the sensor and place it on the "Ready to Ship" shelf. Place a third calibration form copy in the sensor file.

6.1.13 If post-calibration, document results on calibration form and place calibration form in sensor file and deliver copy to data validation group. Then perform repair, maintenance and calibration of sensor.

6.2 Maintenance

6.2.1 Clean the internal bucket area by removing the tipping bucket mechanism with the two screws on the bottom of the bucket. With a firm brush and/or water, clean the inside of the bucket to remove dirt build-up and evidence of insects. (Spiders can stop the rocker arm from its rotation.)

6.2.2 Ensure the summer screen is not clogged; clean if needed with a firm brush and/or water.

6.2.3 Clean the funnel and ensure that the lower opening is not clogged.

6.2.4 Inspect the feet of the bucket to ensure they will provide a proper platform when installed at a site.

6.2.5 Check the bull's eye level to ensure that it has not frozen and cracked the site glass. Replace if necessary.

6.2.6 Check the proximity switch for +5 VDC by connecting the signal wires from the datalogger to the terminal strip located on top of the tipping mechanism. With a multimeter, test that +5 VDC is being sent through the switch.

6.2.7 Inspect the power cord for any frays, cuts or other abrasions that could potentially be a hazard. If any such defect exists, replace the cord.

6.2.8 Check the 120-volt (V) thermostat with freeze spray to activate the heat wrap.

6.3 Repair

6.3.1 If 5 volts direct current (VDC) is not registered at the reed switch, the CR3000 status terminals **P2 and Ground** should be checked to verify if 5 VDC is being sent. If the 5 VDC is present at the CR3000, a voltage break has occurred and should be traced line by line to the destination until the break or bad spot is found.

6.3.2 To replace the tipping mechanism, remove the screws on the bottom of the bucket that secure the old mechanism and replace with a new one (tipping mechanisms come preassembled).

6.3.3 To replace the proximity switch see the manufacturer's manual (included with every installation kit, Attachments A and B).

6.3.4 Replace the power cord with a new one without any splices. Strip the jacket of the power cord back approximately 3 inches. Strip a quarter inch off each of the three inner wires. Crimp a spade connector onto the ground wire, green and yellow. Crimp a blue (16-14 gauge) male bullet connector onto the brown power wire and crimp a female blue bullet connector onto the blue power wire. Refer to attachment C for proper electrical connections.

6.3.5 Remove old thermostat from side of bucket wall. Strip the ends of the new thermostat back a quarter inch. Crimp a blue female bullet connector to one of the thermostat wires and crimp a blue male bullet connector to the other. Refer to attachment C for proper electrical connections.

6.3.6 Remove old heater jacket from funnel. Using a sharp knife or other tool, remove as much of the heat resistant sealant as possible from the funnel surface. Strip a quarter inch of the ends of the wires from the new heater jacket. Place a red (22-18 gauge) female bullet connector on one of the wires and place a red male bullet connector on the other wire. Using heat resistant silicon sealant, coat the back of the heater jacket in a zigzag pattern to ensure even coverage. Wrap heater jacket around funnel and hold in place until sealant begins to dry and jacket starts to adhere to funnel surface. Refer to attachment C for proper electrical connections.

6.3.7 Replace the feet when they become too loose to act as a steady base. If feet are riveted into the bucket, use a drill to punch out the rivets. Replace feet with a #6 nut and screw to attach feet back to bucket.

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*. 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS).* 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications.* EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems*, Vol. I, Principles. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods*. EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements.* EPA-600/4-82-060.

8.0 ATTACHMENTS

Attachment A – Model 525 Switch Conversion

Attachment B – Model 525 Switch Conversion Diagram

Attachment C – Electrical connections for tipping bucket

ATTACHMENT A
Model 525 Switch Conversion

MODEL 525 SWITCH CONVERSION

To Convert From The S1-112 Switch

To The S1-128 Hermetically Enclosed Reed Switch

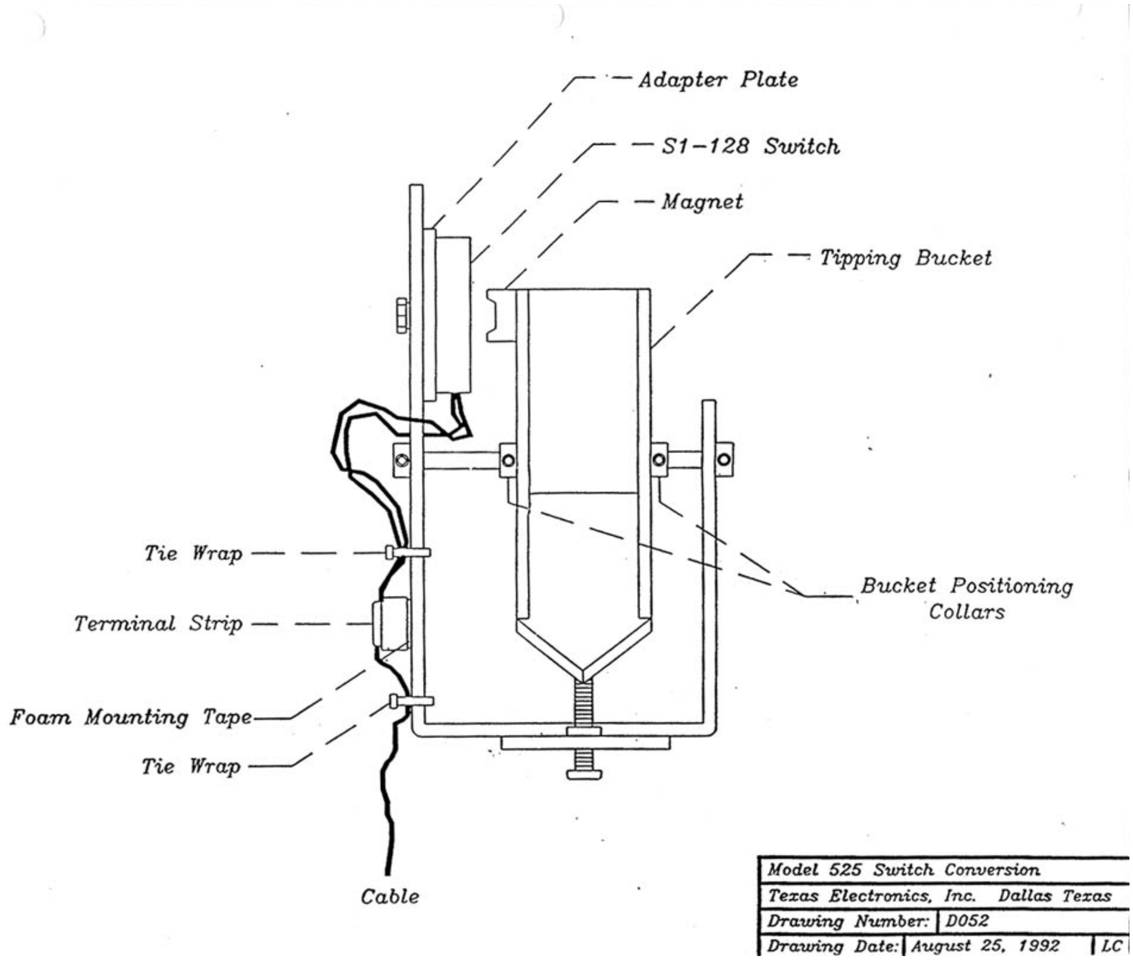
Kit Contents:

1 Each S1-128 Switch, with adapter plate installed.
1 Each TS-101 Barrier Strip.
2 Each No. 2 Spade Lugs.
2 Each Cable Ties
Mounting Tape

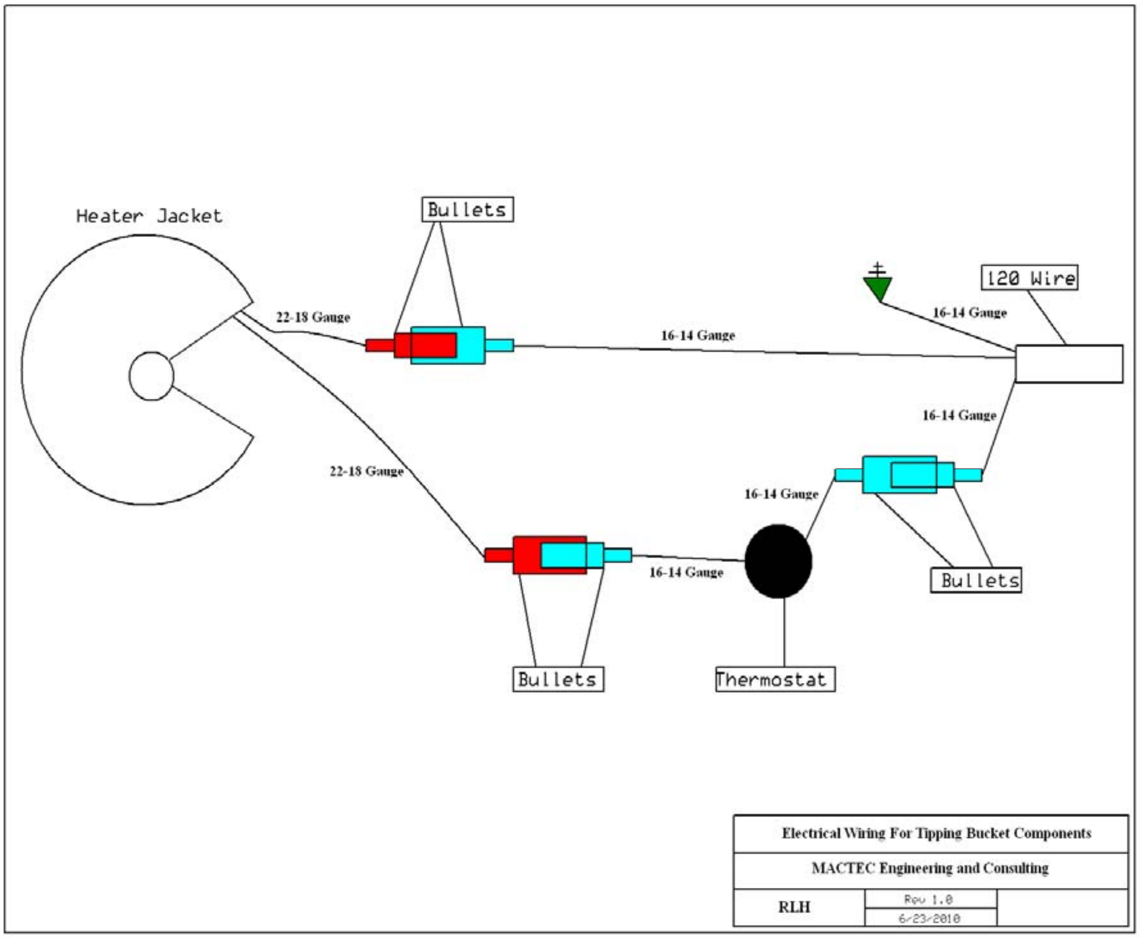
Instructions:

1. Remove the two 6-32 mounting screws that hold tipping bucket assembly inside the main housing.
2. Lift assembly out of housing.
3. Remove old switch and cut cable at the switch.
4. Mount new switch (S1-128) in same mounting hole as old one.
5. Install two spade lugs supplied on end of old cable.
6. Attach switch wires and cable to terminal strip.
7. With mounting tape and cable ties, attach barrier strip to outside of main bracket as shown.
8. Re-position switch and magnet by loosening set screws in the two collars on either side of tipping bucket. Set the gap between switch and magnet to approximately 3/16". Leave at least 20-25 thousandths play between collars and tipping bucket.
9. To check: Connect ohmmeter to end of cable and manually tip bucket back and forth. Make sure switch closes when in the top center position and opens when in the down position on both sides. If it does not, adjust accordingly.
10. Re-install assembly in housing and check calibration, if necessary.

ATTACHMENT B
Model 525 Switch Conversion Diagram



ATTACHMENT C
Electrical connections for tipping bucket



IV. CALIBRATION LABORATORY
C. SITE INSTRUMENTATION
6. CLIMATRONICS
a. WIND DIRECTION

Effective Date: 10/30/14

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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Reviewed by:	Title:	Date:	Signature:
MS	QA/Mgr	11/2/15	[signature]

IV. C. 6. a. WIND DIRECTION

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance for maintenance, handling, and calibration of the Climatronics F-460 wind direction sensor to Clean Air Status and Trends Network (CASTNet) Field Equipment Calibration Laboratory personnel.

2.0 SCOPE

This SOP applies to the maintenance, handling, and calibration of Climatronics F-460 wind direction sensor units administered by the CASTNet Field Equipment Calibration Laboratory.

3.0 SUMMARY

Climatronics F-460 wind direction sensors are calibrated upon receipt from the manufacturer and at the request of field technicians. Repairs and maintenance are performed as necessary.

4.0 MATERIALS AND SUPPLIES

Climatronics F460 wind direction sensor
Multimeter
Data logger
Soldering tool
Solder/flux
Insulated screwdriver
Allen wrench set
Vacuum grease
Wire cutters
24 and 22 gauge wire

5.0 REPAIR AND MAINTENANCE

5.1 Repair

5.1.1 Check the potentiometer using a Fluke multimeter by testing the resistance between pin #1 and pin #3. The resistance should be approximately 10K ohms.

5.1.2 Test the resistor and fuse with the multimeter. The resistor should be approximately 2.34K ohms, and the fuse should be approximately 0 ohms.

5.1.3 Replace the potentiometer, resistor, and fuse if necessary. Refer to the maintenance section for the potentiometer replacement procedures.

5.2 Maintenance

5.2.1 Remove the sensor cover by pulling it toward the base with a slight twisting motion.

5.2.2 Loosen the setscrews in the potentiometer coupling with a 1/16 Allen key.

5.2.3 Remove the shaft that connects the potentiometer to the cap through the top of the sensor column.

5.2.4 Remove the old bearing from the shaft and discard it.

5.2.5 Remove the two screws that secure the sensor support from the upper (column) portion of the sensor.

5.2.6 De-solder the wires from the potentiometer, and (if fuse needs replacement) de-solder the fuse from the sensor base.

5.2.7 Loosen the three retaining clamps that secure the potentiometer. Remove and discard the potentiometer and fuse.

5.2.8 Install a new potentiometer by reversing the above steps. Solder the common (white and black wire) to pin #1, the resistor to pin #2, and a new fuse to pin #3 as well as the sensor base.

5.2.9 Place the new bearing on the shaft and guide the shaft back into its hole from the top until the bearing is seated.

5.2.10 Tighten the coupling set screws.

5.2.11 Inspect and replace any set screws, fastening screws or o-rings that show signs of fatigue.

5.2.12 Lubricate the o-rings with vacuum grease.

5.2.13 Install the sensor cover and cap if they were removed. Do not tighten the cap set screws until after the calibration procedure.

6.0 CALIBRATION PROCEDURE

6.1.1 Use the test data logger for values.

6.1.2 Place the sensor on the test stand pedestal with a clamp on the top of the shaft. The cap on the top of the sensor, held by two small hex screws, should be loose.

6.1.3 Set the wind direction wheel on top so that the half circle on the bottom of the wheel fits on the other half circle on the sensor’s top.

6.1.4 Turn the wheel to **270°**. Rotate the shaft with pliers until the degrees read 270.

6.1.5 Tighten the set screws on the cap (top of the sensor). Record this value.

6.1.6 Turn the wheel counter-clockwise to **180°**. Record this value.

6.1.7 Turn wheel counter-clockwise to **90°** (this setting is East 1). Record this value.

6.1.8 Turn wheel counter-clockwise to **0°** (North). Record this value.

6.1.9 Turn wheel clockwise back to **90°** (this setting is East 2). Record this value.

6.1.10 The readings must agree with the wheel to within ± 3° at all points. If not, replace the potentiometer (see maintenance section).

6.1.11 Remove the sensor from the test stand.

6.1.12 Attach the calibration form to the sensor and place them on the "Ready to Ship" shelf.

7.0 REFERENCES

Climatronics Corporation. *Climatronics F460 Ten Meter Meteorological Monitoring System Manual*

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring. 40* CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS).* 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods*. EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements.* EPA-600/4-82-060.

IV. CALIBRATION LABORATORY
C SITE INSTRUMENTATION
6. CLIMATRONICS
b. WIND SPEED

Effective Date: 10/30/14

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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Reviewed by:	Title:	Date:	Signature:
MS	QA Mgr	11/2/15	[signature]

IV. C. 6. b. WIND SPEED

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance for maintenance, handling, and calibration of the Climatronics F-460 wind speed sensor to Clean Air Status and Trends Network (CASTNET) Field Equipment Calibration Laboratory personnel.

2.0 SCOPE

This SOP applies to the calibration, maintenance, and handling and calibration of Climatronics F-460 wind speed sensor units administered by the CASTNET Field Equipment Calibration Laboratory.

3.0 SUMMARY

Climatronics F-460 Wind Speed Sensors are calibrated upon receipt from the manufacturer and at the request of field technicians. Repairs and maintenance are performed as necessary.

4.0 MATERIALS AND SUPPLIES

Climatronics F-460 wind speed sensor
Climatronics power supply
Digital multimeter
Factory certified synchronous motor
Data logger
Screwdriver
Vacuum grease
Thread-locking compound
Soldering tool
Solder/flux
Wire cutters
24 and 22 gauge wire
Spare screws and o-rings

5.0 REPAIR AND MAINTENANCE

5.1 Repair

5.1.1 Set a multimeter to read hertz (Hz), connect the red lead to P1 and the black lead to the logger ground where the green/yellow wire is connected.

5.1.2 Set the sensor on the test fixture with the sensor cover removed.

5.1.3 Install the synchronous motor and turn at 2100 rpm.

5.1.4 Adjust the potentiometer on the sensor circuit board until the multimeter reads 1050Hz

5.1.5 If this cannot be accomplished replace the sensor circuit board.

5.2 Maintenance

5.2.1 Remove the sensor cap and the sensor cover.

5.2.2 Remove the two screws that secure the circuit board to the sensor.

5.2.3 Remove the top two Phillips head screws from the sensor support. This will allow the sensor to be separated into two portions.

5.2.4 Remove the retainer clip, spacer(s), and bearing from the tip of the shaft.

5.2.5 Remove the shaft assembly from the upper portion of the sensor from the chopper wheel end of the shaft.

5.2.6 Replace the lower shaft bearing and reinstall the shaft assembly into the sensor.

5.2.7 Reinstall the circuit board and internal support (use service removable, thread-locking compound on the support screws).

5.2.8 Replace the upper bearing, spacer(s), and retainer clip.

5.2.9 Reinstall the sensor cap and secure the setscrews.

5.2.10 Inspect and replace any setscrews, fastening screws, and o-rings that show signs of fatigue.

5.2.11 Lubricate the o-rings with vacuum grease.

5.2.12 Replace the sensor cover.

6.0 CALIBRATION PROCEDURE

6.1 Use the test station Data Acquisition System (DAS)/data logger.

6.2 Mount the wind speed sensor on the test stand without the shaft holder on top, using the set screws at the bottom of the sensor to ensure a secure mount.

6.3 Slip the synchronous motor holder over the sensor, and then attach the synchronous motor to the holder and sensor. Use the slow speed motor for the 100 rotations per minute (rpm) range.

6.3.1 Using a multimeter, attach the red lead to P1 and the black lead to the logger ground where the green/yellow wire is connected.

6.3.2 Set the voltmeter to hertz (Hz).

6.4 Turn on the motor and set to 100 rpm. Allow the speed (m/s) to become steady (frequencies will jump around). Average the low and high frequency reading, and then record this value on the Wind Calibration form (Figure 8 at end of Section III).

6.5 Record the speed in (m/s) on the Wind Calibration form.

6.6 Remove slow speed synchronous motor and install standard synchronous motor.

6.7 Repeat above steps for 200, 300, 400, 800, and 1800 rpm.

6.8 At slower rpm (up to 200 rpm), output values must be within 0.2 m/s of the equivalent wind speed. At wind speed test points above 5 m/s, the sensor accuracy must be better than ±3%.

6.9 After calibration, attach the Wind Calibration form to the sensor, and place it on the “Ready to Ship” shelf.

7.0 REFERENCES

Climatronics Corporation. *Climatronics F460 Ten Meter Meteorological Monitoring System Manual*

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*. 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)*. 40 CFR 58, Appendix A.

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U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems,* Vol. I, Principles. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods*. EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements.* EPA-600/4-82-060.

IV. CALIBRATION LABORATORY
C. SITE INSTRUMENTATION
6. CLIMATRONICS
c. TEMPERATURE/DELTA TEMPERATURE

Effective Date: 11-10-11

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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MS	QA Mgr	10/30/14	[signature]
MS	QA Mgr	11/2/15	[signature]

IV. C. 6. c. TEMPERATURE/ DELTA TEMPERATURE

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance for calibration, maintenance, and handling of the Climatronics temperature/delta temperature sensors to Clean Air Status and Trends Network (CASTNET) Field Equipment Calibration Laboratory personnel.

2.0 SCOPE

This SOP applies to the calibration, maintenance, and handling of Climatronics temperature/delta temperature sensors units administered by the CASTNET Field Equipment Calibration Laboratory.

3.0 SUMMARY

Temperature sensors utilized at Climatronics sites are blank R.M. Young RTD probes modified for use at Climatronics sites. The modification consists of the addition of a Bulgin water-tight connector applied directly to the probe leads. These probes are modified and calibrated upon receipt. Once deployed, they are calibrated at the request of field technicians. Repairs and maintenance are performed as necessary.

4.0 MATERIALS AND SUPPLIES

R.M. Young RTD Temperature probe Configured for Climatronics Site
Multimeter
Data logger
Certified NIST traceable Dostmann Precision Digital Thermometer with Probe
Magnetic stir plate
Magnetic stirrer
Device to heat water > 50.0 C˚
Water
Ice
Insulated vessel large enough to accommodate temperature probes, with fitted lid
Small screwdriver
Temperature iForm

5.0 REPAIR AND MAINTENANCE

Using a certified DVM check the sensor resistance. Each probe should read between 998.5 and 1001.5 ohms. If within the specified resistance range the probe will calibrate properly. If not the probe may not calibrate properly in which case return probe to the manufacturer for repair or replacement. Clean probe and probe body.

6.0 CALIBRATION/CERTIFICATION

6.1 Connect the sensors to the CR3000 calibration station.

6.2 Crush ice and make ice water bath in large cooler cup. Insert magnetic stirrer to bottom of the cup and place the cup on the stirring device. Turn the stirring device to setting 3 or 4 making sure the magnetic stirrer is in the center of the cup. Place the Styrofoam lid with holes for thermometer and probes on the cup. Insert the Temperature Primary Dostmann Electronic Precision Digital Thermometer (PDT) probe into center hole of the lid with the black ring at water level. Insert the probes to the same depth.

6.3 Allow the temperature to stabilize. Record the temperature in engineering units as output by the DAS in one of the columns of the “Temperature Data Logger Output” columns of the AS LEFT section of the temperature iForm. Record the Primary PDT output as displayed on its LCD in the iForm in the RTD column of the AS LEFT section of the iForm.

6.4 Make another bath without ice using aliquots of hot and cold water to adjust the temperature. Use magnetic stirrer as above and insert probes. Insert the Primary PDT. Record data on iForm as above.

6.5 Repeat the calibration procedure above using water baths at the following temperatures:

6.6 ~10° C

6.7 ~20° C

6.8 ~30° C

6.9 ~40° C

6.10 ~50° C

6.11 Inspect the iForm for computed rho and alpha values for the probe(s). The Temperature iForm will flag these values if not within specification. If the probes meet specification continue.

6.12 Print two copies of the Temperature iForm for each probe. Place the probe in a sealing bag with one certification form and place on the ready to ship shelf.

6.13 File the remaining iForm copy in the instrument file by Property I.D. number.

7.0 REFERENCES

R.M. Young Company. *Model 41342/41372 Temperature Probe Manual*

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring.* 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS).* 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods.* EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements*. EPA-600/4-82-060.

8.0 FIGURES

Figure 1: Temperature/Relative Humidity Data Form

MACTEC

Temperature

Site Name	Calibrator	Calibration Date	Data Logger	iForms Ver.
MACTEC099	RSM	11/30/2009	Campbell 3000 ID:489 - Campbell 3000 ID:489	1.1.0.0

	10 Meter (T1)		2 Meter (T2)	
	As Found	As Left	As Found	As Left
ID #		07334		
Description		RTD		
Manufacturer		R.M. Young		
Model		43347		
Ro		1000.08		
Alpha		0.00375		
Translator Type				

Transfer Standard					
ID #					
Manufacturer					
Model					
Date of Last Cert.					
Correction Factors					
0°	10°	20°	30°	40°	50°
0.00	0.00	0.00	0.00	0.00	0.00

As Found			Temperature Datalogger Output										
RTD (°C)			Temperature (10m) Output				Temperature 2 (2m) Output				Delta T.	Shelter Temperature	
Uncorrected Temp. (°C)	Correction Factor	Corrected Temp. (°C)	Raw Temp. (°C)	Corrected Temp. (°C)	Raw Diff (°C)	Corrected Diff (°C)	Raw Temp. (°C)	Corrected Temp. (°C)	Raw Diff (°C)	Corrected Diff (°C)	Diff (°C)	Temp. (°C)	Diff (°C)

As Left			Temperature Datalogger Output										
RTD (°C)			Temperature (10m) Output				Temperature 2 (2m) Output				Delta T.	Shelter Temperature	
Uncorrected Temp. (°C)	Correction Factor	Corrected Temp. (°C)	Raw Temp. (°C)	Corrected Temp. (°C)	Raw Diff (°C)	Corrected Diff (°C)	Raw Temp. (°C)	Corrected Temp. (°C)	Raw Diff (°C)	Corrected Diff (°C)	Diff (°C)	Temp. (°C)	Diff (°C)
0.00	0.00	0.00	0.02	0.00	0.02	0.00							
10.00	0.00	10.00	10.04	10.02	0.04	0.02							
20.00	0.00	20.00	20.11	20.09	0.11	0.09							
30.00	0.00	30.00	29.92	29.89	-0.08	-0.11							
40.00	0.00	40.00	40.14	40.11	0.14	0.11							
50.00	0.00	50.00	50.03	50.00	0.03	0.00							

Remarks

LAB CALIBRATION: Primary Standard: Dostmann Electronic P655 SN 65507072328, ID#06499, Probe Model 6000-1018, SN P100 080224. Annual Cerification 11/21/2008.

Reviewd By: ______________________ Date: ______________

IV. CALIBRATION LABORATORY
C. SITE INSTRUMENTATION
6. CLIMATRONICS
d. RELATIVE HUMIDITY

Effective Date: 11-10-11

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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MS	QA Mgr	11/2/15	[signature]

IV. C. 6. d. RELATIVE HUMIDITY

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance for calibration, maintenance, and handling of the Climatronics relative humidity (RH) sensors to Clean Air Status and Trends Network (CASTNET) Field Equipment Calibration Laboratory personnel.

2.0 SCOPE

This SOP applies to the calibration, maintenance, and handling of Climatronics RH sensor units administered by the CASTNET Field Equipment Calibration Laboratory.

3.0 SUMMARY

Climatronics RH sensors are calibrated upon receipt from the manufacturer and at the request of field technicians. Repairs and maintenance are performed as necessary.

4.0 MATERIALS AND SUPPLIES

Vaisala Model HMP50 UAB1A1A RH sensor equipped with Bulgin PX041/04S/4550 connector.
Data logger
Vaportron H100CL Precision Humidity Laboratory or Aqueous saturated salts
(***Note:*** *use salts only as a last resort*)
Insulated screwdriver
Soldering tool
Solder/flux
Small flashlight
Plastic storage bag
Indicating silica gel – spherical, mesh grade 48
Kimwipes®
Wire cutters
Sonic cleaner
Deionized (DI) water
Alcohol

5.0 REPAIR AND MAINTENANCE

5.1 Repair

Inoperative sensors are returned to the manufacturer for repair or replacement. Upon receipt the sensors are calibrated using the procedure described in Section 6.0.

5.2 Maintenance

5.2.1 Clean the removable filter in the sonic cleaner with DI water.

5.2.2 Clean the sensor if necessary with DI water or alcohol.

5.2.3 Cut and trim the sensor wires as necessary.

5.2.4 Replace damaged or suspect inline cable connector. See Figure 4, item 7/K for wiring pin-out.

6.0 CALIBRATION/CERTIFICATION PROCEDURE

6.1 Vaportron H100CL Series Precision Humidity Laboratory

6.1.1 Check the desiccant cartridge located on back of the unit; the indicating silica gel must be a blue color above the red line on the cartridge. If the indicating silica gel is pink at or below the red line on the cartridge please refer to the Vaportron maintenance SOP IV.A.5. for instructions on ***changing indicating silica gel***.

6.1.2 Check the water level by lifting up on cap end of cartridge and looking into the large window near the left desiccant hanger hook. Use a small flashlight to locate the water level. The water level must be between the lower and upper red lines on the fill level decal. If the water level is not between the lines, refer to the Vaportron maintenance SOP for instructions on ***water level service procedure*** *[see attached photos (Fig. 1A and 1B)]*.

6.1.3 Turn the **POWER** on (lower left). The **RH LCD** (center top) and **TEMPERATURE** displays should come on and read the approximate room conditions.

6.1.4 Set the **TEMPERATURE** display using the up or down arrows to **22.5** degrees Celsius (°C).

6.1.5 Set the **RH LCD** display using the up or down arrows to the first test point of **10.0%** RH.

6.1.6 Obtain a **Temperature/RH Data** form and record the serial numbers of the sensor.

6.1.7 Install the sensor into the appropriate port on the Vaportron. **Lightly** tighten the port fitting to hold the port plug securely in door.

6.1.8 Attach the inline connector on the RH Probe to the inline connector on the calibration bench.

6.1.9 Turn the **CONTROL** switch on. A faint, high-pitched sound will indicate the proper operation of the air circulator fan inside the chamber. The Vaportron displays should begin to ramp toward the values that were set. Normally, the RH and temperature readings will stabilize within 2 to 5 minutes.

6.1.10 Let the RH sensor equilibrate for one hour at the set point and then record the output from the Vaportron RH controller and the DAS system on the calibration form.

6.1.11 Set the **RH LCD** display using the up arrow to the next point of **30.0**% RH and repeat step 12.

6.1.12 Repeat step 12 for set point of **50.0**%, **70.0**%, **85%**, **95%**.

6.1.13 After completion of the final point, loosen the aluminum port fitting on the door and remove the Climatronics sensor from the chamber. Install the yellow port plug and set the **RH LCD** display using the down arrow to **50.0**% RH. Let the unit run for 5 minutes at this setting.

6.1.14 Turn the **CONTROL** switch off, and then turn the **POWER** off (lower left).

6.1.15 Check that the calibration form is completed (see the Vaportron sample form, Figure 2). Have the Calibration Laboratory Manager review and sign the calibration form. After review, place the form, sensor and translator in a plastic bag and put them in the appropriate box on the "ready to ship" shelf.

6.2 Aqueous Saturated Salts [NOTE: Use only as a last resort.]

Note: *Take care not to contaminate the probe or the sensor support cap with salt solution. If this happens, see Section 5.1, Repair.*

6.2.1 Obtain a Temperature/RH Data form and record the serial numbers of the translator and sensor. (Note: The translator and sensor are a matched system and must be kept together.)

6.2.2 Install the RH translator in the slot marked RH in the Climatronics test mainframe and plug the RH sensor into the corresponding test cable.

6.2.3 Turn the Climatronics test mainframe power supply on using the power switch.

6.2.4 Check the data acquisition system (DAS) for an output from the sensor with translator card switch in the OPER position.

6.2.5 Turn translator card switch to the ZERO position and check DAS system for an output of 0.000 volts direct current (VDC). Adjust the zero potentiometer to achieve 0.000 VDC, if needed.

6.2.6 Turn the translator card switch to the SPAN position. Check the DAS for an output of 1.000 VDC. Adjust the span potentiometer to achieve 1.000 VDC, if needed.

6.2.7 Return the translator card switch to the OPER position.

6.2.8 Using a Climatronics sensor support cap, insert the Climatronics RH sensor 1 inch into the rubber grommet.

6.2.9 Starting with $MgCl_2$ (32.8%) salt solution, lightly swirl the solution of DI water and salt. Screw the Climatronics sensor support cap and sensor onto the bottle. Place bottle/sensor in the blue bottle caddy.

6.2.10 Let the Climatronics RH sensor equilibrate for 2 hours at the set point, then record the output from the DAS system on the proper calibration form.

6.2.11 Repeat steps 9 and 10 for salt solutions of: Mg $(NO_3)_2$ (52.9%), NaCl (75.3%), and KNO_3 (93.6%).

6.2.12 After completion of the final point, remove the RH sensor from the Climatronics sensor support cap, wipe the sensor with a clean Kimwipe® and install a clean filter.

6.2.13 Check that the calibration form is completed (see sample form, Figure 3). And have the Calibration Laboratory Manager review and sign the form. After review, place the form, sensor, and translator in a plastic bag and put them in the appropriate box on ”the ready to ship” shelf.

6.3 Six week certification update procedure

6.3.1 Perform calibration steps 6.1 through 6.1.10. Record **Vaportron H100CL** and Vaisala RH Probe response to target set-points of 10%, 50% and 90%.

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*. 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS).* 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1997. *National 8-Hour Primary and Secondary Ambient Air Quality Standards for Ozone*. 40 CFR 50, Appendix I.

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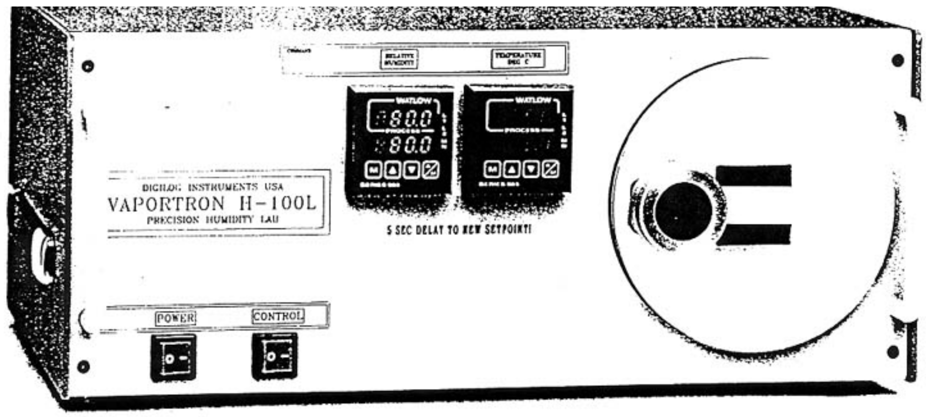
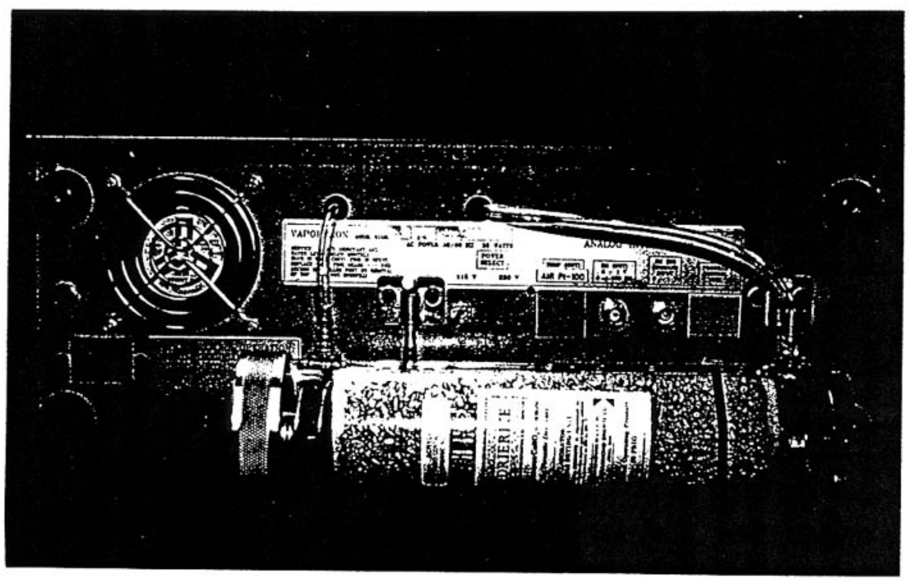
Climatronics Corporation. *Climatronics F460 Ten Meter Meteorological Monitoring System Manual*

8.0 FIGURES

Figure 1A. Vaportron H-100CL

Vaportron H-100CL Front Panel





REAR PANEL WITH DESICCANT CARTRIDGE CORRECTLY INSTALLED

Figure 1B. Water Gauge Window Location

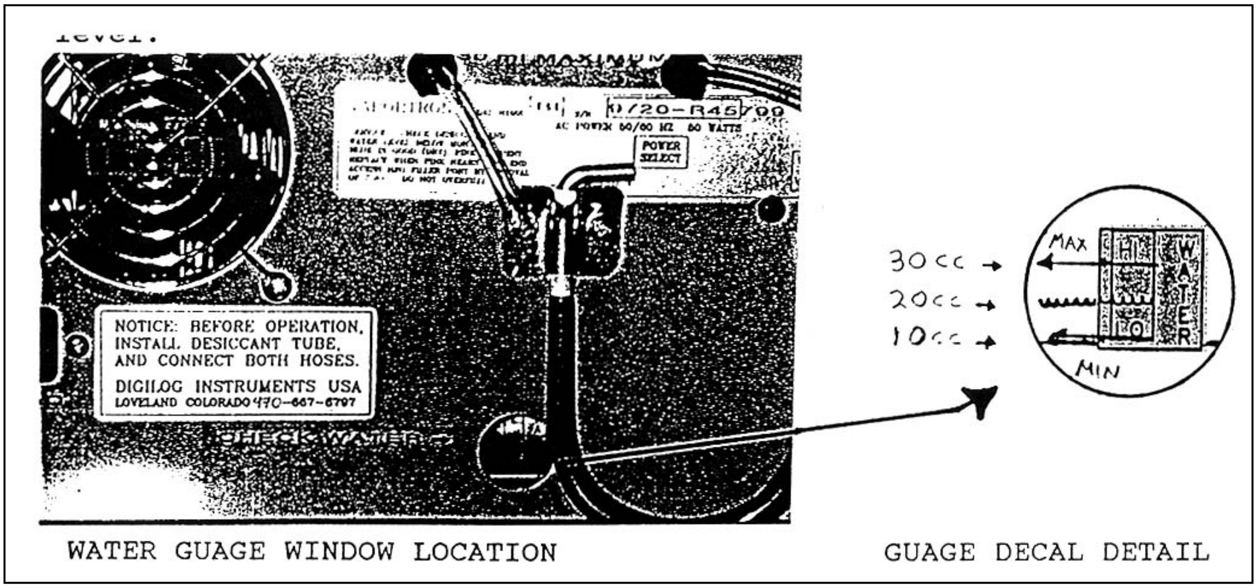


Figure 2. Relative Humidity Sample Form for Vaportron

QST ENVIRONMENTAL — TEMPERATURE/RELATIVE HUMIDITY DATA FORM

Site Name/Number: QST / Test Site Location: Gainesville, FL

DSM 3260 S/N: Air # 00220 DSM 3260L S/N:

TEMPERATURE 10-m Sensor S/N: Translator S/N:
2-m Sensor S/N:

RTD S/N: Temp. Zero: ΔTemp. Zero: Temp. Span: ΔTemp. Span:

THERMOMETER READING (°C) Uncorrected	Corrected	DAS TEMPERATURE OUTPUT 3260 Voltage	3260L Voltage	Temp. (°C)	DAS ΔTEMPERATURE OUTPUT 3260 Voltage	3260L Voltage	Temp. (°C)
			N/A				

RELATIVE HUMIDITY Sensor S/N: NDDN # 00001 Translator S/N: NDDN # 00002
Transfer S/N: AIR # 00672 Climatronics Translator Zero/Span: 0.000 / 1.000

GTL	SALT	EQUIVALENT RELATIVE HUMIDITY Vaportron %	DAS 3260 Voltage	DAS OUTPUT 3260L Voltage	% Rel. Hum.
N/A	N/A	32.8%	0.329	N/A	32.9%
		52.9%	0.533		53.3%
		75.3%	0.751		75.1%
		93.6%	0.929		92.9%

Remarks: Temp. Setting 25.0°C
Set Time 1hr

Clean Switch

Performed by: [signature] Date: 3-30-99 Calibrated: ☐
Reviewed by: [signature] Date: 3-30-99 Audited: ☐

Figure 3. Sample Form for Salts

QST ENVIRONMENTAL — **TEMPERATURE/RELATIVE HUMIDITY DATA FORM**

Site Name/Number: QST - Test **Site Location:** Gainesville, FL

DSM 3260 S/N: NA **DSM 3260L S/N:** 01704

TEMPERATURE	10-m Sensor S/N: ______ Translator S/N: ______ 2-m Sensor S/N: ______
RTD S/N: ______	Temp. Zero: ______ ΔTemp. Zero: ______ Temp. Span: ______ ΔTemp. Span: ______

THERMOMETER READING (°C)		DAS TEMPERATURE OUTPUT			DAS ΔTEMPERATURE OUTPUT		
Uncorrected	Corrected	3260 Voltage	3260L Voltage	Temp. (°C)	3260 Voltage	3260L Voltage	Temp. (°C)
			NA				

RELATIVE HUMIDITY	Sensor S/N: 00123 Translator S/N: 00124 Transfer S/N: Air # 001662 Climatronics Translator Zero/Span: 0.000/1.000

GTL	SALT	EQUIVALENT RELATIVE HUMIDITY	DAS OUTPUT		
			3260 Voltage	3260L Voltage	% Rel. Hum.
NA	$MgCl_2$	32.8%	NA	0.401 ~~0.401~~	40.1%
↓	$Mg(NO_3)_2$	52.9%	↓	0.530	53.0%
	NaCl	75.3%		0.766	76.6%
	KNO_3	93.6%		0.942	94.2%

Remarks: Set Time 2 hrs

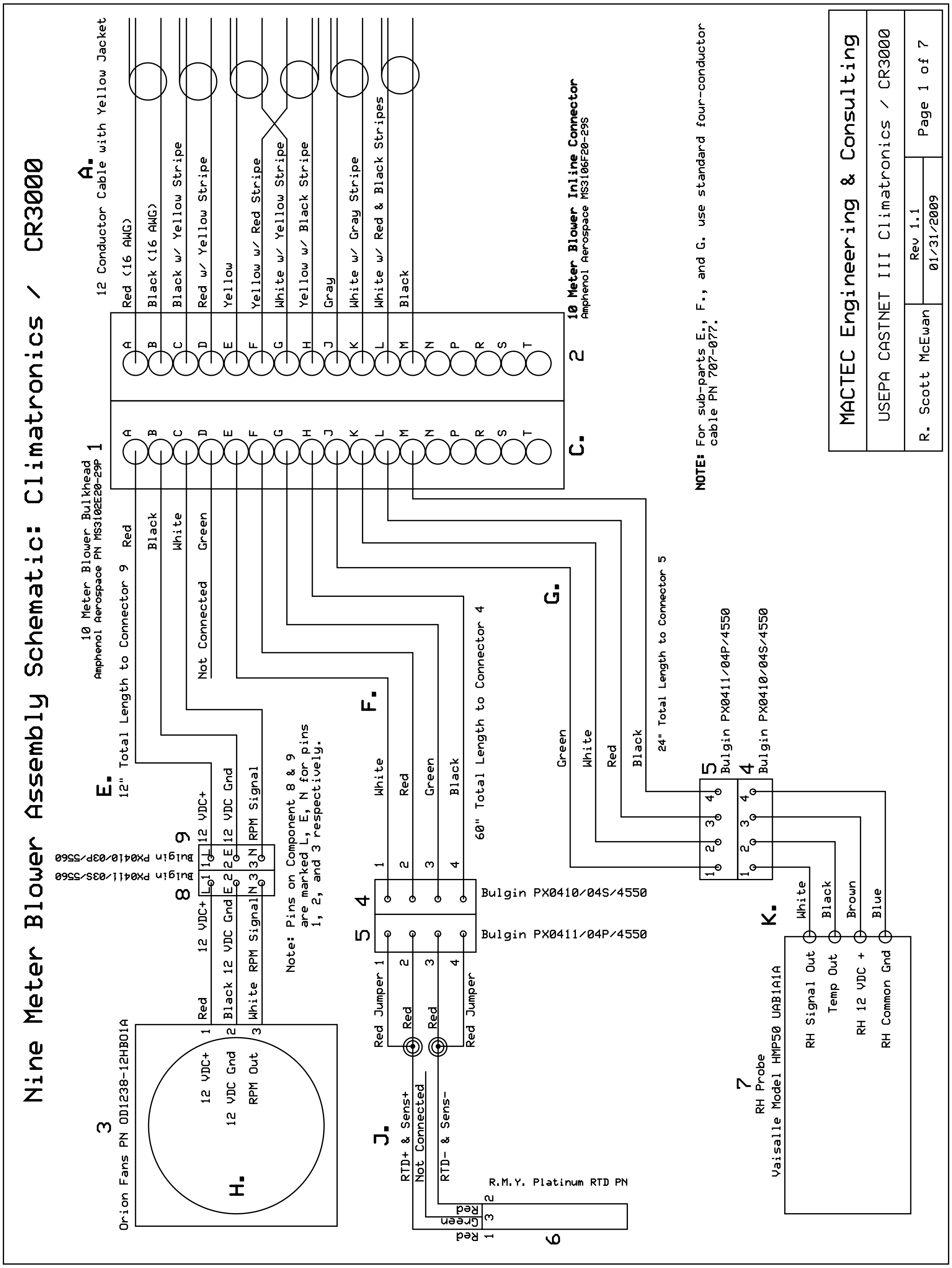
Cleaned switch on Translator

Performed by: [signature] Date: 4-1-99 Calibrated: ☒

Reviewed by: ______ Date: ______ Audited: ☐

WHITE: Site File YELLOW: QST PINK: EPA CI/93012 12/93

Figure 4. Climatronics 9 meter Met Wiring with Vaisala RH Probe Pinout



IV. CERTIFICATION LABORATORY
C. SITE INSTRUMENTATION
7. R.M. YOUNG
a. WIND DIRECTION

Effective Date: 10/30/14

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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IV. C. 7. A. R.M. YOUNG – WIND DIRECTION

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance for maintenance, handling, and calibration of the R.M. Young Wind Monitor Model AQ wind direction sensor (AQ) to Clean Air Status and Trends Network (CASTNET) Field Equipment Calibration Laboratory personnel.

2.0 SCOPE

This SOP applies to the maintenance, handling, and calibration of AQ wind direction sensor units administered by the CASTNET Field Equipment Calibration Laboratory.

3.0 SUMMARY

Wind direction sensors are calibrated upon receipt from the manufacturer and at the request of field technicians. Repairs and maintenance are performed as necessary.

4.0 MATERIALS AND SUPPLIES

Wind direction sensor
Wind direction calibration form
Multimeter
Data logger
Soldering tool
Solder/flux
Insulated screwdriver
Allen wrench set
Vacuum grease
Wire cutters
24 and 22 gauge wire

5.0 REPAIR AND MAINTENANCE

5.1 Remove potentiometer coupling on top of the AQ. Remove the thumbwheel.

5.2 Take the cover off the terminal housing. Unscrew the terminal bracket. For the new model, just remove the wires from the terminal.

5.3 Cut the wires close to the terminal, and then de-solder the wires from the terminal.

5.4 Remove the transducer from the shaft.

5.5 Remove the old bearings (two) and replace with new ones.

5.6 Unscrew the top of the transducer and push out the old potentiometer. Remove the shaft extender and discard the old potentiometer.

5.7 Put the shaft extender on the new potentiometer.

5.8 Using the modified ty-wrap (with the hole on the end) as a tool, pull the potentiometer wires through the bottom of the transducer housing. Screw the transducer and housing back together, coating the threads and bottom with silicon sealant where the wires come through the housing.

5.9 Insert the ty-wrap through the hole at the top of the terminal housing and pull the wires through, placing the transducer back on the top of the unit. Using the R.M. Young gauge, set the distance between the transducer and the housing to 0.5 mm. Tighten the set screws.

5.10 Set the distance between the thumbscrew and the transducer to 0.030 inch using a feeler gauge. Tighten the set screws.

5.11 Place the potentiometer coupling on top of the thumbscrew, but do not tighten (this will be done during calibration).

5.12 Solder the wires to the circuit card as shown on Figure 1.

5.13 Screw the circuit card back onto the terminal housing.

5.14 Replace the housing cover. The unit is now ready for calibration.

6.0 PROCEDURES

6.1 Installation/Setup

6.1.1 Loosen the potentiometer coupling on top of the wind unit.

6.1.2 Mount on the vane angle bench stand.

6.1.3 Set the vane, aligning the potentiometer coupling to the back. (Note: It will click when properly in place.)

6.1.4 Loosen the V-support and drop it down so it does not hamper the movement of the vane.

6.1.5 Torque test the AQ by setting the torque gauge on the top with the pivot point of the sensor and gauge aligned, and gently pull the string to one side and then to the other side. Apply enough force to move the vane. The gauge should not exceed 10 grams per centimeter (g/cm). Be sure that air currents in the room do not influence this procedure.

6.1.6 Raise the V-support to firmly hold the vane and tighten the thumbscrew.

6.2 Calibration

6.2.1 Use test data logger to view values.

6.2.2 Attach the RMY wind wires from test data logger to Wind AQ, as shown in Figure 1.

6.2.3 Turn the vane to 180° as indicated by the calibration disk. Reach inside the vane (where the nose cone would attach to the vane) and turn the potentiometer coupling thumbwheel until the degrees reads 180 on the data logger. Tighten the set screw on the potentiometer coupling. If the degree reading changes while doing this, remove the vane from the wind AQ; remove the potentiometer coupling; remove the thumbwheel; and revolve it slightly. Reset the thumbwheel with a 0.030-inch feeler gauge. Reset the potentiometer coupling (without tightening). Replace the vane and repeat the procedure to set the thumbwheel to 180 degrees on data logger at 180º.

6.2.4 Revolve the vane to 90º. Record the value from the data logger on the data form.

6.2.5 Swing the vane to 180º (south). Record the degrees as above.

6.2.6 Turn the vane to 270º (west). Record the degrees as above.

6.2.7 Turn the vane to 355º. Record the degrees as above.

6.2.8 Slowly revolve the vane toward 360° (north). When readings drop to near zero, this is the crossover point. Record the degrees.

6.2.9 The recorded output should not exceed ±2° of the desired values.

6.2.10 After completing the calibration, place the sensor, translator card, and calibration form into a plastic bag, and place the bag on the “Ready to Ship” shelf.

7.0 REFERENCES

Climatronics Corporation. *Climatronics F460 Ten Meter Meteorological Monitoring System Manual*

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*. 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS).* 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

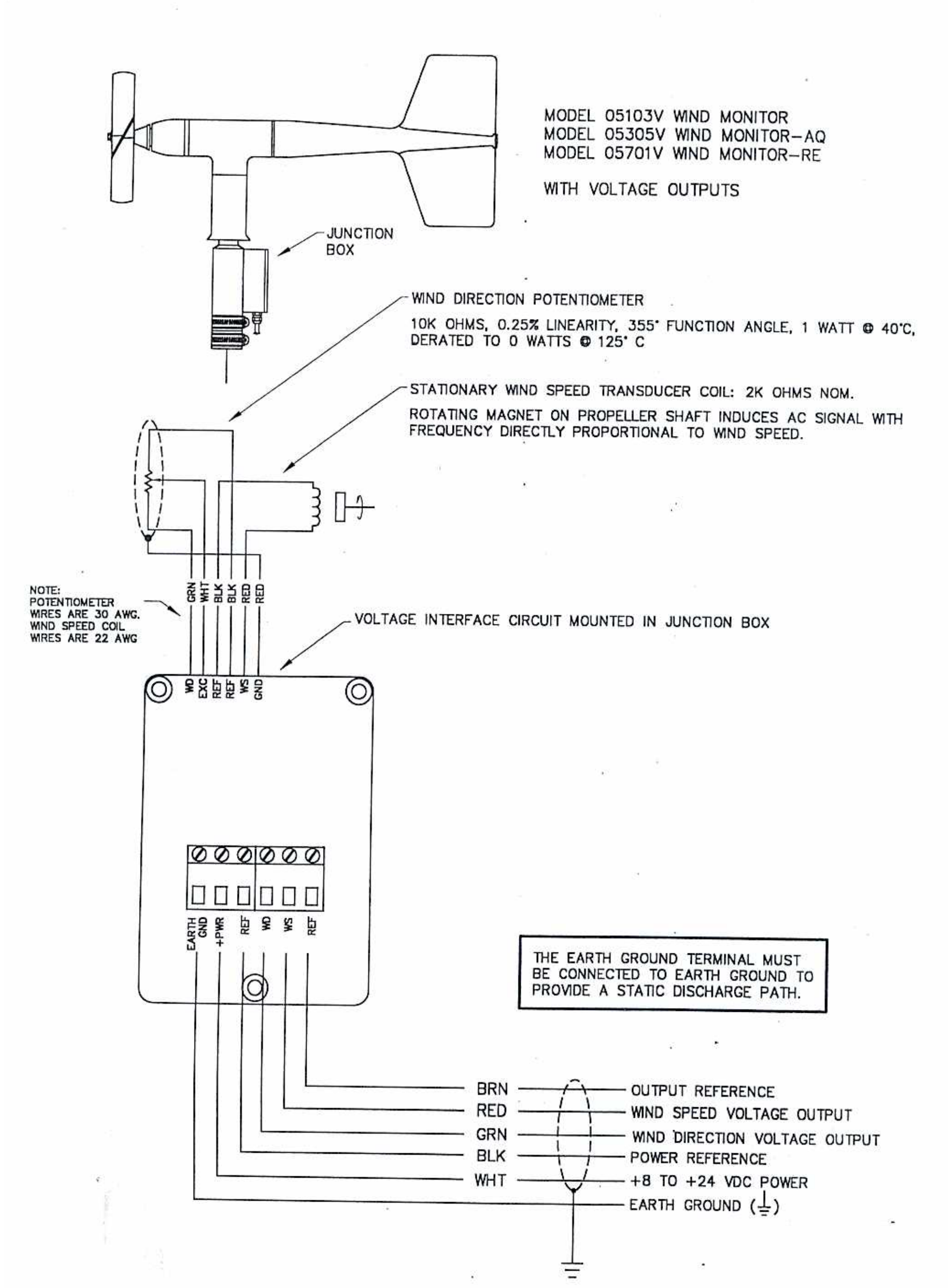
U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods.* EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements*. EPA-600/4-82-060.

8.0 FIGURES

Figure 1. R.M. Young Wind Monitor Cable and Wiring Diagram Model 05103V/05305V/05701V



IV. CERTIFICATION LABORATORY
C. SITE INSTRUMENTATION
7. R.M. YOUNG
b. WIND SPEED

Effective Date: 10/30/14

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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Reviewed by:	Title:	Date:	Signature:
MS	QAMgr	11/2/15	

IV. C. 7. b. R.M. YOUNG WIND SPEED

1.0 PURPOSE

The purpose of this Standard Operating Procedure (SOP) is to provide consistent guidance for maintenance, handling, and calibration of the R.M. Young wind speed sensor to Clean Air Status and Trends Network (CASTNET) Field Equipment Calibration Laboratory personnel.

2.0 SCOPE

This SOP applies to the calibration, maintenance, and handling and calibration of R.M. Young wind speed sensor units administered by the CASTNET Field Equipment Calibration Laboratory.

3.0 SUMMARY

R.M. Young Wind Speed Sensors are calibrated upon receipt from the manufacturer and at the request of field technicians. Repairs and maintenance are performed as necessary.

4.0 MATERIALS AND SUPPLIES

R.M. Young wind speed sensor
Wind direction calibration form
Factory certified synchronous motor
Data logger
Screwdriver
Vacuum grease
Thread-locking compound
Soldering tool
Solder/flux
Wire cutters
24 and 22 gauge wire
Spare screws and o-rings

5.0 REPAIR AND MAINTENANCE

5.1 Coil

5.1.1 Remove junction box cover to expose terminal block, unscrew terminal block from housing and cut the two larger wires (black and red).

5.1.2 Unscrew the two set screws at the base of the coil which hold it to the transducer assembly and remove.

5.1.3 Unscrew the wind direction potentiometer from the top of the coil (these two pieces are sealed with silicon sealant, so it may be slightly difficult to unscrew).

5.1.4 Slide a modified ty-wrap with a hole in the end up through the new coil, and pull the potentiometer wires back through the coil. Then screw the potentiometer back onto the coil housing, applying some silicon sealant to the threads.

5.1.5 Slide the modified ty-wrap up through the back of the terminal block housing and pull all the wires into the terminal block housing. Apply some silicon sealant to the base of the coil, set it onto the base of the transducer assembly, spacing it with the large round end of the RM Young spacing tool (0.5mm) and reset the two set screws.

5.1.6 Re-solder the two wires back onto the circuit card.

5.1.7 Screw the terminal block back into the housing and replace the cover.

5.2 Nose Cone

5.2.1 Remove prop nut (if present).

5.2.2 Remove magnet on top of nose cone with 1/16 inch allen wrench and cap front bearing (plastic ring). Pull shaft out and remove bearings on either side of nose cone housing.

5.2.3 Install new bearings (they will only fit in one way).

5.2.4 Replace cap front bearing (it will only fit in one way) on top of nose cone housing.

5.2.5 Replace shaft and prop nut.

5.2.6 Replace magnet on other side of housing. Set gap with small end (0.5 mm) of R.M. Young gap tool.

5.2.7 Be sure the O-ring is in place (up inside the housing behind the magnet).

6.0 PROCEDURES

6.1 Attach nose/cone assembly to vane. Be careful not to cross-thread.

6.2 Attach synchronous motor drive unit to vane.

6.3 Record the zero reading on the calibration form with the synchronous motor turned to **OFF**.

6.4 Turn the motor speed to 200 rpm. Record wind speed in m/s on the calibration form. Perform this step for each of the following speeds: 400, 800, 1600, 3600, and 8600 rpm.

> ***Note:*** *Output measurement cannot be off by more than 0.2 m/s at speeds < 5.0 m/s.*

6.5 Remove the synchronous motor drive unit and attach the slow speed synchronous motor drive unit.

6.6 Set synchronous motor for 100 rpm and record the response as above.

6.7 The equivalent wind speed multiplier is determined by the serial number of the propeller being used in the field. If the serial number is 53404 or greater, multiply the rpm by 0.00512. If the serial number is less than 53404, multiply the rpm by 0.0049.

6.8 Nose Cone Torque Test

See R.M. Young Manual (Figures 1-3).

7.0 REFERENCES

R.M. Young Company. *Model 05305 Wind Monitor AQ Manual*

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*. 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS)*. 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications*. EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods.* EPA-600/4-77-027a.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements.* EPA-600/4-82-060.

8.0 FIGURES

Figure 1. Approximate Propeller/Cup Wheel Torque versus Wind Speed

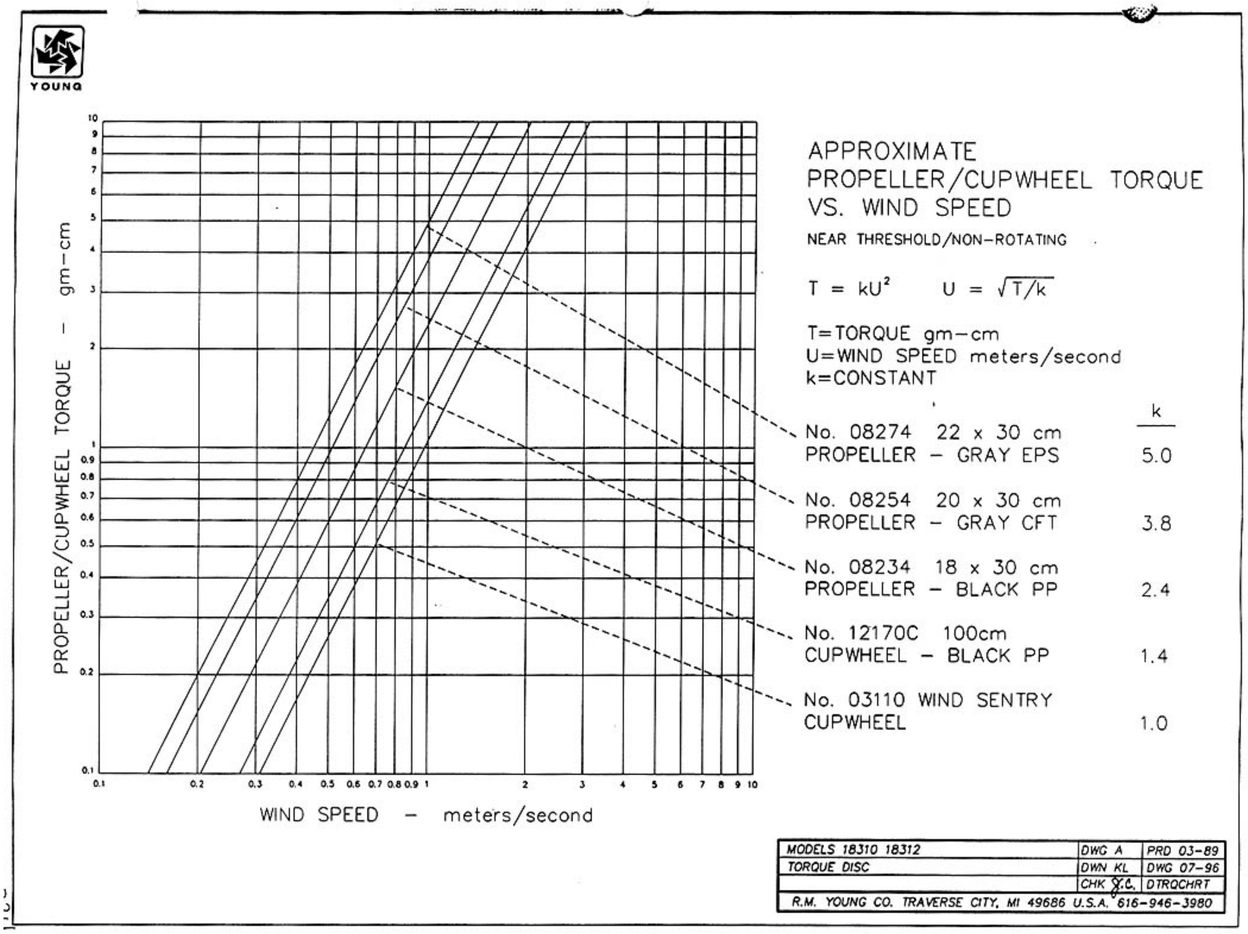


Figure 2. Typical Torque Values

R. M. YOUNG COMPANY

TYPICAL TORQUE VALUES
For Checking Anemometer Bearing and Transducer Condition

Instrument (Standard Models)	Sensor	Transducer	[1]New Instrument Torque gm-cm	[1]New Instrument Threshold m/s	[2]Max torque for threshold of: 0.5 m/s gm-cm	[2]Max torque for threshold of: 1.0 m/s gm-cm
03101-5 Wind Sentry Anemometer	03110	AC Coil	0.3	0.5	0.3	1.0
05103 Wind Monitor	08234	AC Coil	2.4	1.0		2.6
05106 Wind Monitor - MA	08234	AC Coil	2.6	1.0		2.6
05305 Wind Monitor - AQ	08254	AC Coil	0.3	0.3	1.0	3.8
05701 Wind Monitor - RE	08274	AC Coil	0.3	0.2	1.3	5.0
12102 Cup Anemometer	12170C	2400 mV Tach-Gen	0.4	0.5	0.4	1.4
12102D Cup Anemometer/Photo Choper	12170C	Photo Chopper	0.1	0.3	0.4	1.4
21003 Anemometer Bivane	08274	2400 mV Tach-Gen	0.6	0.3	1.3	5.0
27106 Propeller Anemometer	08274	500 mV Tach-Gen	0.5	0.3	1.3	5.0
27106T Propeller Anemometer	08254	500 mV Tach-Gen	0.5	0.4	1.0	3.8
27106D Propeller Anem / Photo Chopper	08274	Photo Chopper	0.3		1.3	5.0

NOTES:

1. New instrument torque and threshold specifications are maximum values
2. Values shown are maximum torque to maintain instrument threshold at or below 0.5 m/s and 1.0 m/s respectively.
3. EPA and NRC instrument specifications designate 0.5 m/s wind speed starting threshold. ASTM D5096-90 "Standard Test Method for Determining the Performance of a Cup Anemometer or Propeller Anemometer" defines "starting threshold" and outlines a method for its determination.

SENSORS:

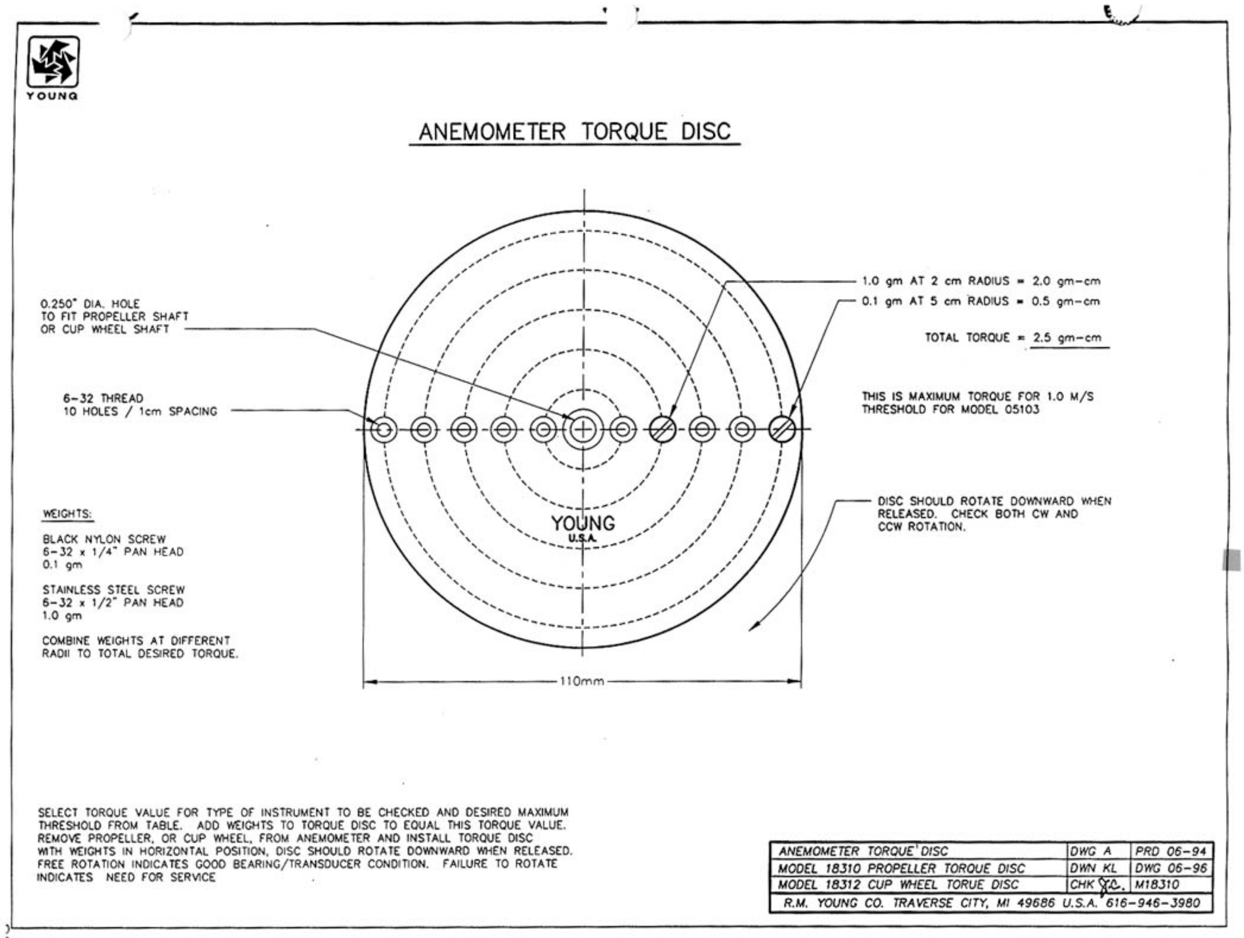
03110 Wind Sentry 75 cm Cup Wheel Assembly
08234 18 X 30 cm Polypropylene Propeller (PP)
08254 20 X 30 cm Carbon Fiber Thermoplastic Propeller (CFT)
08274 22 X 30 cm Expanded Polystyrene Propeller (EPS)
12170C 100 cm Cup Wheel Assembly

STANDARD BEARINGS:

Model 05103 Wind Monitor - Double Teflon seals & lubricated with M-28 low torque grease
Model 05106 Wind Monitor - MA - Double Teflon seals & lubricated with "Sta-lube" waterproof grease.
All other models - Double metal shields & lubricated with LOI instrument oil

JULY 1996
TDISKSUM PM6

Figure 3. Anemometer Torque Disc



IV. FIELD INSTRUMENTATION LABORATORY
C. SITE INSTRUMENTATION
7. RM YOUNG
c. TEMPERATURE

Effective Date: 11-10-11

Reviewed by: Kevin P. Mishoe, Field Operations Manager [signature]

Reviewed by: Marcus O. Stewart, QA Manager [signature]

Approved by: Holton K. Howell, Project Manager [signature]

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Reviewed by:	Title:	Date:	Signature:
MS	QA Mgr	10/30/12	[signature]
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MS	QA Mgr	11/2/15	[signature]

IV.C.7.c. TEMPERATURE

1.0 PURPOSE

The purpose of this standard operating procedure (SOP) is to provide consistent guidance to Clean Air Status and Trends Network (CASTNET) Field Instrumentation Laboratory personnel for the calibration, maintenance, and handling of the RM Young temperature sensors.

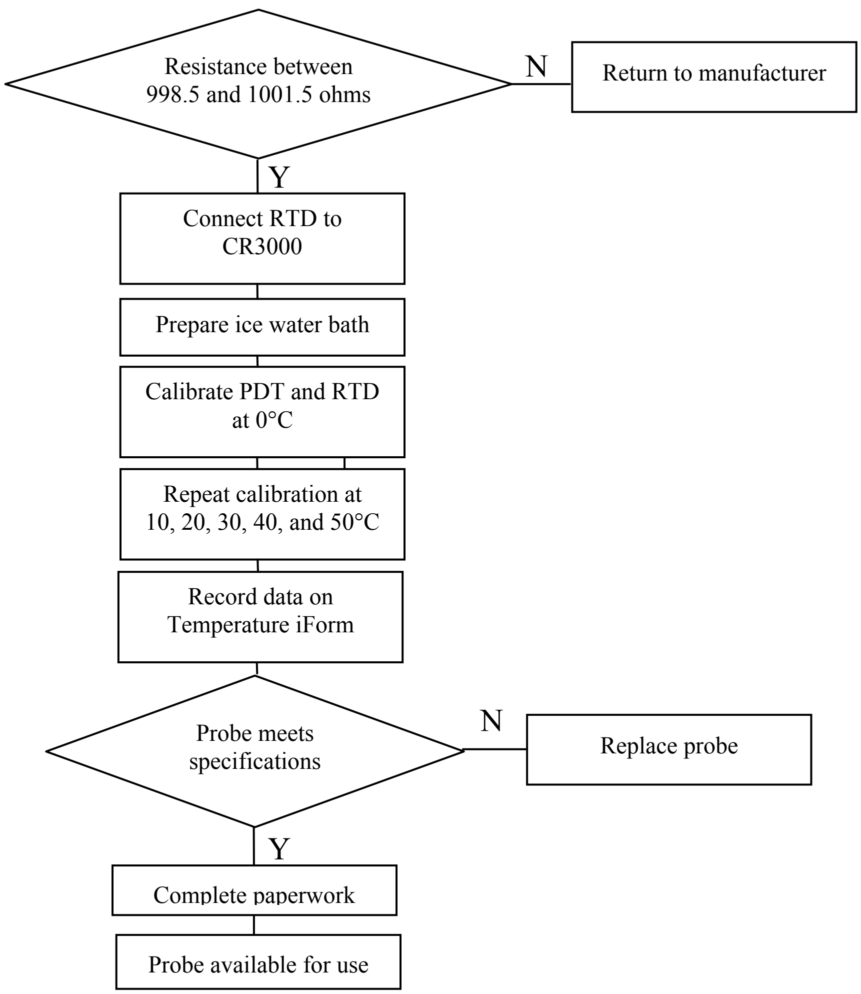
2.0 SCOPE

This SOP applies to the calibration, maintenance, and handling of RM Young resistance temperature device (RTD) sensors by CASTNET Field Instrumentation Laboratory personnel.

3.0 SUMMARY

RM Young RTD sensors are calibrated upon receipt and at the request of field technicians. Figure 1 illustrates the calibration process. Maintenance is performed as necessary.

Figure 1. Temperature Sensor Calibration



Note: Criterion = 0.25°C; PDT = precision digital thermometer; RTD = resistance temperature device.

4.0 MATERIALS

RM Young RTD probe
Certified digital voltage meter
Data logger - Campbell Scientific Inc., Model CR3000 or equivalent
Certified National Institute of Standards and Technology (NIST)-traceable Dostmann Precision Digital Thermometer (PDT) with probe or equivalent
Magnetic stir plate
Magnetic stirrer
Device to heat water > 50.0°Celsuis (C)
Water
Ice
Plastic bags (1 small, 1 large, 1 sized to fit RM Young RTD probe)
Rubber mallet
Insulated vessel (cooler cup) with fitted Styrofoam lid large enough to accommodate temperature probes
Small flat head screwdriver
Temperature iForm and computer access

5.0 SAFETY

The calibration of the RTD sensors requires preparation of crushed ice and hot water (> 50.0°C) to temper the water baths used during the calibration process. Care should be taken while using the rubber mallet to crush the ice. Care should also be taken to prevent the ice from escaping or leaking from the plastic bag during the crushing process, as this could create a slip hazard. Hot water with a temperature > 50.0°C is also used to prepare water baths. Care should be taken when heating, handling, and mixing the hot water.

6.0 PROCEDURE

6.1 Repair and maintenance

Prior to calibration, use a certified digital voltage meter to check the sensor resistance. Each probe should read between 998.5 and 1001.5 ohms. If readings are within the specified resistance range, the probe will calibrate properly. If not, the probe needs to be returned to the manufacturer for replacement, as it may not calibrate properly. Additional maintenance consists of cleaning the probe and probe body.

6.2 Calibration

6.2.1 Connect the RTD probe sensors to the CR3000 calibration station as shown in Figure 2 and Figure 3. Attachment A provides a wiring diagram for the RM Young RTD probes.

Figure 2. Sensor connections at sensor

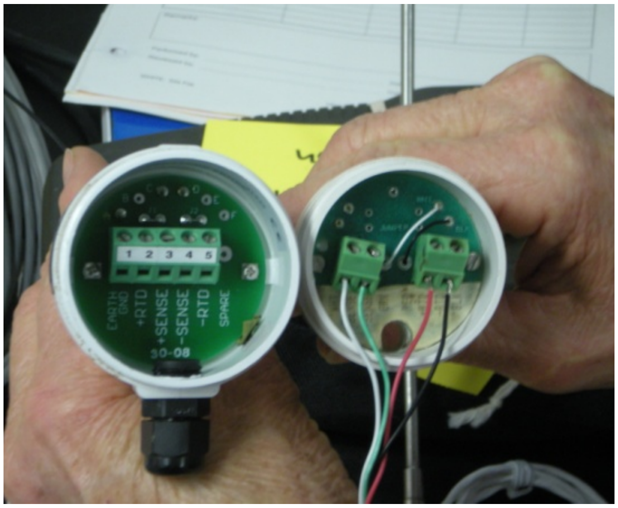
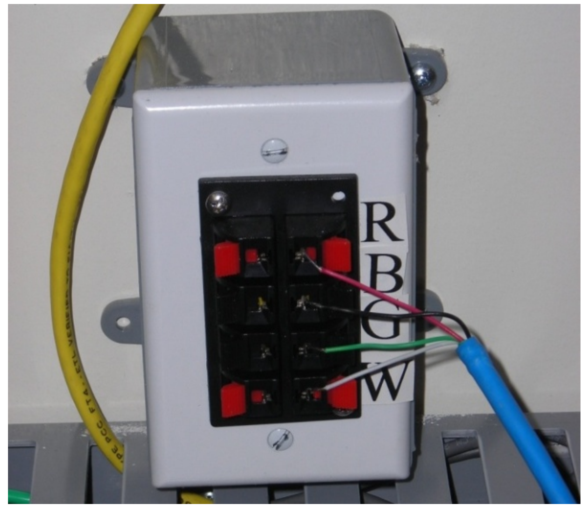


Figure 3. Wall station connecting sensor to data logger



Make an ice water bath in large cooler cup. To prepare the ice bath, crush ice cubes using a rubber mallet (Figure 4). The ice should be crushed into very small pieces. The larger bag will contain any ice that might escape when the seams of the inner bag break. Place the cubes in the smaller of the two plastic bags. Place that bag into the larger plastic bag and verify that all excess air has been removed from the large bag, and the bag is sealed.

Figure 4. Crush ice

Insert the magnetic stirrer (Figure 5) before adding ice so it sinks to the bottom. Fill the cup to within 1 inch of the top with the crushed ice. Add only enough cold water to create a slurry. Place the cup on the stirring device and turn the stirring device to setting 3 or 4 making sure the magnetic stirrer is in the center of the cup. Place the Styrofoam lid on the cup.

The lid has holes for the PDT and RTD probes. Insert the Dostmann PDT into any hole in the lid and keep the black ring at water level. Insert the RTD probes to the same depth as the PDT (Figure 6). The two probes should not touch each other. The black ring should be moved to be the same level as the RTD.

Figure 5. Insert magnetic stirrer

Figure 6. Insert probes in bath

6.2.2 Allow the temperature of the water bath to stabilize to a temperature of 0.0°C ± 0.1°C.

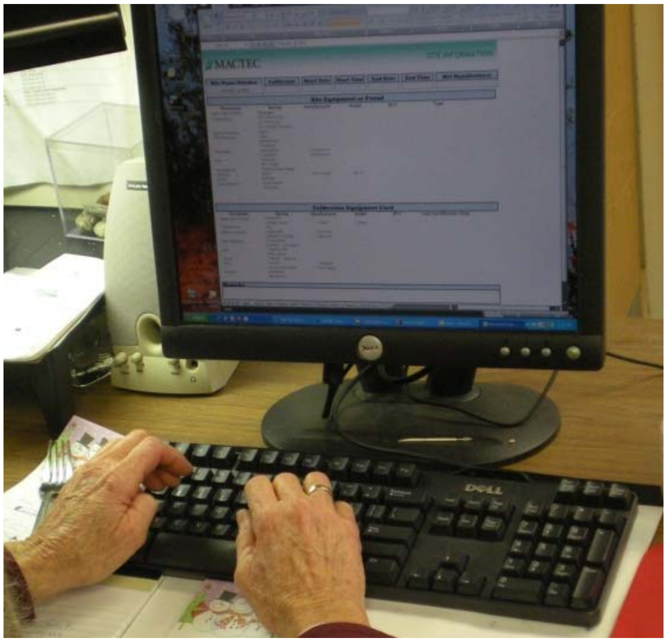
6.2.3 Activate the iForm by entering site, calibrator, and data logger information under the "SITE" and "DAS" tabs. Additionally, the corrections for the six PDT values need to be entered on the iForm in the "Transfer Standard" – "Correction Factors" section in the upper right hand corner of the form. The PDT correction factor is provided on its most recent certification form as the "UUT ERROR" associated with the 0.0 °C "SET VALUE" on the form (Attachment B). This correction should be entered in all six ranges.

6.2.4 Record the temperature from the PDT and RTD (Figure 7) in actual degrees C in the columns of the "As Left" – "Temperature Data Logger Output" section of the Temperature iForm (Figure 8):

- Record the PDT output in the RTD "Uncorrected Temp" column of the "As Left" section of the iForm.
- Record the RTD output in the "Raw Temp" column of the "Temperature (10m) Output" section of the "As Left" section of the iForm.

6.2.5 If the temperature sensors are being calibrated after being replaced during a CASTNET site calibration visit and returned to AMEC for verification, then the temperature data are recorded in the "As Found" section of the Temperature iForm. In this circumstance, existing values for R_o and alpha should be used.

Figure 7. Enter temperature data on iForm



6.2.6 Make another water bath without ice using aliquots of hot and cold water to adjust the temperature. Use the magnetic stirrer as described previously, and insert the RTD probes. Insert the PDT, and record the resulting data on the iForm as described previously.

6.2.7 Repeat this calibration procedure using water baths at the following temperatures:
~10° C
~20° C
~30° C
~40° C
~50° C
The acceptance criterion for this procedure is 0.25°C.

6.2.8 Inspect the iForm for computed R_o and alpha values for the probe(s). The Temperature iForm will flag these values if not within specification. If the probes meet specification, continue to the next step.

6.2.9 Print three copies of the Temperature iForm for each probe. Use color markers to add yellow and pink colors to the top of two forms. Place the probe in a plastic bag with the white and yellow iForms and place the bag on the "ready–to–ship" shelf.

6.2.10 File the third, pink copy iForm by property identification number in the instrument file.

Figure 8. Temperature iForm for Instrumentation Laboratory

MACTEC

Temperature

Site Name	Calibrator	Calibration Date	Data Logger	iForms Ver.
MEC099	KPM	11/30/2009	Campbell 3000 ID:489	1.3.2.0

	10 Meter (T1)		2 Meter (T2)	
	As Found	As Left	As Found	As Left
ID #	02934	07334	02933	02933
Description	RTD	RTD	RTD	RTD
Manufacturer	R.M. Young	R.M. Young	R.M. Young	R.M. Young
Model	43347	43347	43347	
R_o	1001.31	1001.20	1000.9	1000.57
Alpha	0.00372	0.003756	0.00376	0.003760
Translator Type				

Transfer Standard					
ID #			04644		
Manufacturer			Eutechnics		
Model			4600		
Date of Last Cert.			7/20/2009		
Correction Factors					
0°	10°	20°	30°	40°	50°
0.00	0.02	0.03	0.02	0.02	0.02

☑ Show As Left

As Found			Temperature Data Logger Output											
RTD (°C)			Temperature (10m) Output				Temperature 2 (2m) Output				Delta T.	Shelter Temperature	
Uncorrected Temp. (°C)	Correction Factor	Corrected Temp. (°C)	Raw Temp. (°C)	Corrected Temp. (°C)	Raw Diff (°C)	Corrected Diff (°C)	Raw Temp. (°C)	Corrected Temp. (°C)	Raw Diff (°C)	Corrected Diff (°C)	Diff (°C)	Temp. (°C)	Diff (°C)
0.04	0.00	0.04	0.36	0.01	0.32	-0.03	0.19	-0.05	0.15	-0.09	0.06	-0.09	-0.13
24.96	0.03	24.99	25.31	25.13	0.32	0.14	25.21	24.88	0.22	-0.11	0.25	24.84	-0.15
50.14	0.02	50.16	50.61	50.60	0.45	0.44	50.47	50.05	0.31	-0.11	0.55	49.88	-0.28
10.44	0.02	10.46	10.83	10.55	0.37	0.09	10.65	10.37	0.19	-0.09	0.18	10.37	-0.09
30.00	0.02	30.02	30.45	30.30	0.43	0.28	30.27	29.92	0.25	-0.10	0.38	29.75	-0.27
40.80	0.02	40.82	41.28	41.21	0.46	0.39	41.10	40.71	0.28	-0.11	0.49	40.52	-0.30

As Left			Temperature Data Logger Output											
RTD (°C)			Temperature (10m) Output				Temperature 2 (2m) Output				Delta T.	Shelter Temperature	
Uncorrected Temp. (°C)	Correction Factor	Corrected Temp. (°C)	Raw Temp. (°C)	Corrected Temp. (°C)	Raw Diff (°C)	Corrected Diff (°C)	Raw Temp. (°C)	Corrected Temp. (°C)	Raw Diff (°C)	Corrected Diff (°C)	Diff (°C)	Temp. (°C)	Diff (°C)
0.04	0.00	0.04	0.36	0.04	0.32	0.00	0.19	0.04	0.15	0.00	0.00		
24.96	0.03	24.99	25.31	24.92	0.32	-0.07	25.21	24.98	0.22	-0.01	-0.06		
50.14	0.02	50.16	50.61	50.15	0.45	-0.01	50.47	50.16	0.31	0.00	-0.01		
10.44	0.02	10.46	10.83	10.48	0.37	0.02	10.65	10.47	0.19	0.01	0.02		
30.00	0.02	30.02	30.45	30.05	0.43	0.03	30.27	30.02	0.25	0.00	0.02		
40.80	0.02	40.82	41.28	40.85	0.46	0.03	41.10	40.82	0.28	0.00	0.03		

7.0 REFERENCES

RM Young Company. 1996. *Model 41342 Temperature Probe Instruction Sheet.*

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring.* 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS).* 40 CFR 58, Appendix A.

U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements*. EPA-600/4-82-060.

U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications.* EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a*. Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

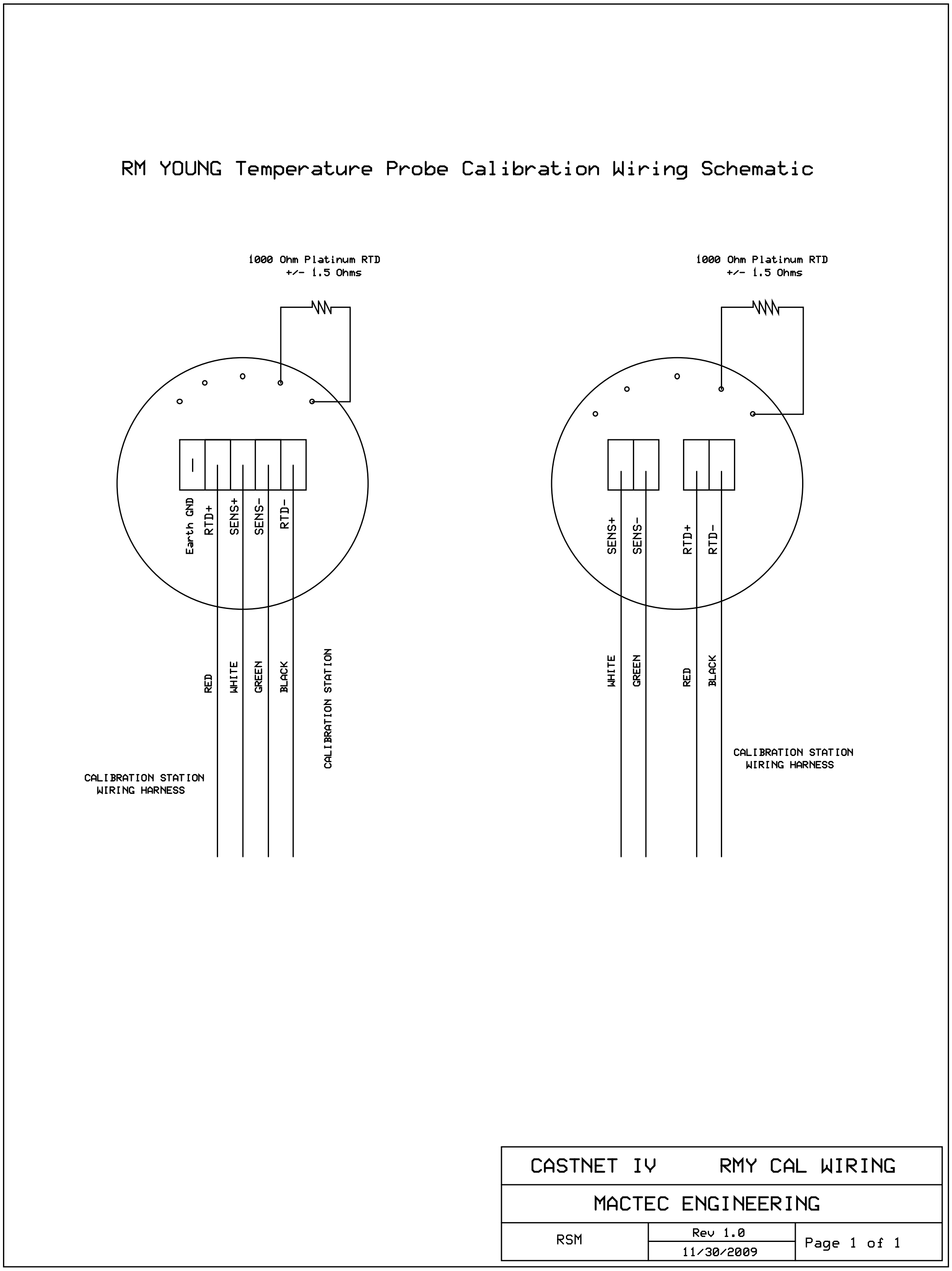
U.S. Environmental Protection Agency (EPA). 1986b. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. II, Ambient Air Specific Methods*. EPA-600/4-77-027a.

8.0 ATTACHMENTS

Attachment A − Wiring Diagram − Calibration Wiring, RM Young Temperature Probes

Attachment B − PDT Certification

ATTACHMENT A
Wiring Diagram − Calibration Wiring, RM Young Temperature Probes



ATTACHMENT B
PDT Certification

05/13/2009 13:23 FAX 8017568948 ThermoWorks 002

C080485

Page 1 of 1

ThermoWorks, Inc.

Ph: 801 756-7705 Fax: 801 756-8948
270 N. Main St. Ste. D
Alpine, UT 84004

EPA #06499
Dostman

REPORT OF CALIBRATION

Model Name: Precision Digital Thermometer
Model No.: P655
Serial No: 65507072328
Probe Model: 6000-1018
Serial No.: P100 080224
Manufacturer: Dostmann Electronic

Submitted by:
Mactec Engineering
Newberry, FL, USA

The Digital Indicator and probe(s) listed above were calibrated as a "System" by comparison to the laboratory reference standards listed below. The UUT was found to be in tolerance. The pertinent data is shown in the table below. This calibration is traceable to NIST or natural physical constants and is in compliance with ANSI/NCSL Z540-1.

SET VALUE	ACTUAL VALUE	UUT VALUE	UUT ERROR	UUT SPECIFICATION
0.000 °C	0.03 °C	0.05 °C	0.02 °C	± 0.03 °C ~ -100 °C to 150 °C
156.598 °C	156.66 °C	156.65 °C	0.01 °C	± 0.05 °C ~ -200 °C to 200 °C
231.928 °C	231.03 °C	232.0 °C	-0.03 °C	0.1% rest of the range
419.527 °C	419.41 °C	419.3 °C	-0.11 °C	

STANDARDS USED				
ID Number	Manufacturer	Model Number	Description	Due Date
TOM I	Hart Scientific	1529	Precision Digital Readout	01/04/2010
570014	Hart Scientific	5614	Precision RTD Probe	02/01/2009 *

Laboratory Environment:
Temperature: 24.19 °C
Humidity: 21.1 %
Procedure Number: L001
Calibration Date: 11/21/2008
Calibration Due: 11/21/2009
PO Number: 200814679

Calibration Performed by: Amber Bowcut

Approved by: Tom Fisher

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IV. CERTIFICATION LABORATORY
C. SITE INSTRUMENTATION
7. R.M. YOUNG
d. RELATIVE HUMIDITY

Effective Date: 11-10-11

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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Reviewed by:	Title:	Date:	Signature:
MS	QA Mgr	10/30/12	[signature]
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MS	QA Mgr	11/2/15	[signature]

IV. C. 7. D. RELATIVE HUMIDITY

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide consistent guidance maintenance and handling of the Vaportron H-100L Precision Relative Humidity Lab to Clean Air Status and Trends Network (CASTNET) Field Calibration Laboratory personnel.

2.0 SCOPE

This SOP applies to the maintenance and handling of Vaportron H-100L Precision Relative Humidity Lab units administered by the CASTNET Field Calibration laboratory.

3.0 SUMMARY

The Vaportron's internal water reservoir is capped and refilled routinely every 1 to 6 weeks and is returned to the manufacture annually for routine maintenance and certification.

4.0 MATERIALS AND SUPPLIES

Rotronic RH sensor or Vaisala RH sensor
Campbell CR3000 Data logger
Vaportron H100CL Precision Humidity Laboratory or Aqueous saturated salts
(***Note:*** *Use salts only as a last resort*)
Insulated screwdriver
Soldering tool
Solder/flux
Small flashlight
Plastic storage bag
DRIERITE desiccant
Kimwipes
Wire cutters
Sonic cleaner
Deionized (DI) water
Alcohol
RH iForm or RH/Temperature Paper Form

5.0 REPAIR AND MAINTENANCE

5.1 Repair

Return inoperable sensors to the manufacturer for repair.

5.2 Maintenance

5.2.1 Rotronic
Replace filter tip and O-ring, as necessary. Otherwise clean Rotronic filter caps in ultrasonic cleaner.

Check and re-solder both ends of signal wire as necessary.

5.2.2 Vaisala
Replace filter tip as necessary.

6.0 CALIBRATION PROCEDURE

6.1 *Using the Vaportron H100CL Series Precision Humidity Laboratory*

6.1.1 Use either iForms or Paper forms for this calibration. If using iForms populate the "Site" and "Data-Logger" pages to reflect the type of equipment used. Also indicate on the RH iForm what type of sensor is being calibrated and its I.D. If iForm is used record the VAPORTRON I.D. in the "Transfer Standard" column and enter 0 for each correction factor.

6.1.2 Check the desiccant cartridge located on the back of the unit; the DRIERITE must be a blue color above the red line on the cartridge. If the indicating DRIERITE is pink at or below the red line on the cartridge, refer to the maintenance SOP (IV.A.5.1) for instructions on changing DRIERITE. Check the water level by lifting up on cap end of cartridge and looking into the large window near the left desiccant hanger hook. Use a small flashlight to locate the water level. The water level must be between the lower and upper red lines on the fill level decal. If the water level is not between the lines, refer to the maintenance SOP (IV.A.5.1) for instructions on the **water level service procedure** (see the Figure IV.A.5.1 for help).

6.1.3 Switch the power to **ON** (lower left). The **RH LCD** (center top) and **TEMPERATURE** displays should come on and read the approximate room conditions.

6.1.4 Set the **TEMPERATURE** display, using the up or down arrows, to 25.0°C (Rotronic) 22.5°C (Vaisala).

6.1.5 Remove the plug from the white chamber access door (right side) and insert the Rotronic RH probe so approximately 1.5 inch of the probe is left outside the aluminum port fitting on the door. **Lightly** tighten the port fitting to hold the probe securely in the chamber.
Vaisala goes into smaller port on access door – wrap parafilm around port and sensor to seal.

6.1.6 Set the **RH LCD** display, using the up or down arrows, to the first point of **10.0** % RH.

6.1.7 Plug the RH sensor into the proper test cable and check the data logger for an output from the sensor. Obtain a Temperature/ RH Data form or RH iForm and record the serial number of the sensor and all relevant data.

6.1.8 Switch **CONTROL** to **ON**. A faint, high-pitched sound should indicate proper operation of the air circulator fan inside the chamber. The Vaportron displays should begin to ramp toward the values that were set. Normally, the **RH** and **Temperature** readings will stabilize within 2 to 5 minutes.

6.1.9 Let the Rotronic RH sensor equilibrate for 1hour or until stable at the set point, then record the output from the Vaportron RH controller and the data logger on the proper calibration form or iForm. If iForm is used record Vaportron Data in the "Portable Hygrometer" column of the "As Left" block. The iForm will automatically populate the corrections factors with zeros. Record the sensor output as read from the CR3000 in the "% Relative Humidity" column of the "Data-Logger Output" block of the iForm.

6.1.10 Set the **RH LCD** display, using the up arrow, to the next point of **30** % RH and repeat step 6.1.8.

6.1.11 Repeat step 9 for set points of: **50**%, **70**%, **85**%, and **95.0**%.

6.1.12 The sensor output must be within 10% RH. . If these criteria are not met, return the sensor to the manufacturer for repair along with a copy of the calibration form.

6.1.13 After completion of the final point, loosen the aluminum port fitting on the door and remove the sensor from the chamber. Install the port plug. Set the **RH LCD** display, using the down arrow, to **50.0** % RH. Let the unit run for 5 minutes at this setting.

6.1.14 Switch the **CONTROL** to OFF. Switch the power to **OFF** (lower left).

6.1.15 Check that the calibration form is completed (see Figure 1) and see Calibration Lab Manager for review and sign off of the calibration form. After review, place the form and sensor in a plastic bag, and put them in the appropriate box on the "ready to ship" shelf. Be sure to file a copy of the calibration form in the sensor calibration file.

6.2 **Using Aqueous Saturated Salts** [NOTE: Discontinued practice]

6.2.1 Plug Rotronic relative humidity (RH) sensor into the proper test cable and check data logger system for an output from sensor. Obtain a Temperature/RH Data form and record the serial number of the sensor

6.2.2 Carefully remove filter cap from the sensor and, starting with Silica Gel, (0.0%) gently screw sensor into opening of bottle (**use great caution not to hit or contaminate strain gauge or RTD when inserting in bottle.** Place bottle/sensor in the blue bottle caddy.).

6.2.3 Let the Rotronic RH sensor equilibrate for 1 hour at the set point and then record the output from the data logger on the proper calibration form.

6.2.4 Repeat steps 2 and 3 for the solutions of deionized (DI) water and salt: $MgCl_2$ (32.8%), $Mg(NO_3)_2$ (52.9%), NaCl (75.3%), and KNO_3 (93.6%). Lightly swirl the solution of DI water and salt, being careful not to get salt solution into the bottleneck. If salt solution gets in bottleneck, clean with a Kimwipe before inserting the probe.

6.2.5 The sensor output must be within 10% at points less than 85% RH and within 3% at points above 85%. If these criteria are not met, return the sensor to the manufacturer for repair.

6.2.6 After the completion of the final point, remove RH sensor from bottle and wipe sensor housing and O-ring with a clean Kimwipe and install a clean filter.

6.2.7 Check to see that the calibration form is completed (See Figure 2) and see the Calibration Lab Manager for review and sign off of calibration form. After review, place the form and sensor in a plastic bag and put them in the appropriate box on the "ready to ship" shelf.

7.0 REFERENCES

R.M. Young Company. *Model 41372 Relative Humidity Probe Manual*

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring.* 40 CFR 58, Appendix B.

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U.S. Environmental Protection Agency (EPA). 1987. *On-Site Meteorological Program Guidance for Regulatory Modeling Applications.* EPA-450/4-87-013.

U.S. Environmental Protection Agency (EPA). 1986a. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. I, Principles*. EPA-600/76-005.

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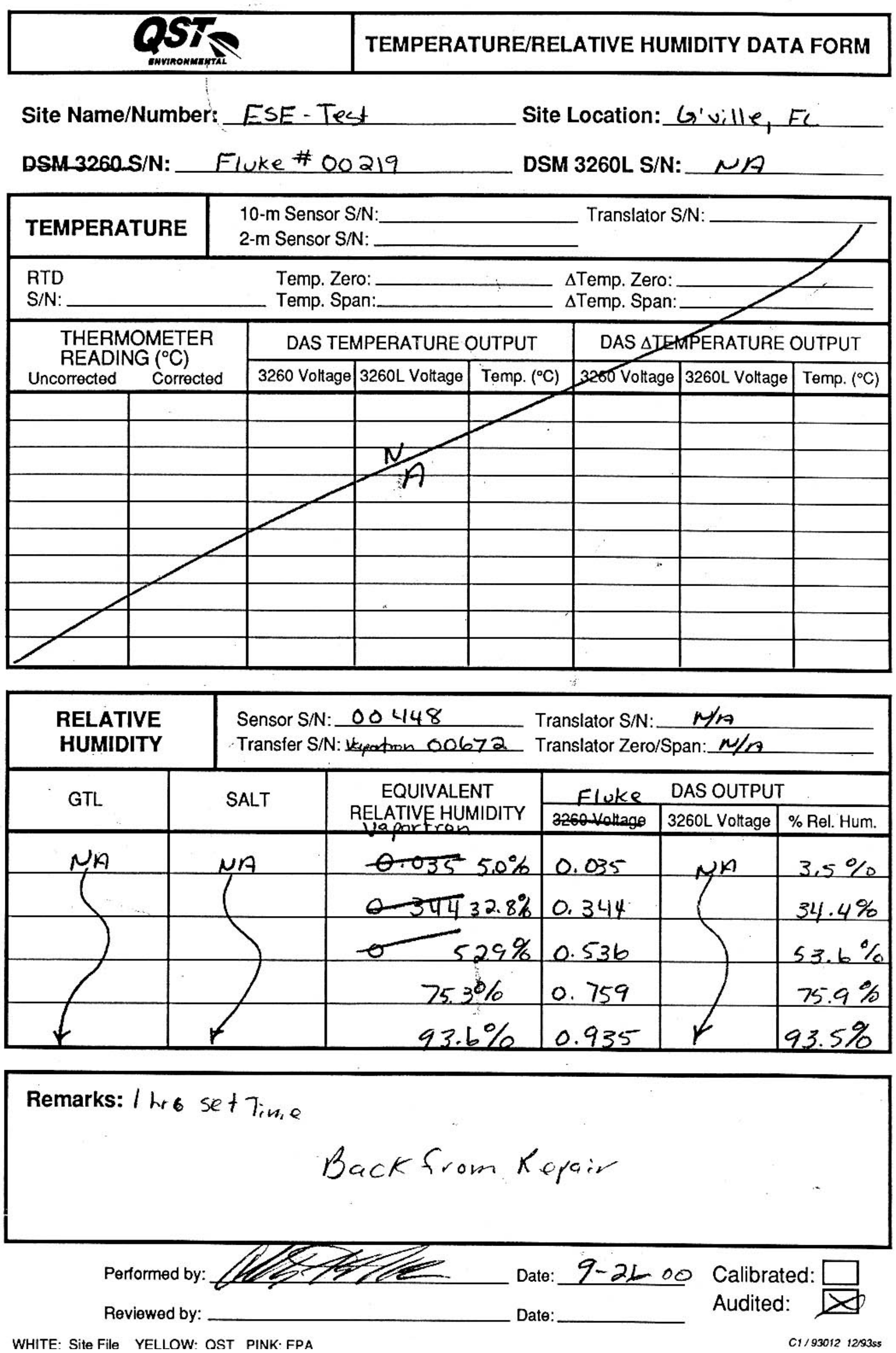
U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements*. EPA-600/4-82-060.

U.S. Environmental Protection Agency (EPA). 1979. *Transfer Standards for Calibration of Air Monitoring Analyzers for Ozone, Technical Assistance Document.* EPA-600/4-79-056.

8.0 FIGURES

Figure 1. Temperature/Relative Humidity Paper Calibration Form Using Vaportron

Example



QST ENVIRONMENTAL — TEMPERATURE/RELATIVE HUMIDITY DATA FORM

Site Name/Number: ESE - Test Site Location: G'ville, FL

~~DSM 3260~~ S/N: Fluke # 00219 DSM 3260L S/N: N/A

TEMPERATURE 10-m Sensor S/N: ____ Translator S/N: ____ 2-m Sensor S/N: ____

RTD S/N: ____ Temp. Zero: ____ Temp. Span: ____ ΔTemp. Zero: ____ ΔTemp. Span: ____

THERMOMETER READING (°C) Uncorrected	Corrected	DAS TEMPERATURE OUTPUT 3260 Voltage	3260L Voltage	Temp. (°C)	DAS ΔTEMPERATURE OUTPUT 3260 Voltage	3260L Voltage	Temp. (°C)
			NA				

RELATIVE HUMIDITY Sensor S/N: 00448 Translator S/N: N/A Transfer S/N: Vaportron 00672 Translator Zero/Span: N/A

GTL	SALT	EQUIVALENT RELATIVE HUMIDITY Vaportron	Fluke ~~3260 Voltage~~	DAS OUTPUT 3260L Voltage	% Rel. Hum.
NA	NA	~~0.035~~ 5.0%	0.035	NA	3.5%
		~~0.344~~ 32.8%	0.344		34.4%
		~~0~~ 52.9%	0.536		53.6%
		75.3%	0.759		75.9%
		93.6%	0.935		93.5%

Remarks: 1 hr set time
Back from Repair

Performed by: [signature] Date: 9-26-00 Calibrated: ☐
Reviewed by: ____ Date: ____ Audited: ☒

WHITE: Site File YELLOW: QST PINK: FPA C1/93012 12/93ss

Figure 2. Temperature/Relative Humidity Paper Data Form Using Salts

Example

QST ENVIRONMENTAL | TEMPERATURE/RELATIVE HUMIDITY DATA FORM

Site Name/Number: ESE-Test Site Location: G'ville, FL

DSM 3260 S/N: 000091 DSM 3260L S/N:

TEMPERATURE
10-m Sensor S/N: Translator S/N:
2-m Sensor S/N:

RTD S/N: Temp. Zero: ΔTemp. Zero:
Temp. Span: ΔTemp. Span:

THERMOMETER READING (°C)		DAS TEMPERATURE OUTPUT			DAS ΔTEMPERATURE OUTPUT		
Uncorrected	Corrected	3260 Voltage	3260L Voltage	Temp. (°C)	3260 Voltage	3260L Voltage	Temp. (°C)
			N/A				

RELATIVE HUMIDITY
Sensor S/N: 04081 Translator S/N: N/A
Transfer S/N: N/A Translator Zero/Span: N/A

GTL	SALT	EQUIVALENT RELATIVE HUMIDITY	DAS OUTPUT		
			3260 Voltage	3260L Voltage	% Rel. Hum.
NA	Silica Gel	0.0%	0.021	N/A	2.1%
↓	$MgCl_2$	32.8%	0.339	↓	33.9%
↓	$Mg(NO_3)_2$	52.9%	0.538	↓	53.8%
↓	NaCl	75.3%	0.771	↓	77.1%
↓	KNO_3	93.6%	0.946	↓	94.6%

Remarks: 1hr set Time
Ch#5
Back from Repair

Performed by: [signature] Date: 10-11-00 Calibrated: ☐
Reviewed by: Date: Audited: ☒

WHITE: Site File YELLOW: QST PINK: EPA C1/93012 12/93ss

Figure 3: RH iForm

MACTEC — Relative Humidity

Site Name	Calibrator	Calibration Date	Data Logger	iForms Ver.
MACTEC099	RSM	11/30/2009	Campbell 3000 ID:489 - Campbell 3000 ID:489	1.1.0.0

	RH Sensor	
	As Found	As Left
ID #	06784	06784
Description	RH	RH
Manufacturer	Rotronics	Rotronics
Model	MP-101-A	MP-101-A
Translator ID #		
Manufacturer		
Zero		
Span		

Humidity Chamber	
ID #	
Manufacturer	VaporPak
Model	
Date of Last Cert.	

Transfer Standard	
ID #	00116
Manufacturer	Rotronics
Model	H-110L
Date of Last Cert.	6/17/2009

Correction Factors					
10%	30%	50%	70%	85%	95%
0.00	0.00	0.00	0.00	0.00	0.00

As Found	Relative Humidity Datalogger Output			
Portable Hygrometer	Correction Factor	Equivalent Relative Humidity	Datalogger Output % Relative Humidity	Diff

As Left	Relative Humidity Datalogger Output			
Portable Hygrometer	Correction Factor	Equivalent Relative Humidity	Datalogger Output % Relative Humidity	Diff
10.0%	0.0%	10.00%	11.20%	1.2%
30.0%	0.0%	30.00%	33.10%	3.1%
50.0%	0.0%	50.00%	49.70%	-0.3%
70.0%	0.0%	70.00%	68.90%	-1.1%
85.0%	0.0%	85.00%	84.00%	-1.0%
90.0%	0.0%	90.00%	92.10%	2.1%

Remarks
Primary Standard used for Lab Calibration: VAPORTRON #000116

Reviewd By: ______________ Date: ______________

IV. CERTIFICATION LABORATORY
C. SITE INSTRUMENTATION
7. R.M. YOUNG
e. SOLAR RADIATION

Effective Date: 11-10-11

Reviewed by: Kevin P. Mishoe, Field Operations Manager

Reviewed by: Marcus O. Stewart, QA Manager

Approved by: Holton K. Howell, Project Manager

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Annual Review			
Reviewed by:	Title:	Date:	Signature:
MS	QA Mgr	10/30/1-	
MS	QA Mgr	10/30/14	
MS	QA Mgr	11/2/15	

IV. C. 7. e. SOLAR RADIATION

1.0 PURPOSE

The purpose of this Standard Operating procedure (SOP) is to provide consistent guidance maintenance and handling of the Solar Radiation system to Clean Air Status and Trends Network (CASTNET) Field Calibration Laboratory personnel.

2.0 SCOPE

This SOP applies to the maintenance and calibration of the Solar Radiation systems administered by the CASTNET Field Calibration laboratory.

3.0 SUMMARY

R.M. Young solar radiation systems are calibrated upon receipt and at the request of field technicians. Repairs and maintenance are performed as necessary. All CASTNET sites administered by E.P.A. utilize R.M. Young S.R. sensor systems.

4.0 MATERIALS AND SUPPLIES

Li-Cor Model LI-2000SA pyranometer (transfer standard)
Eppley Precision Spectral Pyranometer (certified primary standard)
Hukseflux LP02 Pyranometer (certified primary standard)
Fluke Multimeter and cable
Light source
Tool kit including screwdriver, soldering flex, soldering iron, and wire cutters
Campbell datalogger, computer with PC200W program
SR Calibration Form

5.0 REPAIR AND MAINTENANCE

5.1 Testing the sensor (photodiode and accessories)

5.1.1 Connect the Fluke multimeter to the double banana-style cable with BNC connector on the other end. Insert the double banana style cable into the µ Amp (A) and common receptacles on the multimeter. Connect the BNC end of the cable to the Li-Cor sensor BNC connect (use a barrel connector as a union). Set the multimeter for Amps, DC, and 200 µA.

5.1.2 Shine a flashlight or other light source directly on the sensor. The multimeter readout should be at least ~ 35µA. If there is little or no response, repair the sensor as follows:

5.2 Repairing the photodiode

5.2.1 Unscrew the back of the sensor housing. Unscrew the small setscrew near the top of the sensor housing to release the photodiode inside. Cut off the old sensor.

5.2.2 Strip ~ 1/8 inch of insulation from the cable end. Unwrap the shield and wind it into a single strand. Strip ~ 1/8 inch of plastic covering on the central wire. Slip a 2 inch piece of shrink wrap onto the cable.

5.2.2.1 Install old (or new) indulating ring on the new photodiode. Insert photodiode pin legs into miniature PC board. Solder and snip excess. The pin leg closest to the tab on the rim of the photodiode housing is the shield. Solder the woven wire of the coaxial cable to the trace in continuity with this pin. Solder the signal (core wire) of the coaxial cable to the trace in continuity to the other pin.

5.2.3 Test the new photodiode with the multimeter as above.

Inspect the white sensor housing eye for crazing on the vertical surface. Excess crazing will require replacement of the housing eye.

5.2.4 Insert the black plastic ring that came off the old photodiode onto the new photodiode and insert the new sensor into the housing. (Clean the housing inside first, and also be sure not to touch the surface of the new photodiode with your fingers.) Be sure the new photodiode is flush with the inside surface of the housing. Tighten the set screw.

5.2.5 Seal the back cover of the housing with silicon sealant before screwing back on. Put a dab of sealant in the set screw hole as well.

5.2.6 Retest with the multimeter as above. If repairs are not possible, replace the photodiode sensor.

5.3 Maintenance

5.3.1 Clean the sensor housing.

5.3.2 Inspect the cable for damage and repair if necessary.

5.3.3 Check records and verify that the correction factors in the data logger for the primary standards are current and correct.

6.0 CALIBRATION/CERTIFICATION

6.1 Install the Li-Cor sensor on the solar radiation test stand outside of the solar radiation trailer. Be sure it is level. Connect the BNC connectors at the stand with a barrel connect as a union.

6.2 Connect the R.M. Young translator box to the corresponding station inside the solar radiation trailer.

6.3 Do not adjust anything prior to the post calibration (if a post-calibration is necessary).

6.3.1 Post-Calibration

6.3.2 Allow the site instrument to operate for at least one full day. Record data on a sunny day with high solar radiation values if possible.

6.3.3 When retrieving data, record the ID number of the primary sensor and data logger.

6.3.4 Total the columns of the primary and the site instrument using the values from the morning (values above ~ 0 watts) until the evening when the values go back to ~ 0.

6.3.5 Average the total of each column by the number of hourly averages being used.

6.3.6 Calculate the percent differences between the primary and site instrument for the total averages and the hour at which the highest hourly averages occurred. Record on the Solar Radiation Calibration Form.

6.3.7 Perform a linear regression on the two columns. Record the R^2 (correlation squared) and intercept on the Solar Radiation Calibration Form.

6.4 Calibration

6.4.1 Following a post calibration, or to calibrate when a post calibration was not possible or necessary perform the procedure below.

6.4.2 Install the site sensor as outlined above.

6.4.3 Wipe dew from each sensor on a daily basis.

6.4.4 Adjust the gain potentiometer in the translator circuit when total insolation as measured by the Primary Standard is above 700 w/m2.
To adjust the gain potentiometer remove the translator housing cover.
Remove the translator PCB retaining screws.
Lift up and fold the translator PCB down and out to expose the gain potentiometer.
Turn the gain potentiometer screw until the instantaneous Primary Standard values match the site sensor values as displayed by the data-logger.
Continue the calibration by recording a full day of data on a sunny day. Maximum insolation values should be above 700w/m2.

6.4.5 Total the columns of the primary and the site instrument using the values from the morning (values above ~ 0 watts) until the evening when the values go back to ~ 0.

6.4.6 Average the Primary and Site Sensor values.

6.4.7 Calculate the percent differences between the primary and site instrument for the total averages and the hour at which the highest hourly average occurred. Record results on the Solar Radiation Calibration Form. Repeat the procedure or repair as necessary if the sensor does not meet the criteria below.

Site SR Sensor Calibration Criteria	
Intercept	±10 W/M2
Average Difference	± 5%
Difference at Maximum Insolation	± 5%

6.4.8 Perform a linear regression on the two columns. Record the site sensor R^2 value (correlation squared) and intercept on Solar Radiation Calibration Form. If the intercept does not meet the criteria above recalibrate the unit.

6.4.9 After completing the calibration, remove the sensor and matching translator from the test facility. Place them together with the calibration form into a plastic bag. Place the bag on the "Ready to Ship" shelf in the appropriate box.

6.4.10 Place a second copy of the calibration form in the sensor calibration file.

7.0 REFERENCES

U.S. Environmental Protection Agency (EPA). 1998a. *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*. 40 CFR 58, Appendix B.

U.S. Environmental Protection Agency (EPA). 1998b. *Quality Assurance Requirements for State and Local Air Monitoring Stations (SLAMS).* 40 CFR 58, Appendix A.

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U.S. Environmental Protection Agency (EPA). 1989. *Quality Assurance Handbook for Air Pollution Measurement Systems, Vol. IV, Meteorological Measurements*. EPA-600/4-82-060.

Li-Cor, Inc., Environmental Division. LI-200SA *Pyranometer Sensor Manual.*

8.0 FIGURES

Figure 1: Solar Radiation Data From

SOLAR RADIATION DATA FORM

SITE NAME/NUMBER: MACTEC

SITE LOCATION: GAINESVILLE, FL

Sensor Number:		**04257**
Translator Number:		**04345**
PS Number:	(Huxseflux)	**06490**
PS Number:	(Eppley 1)	**01745**
PS Number:	(Eppley 2)	**000108**
Datalogger Number:		**000331**
Channel:		**3**
SLOPE		**0.9837**
INTERCEPT		**3.2841**
CORR COEF		**0.9998**
AVG % DIFF		**-0.5**
MAX % DIFF		**-1.9**

Hour may vary

Date/Time	HUX	Eppley1	Eppley2	PS Avg	Site/Trans
11/19/2009 0:00	0	0	0	0	0
11/19/2009 1:00	0	0	0	0	0
11/19/2009 2:00	0	0	0	0	0
11/19/2009 3:00	0	0	0	0	0
11/19/2009 4:00	0	0	0	0	0
11/19/2009 5:00	0	0	0	0	0
11/19/2009 6:00	0	0	0	0	0
11/19/2009 7:00	0	0	0	0	1
11/19/2009 8:00	30	28	29	29	27
11/19/2009 9:00	226	208	215	216	221
11/19/2009 10:00	418	391	405	405	409
11/19/2009 11:00	569	538	553	553	551
11/19/2009 12:00	659	627	643	643	633
11/19/2009 13:00	681	650	666	666	653
11/19/2009 14:00	623	594	603	607	600
11/19/2009 15:00	362	329	350	347	338
11/19/2009 16:00	300	281	291	291	290
11/19/2009 17:00	134	121	125	127	134
11/19/2009 18:00	10	7	7	8	13
11/19/2009 19:00	0	0	0	0	0
11/19/2009 20:00	0	0	0	0	0
11/19/2009 21:00	0	0	0	0	0
11/19/2009 22:00	0	0	0	0	0
11/19/2009 23:00	0	0	0	0	0

HUX Std Avg	309
Eppley1 Std Avg	290
Eppley2 Std Avg	299
PS Avg	**299**
Site/Trans Avg	**298**

Data reduced from non-shaded values

REMARKS:

Calibrated By: dme

Date: November 20, 2009