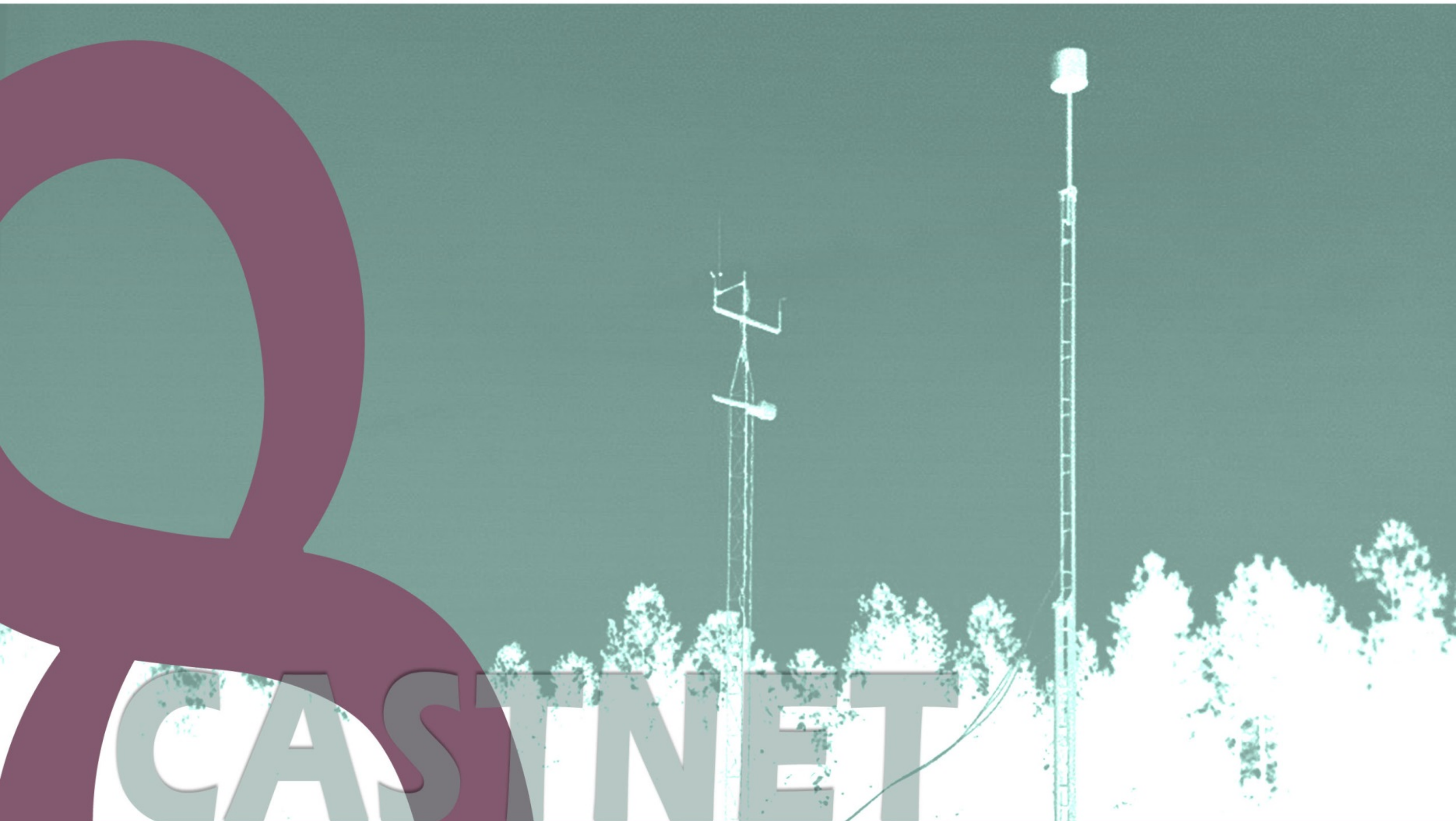

Appendix 3: Air Resource Specialists Standard Operating Procedures

Revision 8.3

Prepared for: US Environmental Protection Agency

Clean Air Status and Trends Network

Quality Assurance Project Plan

Revision 8.3

Appendix 3:

Air Resource Specialists Standard Operating Procedures

October 2015

NPS GASEOUS POLLUTANT MONITORING PROGRAM
List of Standard Operating Procedures and Technical Instructions to be Referenced from the CASTNET QAPP

I. NPS AIR MONITORING NETWORK FIELD OPERATOR PROCEDURES

3176	**Station Operator Maintenance Procedures for Meteorological Monitoring Sites Using the DataView System (Version 0.2 January 2005)**		**3176_003.pdf**
	3176-3100	Checklist Instruction - Weekly Station Visit Wind Speed / Wind Direction Sensor (Climatronics) (Version 3 January 2011)	31763100_003.pdf
	3176-3101	Checklist Instruction - Weekly Station Visit Wind Speed / Wind Direction Sensor (R.M. Young) (Version 3 January 2011)	31763101_003.pdf
	3176-3103	Checklist Instruction – Weekly Station Visit Wind Speed / Wind Direction Sensor (Climatronics – No Translator) (Version 0 April 2006)	31763103_000.pdf
	3176-3110	Checklist Instruction - Weekly Station Visit Temperature/ Delta Temperature Sensor (Climatronics) (Version 3 January 2011)	31763110_003.pdf
	3176-3111	Checklist Instruction - Weekly Station Visit Temperature/Delta Temperature Sensor (R.M. Young) (Version 2 January 2006)	31763111_002.pdf
	3176-3115	Checklist Instruction - Weekly Station Visit Air Temperature and Relative Humidity Sensor (Rotronics) (Version 1 January 2006)	31763115_001.pdf
	3176-3116	Checklist Instruction – Weekly Station Visit Air Temperature and Relative Humidity Sensor (Vaisala) (Version 1 January 2006)	31763116_001.pdf
	3176-3120	Checklist Instruction - Weekly Station Visit Relative Humidity Sensor (Rotronics) (Version 2 January 2011)	31763120_002.pdf
	3176-3121	Checklist Instruction – Weekly Station Visit Relative Humidity Sensor (Vaisala) (Version 2 January 2011)	31763121_002.pdf
	3176-3130	Checklist Instruction - Weekly Station Visit Solar Radiation Sensor (Climatronics) (Version 2 January 2011)	31763130_002.pdf
	3176-3131	Checklist Instruction - Weekly Station Visit Solar Radiation Sensor (R.M. Young) (Version 2 January 2011)	31763131_002.pdf

	3176-3132	Checklist Instruction – Weekly Station Visit Solar Radiation Sensor (Licor) (Version 2 January 2011)	31763132_002.pdf
	3176-3150	Checklist Instruction - Weekly Station Visit Precipitation Sensor (Climatronics) (Version 3 January 2011)	31763150_003.pdf
	3176-3151	Checklist Instruction - Weekly Station Visit Precipitation Sensor (Texas Electronics) (Version 2 January 2011)	31763151_002.pdf
	3176-3153	Checklist Instruction - Weekly Station Visit Precipitation Sensor (RM Young) (Version 1 March 2011)	31763153_001.pdf
	3176-3155	Checklist Instruction – Monthly Check Precipitation Sensor (Various) (Version 2 August 2009)	31763155_002.pdf
3178	**Station Operator Maintenance Procedures for Gaseous Monitoring Sites Using the DataView System (Version 0.4 July 2012)**		**3178_004.pdf**
	3178-3112	Checklist Instruction - Weekly Station Visit Ozone Analyzer (TEI 49i), Ozone Calibrator (TEI 49i) CASTNet Dry Deposition (Version 0 July 2012)	31783112_000.pdf
	3178-3116	Checklist Instruction - Weekly Station Visit Ozone Analyzer (TEI 49C) Ozone Calibrator (TEI 49C) CASTNet Dry Deposition (Version 4 January 2006)	31783116_004.pdf
	3178-3315	Checklist Instruction - Multipoint Calibration Ozone Analyzer (TEI 49C) Ozone Calibrator (TEI 49C) (Version 2 July 2012)	31783315_002.pdf
	3178-3316	Checklist Instruction - Multipoint Calibration Ozone Analyzer (TEI 49i), Ozone Calibrator (TEI 49i) (Version 0 July 2012)	31783316_000.pdf
3180	**Calibration of Mass Flowmeters and Mass Flow Controllers (Version 2.0 November 2004)**		3180_002.pdf
	3180-2100	Calibration and Routine Maintenance of CASTNET Filter Pack Flow Systems (Version 0.0 August 2012)	31802100_000.pdf

II. INFORMATION MANAGEMENT CENTER (IMC) PROCEDURES

3340	**Information Management Center (IMC) Concept and Configuration for the National Park Service Gaseous Pollutant Monitoring Program (Version 4.2 February 2010)**	**3340_009.pdf**
3345	**Day-to-Day Network Operations Technical Support for the National Park Service Gaseous and Meteorological Monitoring Program (Version 1.1 February 2010)**	**3345_007.pdf**

3350	**Collection of Ambient Air Quality and Meteorological Monitoring Data (Version 1.5 February 2010)**		**3350_006.pdf**
	3350-4000	Collection of Ambient Air Quality and Meteorological Monitoring Data Via Modem (Version 2.2 February 2010)	33504000_006.pdf
	3350-4005	Collection of DataView Files via Telephone Modem (Version 0.2 February 2010)	33504005_002.pdf
3450	**Ambient Air Quality and Meteorological Monitoring Data Validation (Version 2.2 February 2010)**		**3450_009.pdf**
	3450-5000	Ambient Air Quality and Meteorological Monitoring Data – Level 0 Validation (Version 1.6 February 2010	34505000_007.pdf
	3450-5010	Ambient Air Quality and Meteorological Monitoring Data – Preliminary Validation (Version 1.7 February 2010)	34505010_008.pdf
	3450-5020	Ambient Air Quality and Meteorological Monitoring Data – Final Validation (Version 2.1 February 2010)	34505020_007.pdf
3550	**Ambient Air Quality and Meteorological Monitoring Data Reporting (Version 5.1 February 2010)**		**3550_007.pdf**
	3550-5000	Ambient Air Quality and Meteorological Monitoring Data – Weekly and Monthly Reporting (Version 4.1 February 2010)	35505000_007.pdf
	3550-5100	Ambient Air Quality and Meteorological Monitoring Data – Annual Reporting (Version 4.0 January 2009)	35505100_006.pdf
	3550-5200	Handling Requests for Ambient Air Quality and Meteorological Monitoring Data (Version 2.5 February 2010)	35505200_007.pdf
	3550-5300	Submitting Ambient Air Quality and Meteorological Monitoring Data to the EPA AQS Database (Version 2.2 January 2009)	35505300_004.pdf
3650	**IMC Manager's Maintenance Responsibilities for the Ambient Air Quality Data Base Management System (AQDBMS) (Version 2.2 February 2010)**		**3650_004.pdf**
Air Quality Data Base Management System (AQDBMS) User's Guide (January 2008)			**AQDBMS_User's Guide 2008.pdf**
Air Quality Data Base Management System (AQDBMS) Database Manager/Programmer's Guide (January 2001)			**AQDBMS_Programmer's Guide 2001.pdf**
STKWIN User Documentation (January 2008)			**Stackplot User's Guide 2008.pdf**

III. FIELD MAINTENANCE AND CALIBRATION PROCEDURES

	3150-2130	Field Calibration and Routine Maintenance of a Tipping Bucket Rain Gauge (Version 1.0 April 2006)	31502130_001.pdf
	3150-2150	Field Calibration and Routine Maintenance of R.M. Young Model 58101 Wetness Sensors (Version 0 September 2005)	31502150_000.pdf
3160	**Calibration of Data Acquisition Systems (Version 1.1 November 2005)**		**3160_002.pdf**
	3160-2100	Calibration ofESC 8816 or 8832 Analog Input Card (Version 0 April 2006)	31602100_000.pdf
3300	**Certification of Ozone Transfer Standards (Version 2.1 November 2005)**		3300_003.pdf

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**PROCEDURES FOR SEMIANNUAL MAINTENANCE VISITS TO A NATIONAL PARK SERVICE AMBIENT AIR MONITORING STATION**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3000**
DATE	**OCTOBER 1990**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	David D. Meisters	
PROJECT MANAGER	John F. Faust	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	G. Mercer
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
0.1	Site visit checklist modifications.	March 1996	G. Mercer
0.2	Modify site visit checklist/change originator.	April 1997	G. Mercer
0.3	Minor procedure changes.	April 1998	G. Mercer
1.0	Added pre- and post-trip proced./update forms.	December 1999	G. Mercer
	Reviewed; no changes necessary.	January 2000	G. Mercer
1.1	Change RH maint. and other minor changes.	January 2001	G. Mercer
	Reviewed; no changes necessary.	January 2002	G. Mercer
	Reviewed; no changes necessary.	January 2003	G. Mercer
	-- continued --		

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QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
	Reviewed; no changes necessary.	January 2004	G. Mercer
1.2	Modify forms and checklists.	January 2005	G. Mercer
1.3	Add consumable items / shelter temp checks	November 2005	G. Mercer
	Reviewed; no changes necessary.	November 2006	G. Mercer
1.4	Added photo documentation procedures.	January 2008	G. Mercer
	Reviewed; no changes necessary.	January 2009	G. Mercer
	Reviewed; no changes necessary.	January 2010	G. Mercer
	Reviewed; no changes necessary.	January 2011	G. Mercer

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LIST OF FIGURES

1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) outlines the steps for performing semiannual maintenance visits to National Park Service (NPS) owned and/or operated ambient air monitoring stations. The primary purpose of a semiannual maintenance visit is to assure quality data capture and minimize data loss by:

- Calibrating and certifying ambient air quality analyzers, samplers, and meteorology sensors to meet U.S. Environmental Protection Agency (EPA) quality assurance requirements.
- Performing preventive maintenance on analyzers, samplers, sensors, and support equipment.
- Providing operator training.

This SOP serves as a guideline to facilitate:

- Trip preparation and notification of appropriate personnel.
- Shelter and tower integrity checks.
- Support systems integrity checks.
- Calibration and maintenance of air quality analyzers.
- Calibration and maintenance of dry deposition sampling systems.
- Calibration and maintenance of meteorology sensors.
- Calibration and maintenance of data acquisition equipment.
- Station modification and enhancements.
- Station operator training.
- Site inventory verification and update.
- Trip reporting and documentation.

Due to the variation of site configurations within the NPS network, portions of this SOP may not apply to every station. Some stations that are unique may require preventive maintenance or other activities not covered within this document. Maintenance personnel are requested to document additional procedures as necessary.

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Coordinate with the NPS Contracting Officer's Technical Representative (COTR) to identify stations to be visited by Air Resource Specialists, Inc. (ARS) personnel, schedule these visits, and see that the park superintendent, NPS Regional Air Quality Coordinator, NPS Regional Air Quality Field Specialists, and park station operators are adequately notified at least two weeks prior to the semiannual visit.

- Review with the ARS field specialist the requirements of the visit depending upon the station configuration, known technical problems, and review of recently collected data.

- Review written trip reports and calibration documents for accuracy and completeness following the site visit.

2.2 FIELD SPECIALIST

The field specialist shall:

- Review with the project manager the requirements of the visit depending upon the station configuration, known technical problems, and review of recently collected data.

- Complete the Pre-Trip Preparation Checklist in preparation for the semiannual visit.

- Contact the station operator and verify that he/she will be available for the semiannual visit and that special transportation or other arrangements can be made.

- Ensure that all calibration standards to be used have been verified and/or calibrated within the appropriate time limits.

- Perform all integrity checks, preventive maintenance, and calibrations in accordance with this SOP.

- Make shipping arrangements for any equipment needed at the site.

- Observe and train the station operator.

- Verify and update site inventories and photographic documentation.

- Complete Equipment Maintenance/Repair Records.

- Update site specifications when appropriate.

- Perform any required station or system modifications or enhancements.

- Complete semiannual station checklists.
- Prepare complete, accurate, written trip reports and calibration documents.
- Follow-up on repairs or calibrations to be completed during the station visit.
- Identify and document any additional action required.

2.3 ADMINISTRATIVE ASSISTANT

The administrative assistant shall:

- Prepare and forward notification letter(s) to the park superintendent, Regional Air Quality Coordinator, Regional Air Quality Field Specialist, and station operator.
- Prepare a trip packet for the field specialist (containing a list of equipment currently at the station to be visited), appropriate maintenance/repair records, and site visit checklists.
- Compile, reproduce, and forward the field specialist's trip reports and documentation.
- Update the electronic status board to document significant repairs or instrument changes made during the station visit.
- Update the equipment inventory database to reflect any changes in monitoring station inventory.
- Update the equipment inventory database to reflect maintenance/repairs recorded on Equipment Maintenance/Repair Records.
- Prepare questions or request specific training to be addressed by the field specialist during the semiannual visit.

2.4 STATION OPERATOR

The station operator shall:

- Be available for the semiannual visit to assist the field specialist and receive training on new equipment or procedures.
- Make any special transportation or other arrangements as necessary for the visit.

3.0 REQUIRED EQUIPMENT AND MATERIALS

Equipment generally required to support a semiannual visit is listed in the Semiannual Site Visit Pre-Trip Preparation Checklist, presented as Figure 3-1. Equipment lists are further detailed in the specific-instrument system SOPs and technical instructions (TIs). Pre-trip and post-trip equipment and materials include a personal computer, word processing and spreadsheet software, and access to the NPS inventory database and the Information Management Center database.

SEMIANNUAL SITE VISIT PRE-TRIP PREPARATION CHECKLIST	Air Resource Specialists, Inc.
✓	**TOOLS AND MISCELLANEOUS EQUIPMENT AND SUPPLIES**
☐	Tools
☐	Datel voltage source and input voltage harness
☐	Datalogger program and software (direct connect cabling)
☐	Digital voltmeter
☐	Laptop computer
☐	Forms
☐	Calculator, notebook
☐	Digital camera
☐	Telephone list with site addresses, motel list, site information table
☐	Trip pack (from Administrative Assistant): inventory, maintenance cards
☐	AC power cords and power strip (at least 4 plugs)
☐	Strapping tape
☐	Calibration stickers, labels, shipping folder, ARS luggage tags
☐	Road maps, atlas
☐	Various equipment batteries (WS motor, flashlight) 9v, AAA, AA
☐	First aid kit
☐	Pump rebuild kit (Thomas, KNF, Brailsford)
☐	"Quick-connect" with tubing to reach BIOS (white color keyed for existing system)
☐	Balston filters
☐	Equipment documentation (usually does not exist on-site)
☐	Climbing belt and bucket
✓	**GASEOUS CALIBRATION AND MAINTENANCE EQUIPMENT AND SUPPLIES**
☐	Transfer standard (ozone)
☐	Zero air source
☐	Charcoal column
☐	Gas regulator
☐	Flow calibrator
☐	Calibration gas
☐	Calibration/audit tubing capped or sealed (1/8", 3/8", 1/2" as required)
☐	Dilution system
☐	Flow pumps if suspect
☐	Teflon fittings/spare glass manifold fittings and o-rings
☐	Filters
☐	Alcohol, Kimwipes, and Q-Tips
☐	Extra lamps (both photometer and generator) (TECO, DASIBI, Monitor Labs)
☐	Ozone scrubbers (Dasibi, Monitor Labs)
☐	Canned air and Snoop
☐	Solenoid valves (ML, TECO, Dasibi, 115 VAC, 24 VDC, etc.)
✓	**METEOROLOGICAL CALIBRATION AND MAINTENANCE EQUIPMENT AND SUPPLIES**
☐	Sling psychrometer and MP601 reference RH sensor
☐	Digital thermometer
☐	Thermos bottles and 12 V heater
☐	Calibration WS motor and controller (test jigs, torque wheel, WD torque tester)
☐	Translator extender card (Climatronics)
☐	Precipitation calibrator (drip bottle, pipette)
☐	Parasitic RH reference holder (Climatronics/Rotronics)
☐	WS/WD bearings, pots, spare keepers OR replacement WS/WD sensors (Climatronics/RMYoung)
☐	Reference solar radiation sensor
☐	Barometer and GPS
☐	Compass and tripod assembly
☐	Campbell datalogger with charger and program instructions
☐	Solar azmuth calculating software

Figure 3-1. Semiannual Site Visit Pre-Trip Preparation Checklist.

4.0 METHODS

This section describes the procedures for semiannual site visits to ambient air quality and meteorological monitoring sites. This section includes three (3) major subsections:

4.1 Pre-Semiannual Site Visit Preparation
4.2 Semiannual Site Visit Procedures
4.3 Post-Semiannual Site Visit Procedures

4.1 PRE-SEMIANNUAL SITE VISIT PREPARATION

The project manager coordinates with the COTR and other personnel to identify what sites require a semiannual maintenance visit and the scheduling of the visits. After the schedule has been agreed upon, all appropriate personnel are notified about the pending visit. The project manager will then discuss specific site maintenance or other requirements needed to be performed during the visit with the assigned field specialist.

The field specialist will contact the station operator and discuss any special arrangements that need to be made for the visit. To ensure that all required equipment and materials will be available for each visit, the field specialist will complete the Semiannual Site Visit Pre-Trip Preparation Checklist (see Figure 3-1). The field specialist will verify that all calibration standards are currently calibrated.

The administrative assistant will prepare and send site visit notification letters two weeks prior to each site visit to the:

- Park superintendent.
- Regional air quality coordinator.
- Regional air quality field specialists.
- Station operator.

The administrative assistant will also prepare a trip pack for the field specialist, which will include:

- A Semiannual Site Visit Pre-Trip Preparation Checklist.
- The current equipment inventory.
- Equipment Maintenance/Repair Records.
- Other pertinent information.

4.2 SEMIANNUAL SITE VISIT PROCEDURES

Semiannual site visits involve several components, including integrity checks, preventive maintenance, calibrations, and corrective actions. The checklist used to ensure that all components of a visit have been adequately addressed is presented in Figure 4-1. Some items on the checklist only require one check. Other items, which relate to the calibration and maintenance of monitoring systems, require three checks as follows:

- **Pre-Maintenance Calibration Check** - Upon arrival and prior to any repairs or adjustments, perform instrument audits, including zero, span, and precision level checks. This audit procedure will help confirm the repeatability confidence established by routine site operations. Document and investigate inconsistencies to identify problems.

- **Preventive/Routine Maintenance** - Perform routine preventive maintenance and make necessary corrective action repairs to stabilize instrument performance and minimize future instrument down time and data loss.

- **Post-Maintenance Calibration** - Following preventive or routine maintenance, perform final calibrations, flow rate, and leakage tests on all instrumentation.

The following subsections detail the procedures to be performed during the semiannual visits.

4.2.1 Shelter and Tower Integrity Check

Refer to Figure 4-1, Semiannual Site Visitation Checklist, Item 1. Upon arriving at the monitoring station, check the following:

- **Shelter exterior** – Check the integrity of the exterior components of the shelter, focusing on the structural and aesthetic conditions, including the roof, siding, door, caulking, weather stripping, power lines, etc.

- **Shelter interior** – Check the integrity of the interior components of the shelter, focusing on the structural and aesthetic conditions, including the floor, walls, ceiling, door, and racks.

- **Shelter electrical –** Check the integrity of the outlets, lights, grounding, and polarity.

- **Shelter heating and air conditioning** – Check the integrity of the heating and cooling systems. Inspect, clean, and check function of thermostats. Review recent shelter temperature values and review DataView for any temperature alarms. Adjust thermostat as necessary to maintain the shelter temperature required for the station instrumentation.

- **Meteorological tower** – Check the integrity of the tower, including supports, guys, hardware, and grounding prior to climbing or lowering.

- **Flow tower –** Check the integrity of the tower, including supports, guys, hardware, and grounding prior to tipping.

SEMIANNUAL SITE VISITATION CHECKLIST
NPS Ambient Air Quality Monitoring Program

Air Resource Specialists, Inc.

Station:
Station Operator:
Visit Conducted By:
Site Visit Dates:

1. SHELTER AND TOWER INTEGRITY (verify condition and proper operation)

	ITEM	CORRECTIVE ACTION
☐	Shelter Exterior (roof, siding, door, etc.)	
☐	Shelter Interior (floor, walls, ceiling, door, racks)	
☐	Shelter Electrical (outlets, lights, grounding, polarity)	
☐	Shelter Heating and Air Conditioning (inspect, clean, check thermostats)	
☐	Meteorological Tower (supports, guys, hardware, grounding)	
☐	Flow Tower (supports, guys, hardware, grounding)	
☐	Other:	

2. SUPPORT SYSTEM INTEGRITY (verify condition and proper operation)

	ITEM	CORRECTIVE ACTION
☐	Lightning Protection Panel (LPP)	
☐	Quality Assurance Monitor (QAM), STP Monitor	
☐	Power and Telephone Lines	
☐	Interconnect Cabling (tower and shelter)	
☐	Intake and Exhaust Manifolds (if applicable)	
☐	Other:	

3. AIR QUALITY EQUIPMENT CALIBRATIONS/MAINTENANCE

Pre Cal.	Maint. Completed	Post-Cal.	ITEM	CORRECTIVE ACTION
☐	☐	☐	O_3 Analyzer	
☐	☐	☐	O_3 Transfer Standard	
☐	☐	☐	Consumable Reagents Replaced (charcoal/dessicant)	
☐	☐	☐	Clean or Change Inlet Tubing	
☐	☐	☐	Other:	

4. DRY DEPOSITION SAMPLING EQUIPMENT CALIBRATION/MAINTENANCE

Pre Cal.	Maint. Completed	Post-Cal.	ITEM	CORRECTIVE ACTION
☐	☐	☐	Sampling System Leak Check	
☐	☐	☐	Flow Controller Calibrated (pre and post values must be documented)	
☐	☐	☐	Replace Balston Particulate Filter	
☐	☐	☐	Rebuild Pump	

5. METEOROLOGICAL EQUIPMENT CALIBRATIONS/MAINTENANCE

Pre Cal.	Maint. Completed	Post-Cal.	ITEM	CORRECTIVE ACTION
☐	☐	☐	Wind Speed Range (4 point)	
☐	☐	☐	Wind Speed Starting Threshold	
☐	☐	☐	Wind Direction Orientation and Linearity (8 point)	
☐	☐	☐	Wind Direction Torque	
☐	☐	☐	Temperature Probes (3 point)	
☐	☐	☐	Relative Humidity Sensor (hourly averages)	
☐	☐	☐	Aspirators (Climatronics/Qualimetrics/RM Young/Rotronics)	
☐	☐	☐	Solar Radiation (hourly averages)	
☐	☐	☐	Precipitation	
☐	☐	☐	Wetness	
☐	☐	☐	Other:	

-- Continued --

Figure 4-1. Semiannual Site Visitation Checklist for the NPS Ambient Air Quality Monitoring Program.

SEMIANNUAL SITE VISITATION CHECKLIST
NPS Ambient Air Quality Monitoring Program

Air Resource Specialists, Inc.

6. DATA ACQUISITION CALIBRATIONS/ MAINTENANCE/ OPERATIONAL VERIFICATION

Pre Cal.	Maint. Completed	Post-Cal.	ITEM	CORRECTIVE ACTION
☐	☐	☐	Datalogger Time and Date	
☐	☐	☐	Datalogger Keyboard (operations test, cleaned)	
☐	☐	☐	Datalogger Modem	
☐	☐	☐	DataView System (computer operational, software functioning, communication links functioning)	
☐	☐	☐	Printer (operations test, ribbon, cleaned)	
☐	☐	☐	Other:	

7. STATION MODIFICATIONS AND CONFIGURATION ENHANCEMENTS

Pre Cal.	Maint. Completed	Post-Cal.	ITEM	CORRECTIVE ACTION
☐	☐	☐		
☐	☐	☐		
☐	☐	☐		
☐	☐	☐		

8. OBSERVE/TRAIN STATION OPERATOR

ITEM	CORRECTIVE ACTION
☐ Observe Operator Competence	
☐ Review Log Notes, Data Documentation	
☐ Train, if necessary	
☐ Review Changes in SOPs or Other Operational Changes	
☐ Verify That On-Site SOPs are Available and Complete	
☐ Encourage/Answer Station Operator Comments or Questions	
☐ Inform Operator if Additional Action is Required	

9. VERIFY AND UPDATE SITE EQUIPMENT INVENTORIES AND DOCUMENTATION

ITEM	CORRECTIVE ACTION
☐ Inventory Completed	
☐ Site Documentation Photographs Taken:	

- Cardinal Directions
- Shelter Exterior Close-up
- Tower(s) with Instrumentation
- All Other Exterior Instrumentation
- Interior Instrumentation
- Scenic Photograph

10. SUPPLEMENTAL FLOW CHECKS (please note)

Pre Cal.	Maint. Completed	Post-Cal.	ITEM	CORRECTIVE ACTION
☐	☐	☐		
☐	☐	☐		
☐	☐	☐		

Semiannual visit checklist.doc (01/08)

-- End --

Figure 4-1 (Continued). Semiannual Site Visitation Checklist for the NPS Ambient Air Quality Monitoring Program.

Correct any condition considered unsafe before continuing any further station activities. Perform standard preventive maintenance and other necessary repairs, and coordinate with the station operator any painting and repair or replacement of any system component deemed unsightly or needing ongoing preventive care.

4.2.2 Support Systems Integrity Checks

Refer to Figure 4-1, Semiannual Site Visitation Checklist, Item 2. Verify the condition and proper operation of the following monitoring support systems:

- **Lightning Protection Panel (LPP)** - Verify the proper operation and check all connections and transorbs. The LPP provides lightning surge protection for instrument AC power, telephone modem, and meteorological signal conditioning cards.

- **Quality Assurance Monitor (QAM) -** Verify proper operation, and verify that the shelter temperature measurement is within 1°C of a NIST-traceable thermometer.

- **Power and Telephone Lines** - Verify the proper operation of the telephone line, and check line polarity, grounding, and lightning protection connections. Check the integrity of the cables.

- **Interconnect Cabling** - Verify that all signal wiring and tower cabling are in good condition, properly strain-relieved, and securely connected.

- **Intake and Exhaust Manifolds** - Verify the integrity and proper assembly and operation of the system (if applicable). Replace intake manifold pump diaphragm annually. Clean and maintain as necessary.

Correct any malfunctions and/or replace system components.

4.2.3 Air Quality Equipment Calibrations and Maintenance

Refer to Figure 4-1, Semiannual Site Visitation Checklist, Item 3. Document in the DataView electronic logbook any preventive maintenance, repair, or adjustments made. Summarize in a written trip report, and note on the instrument's Equipment Maintenance/Repair Record (blue card) as shown in Figure 4-2. Document instrument or sensor response on the appropriate Excel calibration forms.

Pre- and post-maintenance calibrations of ambient air quality analyzers will be made in accordance to ARS SOP 3100, *Calibration of Ambient Air Quality Analyzers*, NPS SOPs, instrument-specific technical instructions, manufacturer's specifications, and other supporting documentation. All sites that have ozone (O_3) monitoring systems; perform the following preventive maintenance tasks for UV photometric-type O_3 analyzers and/or transfer standards:

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Fax: 970-484-3423

EQUIPMENT MAINTENANCE/REPAIR RECORD

Item: ___________ Manufacturer: _________ Model #: ______ Serial #: ______ Owner:

Date	Repair Location	Maintenance or Repair Description

Figure 4-2. Equipment Maintenance/Repair Record (Blue Card).

- **Ozone analyzers** - Inspect and clean the entire absorption cell, including tube(s), mirrors, and windows. Replace the O_3 scrubber (converter) as needed. Check the solenoid valve for leaks across ports (intra-port leak) and replace the solenoid if faulty. Check the entire sample flow path for leaks and seal leaks if found. Replace the ultraviolet source lamp annually or when performance is below manufacturer's specifications, and replace pumps or other components when required.

- **Consumable reagents –** Replace the charcoal or desiccant, as required.

Perform calibration and maintenance procedures on other air quality analyzers (e.g., SO_2, NO_x) as specified in instrument-specific technical instructions. Procedures for some instrumentation may only be practical at an air quality laboratory. The field specialist is responsible for arranging for instrument removal, transport, maintenance, and coordinating removal and installation.

4.2.4 <u>Dry Deposition Sampling Equipment</u>

Refer to Figure 4-1, Semiannual Site Visitation Checklist, Item 4. Complete a calibration check of the filter pack sampling system before and after performing any preventive maintenance. See ARS SOP 3180, *Calibration of Mass Flowmeters and Mass Flow Controllers*, for assistance. Perform the following tasks during calibration checks:

- **Sampling system leak check** - Check the entire sample flow path for leaks and seal leaks if found.

- **Flow controller calibrated** - Calibrate the flow of the mass flow controller. Calculate and adjust the mass flow controller and datalogger to indicate proper flow rate. Finally, document pre- and post-maintenance flow rate, and control setting.

Perform the following preventive maintenance tasks:

- **Replace Balston particulate filter** - Replace the Balston particulate filter.

- **Rebuild pump –** Rebuild the pump semiannually and tighten all fittings and tubing.

- **Replace system tubing** as required.

4.2.5 <u>Meteorological Equipment Calibrations and Maintenance</u>

Refer to Figure 4-1, Semiannual Site Visitation Checklist, Item 5. Calibration of meteorological sensors shall be made in accordance with ARS SOP 3150, *Calibration and Routine Maintenance of Meteorological Monitoring Systems*, instrument-specific TIs, NPS SOPs, manufacturer's specifications, and other supporting documentation. A summary of meteorological checks follow:

- **Wind speed/wind direction** - Replace the bearings annually or more frequently, depending upon the pre-maintenance calibration check. Inspect the wind vane or anemometer cups for damage or corrosion that may affect performances. Inspect and repair wiring and/or connectors, and verify the operation of the heater sleeves.

- **Temperature/Delta temperature** - Inspect for corrosion or damage, and replace if necessary. Check the sensor's response with three known temperature baths.

- **Relative humidity –** Perform pre- and post-maintenance checks with a reference relative humidity sensor and replace the sensor every 6 months for laboratory calibration.

- **Aspirators** - Clean the temperature/relative humidity aspirator housings or non-aspirated shields, and replace the aspirator motor as necessary (i.e., noisy bearings).

- **Solar radiation** - Clean the glass cover and inspect the sensor and cabling. Replace the leveling bubble assembly if broken. Level and tighten the sensor to the mounting arm.

- **Precipitation** - Inspect and clean the tipping bucket type gauge and remove foreign material. Observe free movement of the bucket, level the sensor if necessary, and verify that the heater operates properly.

- **Wetness** - Inspect the sensor for damage and secure the mounting. Test for proper operation.

4.2.6 Data Acquisition Calibrations, Maintenance, and Operational Verification

Refer to Figure 4-1, Semiannual Site Visitation Checklist, Item 6. Calibration of all data acquisition system and strip chart recorders will be made in accordance to ARS SOP 3160, *Calibration of Data Acquisition Systems*, and ARS SOP 3170, *Calibration of Strip Chart Recorders*. Proper operation of the DataView system will also be verified. Perform the following preventive maintenance tasks:

- **Datalogger –** Check all SIP connections, lightning protection circuits through the LPP and AC, and telephone circuits, and tighten or repair if necessary. Check the datalogger's date and time. Verify the operation of the display and clean the display.

- **Datalogger Keyboard –** Clean the keyboard and check for correct operation.

- **Datalogger Modem –** Check the datalogger modem for correct operation.

- **DataView System –** Verify that the DataView computer and software are fully functional, and that the communications links to the datalogger, modem, and printer are operational.

- **Printer –** Check the printer for correct operation, and change the ink cartridge if necessary.

4.2.7 Station Modifications and Configuration Enhancements

Refer to Figure 4-1, Semiannual Site Visitation Checklist, Item 7. The configuration of network stations will evolve in response to changes in instrumentation, technology, quality assurance requirements, or monitoring program goals. Reconfiguration goals include: enhancing accommodation of EPA quality assurance requirements and simplifying regular maintenance; troubleshooting; and calibration tasks performed by station operators, maintenance personnel, and system auditors. ARS will perform any required station modifications or configuration enhancements in response to COTR guidance.

In addition, assistance will be provided to the NPS ARD (National Park Service Air Resources Division) staff, as required, to revise the Quality Assurance Program Plan, standard operating procedures, or technical instructions, or to develop and write new components of quality assurance documentation to account for any system modifications or configuration enhancement.

4.2.8 Observe/Train Station Operator

Refer to Figure 4-1, Semiannual Site Visitation Checklist, Item 8. Following the completion of all scheduled calibrations and maintenance, spend as much time as required with station operators to ensure that the operators have a complete and working knowledge of their required duties. The overall quality of network operators directly translates to the quality of network data. The field specialist will:

- **Observe operator –** Observe the operator perform a complete station check and review procedures for zero checks, precision span checks, and multipoint calibrations.
- **Review log notes** - Review operator log notes, station checklists, calibration forms, other data documentation, and overall station organization.
- **Train** - Further train the station operator on any aspect of multipoint calibrations, precision checks, data reporting, data transmittal, or other operational requirement where deficiencies are observed.
- **Review changes –** Thoroughly review any changes in SOPs or operations with the station operator.
- **Verify on-site SOPs** - Verify that the current versions of all SOPs are available on-site, and update if necessary to reflect any changes in instrumentation, procedures, or protocols.
- **Verify inventory** - Verify that the operator has an adequate inventory of all required forms and consumable supplies, including desiccant, particulate filters, gloves, printer ink, and similar items.
- **Encourage/answer questions –** Encourage station operator comments and fully answer any questions the operator may have. Note any operator comments or suggestions.
- **Inform** - Update the operator on the monitoring program goals and objectives. Instill in each operator a sense of purpose to stimulate self-interest and responsibility.

4.2.9 Verify and Update Site Equipment Inventories and Documentation

Refer to Figure 4-1, Semiannual Site Visitation Checklist, Item 9. Verify the manufacturer, description, model number, serial number, and government property number of all monitoring site equipment against the equipment inventory database listing for the site. Document any inconsistencies noted or changes in system hardware performed during a site visit. A computer printout of inventory items currently at the site is used to verify site equipment. An example printout is presented in Figure 4-3. If the site is new, a Capital Equipment Inventory Checklist is used to list equipment at each site. The checklist is presented in Figure 4-4.

Take site documentation photographs of:

- The four cardinal directions (North, West, South, East)
- A close-up of the shelter exterior
- The meteorological tower(s) with instrumentation
- All other exterior instrumentation
- Interior instrumentation
- A scenic view

4.2.10 Supplemental Flow Checks

Refer to Figure 4-1, Semiannual Site Visitation Checklist, Item 11. In addition to performing sample flow rate checks on the gaseous monitors and dry deposition monitors, document flow checks also performed on any collocated particulate samplers, such as IMPROVE samplers, operated by the NPS. Perform all flow supplemental checks with a mass flowmeter traceable to NIST standards.

4.3 POST-SEMIANNUAL VISIT PROCEDURES

The field specialist will compile a written trip report following each semiannual site visit. Each report will summarize conditions found upon arrival, problems noted, corrective actions, training, inventory lists, site visitation checklist, pre- and post-maintenance calibration documents, and problems requiring further attention. Example trip reports can be found in the Monthly Technical Progress Reports forwarded to the COTR. The administrative assistant will word process the trip reports and forward them to the project manager for review. After review, copies of the trip reports will be delivered to the:

- Station operator (within 14 days of return from site visit).
- IMC Manager.

INVENTORY REPORT FROM FILE LINPSINV.vws
FOR SITE BIBE
01/06/97 16:35:21

ITEM ID #	SITE NAME	ITEM NAME	MAN'F	MODEL	SERIAL #	PROPERTY #	BAR CODE #
88	BIBE	ASPIRATOR (UPPER)	CLIMATRONICS	1000325	1275		
89		ASPIRATOR (LOWER)	CLIMATRONICS	100325	1386	01497	----
173		CALIBRATOR - O3	DASIBI	1003-PC	5169	02262	NP1200065050
1582		CROSSARM	CLIMATRONICS	100487	1496		
222		DATALOGGER	SUMX	SX444	028	01566	----
1433		DATA STORAGE MODULE	SUMX		14923		
1646		DESK	WW GRAINGER	32385			
398		JUNCTION BOX	CLIMATRONICS			01501	NP1200002973
447		KEYBOARD	TANDY	102	802003220		
499		LPP	DRI		116		
538		MAINFRAME	CLIMATRONICS	100081	1379		
2002		MASS FLOW CONTROLLER	TYLAN		FP9403014		
32		MODEM	VIVA	24	10042-CT		
1700		MOUNTAIN PLATE	DAN WILSON				
633		POWER SUPPLY	CLIMATRONICS	101074	806	01500	NP12000002974
655		PPT SENSOR	CLIMATRONICS	100508	414	01498	NP1200002976
729		PRINTER	TANDY	DMP-107	0219910		
1335		QAM	INTERMOUNTAIN AC		021		
792		RECORDER	CHESEL	300D	8607-718	01140	----
2003		RH SENSOR	CLIMATRONICS			EPA 01342	
2053		RH SENSOR	CLIMATRONICS		23380C	EPA 03251	
2052		RH TRANSLATOR CARD	CLIMATRONICS	100224	196	EPA 00376	
1642		SHELTER	CORNERSTONE				
1416		SOLAR RAD SENSOR	CLIMATRONICS	101655	13178		
2001		TEMP SENSOR (LOWER)	CLIMATRONICS				
2000		TEMP SENSOR (UPPER)	CLIMATRONICS			EPA 0270	
1110		WD SENSOR	CLIMATRONICS	100076	1521		
1164		WD VANE	CLIMATRONICS		50		
1999		WETNESS SENSOR	R.M. YOUNG	58120		EPA 03014	
1222		WS CUPS	CLIMATRONICS		069		
1205		WS SENSOR	CLIMATRONICS	100075	1806		

Figure 4-3. Example Computer Printout of Inventory Items.

NPSAIR CAPITAL EQUIPMENT INVENTORY CHECKLIST					
Site:		Date:		Taken by:	
✓	Description	Manufacturer	Model #	Serial #	NPS #
	Analyzer - O_3				
	Analyzer - SO_2				
	Transfer Standard - O_3				
	Transfer Standard - SO_2				
	O_3				
	SO_2				
	Calibrator(s)				
	Zero air source				
	Power supply				
	Mainframe				
	Aspirator (upper)				
	Telephone				
	Modem				
	Datalogger				
	Computer (laptop)				
	Printer				
	Junction box				
	Crossarm				
	LPP				
	SIP				
	Wind speed cups				
	Wind vane				
	QAM				
	Wind speed sensor				
	Wind direction sensor				
	Temperature sensor (upper)				
	Station temp reference				
	Solar radiation sensor				
	Precipitation sensor				
	Relative humidity sensor				
	Radiation card				
	Wind card				
	Temperature card				
	Temperature sensor (lower)				
	Aspirator (lower)				
	Wetness sensor				
	Filter pack flow controller				
	RH aspirator				
EQUIPMENT REMOVED					

AAQ inventory checklist.doc (12/99)

Figure 4-4. NPSAIR Capital Equipment Inventory Checklist.

Trip reports should include the following sections:

1.0 INTRODUCTION

2.0 SITE VISIT	Station Operator Monitoring Shelter Meteorological Instrumentation Ozone (O_3) Instrumentation Other Instrumentation Additional Action Required
3.0 CALIBRATION FORMS	Ozone (O_3) Calibration Pre-Maintenance Ozone (O_3) Calibration Post-Maintenance Sulfur Dioxide (SO_2) Calibration Carbon Monoxide (CO) Calibration Oxides of Nitrogen (NO,NO_2, NO_x) Calibration Meteorological Calibration - Wind Speed/Wind Direction Meteorological Calibration - Weather Parameters: Temperature, Delta Temperature, Relative Humidity, Solar Radiation, Precipitation, Wetness Dry Deposition Sampler Flow Data Semiannual Site Visitation Checklist Site Inventory Checklist

The field specialist shall also follow-up on repairs or other action required at the sites, and ensure these actions are performed, as documented in the trip report.

The administrative assistant will update the Electronic Status Board to document repairs or instrument changes at the site, update the Equipment Inventory database to reflect changes in inventory at the site, and document maintenance or repairs made to equipment. Finally, the administrative assistant will produce, deliver, and file the trip reports and repair records.

Air Resource Specialists, Inc.
1901 Sharp Point Drive, Suite E
Fort Collins, CO 80525
Phone: 970-484-7941
Fax: 970-484-3423

QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**SITING OF AMBIENT AIR QUALITY MONITORING STATIONS**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3050**
DATE	**JULY 2004**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Gloria S. Mercer	Gloria S. Mercer
PROJECT MANAGER	John F. Faust	John F. Faust
PROGRAM MANAGER	Joe Adlhoch	
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
	Reviewed; no changes necessary.	July 2005	G. Mercer
0.1	Add met sensor height, correct ozone height.	November 2005	G. Mercer
	Reviewed; no changes necessary.	November 2006	G. Mercer
	Reviewed; no changes necessary.	November 2007	G. Mercer
	Reviewed; no changes necessary.	November 2008	G. Mercer
0.2	Updated Reference section.	November 2009	G. Mercer
	Reviewed; no changes necessary.	November 2010	G. Mercer

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1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) outlines the site selection criteria required for ambient air monitoring stations. Proper siting of a monitoring station can help ensure that collected on-site data are valid. In all cases, the meteorological data collected should be of the quality of data collected by the National Weather Service. The objective is to characterize the ambient air in proximity to the monitoring location.

Monitoring sites are representative of the regional, national, and global spatial scales of representativeness defined in 40 CFR Part 58, Appendix D. Site locations and placement of gaseous sample inlet probes meet the requirements of 40 CFR Part 58, Appendix E.

This procedure specifically describes:

- General site criteria.
- Meteorological monitoring site criteria.
- Gaseous monitoring site criteria.

2.0 RESPONSIBILITIES

2.1 PROGRAM MANAGER

The program manager shall:

- Inform the project manager of the location area and site-specific monitoring objectives for a proposed ambient air monitoring site.
- As required, review the selected site with the project manager and the project-specific Contracting Officer’s Technical Representative (COTR).

2.2 PROJECT MANAGER

The project manager shall:

- Prepare project-specific siting and operational objectives, guidelines, and considerations.
- Review with the field specialist photographic documentation, maps, and other information to determine the suitability of a site.
- Select the site based on the criteria outlined in this SOP.
- As required, review the selected site with the program manager.

2.3 FIELD SPECIALIST

The field specialist shall:

- Initiate the search for potential sites by sending pertinent siting criteria and associated materials to a local contact (if available).
- Conduct a siting visit if required.
- Contact the local power and telephone companies for information concerning availability and installation.
- Obtain permission to perform any site preparation that may be required.
- Obtain permission from private or public landowners for permanent access to the monitoring location.
- Obtain permits or Environmental Impact Statements if required.
- Work with the local contact or sponsoring agency to identify a site operator and local primary contact to service the equipment.
- Review with the project manager photographic documentation, maps, and other information to determine the suitability of a site.
- Forward all site selection information to the Information Management Center (IMC) for input into the Air Quality Data Base Management System.

2.4 LOCAL (ON-SITE) CONTACT

The local contact (if available) shall:

- Locate and document potential sites upon receiving the siting criteria and associated materials from the field specialist.
- Provide the field specialist with any pertinent site-related information.
- Assist the field specialist in obtaining any site access and/or installation-related clearances or permissions.

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment and materials are generally required to complete the site selection process:

- Topographic maps of the area of interest
- Camera(s) to photograph the proposed site and area
- A list of monitoring objectives, requirements, and associated air quality monitoring equipment

- A list of local sources affecting the air in the area of interest
- Information about the availability of AC power and telephone service
- New Site/Site Relocation Form

4.0 METHODS

This section describes site selection procedures and includes four (4) major subsections:

4.1 General Site Criteria
4.2 Meteorological Monitoring Site Criteria
4.3 Gaseous Monitoring Site Criteria
4.4 Site Documentation

4.1 GENERAL SITE CRITERIA

General site criteria to consider when locating potential ambient air monitoring sites are:

- The site is representative of the air mass to be monitored.
- The site is representative of regional, not local meteorological conditions.
- The site has year-round accessibility.
- A power supply is available nearby.
- The site is in open space away from obstructions.
- The site is secure from vandalism or damage due to animals.
- The site's proximity to a nearby town.
- The monitoring station will be aesthetically pleasing and blend in with the surrounding environment.
- The site is at least 500 meters (1,650 feet) from heavily traveled roadways.
- The site is at least 2 km (1.2 miles) from major highways, airports, navigable waterways, and rail yards.
- The site is at least 200 meters (660 feet) from large parking lots and at least 100 meters from small parking lots.
- The site is at least 500 meters from intensive agricultural operations.
- The site is at least 200 meters (660 feet) from grazing animals or range used by livestock.

4.2 METEOROLOGICAL MONITORING SITE CRITERIA

Site criteria to consider for meteorological monitoring instrumentation are:

- The standard exposure height of wind instruments should be 10 meters (33 feet).
- The distance between the instrument and an obstruction should be at least 10 times the height of that obstruction.
- Wind instruments should be mounted on booms at 90° to the predominant wind direction (for up-valley and down-valley flows).
- The recommended vertical heights for measuring temperature difference are 2 meters (6.6 feet) and 9 meters.
- The site elevation is between the highest and lowest elevations within the nearest Class I area.
- Aspirated shields should be used to ventilate instruments.
- Temperature sensors should be located at a distance of at least 4 times the height of any obstruction.
- Temperature sensors should be located at least 30 meters (100 feet) from large paved areas.
- Heated rain gauges should be used to properly measure frozen precipitation.
- Rain gauges should be located at 1-2 meters above ground level so the mouth is horizontal to the sky.
- Wind shields should be used where significant snowfall occurs.
- Pyranometers (measuring incoming solar radiation) should be located where no shadows are cast.
- Pyranometers should have an unrestricted view of the sky from all directions in all seasons at 1-2 meters above ground level.
- Barometric pressure sensors should be located at 2 meters above ground level.
- Wetness sensors should be located at 2 meters above ground level.
- Approval and/or permits are obtained to clear land for site installation.

4.3 GASEOUS MONITORING SITE CRITERIA

Monitoring site criteria to consider when locating gaseous instrumentation are detailed in the following subsections.

4.3.1 Ozone Probe Site Criteria

- Vertical probe placement is 3-15 meters above ground.
- Spacing from supporting structures is more than 1 meter.
- Obstacle distance is at least twice the height the obstacle protrudes above the probe.
- The probe must have unrestricted airflow. It must include the predominant wind; 270°, otherwise 180° if the probe is located on the side of a building.
- Spacing between the station and roadway (see Table 4-1).

Table 4-1

Minimum Separation Distance Between Roadways and Probes or Monitoring Paths for Monitoring Neighborhood and Urban Scale Ozone and Nitrogen Dioxide

Roadway average daily traffic, vehicles per day	Minimum separation distance[1] in meters
≤ 10,000	10
15,000	20
20,000	30
40,000	50
70,000	100
≥ 110,000	250

[1] Distance from the edge of the nearest traffic lane. The distance for intermediate traffic counts should be interpolated from the table values based on the actual traffic count.

- Spacing from trees should be at least 20 meters from dripline, and must be at least 10 meters if blocking daytime wind from an urban core.
- The probe material must be of Teflon or Pyrex glass.
- Residence time must be less than 20 seconds.

4.3.2 Sulfur Dioxide Probe Site Criteria

- Horizontal and vertical probe placement is 3-15 meters above ground and more than 1 meter from a supporting structure.
- Probe placement must be away from dirty, dusty areas, and if on the side of a building, should be on the side of the prevailing winter wind.
- The probe should be at least 1 meter from walls, parapets, penthouses, etc.
- If neighborhood scale, the probe must be at a distance at least twice the height the obstacle protrudes above the probe.

- The probe must have at least a 270° arc of unrestricted airflow around vertical probes (180° if on the side of a building), and wind during the peak season must be included in the arc.
- No furnace or incineration flues or other minor sources of SO_2 should be nearby.
- Spacing from trees should be at least 20 meters from dripline, and must be at least 10 meters if trees act as an obstruction.

4.3.3 <u>Carbon Monoxide Probe Site Criteria</u>

- Horizontal and vertical probe placement is 3 (±1½) meters above ground for microscale and 3-15 meters above ground for middle and neighborhood scale.
- Spacing from obstructions is at least 270°, or 180° if the probe is located on the side of a building.
- Spacing from roads is 2-10 meters from the edge of the nearest traffic lane for microscale, or at least 10 meters from an intersection, preferably at midblock. See Table 4-2 for middle and neighborhood scale.

Table 4-2

Minimum Separation Distance Between Roadways and Probes or Monitoring Paths for Monitoring Neighborhood Scale Carbon Monoxide

Roadway average daily traffic, vehicles per day	Minimum separation distance[1] for probes or 90% of a monitoring path (meters)
≤ 10,000	10
15,000	25
20,000	45
30,000	80
40,000	115
50,000	135
≤ 60,000	150

[1] Distance from the edge of the nearest traffic lane. The distance for intermediate traffic counts should be interpolated from the table values based on the actual traffic count.

- Spacing from trees should be at least 10 meters from dripline, if tree is at least 5 meters above sampler and is between the probe and the road.

4.3.4 <u>Nitrogen Dioxide Probe Site Criteria</u>

- Vertical probe placement is 3-15 meters above ground.
- Spacing from supporting structures is more than 1 meter.
- Obstacle distance is at least twice the height the obstacle protrudes above the probe.

- The probe must have unrestricted airflow; 270° or 180° if the probe is located on the side of a building.
- Spacing between station and roadway (see Table 4-1).
- Spacing from trees should be at least 20 meters from dripline, if tree is above the height of the probe by 5 meters or more.
- Probe material must be of Teflon or Pyrex glass.
- Residence time must be less than 20 seconds.

4.4 SITE DOCUMENTATION

The IMC maintains records of the characteristics of the sites (refer to SOP 3650, *IMC Staff's Maintenance Responsibilities for the Ambient Air Quality Data Base Management System (AQDBMS).* These records are intended to provide a permanent history of the following site information (see Figure 4-1):

- Site identification
- Site classification
- Topographic characteristics
- Meteorology and climatology
- Obstructions that influence the site
- Characteristics of the sampling probes
- Pollutant parameter monitors
- Site and data record histories
- Site representativenss
- Custody and control of data

These records will be upgraded as changes occur and will be used to document compliance with the Part 58 network design and siting criteria.

5.0 REFERENCES

Environmental Protection Agency, 2007, 40 CFR Part 58 Appendix D, June.

Environmental Protection Agency, 2006, 40 CFR Part 58 Appendix E, October.

Environmental Protection Agency, 2000, Meteorological Monitoring Guidance for Regulatory Modeling Applications, Office of Air Quality Planning and Standards, EPA-450/R-99-005, Research Triangle Park, NC, February.

Information Management Center (IMC)
New Site / Site Relocation Form

Today's Date: __________________ Change Effective Date: __________________ Initials: ________________ Site Name: __________________________

Landmark Location Description: ____ Six-Letter Abbr.: __________ Polling Abbr.: __________

Password: ______________________ Database Site Number: ____________ No. of Parameters: ____________

Site Telephone Number: ________________________ Land Line or Cell: ___________________

DataView: (Y/N) Datalogger type: __________________ Datalogger ID: _______________ Modem Type: ________________ Baud Rate: ______________

AIRS Codes: State:________ County: ____________ Agency: ______________ Site Number: _________ EPA Region: __________

Location: (Nearest City or County, etc.): __________________________ State: ________ Time Zone: ___________ NPS Region: __________________

Line ID(s): ______________ _________________ ___________________ Calibration Sequence(s): ____

Latitude: Deg_______ Min______ Sec_______ Longitude: Deg______ Min______ Sec______ Elevation (m): _____________

New Configuration: **PLEASE ADVISE IMC PRIOR TO EFFECTIVE DATE OF AS MUCH OF THIS INFORMATION AS POSSIBLE**

Channel Number																						
Channel Name																						
Channel Units																						
Full Scale Value																						
High Output																						
Low Output																						
Resolution (decimal places)																						
Load Channel (Y/N)																						

Comments: ____

____

____

Figure 4-1. Information Management Center (IMC) New Site / Site Relocation Form.

Information Management Center (IMC)
New Site / Site Relocation Form

SITE:

____

LOCATION SETTING:

_______________ Urban (1)

_______________ Suburban (2)

_______________ Rural (3)

LAND USE:

______________ Forest (5)

______________ Desert (6)

______________ Other (Specify)

ROAD TYPE:

______________ Arterial (1)

______________ Expressway (2)

______________ Freeway (3)

______________ Major Street or Highway (4)

______________ Through Street or Highway (5)

______________ Local Street or Highway (6)

ESTIMATED DAILY TRAFFIC FLOW:

________________ cars/day

NEAREST STREET NAME:

____

ESTIMATE OF ACCURACY IN DETERMINING LAT/LONG:

____________ Min

____________ Sec

METHOD OF DETERMINING LAT/LONG:

____________ Navigation Quality GPS (NAV-GPS)

____________ Geodetic Quality GPS (SUR-GPS)

____________ 7.5' x 7.5' (Scale 1:20,000) Map (20000A)

____________ 7.5' x 7.5' (Scale 1:20,000 Map (20000B)

____________ 7.5' x 7.5' (Scale 1:24,000) Map (24000A)

____________ 7.5' x 15' (Scale 1:24,000) Map (24000B)

____________ Other map (Specify Scale: 1:_______________)

____________ Other Method (Specify: ___________________)

Figure 4-1 (continued). Information Management Center (IMC) New Site / Site Relocation Form.

Information Management Center (IMC)
New Site / Site Relocation Form

Site Evaluation in Conformance with EPA Requirements: Site Name: ______________________ Observed by: ______________

Make and Model #: Carbon Monoxide Monitor: ______________________ Nitrogen Dioxide Monitor: ______________________

CRITERIA	REQUIREMENTS*	CRITERIA MET? Yes	No
CARBON MONOXIDE			
Horizontal and Vertical Probe Placement (Par. 4.1)	3 ± 1 ½ m for microscale		
	3-15 m for middle and neighborhood scale		
Spacing from Obstructions (Par. 4.2)	≥270° or 180° if on side of building		
Spacing from Roads (Par. 4.3)	2-10 m from edge of nearest traffic lane for microscale; ≥10 m from intersection, preferably at midblock		
	See Table 1 for middle and neighborhood scale		
Spacing from Trees (Par 4.4)	Should be ≥10 m from dripline of trees, if tree is ≥5m above sampler and is between the probe and the road.	N/A	
Comments:			

NITROGEN DIOXIDE			
Vertical Probe Placement (Par. 6.1)	3-15 m above ground		
Spacing from Supporting Structure (Par. 6.1)	Greater than 1 m		
Obstacle Distance (Par. 6.2)	≥Twice the height the obstacle protrudes above probe		
Unrestricted Airflow (Par. 6.2)	Must be 270° or 180° if on side of building		
Spacing between Station and Roadway (Par. 6.3)	See Table 2		
Spacing from Trees (Par. 6.4)	Should be ≥20 m from dripline of trees	N/A	
	Must be ≥10 m from dripline, if trees are an obstruction **		
Probe Material (Par. 9)	Teflon or pyrex glass		
Residence Time (Par. 9)	Less than 20 seconds		
Comments:			

* Citations from 40 CFR 58, Appendix E.
** A tree is considered an obstruction if it protrudes above the height of the probe by 5 meters or more.

Figure 4-1 (continued). Information Management Center (IMC) New Site / Site Relocation Form.

Information Management Center (IMC)
New Site / Site Relocation Form

Site Evaluation in Conformance with EPA Requirements: Site Name: ______________________ Observed by: ______________

Make and Model #: Ozone Monitor: __________________________ Sulfur Dioxide Monitor: ______________________

CRITERIA	REQUIREMENTS*	CRITERIA MET?	
		Yes	No
OZONE			
Vertical Probe Placement (Par. 5.1)	3-15 m above ground		
Spacing from Supporting Structure (Par. 5.1)	Greater than 1 m		
Obstacle Distance (Par. 5.2)	≥twice the height the obstacle protrudes above probe		
Unrestricted Airflow (Par. 5.2)	Must include predominant wind. 180° if on side of building. Otherwise 270°.		
Spacing between Station and Roadway (Par. 5.3)	See Table 3		
Spacing from Trees (Par. 5.4)	Should be ≥20 m from dripline	N/A	
	Must be ≥10 m if blocking daytime wind from urban core		
Probe Material (Par. 9)	Teflon or pyrex glass		
Residence time (Par. 9)	Less than 20 seconds		
Comments:			

SULFUR DIOXIDE			
Horizontal and Vertical Probe Placement (Par. 3.1)	3-15 m above ground		
	> 1 m from supporting structure		
	Away from dirty, dusty areas		
	If on side of building, should be on side of prevailing winter wind	N/A	
Spacing from Obstructions (Par. 3.2)	≥1 m from walls, parapets, penthouses, etc.		
	If neighborhood scale, probe must be at a distance ≥twice the height the obstacle protrudes above probe		
	≥270°arc of unrestricted airflow around vertical probes, and wind during peak season must be included in arc		
	180° if on side of building		
	No furnace or incineration flues or other minor sources of SO_2 should be nearby	N/A	
Spacing from Trees (Par. 3.3)	Should be ≥20 m from dripline of trees	N/A	
	≥10 m when trees act as an obstruction		
Comments:			

* Citations from 40 CFR 58, Appendix E.

Figure 4-1 (continued). Information Management Center (IMC) New Site / Site Relocation Form.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**CALIBRATION OF AMBIENT AIR QUALITY ANALYZERS**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3100**
DATE	**JUNE 1990**

AUTHORIZATIONS

TITLE	NAME	SIGNATURE
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PROJECT MANAGER	John F. Faust	John F. Faust
PROGRAM MANAGER	Joe Adlhoch	[illegible]
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY

REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Modifications to precision calculations.	June 1996	G. Mercer
2.0	Modifications to format.	February 1997	G. Mercer
	Reviewed; no changes necessary.	June 1998	G. Mercer
	Reviewed; no changes necessary.	June 1999	G. Mercer
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	Reviewed; no changes necessary.	June 2001	G. Mercer
2.1	Change name of calibration form.	June 2002	G. Mercer
	Reviewed; no changes necessary.	June 2003	G. Mercer
	-- continued --		

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REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
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	Reviewed; no changes necessary.	November 2006	G. Mercer
	Reviewed; no changes necessary.	November 2007	G. Mercer
	Reviewed; no changes necessary.	November 2008	G. Mercer
2.3	Updated Reference section.	November 2009	G. Mercer
	Reviewed; no changes necessary.	November 2010	G. Mercer

TABLE OF CONTENTS

1.0 PURPOSE AND APPLICABILITY

The purpose of this standard operating procedure (SOP) is to outline the steps for calibration and maintenance of air quality analyzers and/or transfer standards. This document applies to calibrations of ozone (O_3), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), and carbon monoxide (CO) analyzers. This document also addresses the calibration of in-station, gas-dilution calibration devices that support SO_2, NO_2, and CO monitoring systems.

Detailed instrument-specific calibration procedures are not included in this SOP. Separate technical instructions (TIs) are developed for each specific monitoring system.

Calibrations (including multipoint, zero, and span) are required under any of the following circumstances:

- Upon acceptance testing of a new instrument
- Upon installation of the instrument at a field station
- Whenever control limits are exceeded
- Prior to any corrective action, service, or maintenance to any portion of the instrument that affects its operational principle
- At a maximum interval of three months

Continuous gas analyzer calibrations will follow protocols as established by EPA/600/4-77/027a *Quality Assurance Handbook for Air Pollution Measurement System: Volume II*, and Appendix B of 40 CFR 58 *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*. All measurement devices and calibration standards will be traceable to the National Institute of Standards and Testing (NIST).

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Establish the project-specific calibration schedule and coordinate with the client as necessary.
- Establish the calibration reporting protocol to satisfy client requirements.
- Review calibration results.
- Identify inconsistencies in calibration results and initiate corrective action as required.

2.2 FIELD SPECIALIST

The field specialist shall:

- Perform required calibrations and maintenance as described in the appropriate TIs.

- Verify that the calibration standards are in good working order and are in current calibration.
- Identify inconsistencies in calibration results and initiate corrective action as required.
- Document all calibration results and maintenance procedures performed.

3.0 REQUIRED EQUIPMENT AND MATERIALS

All calibration equipment must be under current calibration or certification (traceable to NIST standards).

3.1 O_3 ANALYZER CALIBRATION

The following equipment is required for ozone analyzer calibration:

- Digital voltmeter (DVM)
- Certified O_3 transfer standard or verified O_3 primary standard
- Zero air supply
- Clean Teflon tubing and fittings
- Field service tools
- Instrument-specific ARS technical instruction
- Instrument-specific manufacturer's manual
- Station log book
- Ozone calibration forms
- Pen or pencil
- Laptop computer loaded with Excel spreadsheet form (Calibrations.XLT) and CALCU program software
- Cleaning supplies
- Replacement analyzer parts

3.2 SO_2, NO_2, OR CO ANALYZER CALIBRATION

The following equipment is required for SO_2, NO_2, or CO analyzer calibration:

- Digital voltmeter (DVM)
- Certified gas cylinder with 300 or greater psi and stainless steel regulator
- Clean Teflon tubing and fittings

- Instrument-specific ARS technical instruction
- Gas dilution calibrator and zero air supply
- Field service tools
- Instrument-specific manufacturer's manuals
- Station log book
- Gas dilution calibration forms
- Pen or pencil
- Laptop computer loaded with Excel spreadsheet form (GASDIL.XLT) and CALCU program software
- Replacement analyzer parts
- Gas phase titrator

4.0 METHODS

Detailed methods for calibrating and maintaining analyzers are discussed in specific TIs for each type of analyzer. This section discusses general procedures common to any of these analyzers, and includes five (5) major subsections:

4.1 Principles and Policy
4.2 Preparation for Analyzer Calibration
4.3 Multipoint Calibration of Analyzers
4.4 In-station Calibrator Verification
4.5 Documentation

4.1 PRINCIPLES AND POLICY

The philosophy of ambient air monitoring instrument calibration has evolved as instrument manufacturers have improved instrument stability and repeatability. Current EPA guidelines do not specify a time-established schedule (i.e., once per quarter), but only state that calibrations be performed “as necessary.” Each project manager may establish the calibration protocols and other routine analyzer checks (zero, span, and precision checks) to suit the requirements of the project and client. Practical considerations such as established maintenance schedules, budget limitations, audit schedules, and site operator competence must also be considered. Unless an individual project specifically specifies an alternate calibration interval, calibrations of ambient gas analyzers will be performed every three (3) months.

4.1.1 Equipment Applications and Use

IN-STATION CALIBRATORS

In-station calibrators may be used only to make:

- Zero checks
- Span checks
- Precision checks
- Multipoint calibration checks

In-station calibrators are not to be used to make adjustments to analyzers (other than zero), unless calibration of the in-station calibrator immediately precedes the analyzer adjustment.

REFERENCE CALIBRATORS

Reference calibrators may be used to make:

- Zero checks
- Span checks
- Precision checks
- Multipoint calibration checks

4.1.2 Instrument Adjustments

ZERO ADJUSTMENTS

Zero adjustments are required whenever the zero response (zero check) of the analyzer exceeds control limits. Zero adjustments may be made to continuous analyzers without the need for a multipoint calibration check. A span check must follow a zero adjustment.

ANALYZER ADJUSTMENTS

Calibrations (adjustments) of continuous analyzers (other than zero) should only be performed after a pre-maintenance multipoint calibration check. A post-maintenance multipoint calibration check must follow an analyzer adjustment.

4.2 PREPARATION FOR ANALYZER CALIBRATION

Before performing a calibration check, ensure adequate preparation of the operational environment, calibration device (gas dilution unit or transfer standard), and the analyzer by determining the following:

- The station is at the proper temperature.
- Instruments are adequately warmed up.

- Calibration documentation is current, complete, and available.

- All required support tools, diagnostic equipment, supplies, and calibration forms are available.

The above points are detailed in instrument manufacturer's manuals and in the TIs specific to each analyzer.

4.3 MULTIPOINT CALIBRATION OF ANALYZERS

The steps of a five-point calibration check are outlined below. Calibration of an instrument infers an adjustment to the instrument response after a calibration check. Detailed steps will vary with each instrument type and are detailed in instrument-specific TIs.

INTRODUCE GAS

Known concentrations of gas that cover the response range of the analyzer are introduced.

EVALUATE ANALYZER RESPONSE

Allow the analyzer to fully respond and stabilize on each of the five introduced gas concentrations. If response fails to stabilize, abort the calibration check, investigate the problem, and take corrective action. After the analyzer response stabilizes, note and record the analyzer front panel display, analyzer voltage output, and data acquisition response on the appropriate calibration form (or laptop computer Excel spreadsheet) and on the strip chart.

Review the percent difference (Δ%) between designated input and analyzer response calculated by the calibration spreadsheet.

Compare the Δ% at each point with the average Δ%. If the Δ% at any individual point differs from the average Δ% by more than 5%, re-calculate the flow rates or transfer standard setting and re-run the point. If, on this second run, the point falls within 5% of the average, accept the new point and re-calculate the average. If not, troubleshoot the analyzer and calibrator to determine the problem and take corrective action.

Review the data to determine if analyzer adjustment (calibration) is required:

If the slope is <0.950 or >1.050, analyzer adjustment is required.

If the intercept is <3.0 ppb (0.3 ppm for CO) analyzer adjustment is required.

If the correlation is <0.9950 analyzer adjustment (or repair) is required.

CALIBRATE (ADJUST) ANALYZER	If analyzer calibration is required, perform the following steps: Introduce a known concentration of gas into the analyzer at 80% to 90% of full scale of the normal operating range. Allow the analyzer to stabilize, then adjust the span accordingly. If the span adjustment is not adequate to bring the analyzer response to within control limits, troubleshoot the analyzer to determine the problem and take corrective action.
CALCULATE SPAN NUMBER (OZONE ANALYZERS)	Following adjustment, check the zero response of the analyzer and perform a post-maintenance calibration check. Record all data on the strip chart and calibration forms (or in Excel spreadsheet). Reevaluate the slope, intercept, and correlation.

4.4 IN-STATION CALIBRATOR VERIFICATION

Verification of the in-station calibrator should be completed whenever a calibration check is performed. The method of verification depends upon the type of in-station calibrator.

Ozone transfer standards are verified (re-certified) using similar methods as calibrating a photometer-based ozone analyzer. Refer to SOP 3300, *Certification of Ozone Transfer Standards*, for re-certification procedures.

In-station gas dilution calibrators may be verified by comparing to a reference calibrator. This may be done by comparing the analyzer response from the in-station calibrator to the analyzer response from the reference calibrator. Refer to SOP 3180, *Calibration of Mass Flowmeters and Mass Flow Controllers*, for calibrating gas dilution systems.

4.5 DOCUMENTATION

Analyzer calibrations require several levels of documentation:

CALIBRATION FORMS	Calibration forms or the computer laptop Excel spreadsheet should be completed entirely. Where possible, use the Excel spreadsheet so that both a hard copy and digital record of the calibration are maintained. Review and sign all calibration forms.
STRIP CHARTS	Strip chart records should be annotated to clearly document both the input concentration values and the analyzer data acquisition system response.
LOG NOTES	A summary of results and maintenance performed must be included in the station log notes. Note any abnormalities in analyzer or calibration operation that could affect the quality of data.

CALIBRATION STICKER	An ARS calibration sticker is placed on the analyzer, marking the date the instrument was calibrated and the name of the technician who calibrated it.
TRIP REPORT	The calibration is thoroughly documented in a written site trip report.

5.0 DEFINITIONS

ACCURACY - The extent to which measurement, or the average of several measurements agree with the true value.

ANALYZER - Instrument that continuously samples ambient air for a specific constituent, determines the concentration, and provides an electrical output to a recording device.

AUDIT - Independent challenge of an analyzer or instrument. Must be completed by personnel and calibration standards not normally used for the operation, certification, calibration, or repair of the equipment subjected to the audit.

CALIBRATION - Adjustment of analyzer (or measurement system) to provide agreement between known inputs and analyzer or output.

CALIBRATOR - Device for generating known outputs.

CALIBRATION CHECK - The method for determining the relationship between a known input and the analyzer response to a certain percentage of agreement.

CONTROL LIMIT - Guidelines for taking action on analyzer maintenance or adjustments when limits are exceeded.

ERROR - The difference between the true and the measured value is defined as the error. Often described as a percent difference from the designated (actual) value.

IN-STATION CALIBRATOR - Equipment located within the monitoring station that is used to generate gas concentrations (zero, span, precision, multipoint values) to the analyzer on a routine, possibly automated basis. It is not to be used to make analyzer adjustments.

MULTIPOINT CALIBRATION CHECK - A calibration check comprising of multiple known inputs to determine the linearity and accuracy of response. A multipoint calibration check will consist of zero and at least four input concentrations distributed over the analyzers operating range.

PRECISION - An assessment of the repeatability of an analyzer to a known concentration input.

PRECISION CHECK - A span check of an analyzer at a designated concentration of 0.08 to 0.10 ppm for SO_2, NO_2, and O_3, and 8.0 to 10.0 ppm for CO. These checks are required by PSD regulations to be performed every two weeks. The results of precision checks are used to calculate precision (repeatability) of an analyzer on a quarterly basis.

PRIMARY STANDARD - Method, device, or material having known, stable, measurable, and readily-reproducible characteristics.

REFERENCE CALIBRATOR - Equipment brought to the monitoring station to generate gas concentrations for analyzer or in-station calibrator adjustments. This equipment is typically a calibrator that is not normally used to make routine zero, precision, or span checks to an analyzer. The flow devices and calibration standards are different from those in the in-station calibrator.

SPAN CHECK - The method of determining the relationship between a known concentration or known electrical impulse generated from a calibrator and the response measured by an analyzer or sensor. This check is used to verify analyzer performance. Span check results demonstrate whether or not the instrument is performing within control limits. Typically a high level value at approximately 80% of the full scale measurement capability of the instrument under test.

TRANSFER STANDARD - (Secondary Standard) A method, device, or material that is calibrated against a primary standard for comparison with a third method, device (analyzer), or material.

6.0 REFERENCES

Environmental Protection Agency (EPA), 2008, Quality Assurance Requirements for SLAMS, SPMs and PSD Air Monitoring, 40 CFR 58, Appendix A.

Environmental Protection Agency (EPA), December 2008, Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II, Ambient Air Monitoring Program. (EPA-454/B-08-003).

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**CALIBRATION AND ROUTINE MAINTENANCE OF THERMO ENVIRONMENTAL INSTRUMENTS MODEL 49C or 49*i* OZONE ANALYZERS**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3100-2004**
DATE	**DECEMBER 2004**

AUTHORIZATIONS		
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OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
0.1	Change instrument adjustment statements.	January 2006	G. Mercer
	Reviewed; no changes necessary.	January 2007	G. Mercer
0.2	Added 49*i* instrument.	March 2007	G. Mercer
	Reviewed; no changes necessary.	March 2008	G. Mercer
	Reviewed; no changes necessary.	March 2009	G. Mercer
	Reviewed; no changes necessary.	March 2010	G. Mercer
	Reviewed; no changes necessary.	March 2011	G. Mercer

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LIST OF FIGURES

1.0 PURPOSE AND APPLICABILITY

The purpose of calibration and maintenance is to assure quality data capture and minimize data loss by performing and documenting scheduled operational checks and preventive maintenance. This technical instruction (TI) provides specific details for routine calibration and maintenance of Thermo Environmental Instruments Model 49C or 49*i* ozone analyzers and transfer standards. This TI is referenced in Standard Operating Procedure (SOP) 3100, *Calibration of Ambient Air Quality Analyzers*, and serves as a guideline to facilitate the following:

- Performing calibration checks
- Evaluating analyzer response
- Calibrating (adjusting) the analyzer
- Performing analyzer maintenance
- Replacing analyzer components

Calibrations (including multipoint, zero, and span) are required under any of the following circumstances:

- Upon acceptance testing of a new instrument
- Upon installation or removal of the instrument at a field station
- Whenever control limits are exceeded
- Prior to any corrective action, service, or maintenance to any portion of the instrument that affects its operational principle
- At a maximum interval of six months

Continuous gas analyzer calibrations will follow protocols as established by EPA/600/4-77/027a *Quality Assurance Handbook for Air Pollution Measurement System: Volume II*, and Appendix B of 40 CFR 58 *Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring*. All measurement devices and calibration standards will be traceable to the National Institute of Standards and Technology (NIST).

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Establish the project-specific calibration schedule and coordinate with the client as necessary.
- Establish the calibration reporting protocol to satisfy client requirements.

- Review calibration results.
- Identify inconsistencies in calibration results and initiate corrective action as required.

2.2 FIELD SPECIALIST

The field specialist shall:

- Perform required calibrations and maintenance as described in this TI.
- Verify that the calibration standards are in good working order and are in current calibration.
- Document all calibration results and maintenance procedures performed.

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment is required for ozone analyzer calibration:

- Digital voltmeter (DVM)
- Certified O_3 transfer standard or verified O_3 primary standard
- Zero air supply
- Clean Teflon tubing and fittings
- Field service tools
- Model 49C or 49*i* instrument manual
- Station log book
- Ozone calibration forms
- Pen or pencil
- Laptop computer loaded with Excel spreadsheet form (Calibrations_edits.xlt) and CALCU and SolarAz program software
- Kimwipes
- Non-metallic rod
- Cotton swabs

Replacement parts may include:

- Ozone converter
- Solenoid valve

- UV photometer lamp
- Sample or calibration pump
- Ozone generator lamp

4.0 METHODS

The procedures described in this TI are specific to 49C and 49*i* analyzers and transfer standards. Calibration and maintenance include tasks that are detailed in the following seven (7) subsections:

4.1 Preparation for Analyzer Calibration
4.2 Calibration Checks
4.3 Ozone Transfer Standard Preparation
4.4 Multipoint Calibration
4.5 Analyzer Maintenance
4.6 Post-Maintenance Calibration Checks
4.7 Documentation

4.1 PREPARATION FOR ANALYZER CALIBRATION

Before performing a calibration check, ensure adequate preparation of the operational environment, calibration device (transfer standard), and the analyzer by determining the following:

- The station is at the proper temperature.
- Instruments are adequately warmed up.
- Calibration documentation is current, complete, and available.
- All required support tools, diagnostic equipment, supplies, and calibration forms are available.

4.2 CALIBRATION CHECKS

A complete calibration check must be performed prior to (pre) and following (post) any maintenance activity. The calibration check procedures described below apply to both pre- or post-maintenance checks. Refer to Figure 4-1, Example Ozone Calibration Form, when performing calibration checks. Document calibration activities on the pre- or post-calibration form as appropriate, and note all maintenance activities or replaced components in the "Comments" field. The form is available as an Excel spreadsheet and should be used at all times. Results of each calibration should be in both hardcopy and digital form.

Before introducing calibration gas into the analyzer, complete the following operational checks. Should any operational check be out of suggested tolerance, complete the calibration check before any maintenance or adjustments are made.

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PRE-MAINTENANCE OZONE CALIBRATION FORM

Network:	Location:	Site:	Date:	Date of Last Site Visit:
				Field Specialist:

EQUIPMENT IDENTIFICATION

	Transfer Standard	Analyzer	Station Reference
Mfg.			
Model #			
Serial #			
Span Setting/ O3 Coefficient			
Zero/ O3 Bkg			
Sample Freq/ Intensity A/ Lamp			
Control Frequency/ Intensity B			
Flow (Lpm)/ Flow A, Flow B			
Offset (ppb)			
Cell Temp / Pressure			

STATION TUBING

Transfer Standard OFFSET = ppb			Analyzer OFFSET = ppb						Station Reference OFFSET = ppb					
Calibration Point	Mechanical Setting	Conc. (ppb)	Display	DVM (volts)	DAS (ppb)	Difference (ppb)	% Difference	Pass/ Fail	Display	DVM (volts)	DAS (ppb)	Difference (ppb)	% Difference	Pass/ Fail
ZERO	0	0												
1														
2														
3														
4														
5														
ZERO														
			Average % Difference:						Average % Difference:					
			Maximum % Difference:						Maximum % Difference:					

CALIBRATION TIME

From:		To:	

EVENT RESPONSE

Station Reference			Analyzer Response					
Calibration Point	Mechanical Setting	DAS (ppb)	Display	DVM (volts)	DAS (ppb)	Recorder (%)	Difference (ppb)	% Difference
ZERO	0							N/A
Precision								
Span								

RESULTS

Linear Regression				
Parameter	Analyzer	Pass/Fail	Station Reference	Pass/Fail
Slope				
Y Intercept				
Correlation Coefficient				

Pre-Maint Ozone Comments:	

Figure 4-1. Example Ozone Calibration Form.

ANNOTATE DATA RECORDS

Make an entry in the station log book and annotate the strip chart recorder and data acquisition system (DAS) indicating the date and time (beginning and ending) of the calibration and maintenance procedures. “Down” the appropriate channels on the DAS or set the calibration flag as appropriate for the DAS being used.

Complete the following fields on the Ozone Calibration Form: network and station name, current date, name of technician performing the calibration, and date of the last calibration and maintenance visit. Also complete information regarding model and serial numbers of the instruments to be calibrated.

DETECTOR FREQUENCY OUTPUT

Check the “A” and “B” detector frequency output by selecting **<MENU> (■)**. Scroll to DIAGNOSTICS using the arrow buttons and select **<ENTER> (↵)**. Then scroll to INTENSITIES using the arrow buttons and select **<ENTER> (↵)**. This frequency is directly proportional to the UV source light output reaching the detectors. Record the display values on the Ozone Calibration Form (Figure 4-1) in the “Sample Frequency” column. Expected values are 70 to 120 kHz.

PRESSURE / TEMPERATURE

Select **<MENU> (■).** Scroll to DIAGNOSTICS using the arrow buttons and select **<ENTER> (↵)**. Scroll to PRESSURE using the arrow buttons and select **<ENTER> (↵)** to display the cell pressure (in mmHg). Select **<MENU> (■)** two more times to display the bench temperature. Record both values in the “Cell Temp/Pressure” column.

NOTE: Make sure the temperature correction and pressure correction are turned on so the ozone measurement is automatically corrected for temperature and pressure. Select **<MENU> (■)**, scroll to INSTRUMENT CONTROLS (**<ENTER>**) (↵), then to TEMP CORRECTION (or PRESSURE CORRECTION) (**<ENTER>**) (↵) and make sure both are selected “ON.”

FLOW RATE CHECK

Check the flow rate by selecting **<MENU> (■)**. Scroll to DIAGNOSTICS using the arrow buttons and select **<ENTER> (↵)**. Scroll to FLOWS using the arrow buttons and select **<ENTER> (↵)**. Record the values in the “Sample (lpm)” field of the calibration form. The flow rates should be even and show between 0.500 and 0.750 lpm for each cell.

4.3 OZONE TRANSFER STANDARD PREPARATION

To prepare the ozone transfer standard:

TURN ON

Turn the transfer standard on and allow it to warm up for at least one hour.

CONNECT ZERO AIR SUPPLY	Connect a zero air supply to the “ZERO AIR” inlet port.
CONNECT TEFLON TUBING	Connect a clean length of Teflon tubing from one “OZONE OUTPUTS” port of the transfer standard to the “INLET” port of the ozone analyzer. Be sure to provide a single vent via a Teflon tee on the calibration input line.
CAP PORTS	Cap all other “OZONE OUTPUTS” ports.
COMPLETE CHECKS	Complete and record the operational checks of the transfer standard as detailed on the Ozone Calibration Form.

Ozone transfer standards are verified (re-certified) using similar methods as calibrating a photometer-based ozone analyzer. Refer to SOP 3300, *Certification of Ozone Transfer Standards*, for re-certification procedures.

4.4 MULTIPOINT CALIBRATION

The following subsections describe the steps of a five-point calibration check. Calibration of an instrument infers an adjustment to the instrument response after a calibration check.

4.4.1 Initiate Calibration

TURN ON	Place the instrument into Local Mode (<**ENTER**>) (↵) and select ZERO (<**RUN**>) (▶). Make sure zero air is being supplied to the instrument. Turn the “sample pump” of the transfer standard on.
ADJUST FLOW	Adjust the transfer standard output flow appropriately. Adjust the pressure ozone generator regulator to ensure some airflow out the vent. Zero air is now flowing to both the transfer standard and the analyzer. Allow the instruments to stabilize and record the responses of both the transfer standard and analyzer on the Ozone Calibration Form as described in Section 4.4.2.
GENERATE OZONE	Known concentrations of gas that cover the response range of the analyzer are introduced. Select the desired ozone concentration output by incrementing the **<RUN> (▶**) button to Level 1. Concentration ranges must include:

0.0 to 0.5 ppm range	**0.0 to 1.0 ppm range**
0.000 ppm	0.000 ppm
0.350 to 0.450 ppm	0.700 to 0.900 ppm
0.300 to 0.350 ppm	0.350 to 0.450 ppm
0.150 to 0.200 ppm	0.300 to 0.350 ppm
0.030 to 0.080 ppm	0.150 to 0.200 ppm
	0.030 to 0.080 ppm

GENERATE OZONE (continued)

Allow the values to stabilize and record the responses of the transfer standard and ozone output on the Ozone Calibration Form as described below in Section 4.4.2.

Select additional ozone concentrations by selecting **<MENU> (■)**. Scroll to INSTRUMENT CONTROLS using the arrow buttons and select **<ENTER> (↵)**. Scroll to OZONATOR LEVEL 1 using the arrow buttons and select **<ENTER> (↵)**. Use the arrows to increase or decrease output concentrations. Record the analyzer and transfer standard responses on the Ozone Calibration Form.

4.4.2 Record and Evaluate Analyzer Response

The following steps must be performed while calibrating the analyzers:

RECORD ANALYZER RESPONSE

Allow the analyzer to fully respond and stabilize on each of the five introduced gas concentrations. If response fails to stabilize, abort the calibration check, investigate the problem, and take corrective action. After the analyzer response stabilizes, note and record the analyzer front panel display, analyzer voltage output, and data acquisition response on the calibration form (or laptop computer Excel spreadsheet) and on the strip chart.

CALCULATE Δ%

Review the percent difference (△%) between the designated input and analyzer response calculated by the Excel calibration spreadsheet, or, if not automatically calculated by the spreadsheet, calculate the percent difference (△%) with the following formula:

$$\%\,Difference = \frac{Analyzer\ Response - Designated\ \ Input}{Designated\ Input}\,x100$$

Example:

$$\Delta\% = \frac{0.410\ ppm - 0.400\ ppm}{0.400\ ppm}\,x100 = 2.5\%$$

Note: Use the data acquisition system recorded response for the analyzer response.

AVERAGE Δ%'S

Average the Δ%'s for all concentrations. Make sure to retain the correct signs (+ or -) during the calculation. Do not include the zero values in the Δ% calculations.

REVIEW DATA

Review the data to determine if analyzer adjustment (calibration) is required:

If the slope is <0.950 or >1.050, analyzer adjustment or repair is required.

REVIEW DATA (continued)	If the intercept is >0.3 ppm, analyzer adjustment or repair is required. If the correlation is <0.9950, analyzer adjustment or repair is required.

4.4.3 <u>Calibrate (Adjust) Analyzer</u>

The calibration factors set the effective span on the analyzer. The nominal value is 1.000. Adjust the O3 Coefficient to compensate for an under- or over-reporting instrument. In a properly operating instrument, any coefficient or background correction should be small (e.g., ±0.1 for coefficient, ±5 for offset).

A certified transfer standard is required to adjust based upon known designated inputs. All maintenance activities must have been completed prior to this procedure.

CONFIGURE ANALYZER	Configure the analyzer and transfer standard as described in Sections 4.2 and 4.3.
ADJUST ZERO	Introduce zero air into the analyzer. Select **<MENU> ( )**, scroll to CALIBRATION (**<ENTER>**) (↵) then scroll to CALIBRATE ZERO (**<ENTER>**) (↵), and set to 0.0 when the instrument has stabilized.
INTRODUCE OZONE	Introduce a concentration of ozone approximately 80% of the operating full scale of the analyzer.
ADJUST O3 COEFFICIENT	Allow the analyzer to stabilize and adjust the O3 Coefficient until the analyzer output agrees with the designated input as reported by the transfer standard. In the Local Mode, select **<MENU> ( )**, scroll to CALIBRATION (**<ENTER>**) (↵) then scroll to CALIBRATE O3 (**<ENTER>**) (↵), and adjust the instrument for the proper response. CAUTION: Take care to operate the unit under calibration in the exact condition it will be in while in routine operation. For instance: - Is the top on? - Is it positioned normally in the rack? - Is the calibration pump turned on? (transfer standard)

Failure to calibrate the instrument in the exact condition in which it is operated may affect the absorption cell temperature. A multipoint calibration check must follow a O3 Coefficient adjustment.

Calibrations (adjustments) of continuous analyzers (other than zero) should be performed only after a pre-maintenance multipoint calibration check. A post-maintenance multipoint calibration check must follow an instrument adjustment.

4.5 ANALYZER MAINTENANCE

A complete multipoint calibration check must be performed prior to (pre) and following (post) any maintenance activity. Analyzer maintenance should be performed on a semiannual basis. Replacement of consumable components will generally be required annually under most monitoring conditions.

SYSTEM LEAK CHECK

Remove the sample line from the "SAMPLE INLET" on the rear panel of the analyzer and hold your finger over the "SAMPLE INLET." The sample flow, as indicated in DIAGNOSTICS should drop to "0.0" and stay at "0.0." If it does not drop to "0.0," there is a leak in the system that must be found and sealed. Tighten all fittings to and from the solenoid, scrubber, and absorption tube to alleviate the leak.

SAMPLE PUMP REPLACEMENT

A pump needs replacement whenever it cannot maintain at least 0.5 lpm of flow. Intermittent starting or noisy bearings may also indicate need of replacement. Replacement of the pump is straightforward:

- Unplug the instrument.
- Unplug the pump from its motherboard connector.
- Loosen and remove the four nuts from the bottom of the instrument.
- Remove the pneumatic fittings and remove the pump.

Installation is a reversal of the above procedures. Make sure to mark the pump with the date of installation.

ABSORPTION CELL TUBE CLEANING

Low detector frequencies (less than 70.0 kHz) may indicate contaminated absorption tubes or dirty mirrors. Inspect and clean them if necessary using the following procedures:

- Remove the two absorption tubes and carefully pass a Kimwipe through each using a non-metallic rod. Do not pass any metal-tipped rod through the tubes. Use a wooden dowel or a length of ¼" Teflon tubing. This procedure will remove loose dust particles only. Any permanent (fixed) imperfections will not disturb the measurement process. After cleaning the tubes with a Kimwipe, blow them out with clean, oil-free air.

ABSORPTION CELL TUBE CLEANING (continued)

- Use a cotton swab to access the window surfaces through the holes that the absorption tube fits into.
- Leak check the reassembled analyzer as described above.

OZONE CONVERTER REPLACEMENT

The ozone converter should be replaced as necessary. Low span response could be attributed to a contaminated converter. Replace the converter as follows:

- Loosen the tube fittings on each end of the converter. Remove the converter.
- Replace the converter by reversing the above procedure. Make sure the fittings are tight.
- Mark the converter with the replacement date and perform a system leak check as described above.

UV LAMP REPLACEMENT

The ultraviolet lamp (photometer lamp) requires replacement only when it fails, becomes excessively noisy, or when the detector frequency cannot be adjusted above 70.0 kHz.

Lamp Replacement

- Remove the old lamp by unplugging the three-wire connector.
- Remove access hold cover on the back panel.
- Loosen the Allen screw on the lamp holder and two screws holding the lamp to the base.
- Slide the lamp out of the bench and instrument case through the access hole.
- To replace the lamp, reverse the procedure.
- Write the replacement date on a tag and attach it to the lamp wire.
- After the lamp has stabilized (approximately 15 minutes), adjust the detector frequencies as described below.

WARNING: DO NOT LOOK AT THE ILLUMINATED LAMP WITH THE NAKED EYE. Permanent retina damage could result.

DETECTOR FREQUENCY ADJUSTMENT

The detector frequency is proportional to the amount of light transmitted through the optical system. A wide range of frequencies can be tolerated, however, optimum values are 80 to 120 kHz.

Frequencies will decrease over time, as the lamp ages, and as the optical system gathers dirt. Make no adjustments until the optical path has been cleaned (see Absorption Cell Tube Cleaning).

<u>Adjust Frequencies</u>

- Place the instrument into Service Mode.
- Select **Lamp Setting**.
- Use arrows to adjust intensities to 80-120 kHz.

4.6 POST-MAINTENANCE CALIBRATION CHECKS

After completing all maintenance and adjustment activities, initiate a post-maintenance calibration check as described in Sections 4.2 through 4.4 of this TI.

4.7 DOCUMENTATION

Analyzer calibrations require several levels of documentation:

CALIBRATION FORMS

Calibration forms or the computer laptop Excel spreadsheet should be completed entirely for each analyzer calibrated and for all transfer standard certifications. Where possible, use the Excel spreadsheet so that both a hard copy and digital record of the calibration are maintained. Review and sign all calibration forms.

STRIP CHARTS

Strip chart records should be annotated to clearly document standard response.

LOG NOTES

A copy of all log notes summarizing work performed and results of the certification. Note any abnormalities in standard operation.

CALIBRATION STICKER

An ARS calibration sticker is placed on the analyzer, marking the date the instrument was certified and the name of the technician who calibrated it.

Figure 4-2. ARS Calibration Sticker.

TRIP REPORT The calibration is thoroughly documented in a written site trip report.

5.0 REFERENCES

Environmental Protection Agency (EPA), 1989, Quality Assurance Requirements for Prevention of Significant Deterioration (PSD) Air Monitoring, 40 CFR 58, Appendix B.

Environmental Protection Agency (EPA), July 1984, Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II. (EPA/600/4-77/027a).

Thermo Electron Corporation, 2004, Model 49C UV Photometric O_3 Analyzer Instruction Manual, April, Franklin, MA.

Thermo Electron Corporation, 2006, Model 49*i* UV Photometric O_3 Analyzer Instruction Manual, March, Franklin, MA.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**CALIBRATION AND ROUTINE MAINTENANCE OF METEOROLOGICAL MONITORING SYSTEMS**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3150**
DATE	**JUNE 1990**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	John F. Faust	John F. Faust
PROJECT MANAGER	John F. Faust	John F. Faust
PROGRAM MANAGER	Joe Adlhoch	[illegible]
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY			
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2.0	Delete operator respon./add maintenance.	September 1997	G. Mercer
3.0	Revise SR and RH proc./ remove dew point.	September 1998	G. Mercer
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OTHER		

REVISION HISTORY			
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3.1	Add RH time limit for replacement	May 2000	G. Mercer
	Reviewed; no changes necessary.	May 2001	G. Mercer
3.2	Generalized text for different mfg'rs.	July 2002	G. Mercer
	Reviewed; no changes necessary.	July 2003	G. Mercer
	Reviewed; no changes necessary.	July 2004	G. Mercer
3.3	Add net radiation and SODAR instruments.	May 2005	G. Mercer
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ORIGINATOR	John F. Faust	John F. Faust
PROJECT MANAGER	John F. Faust	John F. Faust
PROGRAM MANAGER	Joe Adlhoch	
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OTHER		

REVISION HISTORY			
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3.4	Updated wetness sensor procedures	September 2005	G. Mercer
3.5	Changed WD acceptance value	November 2005	G. Mercer
	Reviewed; no changes necessary.	November 2006	G. Mercer
	Reviewed; no changes necessary.	November 2007	G. Mercer
	Reviewed; no changes necessary.	November 2008	G. Mercer
3.6	Updated Reference section.	November 2009	G. Mercer
	Reviewed; no changes necessary.	November 2010	G. Mercer

TABLE OF CONTENTS

1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) is a guide for performing weekly checks and periodic calibration and maintenance to various meteorological sensors. The purpose of this document is to provide calibration and maintenance procedures that will assure quality data capture and minimize data loss of the following sensors:

- Wind speed
- Wind direction
- Temperature/delta temperature
- Relative humidity
- Solar radiation and net radiation
- Barometric pressure
- Precipitation
- Wetness
- SODAR (including RASS)-measured vertical wind and thermal profiles

Detailed manufacturer's specific calibration procedures are not included in this SOP. Separate technical instructions (TIs) are developed for each specific monitoring system.

Calibrations are required under any of the following circumstances:

- Upon acceptance testing of a new instrument
- Upon installation or removal of the instrument at a field station
- Whenever control limits are exceeded
- Prior to any corrective action, service, or maintenance to any portion of the instrument that affects its operation
- At a maximum interval of six months

Meteorological calibrations will follow guidelines established in EPA-600/R-94/038d (March 1995), *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV. Meteorological Measurements*. All measurement devices and calibration standards will be traceable to the National Institute of Standards and Testing (NIST).

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Establish the project-specific calibration and maintenance schedule and coordinate with the client as necessary.
- Establish the calibration reporting protocol to satisfy client requirements.
- Review calibration results.
- Identify inconsistencies in calibration results and initiate corrective action as required.
- Review and approve any changes to calibration procedures.

2.2 FIELD SPECIALIST

The field specialist shall:

- Perform required calibrations and maintenance as described in instrument- or system-specific TIs.
- Document all calibration results and maintenance procedures performed.

3.0 REQUIRED EQUIPMENT AND MATERIALS

Depending upon the sensor and manufacturer, the following equipment may be required:

- Topographic maps of the area
- Protractor
- Magnetic compass and tripod
- Decade resistence box
- Digital voltmeter (4-1/2 digit)
- Field service tools
- Tower climbing belt and safety equipment
- Station log book
- Electronic calibration forms

- Pen or pencil
- Laptop computer loaded with Excel workbook (Calibrations_edits.xlt) and CALCU program software
- ARS calibration stickers
- Calibrated (transfer standard) hand-held barometer
- R.M. Young Model 18801 variable speed calibration motor
- Notched compass wheel and wind direction linearity test jig
- Torque disc and weights
- Repair/replacement parts including wind speed and wind direction rebuilt parts (bearings and potentiometer)
- R.M. Young Model 18801 anemometer drive motor
- Model 18112 vane angle bench stand
- Calibrated thermometers: -20° to +10°C, 0° to +30°C, and +20° to +50°C
- Thermos bottles
- One gallon of distilled water
- Crushed ice
- Portable water heater or hot water
- Reference relative humidity sensor and audit aspirator
- Reference solar and net radiation sensors
- Campbell Scientific 21XL datalogger
- Campbell Scientific 21XL datalogger manual
- Instrument manuals for the specific meteorological sensors applied (e.g., Climatronics, Campbell Scientific, R.M. Young, Licor, etc.)

4.0 METHODS

Meteorological systems must be dynamically checked (pre-maintenance calibration) before any adjustments are made to the signal conditioning software instructions or before servicing the meteorological sensors. Throughout the calibration and maintenance period, the datalogger, calibration forms, and strip chart (if used) must be annotated to indicate that data taken during the calibration period should not be included as standard observations.

After performing system adjustments and maintenance, the system again needs to be dynamically checked (post-maintenance calibration) to ensure proper operation of the sensor. The pre- and post- maintenance calibration techniques are identical. Do not adjust the signal conditioning cards or perform any maintenance to the sensors until all pre-calibration checks are completed.

Calibration and maintenance include tasks that are detailed in the following five (5) major subsections:

4.1 Calibration Checks
4.2 Sensor Adjustments
4.3 Sensor Maintenance
4.4 Post-Maintenance Calibration Checks
4.5 Documentation

4.1 CALIBRATION CHECKS

Calibration checks are performed semiannually. Should any operational check be out of suggested tolerance, complete the calibration check before any maintenance or adjustments are made. The following operational checks should be performed:

ANNOTATE DATA RECORDS — Make an entry in the station log book indicating the date and time (beginning and ending) of the calibration and maintenance procedures. "Down" the appropriate channels on the DAS or set the calibration flag as appropriate for the DAS being used.

Complete the following fields on the appropriate calibration form: network and station name; current date; name of technician performing the calibration; manufacturer, model, and serial number of the instrument; and date of the last calibration.

RECORD READINGS — Connect a digital voltmeter (DVM) to the output of each sensor or signal conditioning card under calibration. Simultaneously record the pre-maintenance DVM and DAS readings of the sensor under calibration and the output or values of the reference sensor or measuring device. Repeat recording after maintenance or adjustment (post-) for each sensor.

Both pre- and post-maintenance calibrations of all sensors are required. Throughout the calibration and maintenance period, the datalogger, calibration forms, and strip chart (if used) must be annotated to indicate that data taken during the period should not be included as standard observations. Calibrations of sensors will be made by the field specialist in the following manner:

WIND DIRECTION — Orientation - Two horizon landmarks will be identified and the azimuth determined from a topographic map, compass or previous survey. Some situations may allow the use of a GPS. Use care to adjust the compass for proper declination or use the solar azimuth method in the CALCU program and laptop computer. The sensor's vane will be pointed to each landmark, and the recorded output logged on the wind direction calibration

WIND DIRECTION (continued)

form. The tail of the vane will then be aimed at each landmark and the outputs recorded. The difference between the designated landmark azimuths and the sensor indicated value will be calculated and averaged. Averaged differences of greater ±5° will require reorientation of the sensor.

Linearity - For vane-type sensors (Climatronics, Qualimetrics, etc.), affix the linearity test fixture to the wind direction sensor and replace the vane with the compass wheel. Cycle the index wheel through each of the eight 45° increments on the compass wheel, and record the values from each indexed location. If any value is greater than ±3° from 45° increments, the sensor is non-linear and requires service.

Use the R. M. Young vane angle fixture for prop-vane-type sensors, and follow similar procedures.

Starting Threshold - Affix the torque arm to the wind direction vane. Deflect the vane, noting the grams of torque required to deflect it. Consult the appropriate TI for the instrument-specific threshold limit. Sensors over limit require service.

WIND SPEED (HORIZONTAL OR VERTICAL)

Motor Response - Remove the anemometer cups or propeller from the sensor and mount the R. M. Young Model 18801 variable speed motor assembly to the sensor shaft. Consult the appropriate sensor-specific TI to select appropriate test rpm levels (generally 4 or 5 levels from low to high rpms are tested). Record the sensor's output for each tested rpm level on the Wind Speed Calibration Form. Refer to the applicable TI for designated wind speed values for suggested rpms. The measured instrument response must be within 5% of the designated value plus the sensor starting threshold.

Starting Threshold - Hold the sensor in the horizontal position and replace the anemometer cups or propeller with a torque disc. Adjust the weight on the torque disc until the starting threshold is determined. Record the starting threshold and compare the value with the designated value in the appropriate TI. Any sensor exceeding its designated value requires service.

IMMERSIBLE TEMPERATURE

Remove the temperature probe from the aspiration system and suspend it in a water bath along with a certified thermometer. Agitate the water bath until both the thermometer and sensor responses stabilize. Record values on the ARS temperature calibration form. Three baths should be prepared: ice bath, ambient (about 20°C), and high range (40°-50°C). Compare each measured bath temperature and instrument response. Any difference greater than the sensor-specific threshold (refer to appropriate TI) requires investigation and corrective action.

DELTA (Δ) TEMPERATURE (TEMPERATURE DIFFERENCE)	Remove both temperature and delta temperature probes from their aspirators and place them together in a water bath along with a certified thermometer. Agitate the water bath until the thermometer and sensor responses stabilize. Record the values on the ARS calibration form. Prepare three baths: ice bath, ambient (about 20°C), and high range (40°-50°C), and repeat the procedure. The delta temperature value should not exceed the system-specific threshold (refer to the appropriate TI) at any bath temperature.
NON-IMMERSIBLE TEMPERATURE	The calibration of a thermistor/capacitive resistance-type air temperature sensor can be determined by comparing the ambient measurement to a transfer standard capacitive-resistance sensor. The on-site sensor and the transfer standard sensor should be aspirated or shielded in a similar manner. Temperature value differences greater than 3°C indicate the need for a replacement sensor.
RELATIVE HUMIDITY	Place the appropriate RH reference device and calibrated probe onto the forced-aspirated sensor housing. Attach the reference sensor to the 21XL datalogger and enter the appropriate program. Allow as much time as possible (minimum of 3 hours) and compare the reference values with the sensor values. Follow comparison guidelines in the appropriate TI for replacement protocol.
SOLAR RADIATION AND/OR NET RADIATION	Attach a reference solar (or net) radiation sensor to the existing solar (or net) radiation support bracket. Connect the reference output to a datalogger and record several hours' values. Compare values with data from the station's solar (or net) radiation sensor. If comparisons exceed ±5%, corrective action will be required.
SOLAR (OR NET) RADIATION (ALTERNATE METHOD)	Attach a reference solar (or net) radiation sensor to the existing solar (or net) radiation sensor support bracket. Ideally, several simultaneous measurements over 15-minute averaging periods will be taken over several hours with both the reference sensor and the on-site sensor. The average of all comparisons must be within ±5% of the reference sensor. If comparisons exceed ±5%, corrective action will be required.
BAROMETRIC PRESSURE	A reference (transfer standard) barometric pressure sensor will be used to record the on-site pressure simultaneously with the station sensor. The station sensor must be within ±.04 in hg (±1.5 mb) of the reference sensor. Corrective action, including sensor replacement, is required if the station sensor readings are beyond limits.
PRECIPITATION	A 900 ml calibration bottle will be used to drip (at a controlled rate) a volume into the tipping bucket rain gauge. The number of tips will be recorded and compared to the designated value noted in the appropriate TI. Any discrepancy of ±5% will require corrective action.

PRECIPITATION (continued)	Weighing rain gauges will be calibrated by using a manufacturer supplied calibration weight set or water volume-based weight calibration unit. Any discrepancies of ±5% will require corrective action.
WETNESS	The leaf wetness sensor indicates whether liquid water is present on surfaces. To verify the operation of the sensor, deposit or spray water on the sensor. The output should go to its maximum value. Dry the sensor and verify that the sensor goes to its minimum value. Any noted malfunction will require replacement of the sensor.
SODAR	Manufacturer-specific SODAR (including RASS options) diagnostic programs are run using the SODAR's computer. Indicated error codes will isolate the potential system component requiring repair or replacement. Comparisons between measurements made at specific SODAR (and/or RASS) levels and adjacent tower, radiosonde, or tethersonde measurements can also be employed to verify system measurement accuracies. All tests are system- and site-configuration specific.
SIGNAL CONDITIONING CARDS	Signal conditioning cards will be individually tested for their internal zero and span reference checks. These values are recorded on the ARS calibration form. Any recorded value greater than ±0.1% of the designated value will require adjustment. The appropriate sensor will require a post-calibration if signal card adjustment was required.

4.2 SENSOR ADJUSTMENTS

Consult the manufacturer for instructions if a large offset or adjustment is needed.

WIND DIRECTION	Reorient the sensor if adjustment is necessary.
WIND SPEED	No adjustments are applicable. The sensor must be rebuilt or replaced.
TEMPERATURE/ DELTA (Δ) TEMPERATURE	Adjustments are only possible at the translator card or datalogger.
RELATIVE HUMIDITY	Field adjustment or repair is not recommended. If the sensor response is outside of specification or if the sensor has operated in the field for more than 5 months, replace it with a factory/laboratory calibrated unit.
BAROMETRIC PRESSURE	A trim potentiometer is normally available on the instrument for offset fine adjustment.

SOLAR (OR NET) RADIATION	Adjustments are only possible at the translator card or datalogger.
PRECIPITATION	Adjust the tip sensitivity as necessary.
WETNESS	Adjust the sensitivity and voltage range as necessary.
SODAR	Adjust the physical alignment as required. Adjustments to the sensitivity, profile increments, and other system characteristics are performed through software options.

4.3 SENSOR MAINTENANCE

WIND DIRECTION	Replace the potentiometer and bearings if necessary.
WIND SPEED	Inspect the sensor chopper disc and clean if necessary. Replace the sensor if response remains beyond tolerance. Replace the sensor bearings if the starting threshold is greater than the designated value.
TEMPERATURE/ DELTA (Δ) TEMPERATURE	Inspect the temperature probe(s) and electrical connections for cleanliness and electrical continuity. Correct if necessary. Inspect the aspirator housing(s) and clean if any dirt or cobwebs have accumulated. Inspect the aspirator motor(s) and replace if necessary.
RELATIVE HUMIDITY	Field adjustment or repair is not recommended. If the sensor response is outside of specification or if the sensor has operated in the field for more than 5 months, replace it with a factory calibrated unit.
BAROMETRIC PRESSURE	Field repair other than offset adjustment is not recommended. Replace with a calibrated unit.
SOLAR (OR NET) RADIATION	Inspect and clean the sensor optics. Verify the sensors are level. Verify signal connections.
PRECIPITATION	Clean the system funnel, screen, tip buckets, and mechanisms. Adjust the tip sensitivity as required. Verify signal connections and electrical heater connections.
WETNESS	Clean the grid, adjust the sensitivity so that the sensor switches on at 240 Kohms, and adjust the voltage range to output 1.00 VDC (100%) when wet and 0.00 VDC (0%) when dry. Verify signal connections.
SODAR	Run system diagnostic tests and procedures, mechanically align the antenna and clean antenna and transponder surfaces, verify all electrical and signal connections, and verify control computer operation. Maintenance procedures are instrument- and manufacturer-specific.

4.4 POST-MAINTENANCE CALIBRATION CHECKS

After completing all maintenance and adjustment activities, initiate a post-maintenance calibration check as described in Section 4.1 and record the obtained values as the post-maintenance values.

4.5 DOCUMENTATION

Sensor calibrations require several levels of documentation:

CALIBRATION FORMS	Calibration forms or the computer laptop Excel spreadsheet should be completed entirely. Where possible, use the Excel spreadsheet so that both a hard copy and digital record of the calibration are maintained. Review and sign all calibration forms.
LOG NOTES	A summary of the calibration and maintenance activities must be included in the station log notes. Note any abnormalities in sensor or calibration operation that could affect the quality of data.
CALIBRATION STICKER	An ARS calibration sticker is placed on the sensor, marking the date the instrument was calibrated and the name of the technician who calibrated it.
TRIP REPORT	Calibration and maintenance activities are documented in a written site trip report.
MAINTENANCE CARDS	The sensor-specific maintenance card must be kept current to indicate the most recent calibration, repair, and location of the sensor.

5.0 REFERENCES

Environmental Protection Agency, 2008, Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV. Meteorological Measurements (Version 2.0), EPA-454/B-08-002 (March).

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
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AUTHORIZATIONS		
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1.0	Calibration form changes/update methods.	June 1996	G. Mercer
1.1	Added respon and equip/formatting change	September 1997	G. Mercer
1.2	Updated calibration form/ added table values	September 1998	G. Mercer
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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**CALIBRATION AND ROUTINE MAINTENANCE OF CLIMATRONICS F460 OR QUALIMETRICS 12XX WIND SPEED AND DIRECTION SENSOR SYSTEMS**
TYPE	**TECHNICAL INSTRUCTION**
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AUTHORIZATIONS

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1.0 PURPOSE AND APPLICABILITY

The purpose of calibration and maintenance is to assure quality data capture and minimize data loss by performing and documenting scheduled operational checks and preventive maintenance. This technical instruction (TI) provides specific details to dynamically calibrate:

- A Climatronics modular meteorological station (MMS) F460.
- A Qualimetrics 1220/1250-A wind speed and wind direction system.

Both systems include a power supply mainframe, signal conditioning card, and meteorological sensors.

The two meteorological systems described above have nearly identical components. The notable difference is that the Climatronics system incorporates both wind speed and direction signal conditioning on one card, while the Qualimetrics system uses individual cards for wind speed and direction.

Experienced technicians using this TI, Standard Operating Procedure (SOP) 3150, *Calibration and Routine Maintenance of Meteorological Monitoring Systems*, and the manufacturer's instrument manual should be able to adjust the equipment to fully meet all defined specifications.

Calibrations are required under any of the following circumstances:

- Upon acceptance testing of a new instrument
- Upon installation or removal of the instrument at a field station
- Whenever control limits are exceeded
- Prior to any corrective action, service, or maintenance to any portion of the instrument that affects its operational principle
- At a maximum interval of 6 months

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Establish the project-specific calibration and maintenance schedule and coordinate with the client as necessary.
- Establish the calibration reporting protocol to satisfy client requirements.

- Review calibration results.

- Identify inconsistencies in calibration results and initiate corrective action as required.

- Review and approve any changes to calibration procedures.

2.2 FIELD SPECIALIST

The field specialist shall:

- Perform required calibrations and maintenance as described in this TI.

- Document all calibration results and maintenance procedures performed.

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment and materials are generally required to calibrate and maintain wind speed and direction sensor systems:

- Topographic maps of the area

- Protractor

- Magnetic compass

- Digital voltmeter (4-1/2 digit)

- R.M. Young Model 18801 variable speed calibration motor

- Notched compass wheel and linearity test jig

- Torque disc and weights

- Station log book

- Wind Speed/Wind Direction Calibration Forms

- Pen or pencil

- Laptop computer loaded with EXCEL workbook (NPS.XLT) and CALCU program software

- Climatronics or Qualimetrics instrument manual

- Tower climbing belt and safety equipment

- Field service tools

- ARS calibration stickers

4.0 METHODS

The wind system must be dynamically checked (pre-maintenance calibration) before any electrical adjustments are made to the signal conditioning cards or before servicing the meteorological sensors. Throughout the calibration and maintenance period, the datalogger, calibration forms, and strip chart (if used) must be annotated to indicate that data taken during the calibration period should not be included as standard observations.

After performing system adjustments and maintenance, the system again needs to be dynamically checked (post-maintenance calibration) to ensure proper operation of the sensors. The pre- and post-maintenance calibration techniques are identical. Do not adjust the signal conditioning cards or perform any maintenance to the sensors until all pre-calibration checks are completed.

The procedures described in this TI are specific to Climatronics F460 or Qualimetrics 12XX wind speed and direction sensors. Calibration and maintenance include tasks that are detailed in the following four (4) major subsections:

4.1 Calibration Checks
4.2 Wind Direction Sensor
4.3 Wind Speed Sensor
4.4 Documentation

4.1 CALIBRATION CHECKS

A complete calibration check must be performed prior to (pre) and following (post) any maintenance activity. The calibration check procedures described below apply to both pre- or post-maintenance calibration checks. Refer to Figures 4-1 and 4-2, Example Wind Speed Calibration Form and Example Wind Direction Calibration Form, respectively, when performing calibration checks. Be sure to indicate on the forms whether the calibration is pre- or post-maintenance and note all maintenance activities or replaced components in the "Comments" field. The forms are available as an Excel spreadsheet and should be used for both pre- and post-maintenance checks. Results of each calibration should be in both hardcopy and digital form.

Calibration checks are performed semiannually. Should any operational check be out of suggested tolerance, complete the calibration check before any maintenance or adjustments are made. The following operational checks should be performed:

ANNOTATE DATA RECORDS — Make an entry in the station log book indicating the date and time (beginning and ending) of the calibration and maintenance procedures. "Down" the appropriate channels on the DAS or set the calibration flag as appropriate for the DAS being used.

Complete the following fields on the calibration forms: network and station name; current date; name of technician performing the calibration; manufacturer, model, and serial number of the instrument; and date of the last calibration.

RECORD READINGS — Simultaneously record the pre-maintenance DVM and DAS readings of the sensor to be calibrated.

Air Resource Specialists, Inc.

WIND SPEED
CALIBRATION FORM

Network:	Location:	Site:	Date:	Date of Last Site Visit:
				Field Specialist:

Wind Speed Reference S/N: N/A		Calibration Date:

WIND SPEED

SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.		
Model #		
Serial #		
Translator Serial #		

WIND SPEED TRANSLATOR CARD

Card Setting	PRE		POST	
	DVM (volts)	DAS (m/s)	DVM (volts)	DAS (m/s)
Zero				
Span				
Oscillator Frequency (Hz) =			Data Logger Should Read	

WIND SPEED STARTING THRESHOLD

PRE		POST	
Torque gm-cm	Pass/Fail	Torque gm-cm	Pass/Fail

Wind speed starting threshold accuracy goal:
Climatronics <= 0.2 g-cm

Motor Speed (rpm)			WIND SPEED PRE-MAINTENANCE					WIND SPEED POST MAINTENANCE				
	Climatronics (m/s)	RM Young (m/s)	DVM (volts)	DAS (m/s)	Difference (m/s)	% Difference	Pass/Fail	DVM (volts)	DAS (m/s)	Difference (m/s)	% Difference	Pass/Fail
100	2.574	0.510										
300	7.274	1.540										
600	14.324	3.070										
900	21.375	4.610										
1200	28.425	6.140										
1800	42.526	9.220										
4000	N/A	20.480										
7000	N/A	35.840										
Maximum ABS Difference (use if Wind Speed <5):												
Maximum ABS % Difference (use if Wind Speed >=5):												

Pre-Maint Wind Speed Comments:	
Post Maint Wind Speed Comments:	

Figure 4-1. Example Wind Speed Calibration Form.

Air Resource Specialists, Inc.

WIND DIRECTION CALIBRATION FORM

Network:	Location:	Site:	Date:	Date of Last Site Visit:
				Field Specialist:

To Landmark #1: Degrees True	From Landmark #1:	LM Description:
To Landmark #2: Degrees True	From Landmark #2:	LM Description:
Declination: Degrees		
Wind Direction Reference S/N: N/A		Calibration Date:

WIND DIRECTION

SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.		
Model #		
Serial #		
Translator Serial #		

WIND DIRECTION ALIGNMENT

Land Mark Reference	PRE-MAINTENANCE				POST MAINTENANCE			
	DVM (volts)	DAS (degrees)	Degrees Difference	Pass/Fail	DVM (volts)	DAS (degrees)	Degrees Difference	Pass/Fail
To 1								
From 1								
To 2								
From 2								
	Average Difference:				Average Difference:			
	Maximum Difference:				Maximum Difference:			

WIND DIRECTION TRANSLATOR CARD

Card Setting	PRE		POST	
	DVM (volts)	DAS (m/s)	DVM (volts)	DAS (m/s)
Zero				
Span				
360				
Oscillator Frequency (Hz) =			Data Logger Should Read	

WIND DIRECTION LINEARITY

Check Point	PRE-MAINTENANCE				POST MAINTENANCE			
	DVM (volts)	DAS (degrees)	Degrees Difference	Pass/Fail	DVM (volts)	DAS (degrees)	Degrees Difference	Pass/Fail
1								
2								
3								
4								
5								
6								
7								
8								
	Average Difference:				Average Difference:			
	Maximum Difference:				Maximum Difference:			

WIND DIRECTION STARTING THRESHOLD

PRE		POST	
Torque gm-cm	Pass/Fail	Torque gm-cm	Pass/Fail

Wind direction starting threshold accuracy goal:
Climatronics <= 6 g-cm

Pre-Maint Wind Direction Comments:	
Post Maint Wind Direction Comments:	

Figure 4-2. Example Wind Direction Calibration Form.

4.2 WIND DIRECTION SENSOR

4.2.1 Sensor Checks

ORIENTATION CHECK

The wind direction sensor orientation check includes the following procedures:

- Use a compass, protractor, and topographic map to familiarize yourself with the surrounding terrain.
- Identify two outstanding features on the topographic map.
- Determine the azimuth (to the nearest degree) of the selected feature from a topographic map and/or from a magnetic compass.
- Record the selected features, azimuth measured (degrees true), and magnetic declination used (available from a topographic map) on the calibration form, using a laptop computer and Excel spreadsheet software. An example Wind Direction Calibration Form is presented in Figure 4-2.

  NOTE: When using a compass, calculate degrees true using magnetic declination carefully. If the declination is easterly, <u>increase</u> the measured magnetic azimuth by the amount of declination. If westerly, <u>decrease</u> the reading. For example: Fort Collins, CO, uses a declination of 14° east. If a horizon landmark is measured by compass as 210°, the landmark is 224° true.

- Connect a digital voltmeter (DVM) to the output of the wind direction signal conditioning card.
- Climb the tower and align the nose of the wind direction vane toward landmark 1.
- Alert your assistant to record the data acquisition system wind direction value, DVM reading, and strip chart recorder value on the calibration form as “To Landmark 1.”
- Align the tail of the wind direction vane toward landmark 1.
- Alert your assistant to record the DAS, DVM, and strip chart output values as “From Landmark 1.”
- Repeat this procedure for the remaining landmark.

LINEARITY CHECK

The wind direction sensor linearity check includes the following procedures:

- Attach the wind direction linearity test jig to the wind direction sensor.
- Replace the wind direction vane with the notched compass wheel.
- Index the compass wheel into one of the four notches.
- Alert the assistant to record the DAS, DVM, and strip chart recorder values.
- Repeat the procedure for the remaining indexed positions.

STARTING THRESHOLD CHECK

The sensor bearing starting threshold check includes the following procedures:

- Remove the sensor from the crossarm. Remove the vane or cups.
- Install the torque disc.
- Hold the sensor horizontal and note the weight required to overcome the shaft rotational threshold.

SIGNAL CONDITIONING CARD CHECK

The signal conditioning card electronic balance check includes the following procedures:

- Select “ZERO” (0) on the card mode switch and record the DAS and DVM values.
- Select “SPAN” (360) on the card mode switch and record the DAS and DVM values.
- Select “SPAN 540” (+360) on the card mode switch and record the DAS and DVM values.

4.2.2 Evaluation of Sensor Checks

Evaluate the results of the wind direction calibration checks to determine if the following specifications are met:

ORIENTATION CHECK

“To” and “From” values should not be more than ±5° from any corresponding designated value.

LINEARITY CHECK

Results of the eight indexed positions should increase in 45° increments ±3°.

STARTING THRESHOLD — Starting threshold of the sensor should not be greater than 6 gm/cm.

SIGNAL CONDITIONING CARD BALANCE — ZERO (0), SPAN (360), and SPAN 540 (+360) position values should be within 1° of the following values:

Position	DAS	0-5.000 VDC System	0-1.000 VDC System	0-10 mVDC System
zero (0)	0	0.000	0.000	0.00
span (360)	360	3.333	0.667	6.67
span 540 (+360)	360	3.333	0.667	6.67

4.2.3 Sensor Adjustments

If checks are beyond the designated values, perform the following adjustments:

ORIENTATION — Re-orient the sensor if the alignment check indicated is greater than ±5° difference at any point by:

- Loosening the alignment collar on the crossarm.
- Aligning the wind direction vane to known landmark.
- Twisting the collar until the designated azimuth is achieved.
- Tightening the alignment collar.

SIGNAL CONDITIONING CARD — Adjust the signal conditioning card to the below-mentioned designated values:

CLIMATRONICS		**QUALIMETRICS**	
Position	Adjust Potentiometer	Position	Adjust Potentiometer
zero	R-34	0	R-202
span	R-33	360	R-201
span 540	R-47	+360	R-320

4.2.4 Sensor Maintenance

LINEARITY — Replace the potentiometer if the linearity check indicates greater than ±2° deviation from the suggested values. Consult the manufacturer's instruction manual for the proper procedure.

STARTING THRESHOLD — Replace the bearings if the starting threshold is greater than 6 gm/cm. Consult the manufacturer's instruction manual for the proper procedure.

4.2.5 Post-Maintenance Calibration Checks

After completing all maintenance and adjustment activities, initiate a post-maintenance calibration check as described in Section 4.2.1, and record them as the post-maintenance values.

4.3 WIND SPEED SENSOR

4.3.1 Sensor Checks

MOTOR RESPONSE CHECK (FOUR-POINT)

The wind speed sensor speed response check includes the following procedures:

- Connect the DVM to the wind speed signal conditioning card output.
- Remove the anemometer cups and attach the R. M. Young variable speed calibration motor to the sensor input shaft.
- Adjust the calibrator for 300 rpm and allow the sensor to stabilize.
- Alert the assistant to record the DAS, DVM, and strip chart recorder output on the calibration form.
- Repeat the procedure for 600, 900, and 1800 rpm.

STARTING THRESHOLD CHECK

The sensor starting threshold check includes the following procedures:

- Remove the sensor from the crossarm.
- Attach the torque disc to the input shaft.
- Note the weight, size, and position when the shaft first starts to turn. Bearings will need to be replaced if the starting threshold is greater than 2 gm/cm.

SIGNAL CONDITIONING CARDS CHECK

Check the signal conditioning card balance by adjusting the mode switch on the card to “ZERO” (LOW) and “SPAN” (HI) and recording the output on the calibration form.

4.3.2 Evaluation of Sensor Checks

Evaluate the results of the wind speed sensor tests to determine if the following specifications are met:

SENSOR RESPONSE

Measured instrument response must be within ±5% of the designated value:

	CLIMATRONICS	QUALIMETRICS	
RPM	Designated Value (0-50 m/s range) (meters/second)	Designated Value (0-100 mph range) (miles/hour)	Designated Value (0-44.7 m/s range) (meters/second)
300	7.3	15.2	6.8
600	14.3	30.0	13.4
900	21.4	44.7	20.0
1800	42.5	88.8	39.7

STARTING THRESHOLD

Starting threshold of the sensor should not be greater than 0.25 m/s or 0.5 mph.

SIGNAL CONDITIONING CARD

Zero and span position values should be as follows (to within ±0.005 VDC):

CLIMATRONICS			QUALIMETRICS			
Mode	DAS (m/s)	Designated Value (0-5.000 VDC System)	Mode	DAS (mph)	DAS (m/s)	Designated Value (0-5.000 VDC System)
Zero	0.2	0.020	Low	0.4	0.2	0.020
Span	25.0	2.500	Hi	45.3	20.2	2.265

4.3.3 Sensor Adjustments

No adjustments can be made to these sensors.

4.3.4 Sensor Maintenance

If checks are beyond the values, perform the following maintenance:

SENSOR RESPONSE

Inspect the sensor chopper disc and clean if necessary. Replace the sensor if response remains beyond tolerance.

STARTING THRESHOLD

Replace the sensor bearings if the starting threshold is greater than the designated value.

4.3.5 Post-Maintenance Calibration Checks

After completing all maintenance and adjustment activities, initiate a post-maintenance calibration check as described in Section 4.3.1, and record them as the post-maintenance values.

4.4 DOCUMENTATION

Sensor calibrations require several levels of documentation:

CALIBRATION FORMS

Calibration forms or the computer laptop Excel spreadsheet should be completed entirely. Where possible, use the Excel spreadsheet so that both a hard copy and digital record of the calibration are maintained. Review and sign all calibration forms.

LOG NOTES

A summary of results and maintenance performed must be included in the station log notes. Note any abnormalities in sensor or calibration operation that could affect the quality of data.

CALIBRATION STICKER

An ARS calibration sticker is placed on the sensor, marking the date the instrument was calibrated and the name of the technician
who calibrated it.

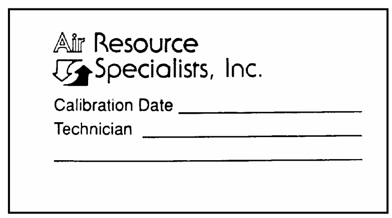

Figure 4-2. ARS Calibration Sticker.

TRIP REPORT

The calibration is thoroughly documented in a written site trip report.

5.0 DEFINITIONS

Calibration Oscillator: A component housed in the mainframe that supplies a test input to the wind speed signal conditioning card when the “span” (high) mode is selected.

Dynamic Check: A dynamic check implies subjecting a sensor to known conditions similar to those conditions under normal sampling. A dynamic check of a wind direction sensor would be to point the vane to a known landmark and comparing the sensor output with the measured landmark azimuth.

Mainframe: The 19-inch wide card cage that physically holds and electrically connects the signal conditioning cards. The mainframe also holds the system power supply.

Power Supply: The modular component that supplies positive and negative operating voltages to the signal conditioning cards.

Signal Conditioning Card: An electronic circuit card that provides operational voltages to the meteorological sensor and converts the raw sensor signal to a linear analog output suitable for recording. The signal conditioning card is housed in a mainframe that is typically near the data acquisition system. Signal conditioning cards are also referred to as "translator cards."

Zero, Span, Span 540 (0, 360, +360): Internal self-check switch positions on the signal conditioning cards that when selected, they supply stable known test conditions to the signal conditioning card.

6.0 REFERENCES

Climatronics Corporation, 1986, Instrument Manual, October. Bohemia, NY.

Qualimetrics, Inc., 1986, Meteorological System Manual, March. Sacramento, CA.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**CALIBRATION AND ROUTINE MAINTENANCE OF CLIMATRONICS F460 WIND SPEED AND DIRECTION SENSORS USED WITH A CAMPBELL SCIENTIFIC 21XL OR CR23X DATALOGGER**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3150-2102**
DATE	**JUNE 1996**

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TITLE	NAME	SIGNATURE
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PROGRAM MANAGER	Joe Adlhoch	[signature]
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

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	Reviewed; no changes necessary.	January 2003	G. Mercer
0.4	Update calibration form.	January 2004	G. Mercer
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OTHER		

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	Reviewed; no changes necessary.	May 2010	G. Mercer
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1.0 PURPOSE AND APPLICABILITY

The purpose of calibration and maintenance is to assure quality data capture and minimize data loss by performing and documenting scheduled operational checks and preventive maintenance. This technical instruction (TI) provides specific details for routine calibration and maintenance of Climatronics F460 wind speed and wind direction sensors used with a Campbell Scientific 21XL or CR23X datalogger. This TI assumes general operating knowledge of the 21XL or CR23X datalogger and only details the instructions and commands specific to the wind measurement system. The 21XL or CR23X datalogger supplied sensor power and signal conditioning eliminates the need for separate sensor power supply and signal conditioning cards.

Experienced technicians using this TI, Standard Operating Procedure (SOP) 3150, *Calibration and Routine Maintenance of Meteorological Monitoring Systems*, and the manufacturer's instrument manual should be able to adjust the equipment to fully meet all defined specifications.

Calibrations are required under any of the following circumstances:

- Upon acceptance testing of a new instrument
- Upon installation or removal of the instrument at a field station
- Whenever control limits are exceeded
- Prior to any corrective action, service, or maintenance to any portion of the instrument that affects its operational principle
- At a maximum interval of 6 months

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Establish the project-specific calibration and maintenance schedule and coordinate with the client as necessary.
- Establish the calibration reporting protocol to satisfy client requirements.
- Review calibration results.
- Identify inconsistencies in calibration results and initiate corrective action as required.
- Review and approve any changes to calibration procedures.

2.2 FIELD SPECIALIST

The field specialist shall:

- Perform required calibrations and maintenance as described in this TI.
- Document all calibration results and maintenance procedures performed.

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment and materials are required for Climatronics F460 wind speed and wind direction sensors (used with a Campbell Scientific 21XL or CR23X datalogger) calibration:

- Topographic map with alignment landmarks
- Protractor
- Magnetic compass and tripod
- Digital voltmeter (4-1/2 digit)
- R.M. Young Model 18801 variable speed calibration motor
- Notched compass wheel and linearity test jig
- Torque disc and weights
- Climatronics instrument manual
- Campbell Scientific 21XL or CR23X datalogger manual
- Tower climbing belt and safety equipment
- Field service tools
- Station log book
- Wind Speed and Wind Direction Calibration Forms
- Pen or pencil
- Laptop computer loaded with Excel workbook (Calibrations_edits.XLT) and CALCU program software
- Repair/replacement parts including wind speed and wind direction rebuilt parts (bearings and potentiometer)
- ARS calibration stickers

4.0 METHODS

The wind system must be dynamically checked (pre-maintenance calibration) before any adjustments are made to the signal conditioning software instructions or before servicing the meteorological sensors. Throughout the calibration and maintenance period, the datalogger, calibration forms, and strip chart (if used) must be annotated to indicate that data taken during the calibration period should not be included as standard observations.

After performing system adjustments and maintenance, the system again needs to be dynamically checked (post-maintenance calibration) to ensure proper operation of the sensor. The pre- and post- maintenance calibration techniques are identical. Do not adjust the signal conditioning program or perform any maintenance to the sensors until all pre-calibration checks are completed.

The procedures described in this TI are specific to Climatronics F460 wind speed and direction sensors, operated with a Campbell Scientific 21XL or CR23X datalogger. Calibration and maintenance include tasks that are detailed in the following four (4) major subsections:

4.1 Calibration Checks
4.2 Wind Direction Sensor
4.3 Wind Speed Sensor
4.4 Documentation

4.1 CALIBRATION CHECKS

A complete calibration check must be performed prior to (pre) and following (post) any maintenance activity. The calibration check procedures described below apply to both pre- or post-maintenance calibration checks. Refer to the appropriate calibration forms performing calibration checks. Be sure to indicate on the forms whether the calibration is pre- or post-maintenance and note all maintenance activities or replaced components in the "Comments" field. The forms are available as Excel spreadsheets and should be used at all times. Results of each calibration should be in both hardcopy and digital form.

Calibration checks are performed semiannually. Should any operational check be out of suggested tolerance, complete the calibration check before any maintenance or adjustments are made. The following operational checks should be performed:

ANNOTATE DATA RECORDS

Make an entry in the station log book indicating the date and time (beginning and ending) of the calibration and maintenance procedures. "Down" the appropriate channels on the data acquisition system (DAS) or set the calibration flag as appropriate for the DAS being used.

Complete the following fields on the appropriate calibration form: network and station name; current date; name of technician performing the calibration; manufacturer, model, and serial number of the instrument; and date of the last calibration.

RECORD READINGS

Simultaneously record the pre-maintenance digital voltmeter (DVM) and DAS readings of the sensor to be calibrated. Disregard any columns on the form that refer to translator cards or DVM readings.

4.2 WIND DIRECTION SENSOR

Refer to Figure 4-1, Example Wind Direction Calibration Form, when performing calibration checks.

4.2.1 <u>Sensor Checks</u>

ORIENTATION CHECK

The wind direction sensor orientation check is performed as follows:

- Use a compass, protractor, and topographic map to familiarize yourself with the surrounding terrain.
- Identify two outstanding features. Label these features on the map as "Landmark 1" and "Landmark 2."

Air Resource Specialists, Inc.

WIND DIRECTION CALIBRATION FORM

Network:	Location:	Site:	Date:	Date of Last Site Visit:
				Field Specialist:

To Landmark #1:	Degrees True	From Landmark #1:	LM Description:
To Landmark #2:	Degrees True	From Landmark #2:	LM Description:
Declination:	Degrees		
Wind Direction Reference S/N: N/A			Calibration Date:

WIND DIRECTION

SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.		
Model #		
Serial #		
Translator Serial #		

WIND DIRECTION ALIGNMENT

Land Mark Reference	PRE-MAINTENANCE				POST MAINTENANCE			
	DVM (volts)	DAS (degrees)	Degrees Difference	Pass/Fail	DVM (volts)	DAS (degrees)	Degrees Difference	Pass/Fail
To 1								
From 1								
To 2								
From 2								
	Average Difference:				Average Difference:			
	Maximum Difference:				Maximum Difference:			

WIND DIRECTION TRANSLATOR CARD

Card Setting	PRE		POST	
	DVM (volts)	DAS (m/s)	DVM (volts)	DAS (m/s)
Zero				
Span				
360				
Oscillator Frequency (Hz) =			Data Logger Should Read	

WIND DIRECTION LINEARITY

Check Point	PRE-MAINTENANCE				POST MAINTENANCE			
	DVM (volts)	DAS (degrees)	Degrees Difference	Pass/Fail	DVM (volts)	DAS (degrees)	Degrees Difference	Pass/Fail
1								
2								
3								
4								
5								
6								
7								
8								
	Average Difference:				Average Difference:			
	Maximum Difference:				Maximum Difference:			

WIND DIRECTION STARTING THRESHOLD

PRE		POST	
Torque gm-cm	Pass/Fail	Torque gm-cm	Pass/Fail

Wind direction starting threshold accuracy goal:
Climatronics <= 6 g-cm

Pre-Maint Wind Direction Comments:	
Post Maint Wind Direction Comments:	

Figure 4-1. Example Wind Direction Calibration Form.

ORIENTATION CHECK (continued)

- Determine the azimuth (degrees from true north to the nearest degree) of the selected feature from a topographic map and/or from a magnetic compass. Determine the magnetic declination from the topographic map or, alternately, use the CALCU software program to determine the declination.

- Record on the calibration form the features selected, azimuth measured (degrees true), and magnetic declination used.

  NOTE: When using a compass, calculate degrees true using magnetic declination carefully. If the declination is easterly, increase the measured magnetic azimuth by the amount of declination. If westerly, decrease the reading. For example: Fort Collins, CO, uses a declination of 14° East. If a horizon landmark is measured by compass as 210° Magnetic, the landmark is 224° True.

- Select the appropriate datalogger channel to display the instantaneous wind direction output. Review the execution interval and adjust it to a minimum of 10-second updates. Remember to return the execution interval to its original setting following the calibration.

- Climb the tower and align the nose of the wind direction vane toward Landmark 1. Careful alignment of the vane is critical during all steps of this procedure.

- Alert your assistant to record the wind direction value displayed on the datalogger and strip chart recorder value on the calibration form as “To Landmark 1.”

  NOTE: Good communication with your assistant is essential. Tall or remote towers may require radios or other alternate communication techniques.

- Align the tail of the wind direction vane toward Landmark 1.

- Alert your assistant to record the datalogger and strip chart values as “From Landmark 1.”

- Repeat this procedure for Landmark 2.

- Additional alignment checks using the sensor crossarm may be useful if either landmarks are difficult to identify or measure. Record these values in the “Comments” area of the calibration form.

LINEARITY CHECK

The wind direction sensor linearity check is performed as follows:

- Attach the wind direction linearity test jig to the wind direction sensor.

LINEARITY CHECK (continued)

- Replace the wind direction vane with the notched compass wheel.
- Index the compass wheel into one of the eight notches.
- Alert your assistant to record the datalogger and strip chart recorder values.
- Repeat the procedure for the remaining indexed positions.

STARTING THRESHOLD CHECK

Check the wind direction sensor bearing starting threshold as follows:

- Remove the sensor from the crossarm.
- Remove the vane and install the torque disc on the sensor shaft. Hold the sensor in a horizontal position.
- Note the weight size and position when the shaft first turns.

4.2.2 Datalogger Program

WIND DIRECTION SENSOR

The wind direction sensor signal is processed using the P4 "Excite, Delay, Volt (SE)" instruction. An example program instruction is listed below:

P4	Excite, Delay, Volt (SE)
01:01*	Number of Repetitions
02:05	5000 mV Slow Range
03:01*	Input Location
04:01	Excite with EX channel 1
05:20	Delay (units 0.01 sec)
06:50 00	mV Excitation
07:01	Location of Intermediate Data (example)
08:0.144	Multiplier *sensor and cable specific*
09:0.000	Offset

*Response will be specific to station configuration.

MULTIPLIER

Although the multiplier can be changed to accommodate individual sensors or extremely long (>500 feet) sensor cables, this is rarely necessary. The following steps may be followed to determine an individual sensor/signal cable combination multiplier value.

- Change the multiplier to "1.000."
- Rotate the sensor shaft slowly; note the highest value reached on the datalogger display.
- Divide the highest value noted by 360.
- Enter the calculated value for the multiplier response.

OFFSET	Leave the offset at “0.000.” If the pre-calibration check indicates the sensor is misoriented, reorient the sensor as described in Section 4.2.1.

4.2.3 Evaluation of Wind Direction Sensor Checks

Evaluate the results of the wind direction calibration checks to determine if the following specifications are met:

ORIENTATION CHECK	“To” and “From” values should not be more than ±5° from any corresponding designated value.
LINEARITY CHECK	Results of the four indexed positions should increase in increments ±2°.
STARTING THRESHOLD	The starting threshold of the sensor should not be greater than 6 gm-cm.

4.2.4 Sensor Adjustments

If checks are beyond the designated values, perform the following adjustments:

ORIENTATION — Reorient the sensor if the alignment check indicated is greater than ±5° difference at any point by:

- Loosening the alignment collar on the crossarm.
- Aligning the wind direction vane to a known landmark.
- Twisting the collar until the designated azimuth is achieved.
- Tightening the alignment collar.

4.2.5 Sensor Maintenance

LINEARITY	Replace the potentiometer if the linearity check indicates a greater than ±2° deviation from the suggested values. Consult the manufacturer’s instruction manual for the proper procedure (Figure 4-2).
STARTING THRESHOLD	Replace the upper bearings and potentiometer if the starting threshold is greater than 6 gm-cm. Consult the manufacturer’s instruction manual for the proper procedure.

4.2.6 Post-Maintenance Calibration Checks

After completing all maintenance and adjustment activities, initiate a post-maintenance calibration check as described in Section 4.2.1 and record them as the post-maintenance values.

F460 Wind Sensors

FEATURES:
- Low Threshold
- High Survivability
- Excellent Dynamic Response
- CMOS Design
- Optional Internal/External Heaters

Climatronics' F460 Wind Sensors are capable of operation in virtually all weather conditions. Designed to meet the requirements of Specification No. F460-SP001 for the National Weather Service, the durability of these sensors make them ideal for multilevel tower installations. Although moderately priced, the F460 wind sensors offer the combination of low starting threshold, quick response, and high accuracy with excellent reliability over a wide range of operating conditions.

The F460 Wind Speed Sensor, P/N 100075, monitors the wind speed with a three-cup anemometer assembly. A 30-hole chopper with an LED photochopper device provides a frequency output directly proportional to the wind speed. Traceability to NIST(formerly NBS) is available as an option for each anemometer cup assembly by comparison testing against an NIST transfer standard in our wind tunnel test facility.

The F460 Wind Direction Sensor, P/N 100076, consists of a counter-balanced, lightweight vane and a precision, low-torque, highly-reliable potentiometer to yield a voltage output proportional to the wind direction. Once properly oriented on the keyed cross-arm mount at a particular installation, the wind direction sensor may be removed or replaced without requiring reorientation.

Installation of the sensors is a simple matter of either fastening each sensor to separate pipes of 1¼ inch IPS or attaching both sensors to Climatronics' prewired crossarm, P/N 100487, which in turn mounts on a 1¼ inch IPS pipe. Internal sensor electronics are accessed by sliding off the outer aluminum sleeve. Optional internal and external heaters for both sensors are available. The Internal Heaters, P/N 101263, consume approximately four watts of power and operate on a continuous basis, while the External Heaters, P/N 101235, consume approximately 20 watts of power and are thermostatically controlled.

Figure 4-2. Manufacturer's Specifications for the Climatronics F460 Wind Speed and Direction Sensors (Page 1).

Signal conditioners for the F460 sensors are available in modular form with a variety of full scale ranges, engineering units, outputs, and several other options. Please consult the Modular Meteorological System (MMS) and the Remote Meteorological System (RMS) data sheets for more details.

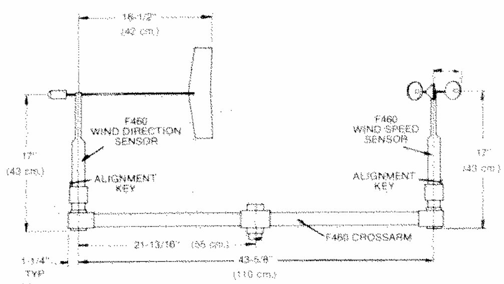
The sensors may be directly interfaced either to Climatronics' IMP-800 series of digital data acquisition units or almost any of the currently available data loggers/data acquisition units.

The Component Anemometer, P/N 101284, can be used in conjunction with the F460 System to measure the vertical component of the wind. Consult the Orthogonal (UVW) Wind Sensor data sheet for additional details.

SPECIFICATIONS:

	F460 Wind Speed (P/N 100075)	F460 Wind Direction (P/N 100076)
PERFORMANCE:		
Signal Output	2.0 Vpp into 2K ohms, frequency proportional to wind speed	Variable DC voltage magnitude proportional to wind direction
Accuracy	0.15 mph (± 0.07 m/s) or ± 1.0% of true air speed (whichever is greater)	± 2°
Threshold	0.5 mph (0.22 m/s)	0.5 mph (0.22 m/s)
Distance Constant	Vinyl: 5 ft. (1.5 m) of air max. Stainless Steel: 8.0 ft. (2.4 m) of air max.	2.95 ft. (.9 m) of air max.
Damping Ratio	----	0.4 at 10° initial angle of attack
Operating Range	0-125 mph (0-56 m/s)	0 to 360°
ELECTRICAL:		
Power Requirements*	+ 12 VDC at 1 mA nominal	Max. 1 mA through 10K ohms
PHYSICAL:		
Size	2.25" (5.7 cm) max. diameter 11.5" (29.2 cm) high	2.25" (5.7 cm) max. diameter 11.5" (29.2 cm) high
Weight	Less than 2 lbs. (0.9 Kg)	Less than 2 lbs. (0.9 Kg)
Turning Radius	3.75" (9.5 cm)	16.5" (41.9 cm)
Operating Temperture	-40 to 140° F (-40 to 60° C)	-40 to 140° F (-40 to 60° C)
Use with Signal Conditioner	P/N 100163 (MMS) P/N 100778 (RMS)	P/N 100163 (MMS) P/N 100779 (RMS)
CROSSARM:		
P/N 100487		
Length	45" (114.3 cm)	----
Weight	7 lbs. (3.2 Kg)	----
Mounting	1.66" (4.2 cm)	O.D. pipe (1¼" IPS)
HEATER:		
P/N 101263 Internal	12 VDC, 2 watts per sensor	
P/N 101235 External	115 VAC/60 Hz, 20 watts per sensor	

*Proper power provided by signal conditioner.



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RECYCLE
9/90

Figure 4-2. (Continued). Manufacturer's Specifications for the Climatronics F460 Wind Speed and Direction Sensors (Page 2).

4.3 WIND SPEED SENSOR

Refer to Figure 4-3, Example Wind Speed Calibration Form, when performing calibration checks.

4.3.1 Sensor Checks

MOTOR RESPONSE CHECK (FOUR-POINT)

Check the wind speed sensor speed response as follows:

- Select the appropriate datalogger channel to display the instantaneous wind speed output. Review the execution interval and adjust it to a minimum of 10-second updates. Remember to return the execution interval to its original setting following the calibration.
- Remove the anemometer cups and attach the R.M. Young variable speed calibration motor to the sensor input shaft.
- Set the calibrator for 300 rpm and allow the sensor to stabilize.
- Alert your assistant to record the datalogger and strip chart recorder output on the calibration form.
- Repeat the procedure for 600, 900, and 1800 rpm. Other speeds may be selected as appropriate Table 4-1 lists the designated values for selected rpms.

Table 4-1

Climatronics F460 Sensor
Designated Values

Climatronics F460 Sensor with Vinyl or Aluminum Cups		
RPM	Designated Value (meters/second)	Designated Value (miles/hour)
100	2.574	5.8
300	7.274	16.3
600	14.324	32.0
900	21.375	47.8
1200	28.425	63.6
1800	42.526	95.1

STARTING THRESHOLD CHECK

Check the sensor for the starting threshold as follows:

- Remove the sensor from the crossarm.
- Remove the anemometer cups and attach the torque disc to the sensor shaft. Hold the sensor in a horizontal position.
- Note the weight size and position when the shaft first begins to turn.

Air Resource Specialists, Inc.

WIND SPEED CALIBRATION FORM

Network:	Location:	Site:	Date:	Date of Last Site Visit:
				Field Specialist:

Wind Speed Reference S/N: N/A		Calibration Date:

WIND SPEED

SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.		
Model #		
Serial #		
Translator Serial #		

WIND SPEED TRANSLATOR CARD

Card Setting	PRE		POST	
	DVM (volts)	DAS (m/s)	DVM (volts)	DAS (m/s)
Zero				
Span				
Oscillator Frequency (Hz) =			Data Logger Should Read	

WIND SPEED STARTING THRESHOLD

PRE		POST	
Torque gm-cm	Pass/Fail	Torque gm-cm	Pass/Fail

Wind speed starting threshold accuracy goal:
Climatronics <= 0.2 g-cm

Motor Speed (rpm)			WIND SPEED PRE-MAINTENANCE					WIND SPEED POST MAINTENANCE				
	Climatronics (m/s)	RM Young (m/s)	DVM (volts)	DAS (m/s)	Difference (m/s)	% Difference	Pass/Fail	DVM (volts)	DAS (m/s)	Difference (m/s)	% Difference	Pass/Fail
100	2.574	0.510										
300	7.274	1.540										
600	14.324	3.070										
900	21.375	4.610										
1200	28.425	6.140										
1800	42.526	9.220										
4000	N/A	20.480										
7000	N/A	35.840										
Maximum ABS Difference (use if Wind Speed <5):												
Maximum ABS % Difference (use if Wind Speed >=5):												

Pre-Maint Wind Speed Comments:	
Post Maint Wind Speed Comments:	

Figure 4-3. Example Wind Speed Calibration Form.

4.3.2 Datalogger Program

The data wind speed sensor signal is processed using the P3 "Pulse Input" instruction. Instruction Parameter 3 "CONFIGuration" utilizes Option 3 "High Frequency, 16 Bit" counts. This configuration allows wind speed calculation independent of the execution interval. An example program instruction is listed below:

P3	Pulse
01:01*	Number of Repetitions
02:02*	Pulse Input Channel in Use
03:20	High Frequency: Output Hz
04:01*	Location of Intermediate data (example)
05:0.105	Multiplier for Miles Per Hour Output (0.047 for meters per second output)
06:05	Offset for Sensor Starting Threshold in Miles Per Hour (0.2 for meters per second output)

*Response will be specific to station configuration.

Alteration of the datalogger program to correct a sensor response problem is not recommended; all corrective action should be made to the sensor.

4.3.3 Evaluation of Wind Speed Sensor Checks

Evaluate the results of the wind speed calibration checks to determine if the following specifications are met:

SENSOR RESPONSE — Measured instrument response must be within ±5% of the designated value (see Section 4.3.1).

STARTING THRESHOLD — Starting threshold of the sensor should not be greater than 0.2 gm-cm (equivalent to 0.27 m/s).

4.3.4 Sensor Adjustments

No adjustments can be made to the sensor.

4.3.5 Sensor Maintenance

If checks are beyond the designated values, perform the following maintenance:

SENSOR RESPONSE — Inspect the sensor chopper disc and clean if necessary. Replace the sensor if the response remains beyond tolerance.

STARTING THRESHOLD — Replace the sensor bearings if the starting threshold is greater than the designated value.

4.3.6 Post-Maintenance Calibration Checks

After completing all maintenance and adjustment activities, initiate a post-maintenance calibration check as described in Section 4.3.1 and record them as the post-maintenance values.

4.4 DOCUMENTATION

Sensor calibrations require several levels of documentation:

CALIBRATION FORMS — Calibration forms or the computer laptop Excel spreadsheet should be completed entirely. Where possible, use the Excel spreadsheet so that both a hard copy and digital record of the calibration are maintained. Review and sign all calibration forms.

LOG NOTES — A summary of results and maintenance performed must be included in the station log notes. Note any abnormalities in sensor or calibration operation that could affect the quality of data.

CALIBRATION STICKER — An ARS calibration sticker is placed on the sensor, marking the date the instrument was calibrated and the name of the technician
who calibrated it.

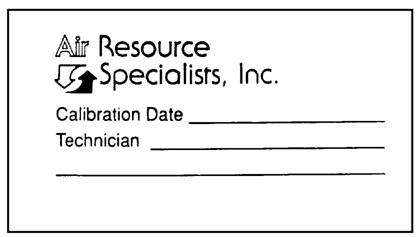

Figure 4-4. ARS Calibration Sticker.

TRIP REPORT — The calibration is thoroughly documented in a written site trip report.

5.0 REFERENCES

Campbell Scientific, Inc., 1991, 21X Micrologger Operator's Manual, Logan, UT.

Campbell Scientific, Inc., 1998, CR23X Micrologger Operator's Manual, Logan, UT.

Climatronics Corporation, REV E, F460 Wind Speed Sensor Manual , Bohemia, NY.

Climatronics Corporation, REV C F460 Wind Direction Sensor Manual, Bohemia, NY.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**CALIBRATION AND ROUTINE MAINTENANCE OF R.M. YOUNG MODEL 05305 WIND MONITOR-AQ WIND SPEED AND DIRECTION SENSOR SYSTEMS**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3150-2103**
DATE	**AUGUST 1996**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	David D. Meisters	
PROJECT MANAGER	John F. Faust	
PROGRAM MANAGER	Joe Adlhoch	
QA MANAGER	Gloria S. Mercer	
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
0.1	Change responsibilities and documentation.	September 1997	G. Mercer
0.2	Update calibration form.	September 1998	G. Mercer
	Reviewed; no changes necessary.	September 1999	G. Mercer
	Reviewed; no changes necessary.	September 2000	G. Mercer
	Reviewed; no changes necessary.	September 2001	G. Mercer
0.3	Update calibration forms.	June 2002	G. Mercer
	Reviewed; no changes necessary.	June 2003	G. Mercer
	Reviewed; no changes necessary.	June 2004	G. Mercer
	-- continued --		

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**CALIBRATION AND ROUTINE MAINTENANCE OF R.M. YOUNG MODEL 05305 WIND MONITOR-AQ WIND SPEED AND DIRECTION SENSOR SYSTEMS**
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ORIGINATOR	David D. Meisters	
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PROGRAM MANAGER	Joe Adlhoch	
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
	Reviewed; no changes necessary.	June 2005	G. Mercer
0.4	Change starting threshold value	November 2005	G. Mercer
	Reviewed; no changes necessary.	November 2006	G. Mercer
	Reviewed; no changes necessary.	November 2007	G. Mercer
	Reviewed; no changes necessary.	November 2008	G. Mercer
	Reviewed; no changes necessary.	November 2009	G. Mercer
	Reviewed; no changes necessary.	November 2010	G. Mercer

TABLE OF CONTENTS

LIST OF FIGURES

1.0 PURPOSE AND APPLICABILITY

The purpose of calibration and maintenance is to assure quality data capture and minimize data loss by performing and documenting scheduled operational checks and preventive maintenance. This technical instruction (TI) provides specific details to dynamically calibrate an R.M. Young model 05305 Wind Monitor-AQ.

The corrosion resistant Wind Monitor-AQ sensor measures both horizontal wind speed and direction. The sensor incorporates a horizontal propeller shaft and vertical direction shaft that use stainless steel precision grade ball bearings shielded from contamination and moisture all housed in one injection molded, U.V. stabilized plastic cowling.

Propeller rotation produces an AC sine wave signal with a frequency proportional to wind speed. Vane position is transmitted by a 10K Ohm precision conductive plastic potentiometer which requires a regulated excitation voltage. With a constant voltage applied to the potentiometer, the output signal is an analog voltage directly proportional to azimuth angle.

The sensor mounts on standard one-inch pipe, (OD 35 mm, 1.34”). An orientation ring is provided to ensure proper realignment after it has been removed for maintenance, and a stainless steel band clamp secures the mounting post assembly and orientation ring to the pipe. A junction box at the base of the pipe merge the electrical connections and signal cable to the signal conditioning, display, and recording devices.

Experienced technicians using this TI, Standard Operating Procedure (SOP) 3150, *Calibration and Routine Maintenance of Meteorological Monitoring Systems*, and the manufacturer’s instrument manual should be able to adjust the equipment to fully meet all defined specifications.

Calibrations are required under any of the following circumstances:

- Upon acceptance testing of a new instrument
- Upon installation or removal of the instrument at a field station
- Whenever control limits are exceeded
- Prior to any corrective action, service, or maintenance to any portion of the instrument that affects its operational principle
- At a maximum interval of 6 months

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Establish the project-specific calibration and maintenance schedule and coordinate with the client as necessary.

- Establish the calibration reporting protocol to satisfy client requirements.
- Review calibration results.
- Identify inconsistencies in calibration results and initiate corrective action as required.
- Review and approve any changes to calibration procedures.

2.2 FIELD SPECIALIST

The field specialist shall:

- Perform required calibrations and maintenance as described in this TI.
- Document all calibration results and maintenance procedures performed.

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment and materials are generally required to calibrate and maintain wind speed and wind direction sensor systems:

- Topographic maps of the area
- Protractor
- Magnetic compass
- Digital voltmeter (4-1/2 digit)
- R.M. Young Model 18801 or 18802 anemometer drive motor
- Torque disc and weights
- Model 18112 vane angle bench stand
- Laptop computer with Excel workbook (Calibrations.XLT) and CALCU program software
- R.M. Young instrument manual
- Tower climbing belt and safety equipment
- Field service tools
- Station log book
- Wind Speed Calibration Forms
- Wind Direction Calibration Forms
- Pen or pencil
- ARS calibration stickers

4.0 METHODS

The wind system must be dynamically checked (pre-maintenance calibration) before any electrical adjustments are made to the programmable translator or before servicing the meteorological sensors. Throughout the calibration and maintenance period, the datalogger, calibration forms, and strip chart (if used) must be annotated to indicate that data taken during the calibration period should not be included as standard observations.

After performing system adjustments and maintenance, the system again needs to be dynamically checked (post-maintenance calibration) to ensure proper operation of the sensors. The pre- and post-maintenance calibration techniques are identical. Do not adjust the signal conditioning cards or perform any maintenance to the sensors until all pre-calibration checks are completed.

The procedures described in this TI are specific to R.M. Young model 05305 Wind Monitor-AQ wind speed and direction sensors. Calibration and maintenance include tasks that are detailed in the following four (4) major subsections:

4.1 Calibration Checks
4.2 Wind Direction Sensor
4.3 Wind Speed Sensor
4.4 Documentation

4.1 CALIBRATION CHECKS

A complete calibration check must be performed prior to (pre) and following (post) any maintenance activity. The calibration check procedures described below apply to both pre- or post-maintenance calibration checks. Refer to Figures 4-1 and 4-2, Example Wind Speed and Example Wind Direction Calibration Form, when performing calibration checks. Be sure to indicate on the form whether the calibration is pre- or post-maintenance and note all maintenance activities or replaced components in the “Comments” field. The form is available as an Excel spreadsheet and should be used for both pre- and post- maintenance checks. Results of each calibration should be in both hardcopy and digital form.

Calibration checks are performed semiannually. Should any operational check be out of suggested tolerance, complete the calibration check before any maintenance or adjustments are made. The following operational checks should be performed:

ANNOTATE DATA RECORDS	Make an entry in the station log book indicating the date and time (beginning and ending) of the calibration and maintenance procedures. “Down” the appropriate channels on the DAS or set the calibration flag as appropriate for the DAS being used. Complete the following fields on the Wind Speed and Wind Direction Calibration Forms: network and station name; current date; name of technician performing the calibration; manufacturer, model, and serial number of the instrument; and date of the last calibration.
RECORD READINGS	Simultaneously record the pre-maintenance DVM and DAS of the sensor to be calibrated.

Air Resource Specialists, Inc.

WIND SPEED CALIBRATION FORM

Network:	Park:	Site:	Date: 06/26/02	Date of Last Site Visit:
				Field Specialist:

Wind Speed Reference S/N: test17		Calibration Date: test17

WIND SPEED

SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.		
Model #		
Serial #		
Translator Serial #		

WIND SPEED TRANSLATOR CARD

Card Setting	PRE		POST	
	DVM (volts)	DAS (m/s)	DVM (volts)	DAS (m/s)
Zero				
Span				
Oscillator Frequency (Hz) =			Data Logger Should Read	

WIND SPEED STARTING THRESHOLD

Torque gm-cm	Pass/Fail	Torque gm-cm	Pass/Fail

Wind direction starting threshold accuracy goal.
RM Young MA <= 2 9 g-cm

Motor Speed (rpm)			WIND SPEED PRE-MAINTENANCE					WIND SPEED POST MAINTENANCE				
	Climatronics (m/s)	RM Young (m/s)	DVM (volts)	DAS (m/s)	Difference (m/s)	% Difference	Pass/Fail	DVM (volts)	DAS (m/s)	Difference (m/s)	% Difference	Pass/Fail
100	2.574	0.510										
300	7.274	1.540										
600	14.324	3.070										
900	21.375	4.610										
1200	28.425	6.140										
1800	42.526	9.220										
4000	N/A	20.480										
7000	N/A	35.840										
Maximum ABS Difference (use if Wind Speed <5):												
Maximum ABS % Difference (use if Wind Speed >=5):												

Pre-Maint Wind Speed Comments:	
Post Maint Wind Speed Comments:	

Figure 4-1. Example Wind Speed Calibration Form.

Air Resource Specialists, Inc.

WIND DIRECTION CALIBRATION FORM

Network:	Park:	Site:	Date: 06/26/02	Date of Last Site Visit:
				Field Specialist:

To Landmark #1: Degrees True	From Landmark #1:	LM Description:
To Landmark #2: Degrees True	From Landmark #2:	LM Description:
Declination: Degrees		
Wind Direction Reference S/N: test15		Calibration Date: test15

WIND DIRECTION

SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.		
Model #		
Serial #		
Translator Serial #		

WIND DIRECTION TRANSLATOR CARD

Card Setting	PRE		POST	
	DVM (volts)	DAS (m/s)	DVM (volts)	DAS (m/s)
Zero				
Span				
360				
Oscillator Frequency (Hz) =			Data Logger Should Read	

WIND DIRECTION STARTING THRESHOLD

Torque gm-cm	Pass/Fail	Torque gm-cm	Pass/Fail

Wind direction starting threshold accuracy goal:
RM Young MA <= 30 g-cm

WIND DIRECTION ALIGNMENT

Land Mark Reference	PRE-MAINTENANCE				POST MAINTENANCE			
	DVM (volts)	DAS (degrees)	Degrees Difference	Pass/Fail	DVM (volts)	DAS (degrees)	Degrees Difference	Pass/Fail
To 1								
From 1								
To 2								
From 2								
	Average Difference:				Average Difference:			
	Maximum Difference:				Maximum Difference:			

WIND DIRECTION LINEARITY

Check Point	PRE-MAINTENANCE				POST MAINTENANCE			
	DVM (volts)	DAS (degrees)	Degrees Difference	Pass/Fail	DVM (volts)	DAS (degrees)	Degrees Difference	Pass/Fail
1								
2								
3								
4								
5								
6								
7								
8								
	Average Difference:				Average Difference:			
	Maximum Difference:				Maximum Difference:			

Pre-Maint Wind Direction Comments:	
Post Maint Wind Direction Comments:	

Figure 4-2. Example Wind Direction Calibration Form.

4.2 WIND DIRECTION SENSOR

4.2.1 Sensor Checks

ORIENTATION CHECK

The wind direction sensor orientation check includes the following procedures:

- Use a compass, protractor, and topographic map to familiarize yourself with the surrounding terrain.
- Identify two outstanding features on the topographic map.
- Determine the azimuth (to the nearest degree) of the selected feature from a topographic map and/or from a magnetic compass.
- Record the selected features, azimuth measured (degrees true), and magnetic declination used (available from a topographic map) on the calibration form, using a laptop computer and Excel spreadsheet software. An example Wind Speed and Wind Direction Calibration Forms is presented in Figures 4-1 and 4-2.

  NOTE: When using a compass, calculate degrees true using magnetic declination carefully. If the declination is easterly, increase the measured magnetic azimuth by the amount of declination. If westerly, decrease the reading. For example: Fort Collins, CO, uses a declination of 14° east. If a horizon landmark is measured by compass as 210°, the landmark is 224° true.

- Connect a digital voltmeter (DVM) to the output of the wind direction signal conditioning card.
- Climb the tower and align the nose of the wind direction vane toward landmark 1.
- Alert your assistant to record the data acquisition system wind direction value, DVM reading, and strip chart recorder value on the calibration form as “To Landmark 1.”
- Align the tail of the wind direction vane toward landmark 1.
- Alert your assistant to record the DAS, DVM, and strip chart output values as “From Landmark 1.”
- Repeat this procedure for the remaining landmark.

LINEARITY CHECK

The wind direction sensor linearity check includes the following procedures:

- Attach the wind direction vane angle bench stand to the wind direction sensor.
- Position the vane into 45° increments using the vane angle bench stands 0° - 360° scale.
- Alert the assistant to record the DAS and DVM values at each increment.

STARTING THRESHOLD CHECK

The sensor bearing starting threshold check includes the following procedures:

- Remove the sensor from the crossarm. Remove the cups.
- Install the torque disc.
- Note the weight required to overcome the shaft rotational threshold.

4.2.2 Evaluation of Wind Direction Sensor Checks

Evaluate the results of the wind direction calibration checks to determine if the following specifications are met:

ORIENTATION CHECK

"To" and "From" values should not be more than 5° from any corresponding designated value.

LINEARITY CHECK

Results of the eight indexed positions should increase in 45° increments ±3°.

STARTING THRESHOLD

Starting threshold of the sensors wind direction shaft should not be greater than 9 gm-cm.

4.2.3 Sensor Adjustments

If checks are beyond the designated values, perform the following adjustments:

ORIENTATION

Re-orient the sensor if the alignment check indicated is greater than ±5° difference at any point by:

- Loosening the alignment collar on the crossarm.
- Aligning the wind direction vane to known landmark.
- Twisting the collar until the designated azimuth is achieved.
- Tightening the alignment collar.

4.2.4 Sensor Maintenance

LINEARITY	Replace the potentiometer if the linearity check indicates greater than 3° deviation from the suggested values. Consult the manufacturer's instruction manual for the proper procedure.
STARTING THRESHOLD	Replace the bearings if the starting threshold is greater than 6 gm-cm. Consult the manufacturer's instruction manual for the proper procedure.

4.2.5 Post-Maintenance Calibration Checks

After completing all maintenance and adjustment activities, initiate a post-maintenance calibration check as described in Section 4.2.1, and record them as the post-maintenance values.

4.3 WIND SPEED SENSOR

4.3.1 Sensor Checks

MOTOR RESPONSE CHECK(FOUR-POINT)

The wind speed sensor speed response check includes the following procedures:

- Connect the DVM to the wind speed signal conditioning card output.
- Remove the anemometer propeller and attach the R. M. Young anemometer drive motor to the sensor input shaft.
- Adjust the calibrator for 600 rpm and allow the sensor to stabilize.
- Alert the assistant to record the DAS, DVM, and strip chart recorder output on the calibration form.
- Repeat the procedure for 1800, 4000, and 7000 rpm.

STARTING THRESHOLD CHECK

The sensor starting threshold check includes the following procedures:

- Remove the sensor.
- Attach the torque disc to the anemometer shaft.
- Note the weight and position when the shaft first starts to turn.

4.3.2 Evaluation of Wind Speed Sensor Checks

Evaluate the results of the wind speed sensor tests to determine if the following specifications are met:

SENSOR RESPONSE — Measured instrument response must be within ±5% of the designated value:

R.M. YOUNG WIND MONITOR-AQ		
RPM	Designated Value (0-50 m/s range) (m/s=0.00512 x rpm)	Designated Value (0-100 mph range) (mph=0.01145 x rpm)
600	3.1	6.9
1800	9.2	20.6
4000	20.5	45.8
7000	35.8	80.1

STARTING THRESHOLD — Starting threshold of the sensor's anemometer shaft should not be greater than 0.25 m/s or 0.5 mph.

4.3.3 Sensor Adjustments

To calibrate the wind system electronics using a signal from the instrument, temporarily remove the propeller and connect the Model 18801 or 18802 Anemometer Drive to the propeller shaft. Apply the appropriate calibration formula to the calibrating motor RPM and adjust the electronics for the proper value. For example, with the propeller shaft turning at 3600 RPM, adjust an indicator to display 18.4 meters per second (3600 rpm x 0.00512 m/s/rpm = 18.4 m/s).

4.3.4 Sensor Maintenance

If checks are beyond the designated values, perform the following maintenance:

SENSOR RESPONSE — Inspect the sensor chopper disc and clean if necessary. Replace the sensor if response remains beyond tolerance.

STARTING THRESHOLD — Replace the sensor bearings if the starting threshold is greater than 0.3 gm-cm.

4.3.5 Post-Maintenance Calibration Checks

After completing all maintenance and adjustment activities, initiate a post-maintenance calibration check as described in Section 4.3.1 and record them as post-maintenance values.

4.4 DOCUMENTATION

Sensor calibrations require several levels of documentation:

CALIBRATION FORMS
Calibration forms or the computer laptop Excel spreadsheet should be completed entirely. Where possible, use the Excel spreadsheet so that both a hard copy and digital record of the calibration are maintained. Review and sign all calibration forms.

LOG NOTES
A summary of results and maintenance performed must be included in the station log notes. Note any abnormalities in sensor or calibration operation that could affect the quality of data.

CALIBRATION STICKER
An ARS calibration sticker is placed on the sensor, marking the date the instrument was calibrated and the name of the technician who calibrated it.

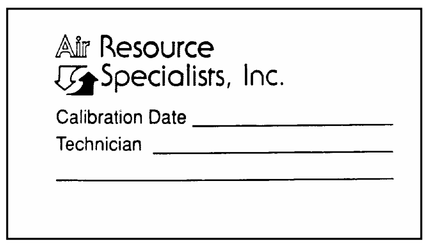

Figure 4-3. ARS Calibration Sticker.

TRIP REPORT
The calibration is thoroughly documented in a written site trip report.

5.0 DEFINITIONS

Dynamic Check: A dynamic check implies subjecting a sensor to known conditions similar to those conditions under normal sampling. A dynamic check of a wind direction sensor would be to point the vane to a known landmark and comparing the sensor output with the measured landmark azimuth.

Power Supply: The modular component that supplies positive and negative operating voltages to the signal conditioning cards.

Signal Conditioning Card: An electronic circuit card that provides operational voltages to the meteorological sensor and converts the raw sensor signal to a linear analog output suitable for recording. Signal conditioning cards are also referred to as “translator cards.”

6.0 REFERENCES

R.M. Young Company, 1995, Meteorological Instruments Model 05305 Wind Monitor - AQ Instructions, July. Traverse City, MI.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**CALIBRATION AND ROUTINE MAINTENANCE OF CLIMATRONICS OR QUALIMETRICS TEMPERATURE/DELTA TEMPERATURE SYSTEMS**
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AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
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	Reviewed; no changes necessary.	September 2002	G. Mercer
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AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	John F. Faust	John F. Faust
PROJECT MANAGER	John F. Faust	John F. Faust
PROGRAM MANAGER	David L. Dietrich	[illegible]
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
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REVISION HISTORY			
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LIST OF FIGURES

1.0 PURPOSE AND APPLICABILITY

The purpose of calibration and maintenance is to assure quality data capture and minimize data loss by performing and documenting scheduled operational checks and preventive maintenance. This technical instruction (TI) provides specific details to dynamically calibrate:

- A Climatronics P/N 100087 temperature card with P/N 100093-2 temperature probes and a P/N 100829-1 delta temperature card.

- A Qualimetrics M/N 1410 temperature signal conditioning card with a M/N 4480-A temperature probe.

The two temperature systems described above have nearly identical components. Both systems include a power supply and mainframe, signal conditioning card, forced aspiration housing, and temperature probe.

Experienced technicians using this TI, Standard Operating Procedure (SOP) 3150, *Calibration and Routine Maintenance of Meteorological Monitoring Systems*, and the manufacturer's instrument manual should be able to adjust the equipment to fully meet all defined specifications.

Calibrations are required under any of the following circumstances:

- Upon acceptance testing of a new instrument

- Upon installation or removal of the instrument at a field station

- Whenever control limits are exceeded

- Prior to any corrective action, service, or maintenance to any portion of the instrument that affects its operational principle

- At a maximum interval of 6 months

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Establish the project-specific calibration and maintenance schedule and coordinate with the client as necessary.

- Establish the calibration reporting protocol to satisfy client requirements.

- Review calibration results.

- Identify inconsistencies in calibration results and initiate corrective action as required.

- Review and approve any changes to calibration procedures.

2.2 FIELD SPECIALIST

The field specialist shall:

- Perform required calibrations and maintenance as described in this TI.
- Document all calibration results and maintenance procedures performed.

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment and materials are generally required to calibrate and maintain temperature/delta temperature systems:

- Calibrated thermometers: -20° to +10°C, 0° to +30°C, and +20° to +50°C
- Thermos bottles
- One gallon of distilled water
- Crushed ice
- Portable water heater or hot water
- Digital voltmeter (4-1/2 digit)
- Field service tools
- Station log book
- Calibration forms
- Pen or pencil
- Laptop computer with Excel workbook (NPS.XLT) and CALCU program software
- ARS calibration stickers

4.0 METHODS

The temperature/delta temperature system must be dynamically checked (pre-maintenance calibration) before any electrical adjustments are made to the signal conditioning cards or before servicing the meteorological sensors. Throughout the calibration and maintenance period, the datalogger, calibration forms, and strip chart (if used) must be annotated to indicate that data taken during the calibration period should not be included as standard observations.

After performing system adjustments and maintenance, the system again needs to be dynamically checked (post-maintenance calibration) to ensure proper operation of the sensors. The pre- and post-maintenance calibration techniques are identical. Do not adjust the signal conditioning cards or perform any maintenance to the sensors until all pre-calibration checks are completed.

The procedures described in this TI are specific to Climatronics or Qualimetrics temperature/delta temperature systems. Calibration and maintenance include tasks that are detailed in the following five (5) major subsections:

4.1 Calibration Checks
4.2 Sensor Adjustments
4.3 Sensor Maintenance
4.4 Post-Maintenance Calibration Checks
4.5 Documentation

4.1 CALIBRATION CHECKS

A complete calibration check must be performed prior to (pre) and following (post) any maintenance activity. The calibration check procedures described below apply to both pre- or post-maintenance calibration checks. Refer to Figure 4-1, Example Temperature, Delta Temperature, and Relative Humidity Calibration Form, when performing calibration checks. Be sure to indicate on the form whether the calibration is pre- or post-maintenance and note all maintenance activities or replaced components in the "Comments" field. The form is available as an Excel spreadsheet and should be used for both pre- and post- maintenance checks. Results of each calibration should be in both hardcopy and digital form.

Calibration checks are performed semiannually. Should any operational check be out of suggested tolerance, complete the calibration check before any maintenance or adjustments are made. The following operational checks should be performed:

ANNOTATE DATA RECORDS

Make an entry in the station log book indicating the date and time (beginning and ending) of the calibration and maintenance procedures. "Down" the appropriate channels on the DAS or set the calibration flag as appropriate for the DAS being used.

Complete the following fields on the calibration form: network and station name; current date; name of technician performing the calibration; manufacturer, model, and serial number of the instrument; and date of the last calibration.

RECORD READINGS

Simultaneously record the pre-maintenance DVM and DAS readings of the sensor to be calibrated. Connect a DVM to the output of the temperature signal conditioning card.

PREPARE WATER BATHS

Three water baths need to be prepared: one bath with ambient water near 20°C, one bath with water and crushed ice, and one bath with 40°-50°C water. Make arrangements to hang or support the baths in the vicinity of the temperature probes.

CALIBRATION CHECK PROCEDURES

A temperature calibration check is performed as follows:

- Remove the temperature probe(s) from the aspirator(s) and fully immerse the probe(s) into the ambient water bath. Insert a calibrated thermometer of the appropriate range into the water bath.

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TEMPERATURE, DELTA TEMPERATURE AND RELATIVE HUMIDITY CALIBRATION FORM

Network:	Location:	Site:	Date:	Date of Last Site Visit:
				Field Specialist:

Reference Thermometer S/N: N/A		Calibration Date:
Relative Humidity Reference S/N: test		Calibration Date:

TEMPERATURE / DELTA TEMPERATURE

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.		
Model #		
Serial #		
Translator Serial #		

PRE-MAINTENANCE SENSOR RESPONSE

BATH TEMP (° C)	TEMPERATURE		Difference (° C)	Pass/Fail	Δ TEMPERATURE		Difference (° C)	Pass/Fail
	DVM (volts)	DAS (° C)			DVM (volts)	DAS (° C)		
	Maximum Difference:				Maximum Difference:			

PRE- TRANSLATOR CARD RESPONSE

SETTING	TEMPERATURE		Δ TEMPERATURE	
	DVM (volts)	DAS (° C)	DVM (volts)	DAS (° C)
Zero				
Span				

POST MAINTENANCE SENSOR RESPONSE

BATH TEMP (° C)	TEMPERATURE		Difference (° C)	Pass/Fail	Δ TEMPERATURE		Difference (° C)	Pass/Fail
	DVM (volts)	DAS (° C)			DVM (volts)	DAS (° C)		
	Maximum Difference:				Maximum Difference:			

POST TRANSLATOR CARD RESPONSE

SETTING	TEMPERATURE		Δ TEMPERATURE	
	DVM (volts)	DAS (° C)	DVM (volts)	DAS (° C)
Zero				
Span				

Pre-Maint Temperature Comments:	
Post Maint Temperature Comments:	

RELATIVE HUMIDITY

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.	Rotronics RH	Rotronics RH
Model #	MP601A	MP601A
Serial #		

PRE-MAINTENANCE SENSOR RESPONSE

HOUR	DAS	T.STD	Difference	Pass/Fail
10:00				
11:00				
12:00				
13:00				
14:00				
15:00				
Average ABS % Difference:				
Maximum % Difference:				

POST MAINTENANCE SENSOR RESPONSE

HOUR	DAS	T.STD	Difference	Pass/Fail
10:00				
11:00				
12:00				
13:00				
14:00				
15:00				
Average ABS % Difference:				
Maximum % Difference:				

Screen dirty/clogged on RH pre-maintenance sensor? (check one): ☐ Yes ☐ No

Pre-Maint Relative Humidity Comments:	
Post Maint Relative Humidity Comments:	

Figure 4-1. Example Temperature, Delta Temperature, and Relative Humidity Calibration Form.

CALIBRATION CHECK PROCEDURES (continued)

- Agitate the bath for two to five minutes or until both the temperature value indicated on the data acquisition system (DAS) and the observed value on the thermometer stabilize, and the delta temperature is zero.

- Record the observed value of the thermometer as the designated value on the calibration form. Record the DAS, DVM, and chart recorder values for temperature and delta temperature on the calibration form.

- Repeat the above procedures for the ice bath and the warm bath.

SIGNAL CONDITIONING CARD CHECKS

Check the signal conditioning card(s) for proper electronic balance as follows:

- Select "ZERO" (LOW) on the card mode switch(s) and record the DAS, DVM, and chart recorder values for temperature and delta temperature on the calibration sheet.

- Select "SPAN" (HIGH) on each card mode switch(s) and record the DAS, DVM, and chart recorder values for temperature and delta temperature on the calibration sheet.

4.1.1 Evaluation of Temperature/Delta Temperature Sensor Checks

Evaluate the results of the temperature/delta temperature calibration checks to determine if the following specifications are met:

WATER BATH CHECK

The temperature indicated value from the DAS should not differ by more than ±0.2°C from the designated value at any bath temperature.

SIGNAL CONDITIOINING CARD(S) BALANCE

ZERO (LOW), SPAN (HIGH) position values should be within ±0.1°C of the following designated values:

Card	Position	DAS (°C)	0-5.000 VDC System (±0.005)	0-1.000 VDC System (±0.001)	0-10.00 VDC System (±0.01)
Temperature	Zero (low)	-50.0	0.000	0.000	0.00
	Span (high)	+50.0	5.000	1.000	10.00
Delta	Zero (low)	+5.0	0.000	0.000	0.00
Temperature	Span (high)	-5.0	5.000	1.000	10.00

4.2 SENSOR ADJUSTMENTS

No adjustments can be made to the sensors.

4.3 SENSOR MAINTENANCE

If checks are beyond the designated values, perform the following maintenance:

INSPECT TEMPERATURE PROBE(S) — Inspect the temperature probe(s) and electrical connections for cleanliness and electrical continuity. Correct if necessary.

INSPECT ASPIRATOR HOUSING(S) — Inspect the aspirator housing(s) and clean if any dirt or cobwebs have accumulated. Inspect the aspirator motor(s) and replace if necessary.

SIGNAL CONDITIONNG CARD — Adjust the signal conditioning card to the following designated values:

Card	CLIMATRONICS		QUALIMETRICS	
	Position	Adjust Potentiometer	Position	Adjust Potentiometer
Temperature	ZERO	R-8	LOW	VR-302
	SPAN	R-15	HIGH	VR-302
Delta Temperature	ZERO	R-1	LOW	Not available
	SPAN	R-2	HIGH	Not available

4.4 POST-MAINTENANCE CALIBRATION CHECKS

After completing all maintenance and adjustment activities, initiate a post-maintenance calibration check as described in Section 4.1 and record them as post-maintenance values.

4.5 DOCUMENTATION

Sensor calibrations require several levels of documentation:

CALIBRATION FORMS — Calibration forms or the computer laptop Excel spreadsheet should be completed entirely. Where possible, use the Excel spreadsheet so that both a hard copy and digital record of the calibration aremaintained. Review and sign all calibration forms.

LOG NOTES — A summary of results and maintenance performed must be included in the station log notes. Note any abnormalities in sensor or calibration operation that could affect the quality of data.

CALIBRATION STICKER — An ARS calibration sticker is placed on the sensor, marking the date the instrument was calibrated and the name of the technician
who calibrated it.

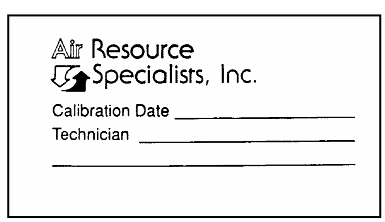

Figure 4-2. ARS Calibration Sticker.

TRIP REPORT	The calibration is thoroughly documented in a written site trip report.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**CALIBRATION AND ROUTINE MAINTENANCE OF R.M. YOUNG TEMPERATURE/DELTA TEMPERATURE SYSTEMS**
TYPE	**TECHNICAL INSTRUCTION**
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PROGRAM MANAGER	David L. Dietrich	[illegible]
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY			
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0.1	Change responsibilities and documentation.	September 1997	G. Mercer
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	Reviewed; no changes necessary.	September 2001	G. Mercer
0.3	Update calibration form.	June 2002	G. Mercer
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	Reviewed; no changes necessary.	June 2004	G. Mercer
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ORIGINATOR	Mark Tigges	
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PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	G. S. Mercer
OTHER		

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	Reviewed; no changes necessary.	June 2007	G. Mercer
	Reviewed; no changes necessary.	June 2008	G. Mercer
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	Reviewed; no changes necessary.	June 2010	G. Mercer
	Reviewed; no changes necessary.	June 2011	G. Mercer

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LIST OF FIGURES

1.0 PURPOSE AND APPLICABILITY

The purpose of calibration and maintenance is to assure quality data capture and minimize data loss by performing and documenting scheduled operational checks and preventive maintenance. This technical instruction (TI) provides specific details to dynamically calibrate an R.M. Young Model 26700 programmable translator unit with two Model 41342 temperature probes.

The R.M. Young temperature/delta temperature system includes a power supply, programmable translator, two forced aspiration housings, and two temperature probes.

Experienced technicians using this TI, Standard Operating Procedure (SOP) 3150, *Calibration and Routine Maintenance of Meteorological Monitoring Systems*, and the manufacturer's instrument manual should be able to adjust the equipment to fully meet all defined specifications.

Calibrations are required under any of the following circumstances:

- Upon acceptance testing of a new instrument
- Upon installation or removal of the instrument at a field station
- Whenever control limits are exceeded
- Prior to any corrective action, service, or maintenance to any portion of the instrument that affects its operational principle
- At a maximum interval of 6 months

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Establish the project-specific calibration and maintenance schedule and coordinate with the client as necessary.
- Establish the calibration reporting protocol to satisfy client requirements.
- Review calibration results.
- Identify inconsistencies in calibration results and initiate corrective action as required.
- Review and approve any changes to calibration procedures.

2.2 FIELD SPECIALIST

The field specialist shall:

- Perform required calibrations and maintenance as described in this TI.
- Document all calibration results and maintenance procedures performed.

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment and materials are generally required to calibrate and maintain temperature/delta temperature systems:

- NIST certified digital thermometer
- Thermos bottles
- One gallon of distilled water
- Crushed ice
- Portable water heater or hot water
- Digital voltmeter (4-1/2 digit)
- Field service tools
- Station log book
- Temperature, delta temperature and relative humidity calibration form
- Pen or pencil
- Laptop computer with Excel workbook (Calibrations.XLT) and CALCU program software
- ARS calibration stickers

4.0 METHODS

The temperature/delta temperature system must be dynamically checked (pre-maintenance calibration) before any electrical adjustments are made to the signal conditioning cards or before servicing the meteorological sensors. Throughout the calibration and maintenance period, the datalogger, calibration forms, and strip chart (if used) must be annotated to indicate that data taken during the calibration period should not be included as standard observations.

After performing system adjustments and maintenance, the system again needs to be dynamically checked (post-maintenance calibration) to ensure proper operation of the sensors. The pre- and post-maintenance calibration techniques are identical. Do not adjust the signal conditioning cards or perform any maintenance to the sensors until all pre-calibration checks are completed.

The procedures described in this TI are specific to R.M. Young temperature/delta temperature systems. Calibration and maintenance include tasks that are detailed in the following five (5) major subsections:

4.1 Calibration Checks
4.2 Sensor Adjustments
4.3 Sensor Maintenance
4.4 Post-Maintenance Calibration Checks
4.5 Documentation

4.1 CALIBRATION CHECKS

A complete calibration check must be performed prior to (pre) and following (post) any maintenance activity. The calibration check procedures described below apply to both pre- or post-maintenance calibration checks. Refer to Figure 4-1 Example temperature, delta temperature and relative humidity calibration form, when performing calibration checks. Be sure to indicate on the form whether the calibration is pre- or post-maintenance and note all maintenance activities or replaced components in the "Comments" field. The form is available as an Excel spreadsheet and should be used for both pre- and post- maintenance checks. Results of each calibration should be in both hardcopy and digital form.

Calibration checks are performed semiannually. Should any operational check be out of suggested tolerance, complete the calibration check before any maintenance or adjustments are made. The following operational checks should be performed:

ANNOTATE DATA RECORDS

Make an entry in the station log book indicating the date and time (beginning and ending) of the calibration and maintenance procedures. "Down" the appropriate channels on the DAS or set the calibration flag as appropriate for the DAS being used.

Complete the following fields on the Temperature, Delta Temperature and Relative Humidity Calibration Form: network and station name; current date; name of technician performing the calibration; manufacturer, model, and serial number of the instrument; and date of the last calibration.

RECORD READINGS

Simultaneously record the pre-maintenance DVM and DAS readings of the sensor to be calibrated. Connect a DVM to the output of the temperature signal conditioning card.

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TEMPERATURE, DELTA TEMPERATURE AND RELATIVE HUMIDITY CALIBRATION FORM

Network:	Park:	Site:	Date: 06/26/02	Date of Last Site Visit:
				Field Specialist:

Reference Thermometer S/N: test12		Calibration Date: test12
Relative Humidity Reference S/N: test9		Calibration Date: test9

TEMPERATURE / DELTA TEMPERATURE

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.		
Model #		
Serial #		
Translator Serial #		

PRE-MAINTENANCE SENSOR RESPONSE

BATH TEMP (° C)	TEMPERATURE		Difference (° C)	Pass/Fail	Δ TEMPERATURE		Difference (° C)	Pass/Fail
	DVM (volts)	DAS (° C)			DVM (volts)	DAS (° C)		
	Maximum Difference:				Maximum Difference:			

PRE- TRANSLATOR CARD RESPONSE

SETTING	TEMPERATURE		Δ TEMPERATURE	
	DVM (volts)	DAS (° C)	DVM (volts)	DAS (° C)
Zero				
Span				

POST MAINTENANCE SENSOR RESPONSE

BATH TEMP (° C)	TEMPERATURE		Difference (° C)	Pass/Fail	Δ TEMPERATURE		Difference (° C)	Pass/Fail
	DVM (volts)	DAS (° C)			DVM (volts)	DAS (° C)		
	Maximum Difference:				Maximum Difference:			

POST TRANSLATOR CARD RESPONSE

SETTING	TEMPERATURE		Δ TEMPERATURE	
	DVM (volts)	DAS (° C)	DVM (volts)	DAS (° C)
Zero				
Span				

Pre-Maint Temperature Comments:	
Post Maint Temperature Comments:	

RELATIVE HUMIDITY

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.		
Model #		
Serial #		

PRE-MAINTENANCE SENSOR RESPONSE

HOUR	DAS	T.STD	% Difference	Pass/Fail
10:00				
11:00				
12:00				
13:00				
14:00				
15:00				
Average ABS % Difference:				
Maximum % Difference:				

POST MAINTENANCE SENSOR RESPONSE

HOUR	DAS	T.STD	% Difference	Pass/Fail
10:00				
11:00				
12:00				
13:00				
14:00				
15:00				
Average ABS % Difference:				
Maximum % Difference:				

Pre-Maint Relative Humidity Comments:	
Post Maint Relative Humidity Comments:	

Figure 4-1. Example Temperature, Delta Temperature and Relative Humidity Calibration Form.

PREPARE WATER BATHS — Three water baths need to be prepared: one bath with ambient water near 20°C, one bath with water and crushed ice at 0°C, and one bath with 40°-50°C water. Make arrangements to hang or support the baths in the vicinity of the temperature probes.

CALIBRATION CHECK PROCEDURES — A temperature calibration check is performed as follows:

- Remove the temperature probes from the aspirators, tape them together so that the probe ends are close or touching, and fully immerse them into the ambient water bath. Insert a calibrated thermometer of the appropriate range into the water bath.

- Agitate the bath for two to five minutes or until both the temperature value indicated on the data acquisition system (DAS) and the observed value on the thermometer stabilize, and the delta temperature is stable (it should be zero or near zero).

- Record the observed value of the thermometer as the designated value on the calibration form. Record the DAS, DVM, and chart recorder values for temperature and delta temperature on the calibration form.

- Repeat the above procedures for the ice bath and the warm bath.

4.1.1 Evaluation of Temperature/Delta Temperature Sensor Checks

Evaluate the results of the temperature/delta temperature calibration checks to determine if the following specifications are met:

WATER BATH CHECK — The temperature indicated value from the DAS should not differ by more than ≤±0.5°C from the designated value at any bath temperature.

The delta temperature indicated value from the DAS should not differ by more than ±0.2°C from 0.0°C at any temperature.

4.2 SENSOR ADJUSTMENTS

If checks are beyond the designated values, perform the following adjustments:

INSPECT ASPIRATOR HOUSINGS — Inspect the aspirator housings for level, adjust if necessary.

4.3 SENSOR MAINTENANCE

INSPECT TEMPERATURE PROBES — Inspect the temperature probes and electrical connections for cleanliness and wire continuity. Correct if necessary.

INSPECT ASPIRATOR HOUSINGS — Inspect the aspirator housings and clean if any dirt or cobwebs have accumulated. Inspect the aspirator motor and fan blades, they should be moving. Replace if necessary.

4.4 POST-MAINTENANCE CALIBRATION CHECKS

After completing all maintenance and adjustment activities, initiate a post-maintenance calibration check as described in Section 4.1 and record them as post-maintenance values.

4.5 DOCUMENTATION

Sensor calibrations require several levels of documentation:

CALIBRATION FORMS — Calibration forms or the computer laptop Excel spreadsheet should be completed entirely. Where possible, use the Excel spreadsheet so that both a hard copy and digital record of the calibration are maintained. Review and sign all calibration forms.

LOG NOTES — A summary of results and maintenance performed must be included in the station log notes. Note any abnormalities in sensor or calibration operation that could affect the quality of data.

CALIBRATION STICKER — An ARS calibration sticker is placed on the sensor, marking the date the instrument was calibrated and the name of the technician who calibrated it.

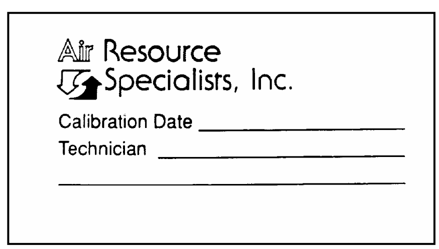

Figure 4-2. ARS Calibration Sticker.

TRIP REPORT — The calibration is thoroughly documented in a written site trip report.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES

TITLE	**LABORATORY CALIBRATION AND REPAIR OF ROTRONICS MP-101A AT/RH SENSORS, ROTRONICS MP-601A RELATIVE HUMIDITY SENSORS, OR VAISALA 45AC AT/RH SENSORS**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3150-2114**
DATE	**DECEMBER 1999**

AUTHORIZATIONS

TITLE	NAME	SIGNATURE
ORIGINATOR	E. Marty Mills	Marty Mills
PROJECT MANAGER	John F. Faust	John F. Faust
PROGRAM MANAGER	David L. Dietrich	David L. Dietrich
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY

REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
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1.1	Change error percentages on calibration form.	May 2001	G. Mercer
	Reviewed; no changes necessary.	May 2002	G. Mercer
2.0	Major changes in data reduction procedures.	August 2003	G. Mercer
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3.0	Added procedures for Vaisala sensors.	September 2004	G. Mercer
	Reviewed; no changes necessary.	September 2005	G. Mercer
	Reviewed; no changes necessary.	September 2006	G. Mercer
	-- continued --		

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PROJECT MANAGER	John F. Faust	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
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	Reviewed; no changes necessary.	September 2008	G. Mercer
	Reviewed; no changes necessary.	September 2009	G. Mercer
	Reviewed; no changes necessary.	September 2010	G. Mercer
	Reviewed; no changes necessary.	September 2011	G. Mercer

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1.0 PURPOSE AND APPLICABILITY

The purpose of calibration and maintenance is to assure quality data capture and minimize data loss by performing and documenting scheduled operational checks and preventive maintenance. This technical instruction (TI) provides specific details for laboratory calibration and repair of Rotronics MP-101A ambient temperature/relative humidity (AT/RH) sensors, Rotronics MP-601A relative humidity sensors, or Vaisala 45AC AT/RH sensors. The purpose of the calibration is to ensure that the sensor accuracy under normal operating conditions is within specified manufacturer's or project accuracy limits.

Experienced technicians using this TI, Standard Operating Procedure (SOP) 3150, *Calibration and Routine Maintenance of Meteorological Monitoring Systems*, and the manufacturer’s instrument manual should be able to adjust the equipment to fully meet all defined specifications.

Calibrations are required under any of the following circumstances:

- Upon acceptance testing of a new sensor
- Upon installation or removal of the sensor at a field station
- Whenever control limits are exceeded
- Prior to any corrective action, service, or maintenance
- At a maximum interval of 12 months

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Establish the project-specific calibration and repair schedule and coordinate with the client as necessary.
- Establish the calibration reporting protocol to satisfy client requirements.
- Review calibration results.
- Identify inconsistencies in calibration results and initiate corrective action as required.
- Review and approve any changes to calibration procedures.

2.2 INSTRUMENT TECHNICIAN

The instrument technician shall:

- Perform all laboratory calibrations and repair as described in this TI.
- Document all calibration results and repair procedures performed using the forms described in this TI.
- Maintain a file of all calibration and repair records.

2.3 TECHNICAL ASSISTANT

The technical assistant shall:

- Verify that the Instrument Service Order Form is complete.
- Forward the Form and sensor to the instrument technician.
- Update the equipment inventory and sensor maintenance cards.
- File a duplicate of all calibration information.

2.4 DATA TECHNICIAN

The data technician shall enter the calibration results into the calibration cost accounting database.

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment and materials are required for laboratory AT/RH sensor calibration:

- Vaportron H-100L calibrator, CR10
- TESTO hygrometer
- TESTO probe
- Personal computer with two I/O ports
- Vaportron 2.1 application software:
  - RHprecal.RAS
  - RHpstcal.RAS
- Campbell Scientific CR10 datalogger
- Campbell Scientific serial data interface (SC32A)
- PC208W software (Campbell Scientific datalogger-to-PC interface program)

- Instrument Service Order Form
- Sensor maintenance card
- AT/RH Sensor Calibration Form
- ARS calibration stickers
- Pen or pencil
- TI 3150-2114, *Laboratory Calibration and Repair of Rotronics MP-101A AT/RH Sensors, Rotronics MP-601A Relative Humidity Sensors, or Vaisala 45AC AT/RH Sensors*
- Miscellaneous adapters
- Microsoft Access database software
- Rotronics MP-101A Instruction Manual
- Rotronics MP-601A Instruction Manual
- Vaisala HMP45A & HMP45D Humidity and Temperature Probes Operating Manual

4.0 METHODS

The procedures described in this TI are specific to Rotronics MP-101A AT/RH sensors, Rotronics MP-601A RH sensors, and Vaisala 45AC AT/RH sensors. Laboratory calibration includes tasks that are detailed in the following five (5) major subsections:

4.1 Sensor Tracking and Calibration Order
4.2 Pre-Maintenance Calibration
4.3 Sensor Adjustments and Repair
4.4 Post-Calibration Checks
4.5 Documentation

Routine field procedures are not discussed herein. Refer to TI 3150-2115, *Field Calibration and Routine Maintenance of Rotronics MP-101A AT/RH Sensors or Rotronics MP-601A Relative Humidity Sensors*, or TI 3150-2116, *Field Calibration and Routine Maintenance of Vaisala HMP 45AC AT/RH Sensors*, for routine maintenance procedures.

A sensor received from the field should have an Instrument Service Order Form accompanying it. The field technician or person turning the sensor into the laboratory for maintenance should complete the following information on the form:

- Instrument name
- Model number
- Serial number
- Project
- Date arrived
- Date return required
- Responsible ARS employee
- Shipping address
- Service type
- Comments/problems of sensor

4.1 SENSOR TRACKING AND CALIBRATION ORDER

Rotronics and Vaisala sensors will be submitted for ARS calibration immediately upon return from the field. The field specialists will complete the sensor maintenance card and Instrument Service Order Form (Figure 4-1) and give the form, sensor, and field audit results to the technical assistant.

It is important that the field specialist be as thorough as possible when completing page 1 of the Instrument Service Order Form. The technical assistant will verify that the form and supplemental information are complete. The technical assistant will also verify and/or update the equipment inventory, and will transfer the sensor and supporting documentation to the instrument technician within one day of receiving all complete information and the sensor from the field specialist.

4.2 PRE-MAINTENANCE CALIBRATION

A pre-maintenance calibration must be performed prior to any maintenance activity. Refer to Figure 4-2, Example AT/RH Sensor Calibration Form, when performing pre-maintenance calibrations, and perform the following procedures:

TURN ON INSTRUMENTATION — Power up the Vaportron, personal computer, and monitor.

INITIATE SOFTWARE — Open the Vaportron 2.1 program on the personal computer and start the PC208W program to setup hardware connections as follows:

- On the PC208W toolbar, click the **connect** button. The CR10 window will appear.
- Click the **tools** tab at the bottom of the CR10 window.
- Click the **send** button.
- Click **ok** in the Change to Datalogger Program May Result in Irrevocable Data Loss window.
- To calibrate only Rotronics sensors, select the program *O:\Vaprtron\vapor\autoatrh.dld***.** To calibrate only Vaisala sensors, or both Vaisala and Rotronics sensors, select *O:\vaprtron\vapor\hmp45c.dld*.
- Click **ok** after the Successful Transfer window appears.
- Click the **numeric display** tab at the bottom of the CR10 window.

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INSTRUMENT SERVICE ORDER FORM

TO BE SUBMITTED WITH EACH INSTRUMENT

Air Resource Specialists Employee: ______________________________
Site/Where Did Instrument Come From: ______________________________
Date Removed from Site: ______________________________
Date Arrived at Air Resource Specialists: ______________________________
Date Return Required: ______________________________
Project Charge Number: ______________________________

Instrument Name: ______________________________
Model Number: ______________________________
Serial Number: ______________________________

Customer Shipping Address	Customer Contact(s)	Phone	FAX

Service type:
______ Annual Service
______ Semi-Annual Service
______ Quarterly Service
______ Repair Service
______ Warranty Service

Description of Problem: ______________________________

Problem Resolution/Repair: ______________________________

1 N:\Project\ARS\FORMS\GENERAL\RHForm.doc(4/00)

Figure 4-1. Instrument Service Order Form.

INSTRUMENT SERVICE ORDER FORM
TO BE SUBMITTED WITH EACH INSTRUMENT

Labor:

Technician	Hours Worked	Dates

Parts Used:

Part #	Description	No. Units	Code

Codes: J Adjustments/Calibration only - No parts requried
A Annual Service (Part included as a part of annual service.)
R Repair Service
W Warranty Repair

Service checklist attached.

2 N:\Project\ARS\FORMS\GENERAL\RHForm.doc(4/00)

Figure 4-1 (continued). Instrument Service Order Form.

AT/RH Sensor Calibration Form

Serial Number:	22609	**Owner:**	IMPROVE
Model Number:	Rotronic MP-100F	**Date of Last Operation:**	12/18/02 to 4/15/03
Calibration Date:	4/22/03	**Last Operational Site:**	GRSM1
Service Technician:	Marty Mills		
Service Type:	Repair		
Comments:	Sensor dropped from high 90s to 20s when conditions were wet.		

Pre - Calibration Relative Humidity:

Check Point	Nominal Time	NIST Traceable	Sensor	Deviation
10%	10 min.	10.0%	11.3%	1.3%
35%	10 min.	35.1%	35.8%	0.7%
50%	10 min.	50.2%	49.6%	-0.5%
60%	10 min.	60.1%	59.7%	-0.4%
70%	10 min.	70.1%	69.6%	-0.5%
80%	10 min.	80.1%	79.4%	-0.7%
90%	10 min.	90.1%	89.0%	-1.1%
95%	10 min.	95.1%	93.7%	-1.4%

RMS Error	Minimum Error	Maximum Error	Within Mfg Specifications
0.9%	0.4%	1.4%	True

Pre - Calibration Temperature:

Check Point	Nominal Time	NIST Traceable	Sensor	Deviation
15 degrees	10 min.	14.8	15.6	0.8
25 degrees	10 min.	25.0	25.2	0.2
35 degrees	10 min.	35.0	34.7	-0.3

RMS Error	Minimum Error	Maximum Error	Within Mfg Specifications
0.5	0.16	0.78	True

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Figure 4-2. Example AT/RH Sensor Calibration Form.

AT/RH Sensor Calibration Form

Serial Number: 22609 **Calibration Date:** 4/22/03

Post - Calibration Relative Humidity:

Check Point	Nominal Time	NIST Traceable	Sensor	Deviation
10%	10 min.	10.033%	11.318%	1.285%
35%	10 min.	35.111%	35.728%	0.617%
50%	10 min.	50.160%	49.561%	-0.599%
60%	10 min.	60.066%	59.598%	-0.468%
70%	10 min.	70.110%	69.584%	-0.526%
80%	10 min.	80.110%	79.460%	-0.650%
90%	10 min.	90.100%	89.230%	-0.870%
95%	10 min.	95.110%	94.050%	-1.060%

RMS Error	Minimum Error	Maximum Error	Within Mfg Specifications
0.8%	0.470%	1.290%	True

Post - Calibration Temperature:

Check Point	Nominal Time	NIST Traceable	Sensor	Deviation
15 degrees	10 min.	15.1	15.7	0.7
25 degrees	10 min.	24.9	25.2	0.2
35 degrees	10 min.	34.8	34.6	-0.3

RMS Error	Minimum Error	Maximum Error	Within Mfg Specifications
0.4	0.24	0.65	True

Calibration Equipment:

Manufacturer	Model Number	Serial Number	Last Date Calibrated	Minimum Error RH	Maximum Error RH	Minimum Error Temp	Maximum Error Temp
Vaportron	H-100L	9810-R49426	3/5/03	-2.03	2.03	-1	1

Adjustments / Repair:

RH Adjustments Made at Set Points: ☐ **10%** ☐ **35%** ☐ **80%**

Temperature Adjustments Made Set Points: ☐ **25 Degrees Celsius**

Repairs Made:

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Figure 4-2 (Continued). Example AT/RH Sensor Calibration Form.

INITIATE SOFTWARE (continued)

- On the PC208W toolbar, click the **setup** button. The Setup Connections window will appear on screen.
- Click the **data collection** tab at the bottom of the Setup Connections window.
- Click the **browse** button.
- Name the file *O:\vaprtron\yyTSTjd.dat*, where *yy* is the year, *TST* is either PRE or PST, and *jd* is the Julian date. PRE is for pre-calibration and PST is for post-calibration.
- Click the **save edits** button.
- Close the Setup Connections window.

PREPARE SENSOR FOR CALIBRATION

Rotronics

Remove the foam filter from the sensor to be calibrated and replace it with a plastic cage cap. Slide an O-ring over the body.

Slide the sensor approximately 1/3 of its length into a port of the Vaportron, making sure the O-ring makes a good seal.

Attach the sensor connector to a numbered CR10 connector, ports 1-4 (if a Vaisala sensor is being calibrated, do not use port 3).

Repeat for each sensor; up to four sensors can be calibrated simultaneously.

Vaisala

Remove the filter cap from the probe head. Remove the inner membrane filter from the cap, and replace the outer plastic cage back on the probe head.

Attach the probe head to the probe handle. Slide the O-ring over the probe head.

Push the small diameter port adapter into port #3 of the vaportron.

Slide the probe head ½ of its length into the port adapter.

Attach the probe handle's 8-position connector to its mating CR10 connector.

Since the Vaisala sensors can only be placed in port #3, only one sensor may be calibrated at any one time.

TEST AND RECORD RELATIVE HUMIDITY AND TEMPERATURE VALUES

In the Vaportron window, select **open** from the Ramp&Soak menu. Select **RHprecal.ras** or **RHpstcal.ras.**

Click **run** from the Ramp&Soak menu.

Click **start** in the Ramp & Soak Run Control window.

The ramp and soak should take approximately 3 hours for a pre-calibration and 10 hours for a post-calibration.

The ramp and soak function will run through the eight relative humidity and three temperature test values listed on the calibration form automatically, leaving the sensors soaking at all the points for the nominal time required on the calibration form.

SAVE THE FILE

After the ramp and soak program is completed, perform the following steps:

- On the PC208W toolbar, click the **setup** button. The Setup Connections window will appear.
- Click the **data collection** tab at the bottom of the Setup Connections window.
- Click the **browse** button.
- Name the file *C:\vaprtron\data\trash.dat***.**
- Click the **save edits** button.
- Close the Setup Connections window.

REDUCE PRE-CALIBRATION DATA

Open the AT/RH Sensor Calibration Form found at O:\VAPRTRON\Database\AT RH Sensor Calibration Form.mdb (see Figure 4-3).

On the Main menu, select **Calibrations.**

On the AT/RH Sensor Calibration screen, click the **Add Record** button.

Complete the fields for serial number, model number, calibration date, service technician, Cal Equipment, Owner, Begin date of last operation, End date of last operation, Last operational site, Service type, and any Comments.

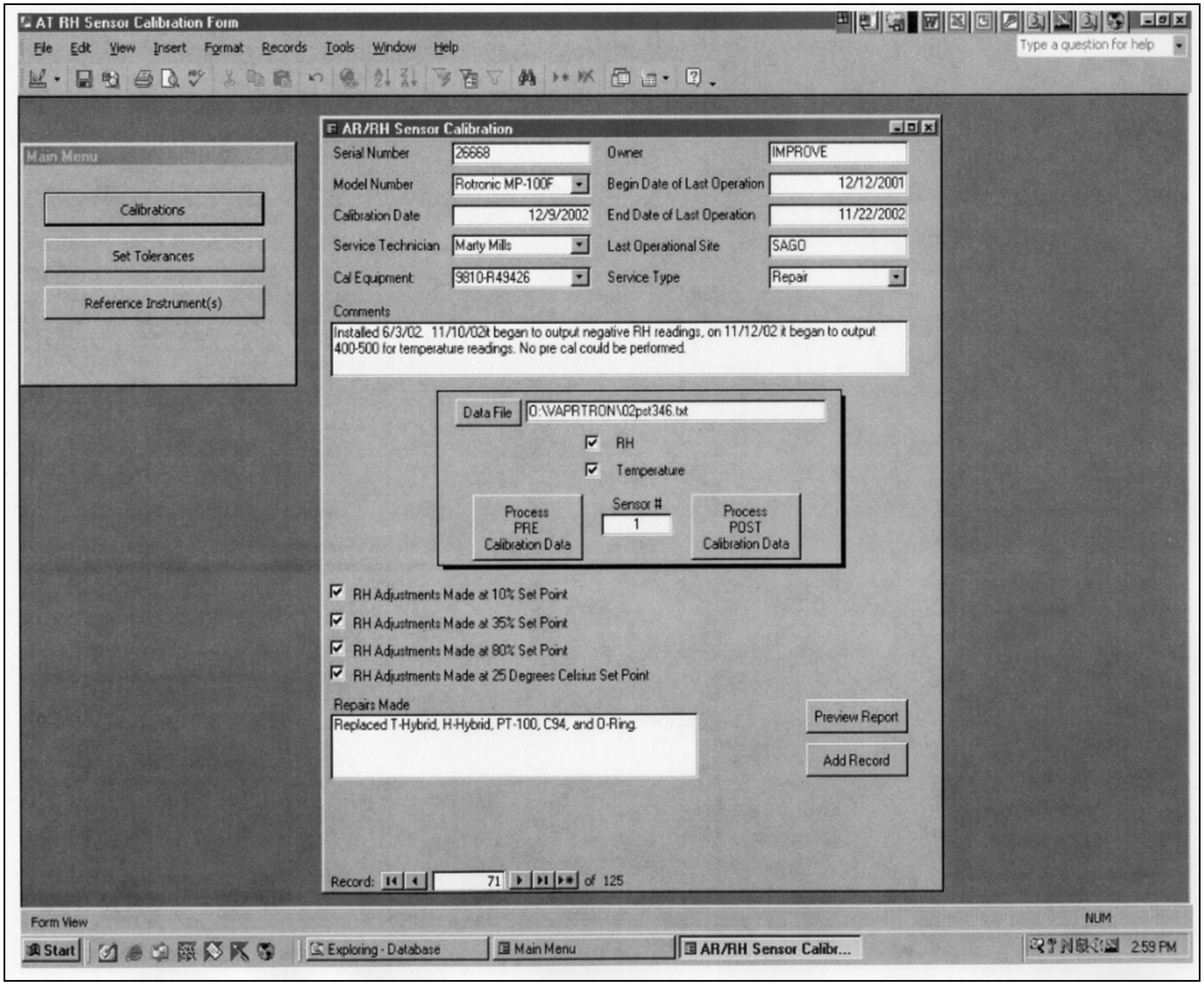

Figure 4-3. Example Access Calibration Data Entry Screen.

REDUCE PRE-CALIBRATION DATA (continued)

Click the **Data File** button and click on the file that was used to capture the data.

If the calibrated sensor was an MP601, deselect **Temperature.**

In the *Sensor #* field, enter the CR10 position number.

Click the **Process PRE Calibration Data** button.

Click the **Preview Report** button.

Click **File** and then **Print** and print page one.

Close the preview screen.

To reduce data for another sensor, click the **Add Record** button and complete as instructed above.

When finished adding sensors, close the AT/RH Sensor Calibration Form.

4.3 SENSOR ADJUSTMENTS AND REPAIR

The following corrective actions are appropriate if the above checks reveal that the test AT/RH sensor's response is beyond the manufacturer's specifications.

ADJUSTMENTS

Adjust out of tolerance probes or replace sensors that cannot be adjusted to specifications. Indicate what adjustments were made on the calibration form and at what set points. Appropriate specifications for sensors are listed on the calibration form and in Tables 4-1 and 4-2, Rotronics and Vaisala, respectively. Refer to the manufacturer's instruction manual (appropriate to the sensor model) for adjustment procedures.

WIRING INSPECTION AND REPAIR

Inspect all AT/RH wiring for abrasions, cuts, or loose connections. Inspect all connector pins for possible corrosion, and repair as required. Table 4-3 presents the wiring diagram for Rotronics sensors. There is no wiring diagram for Vaisala sensors.

Table 4-1

Specifications of Rotronics AT/RH Sensor

SPECIFICATIONS

Humidity Sensor	ROTRONICS HYGROMER™ C94
Temperature Sensor	Pt100 RTD
Humidity Measuring Range	0..100% RH
Temperature Measuring Range	See Temperature Limits
Temperature Limits	-40..+60°C
Humidity Output Signal (linear)	0..1.0 VDC = 0..100% RH
Temperature Output Signal (linear)	Standard: -0.4..0.6 VDC = -40..+60°C Optional: 0.0..1.0 VDC = -40..+60°C Optional: 0.0..1.0 VDC = -30..+70°C
Minimum Load per Output	1000 Ω
Accuracy (at 20..25°C)	±1% RH from 0 to 100% RH* ±0.3°C
Repeatability	±0.3% RH and ±0.1°C
Humidity Sensor Stability	better than 1% RH over a year
Response Time (without filter)	10 seconds (% RH and temperature)
Calibration Potentiometers	35, 80% RH and RH min. Tmin and Tmax
Supply Voltage	4.8 to 26.5 VDC (MP-101A) 4.8 to 30.0 VDC (MP-601A)
Max. Current Consumption	10 mA (MP-101A) 2.5 mA when powered with 12 VDC or less (MP-601A)
Connector	MP 101A-C4: 4-pin CANNON MP 101A-C5: 5-pin CANNON MP 101A-T7: 7-pin TUCHEL
Cable Length	MP 101A-C4 or C5: 6.5 ft (2 m) MP 101A-T7: connector is on the probe
Sensor Protection	Standard (MP-101A): foam filter MF25C Optional (MP-101A): wire mesh filter SP-W25 Standard (MP-601A): D25 wire mesh filter Optional (MP-601A): MF25-MP foam filter
Weight	70..700g (0.15..1.50 lb)

* When calibrated against highest quality reference standards. Both factory calibration and field calibration with ROTRONIC standards result in ±1.5%RH accuracy or better.

Accessories (order separately)

Natural Aspiration Shield	SMP-41002
Motor Aspirated Shield	MAS-41003 (12 VDC, 75 mA)
Calibration Device	EM25

Table 4-2

Specifications of Vaisala AT/RH Sensor

SPECIFICATIONS

Humidity Sensor	Vaisala HMP 45A & HMP45D
Measurement Range	0.8...100 %RH
Output Scale	0...100 %RH equals 0-1 VDC
Accuracy at +20°C (including non-linearity and hysteresis):	
Against factory references	±1 %RH
Field calibration against references	±2 %RH (0...90 %RH)
	±3 %RH (90...100 %RH)
Typical Long-Term Stability	Better than 1 %RH per year
Temperature Dependence	± 0.05 % RH/°C
Response time (90%) at +20°C	15 s with membrane filter
Humidity Sensor	HUMICAP® 180
Temperature Sensor	Vaisala HMP45A
Measurement Range	-39.2... +60°C
Output Scale	-40...+60°C equals 0...1 VDC
Accuracy at 20°C	±0.2°C
General:	
Operating Temperature Range	-40...+60°C
Storage Temperature Range	-40...+80°C
Supply Voltage	7...35 VDC
Settling Time	500 ms
Power Consumption	< 4 mA
Output Load	> 10 kohm (to ground)
Weight	350 g (including package)
Cable Length	3.5 m
Housing Material	ABS plastic
Housing Classification (electronics)	IP 65 (NEMA 4)
Sensor Protection (standard)	Membrane filter, part # 2787HM

Table 4-3

Rotronics AT/RH Sensor Wiring

Function	Color	Pin#
Cable connector – 4-pin AMP male reverse sex plug		
12V	Red	1
Ground	Black	2
Relative Humidity	Green	3
Temperature	White	4
Sensor connector – 4-socket AMP female reverse sex receptacle		
12V	Red	1
Ground	Black and Shield	2
Relative Humidity	Green	3
Temperature	White	4

4.4 POST-CALIBRATION CHECKS

The post-maintenance calibration procedures are essentially the same as pre-calibration procedures described in Section 4.1. After completing all repair and adjustment activities, initiate a post-calibration and record as the post-calibration values. Use RHpstcal.ras when performing a post-calibration.

REDUCE POST-CALIBRATION DATA

Open the AT/RH Sensor Calibration Form found at O:\VAPRTRON\Database\AT RH Sensor Calibration Form.mdb (see Figure 4-3).

On the Main menu select **Calibrations**.

Use the record navigation buttons to find the record of the sensor you want to reduce data for.

Click the **Data File** button and click on the file that was used to capture the data.

If the calibrated sensor was an MP601, deselect **Temperature**.

In the *Sensor #* field, enter the CR10 position number.

Check all adjustments that were made.

Make any comments necessary in the Repairs Made field.

Click the **Process POST Calibration Data** button and the Preview Report screen will pop up.

Click **File** and then **Print** and print page two.

Close the preview screen.

Use the navigation buttons to find another record to reduce data for or if you are done close the AT/RH Sensor Calibration Form.

4.5 DOCUMENTATION

Sensor calibrations require several levels of documentation:

CALIBRATION STICKER — An ARS calibration sticker is placed on the sensor, marking the date the instrument was calibrated and the name of the technician who calibrated it (Figure 4-4).

Figure 4-4. ARS Calibration Sticker.

CALIBRATION FORMS — Calibration forms will be completed, reviewed, and signed by the instrument technician. The instrument technician shall also maintain the forms and the Excel data files in the instrument laboratory, and provide copies of both the calibration form and Instrument Service Order Form to the data technician for entry into the cost accounting database, and to the technical assistant along with the calibrated sensor.

MAINTENANCE CARDS — Upon receipt of the completed forms and the calibrated sensor from the instrument technician, the technical assistant will file both forms with the sensor's maintenance card, update the card, and place each sensor in the calibrated bin for deployment by the field specialists.

5.0 REFERENCES

Rotronics, Inc., 1995, MP-601A Instruction Manual, July.

Rotronics, Inc., 1994, MP-101A Instruction Manual. March.

Vaisala Oy, 1997, HMP45A & HMP45D Humidity and Temperature Probes Operating Manual, September.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**FIELD CALIBRATION AND ROUTINE MAINTENANCE OF ROTRONICS MP-101A AT/RH SENSORS OR ROTRONICS MP-601A RELATIVE HUMIDITY SENSORS**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3150-2115**
DATE	**AUGUST 1996**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
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PROGRAM MANAGER	Joe Adlhoch	[illegible]
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OTHER		

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TITLE	NAME	SIGNATURE
ORIGINATOR	Mikell T. Bagby	Mikell T. Bagby
PROJECT MANAGER	John F. Faust	John F. Faust
PROGRAM MANAGER	Joe Adlhoch	[signature]
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OTHER		

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	Reviewed; no changes necessary.	November 2010	G. Mercer

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1.0 PURPOSE AND APPLICABILITY

The purpose of calibration and maintenance is to assure quality data capture and minimize data loss by performing and documenting scheduled operational checks and preventive maintenance. This technical instruction (TI) provides specific details for routine calibration and maintenance of Rotronics MP-101A ambient temperature/relative humidity (AT/RH) sensors and Rotronics MP-601A relative humidity sensors. The purpose of the calibration is to ensure that the sensor accuracy under normal operating conditions is within specified manufacturer's or project accuracy limits. Both the Rotronics AT/RH system and the RH system include a DC power supply, sensor, and radiation shield.

Experienced technicians using this TI, Standard Operating Procedure (SOP) 3150, *Calibration and Routine Maintenance of Meteorological Monitoring Systems*, and the manufacturer's instrument manual should be able to adjust the equipment to fully meet all defined specifications.

This TI is intended for use by field specialists who understand general instrument operational concepts and have their own National Institute of Standards and Technology (NIST) certified equipment.

Calibrations are required under any of the following circumstances:

- Upon acceptance testing of a new instrument
- Upon installation or removal of the instrument at a field station
- Whenever control limits are exceeded
- Prior to any corrective action, service, or maintenance to any portion of the instrument that affects its operational principle
- At a maximum interval of 6 months

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Establish the project-specific calibration and maintenance schedule and coordinate with the client as necessary.
- Establish the calibration reporting protocol to satisfy client requirements.
- Review calibration results.
- Identify inconsistencies in calibration results and initiate corrective action as required.
- Review and approve any changes to calibration procedures.

2.2 FIELD SPECIALIST

The field specialist shall:

- Perform required calibrations and maintenance as described in this TI.
- Document all calibration results and maintenance procedures performed.

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment and materials are required for AT/RH sensor calibration:

- A calibrated reference AT/RH sensor
- A replacement sensor
- A portable datalogger (Campbell 21XL or similar)
- Appropriate audit parositic aspirator
- Digital voltmeter (4-1/2 digit)
- Sensor maintenance cards
- Field service tools
- Station log book or DataView
- Temperature, Delta Temperature, and Relative Humidity Calibration Forms
- Pen or pencil
- Laptop computer loaded with Excel workbook (NPS.XLT) and CALCU program software
- ARS calibration stickers

4.0 METHODS

The AT/RH or RH system must be checked (pre-maintenance calibration) before servicing any system components. Throughout the calibration and maintenance period, the datalogger, calibration forms, DataView, and strip chart (if used) must be annotated to indicate that data taken during the calibration period should not be included as standard observations.

After performing system adjustments and maintenance, the system again needs to be dynamically checked (post-maintenance calibration) to ensure proper operation of the sensors The pre-and post-maintenance calibration techniques are identical. Do not perform any maintenance to the sensors until all pre-calibration checks are completed.

The procedures described in this TI are specific to Rotronics 100 or 101 series AT/RH sensors and Rotronics MP-601 series RH sensors. Calibration and maintenance include tasks that are detailed in the following five (5) major subsections:

4.1 Calibration Checks
4.2 Sensor Adjustments
4.3 Sensor Maintenance
4.4 Post-Maintenance Calibration Checks
4.5 Documentation

4.1 CALIBRATION CHECKS

A complete calibration check must be performed prior to (pre) and following (post) any maintenance activity. The calibration check procedures described below apply to both pre- or post-maintenance calibration checks. Refer to Figure 4-1, Example Temperature, Delta Temperature, and Relative Humidity Calibration Form, when performing calibration checks. Be sure to indicate on the form whether the calibration is pre- or post-maintenance and note all maintenance activities or replaced components in the “Comments” field. The form is available as an Excel spreadsheet and should be used for both pre- and post- maintenance checks. Results of each calibration should be in both hardcopy and digital form.

Calibration checks are performed semiannually. Should any operational check be out of suggested tolerance, complete the calibration check before any maintenance or adjustments are made. The following operational checks should be performed:

ANNOTATE DATA RECORDS	Make an entry in the station log book indicating the date and time (beginning and ending) of the calibration and maintenance procedures. “Down” the appropriate channels on the DAS or set the calibration flag as appropriate for the DAS being used. Complete the following fields on the Temperature, Delta Temperature, and Relative Humidity Calibration Form: network and station name; current date; name of technician performing the calibration; manufacturer, model, and serial number of the instrument; and date of the last calibration.
RECORD READINGS	Simultaneously record the pre-maintenance DVM and DAS of the sensor to be calibrated. Install the parositic aspirator onto the existing station aspirator The accuracy of the AT/RH or RH sensor response should be evaluated by comparing the ambient AT/RH or RH measured from the station sensor against a reference AT/RH sensor.

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TEMPERATURE, DELTA TEMPERATURE AND RELATIVE HUMIDITY CALIBRATION FORM

Network:	Location:	Site:	Date:	Date of Last Site Visit:
				Field Specialist:

Reference Thermometer S/N: N/A		Calibration Date:
Relative Humidity Reference S/N: test		Calibration Date:

TEMPERATURE / DELTA TEMPERATURE

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.		
Model #		
Serial #		
Translator Serial #		

PRE-MAINTENANCE SENSOR RESPONSE

BATH TEMP (° C)	TEMPERATURE		Difference (° C)	Pass/Fail	Δ TEMPERATURE		Difference (° C)	Pass/Fail
	DVM (volts)	DAS (° C)			DVM (volts)	DAS (° C)		
	Maximum Difference:				Maximum Difference:			

PRE- TRANSLATOR CARD RESPONSE

SETTING	TEMPERATURE		Δ TEMPERATURE	
	DVM (volts)	DAS (° C)	DVM (volts)	DAS (° C)
Zero				
Span				

POST MAINTENANCE SENSOR RESPONSE

BATH TEMP (° C)	TEMPERATURE		Difference (° C)	Pass/Fail	Δ TEMPERATURE		Difference (° C)	Pass/Fail
	DVM (volts)	DAS (° C)			DVM (volts)	DAS (° C)		
	Maximum Difference:				Maximum Difference:			

POST TRANSLATOR CARD RESPONSE

SETTING	TEMPERATURE		Δ TEMPERATURE	
	DVM (volts)	DAS (° C)	DVM (volts)	DAS (° C)
Zero				
Span				

Pre-Maint Temperature Comments:	
Post Maint Temperature Comments:	

RELATIVE HUMIDITY

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.	Rotronics RH	Rotronics RH
Model #	MP601A	MP601A
Serial #		

PRE-MAINTENANCE SENSOR RESPONSE

HOUR	DAS	T.STD	Difference	Pass/Fail
10:00				
11:00				
12:00				
13:00				
14:00				
15:00				
Average ABS % Difference:				
Maximum % Difference:				

POST MAINTENANCE SENSOR RESPONSE

HOUR	DAS	T.STD	Difference	Pass/Fail
10:00				
11:00				
12:00				
13:00				
14:00				
15:00				
Average ABS % Difference:				
Maximum % Difference:				

Screen dirty/clogged on RH pre-maintenance sensor? (check one):	☐ Yes ☐ No

Pre-Maint Relative Humidity Comments:	
Post Maint Relative Humidity Comments:	

Figure 4-1. Example Temperature, Delta Temperature, and Relative Humidity Calibration Form.

CALIBRATE SENSOR

Calibrate the sensor as follows:

- Install the reference sensor (Rotronics MP101A sensor used in example below) and attach leads to the portable datalogger. Use the following program for the 21XL. Allow the reference sensor to record for as long as practical (3 to 12 hours recommended). Retrieve the data and compare to hourly averages of the existing sensor.

Air Temperature/Relative Humidity/Solar Radiation Audit Program

```
*Table 1 Program
        01: 60  Execution Interval (seconds)

1:  Volts (SE)  (P1)
        1:  1           Reps
        2:  1           1000 mV Slow Range
        3:  1           SE Channel
        4:  1           Loc REF AT
        5:  .10000      Multi
        6:  __30        Offset

2:  Volts (SE)  (P1)
        1:  1           Reps
        2:  5           5000 mV Slow Range
        3:  2           SE Channel
        4:  2           Loc REF RH
        5:  .10000      Mult
        6:  0.0         Offset

3:  Volt (Diff)  (P2)
        1:  1           Reps
        2:  2           15 mV Slow Range
        3:  2           DIFF Channel
        4:  3           Loc REF SOLAR
        5:  x.xxx       Mult
        6:  0.0         Offset
        Note: x.xxx = calibration constant for reference radiometer.

4:  If time is  (P92)
        1:  0000        Minutes into a
        2:  0060        Minute Interval
        3:  10          Set Output Flag High

5:  Real Time  (P77)
        1:  0110        Day, Hour/Minute (midnight = 0000)

6:  Average  (P71)
        1:  3           Reps
        2:  1           Loc REF RH AND SOLAR
```

CALIBRATE SENSOR (continued)

WIRING AT/RH CABLE TO 21XL DATALOGGER

RED	+12 VOLTS
WHITE	1 HIGH
GREEN	1 LOW
BLACK	GROUND
SHIELD	GROUND

WIRING SOLAR RADIATION TO 21XL DATALOGGER

RED	2H
BLACK	2L

- Record the AT and RH values as the reference values listed on the calibration form, then record the corresponding datalogger and DVM values.

4.1.1 <u>Evaluation of Air Temperature and Relative Humidity Checks</u>

Evaluate the results of the air temperature and relative humidity calibration check, and verify that the air temperature sensor is within 1°C and the relative humidity value is within ±5% of the reference values.

4.2 SENSOR REPLACEMENT

Any sensor that has operated in the field for 5 or more months should be replaced with a laboratory-calibrated sensor. The replacement sensor operation should be verified by a post-maintenance calibration check (see Section 4.4). The replaced sensor should be submitted for ARS calibration immediately upon return from the field.

4.3 SYSTEM MAINTENANCE

The following corrective actions are appropriate if the above checks reveal that the AT/RH response is beyond the tolerance discussed in Section 4.1.1:

WIRING INSPECTION AND REPAIR

Inspect all AT/RH wiring for abrasions, cuts, or loose connections. Measure the supply voltage between pins 1 and 2 of the 5-pin Rotronics connector, verifying that the sensor has a supply voltage between 5 and 26 DC volts (MP-101A) or 5 and 30 DC volts (MP-601A). Inspect all connector pins for possible corrosion, and repair as required. Figure 4-2 presents the wiring diagram.

AT/RH OR RH SENSOR

Field adjustment or repair of the Rotronics MP-101A AT/RH sensor or MP-601A RH sensor is not recommended. If the sensor response is outside of specification, or if the sensor has been on-site for 5 or more months, replace it with a laboratory-calibrated unit, then continue with the post-maintenance calibration procedures. Appropriate specifications are listed in Table 4-1.

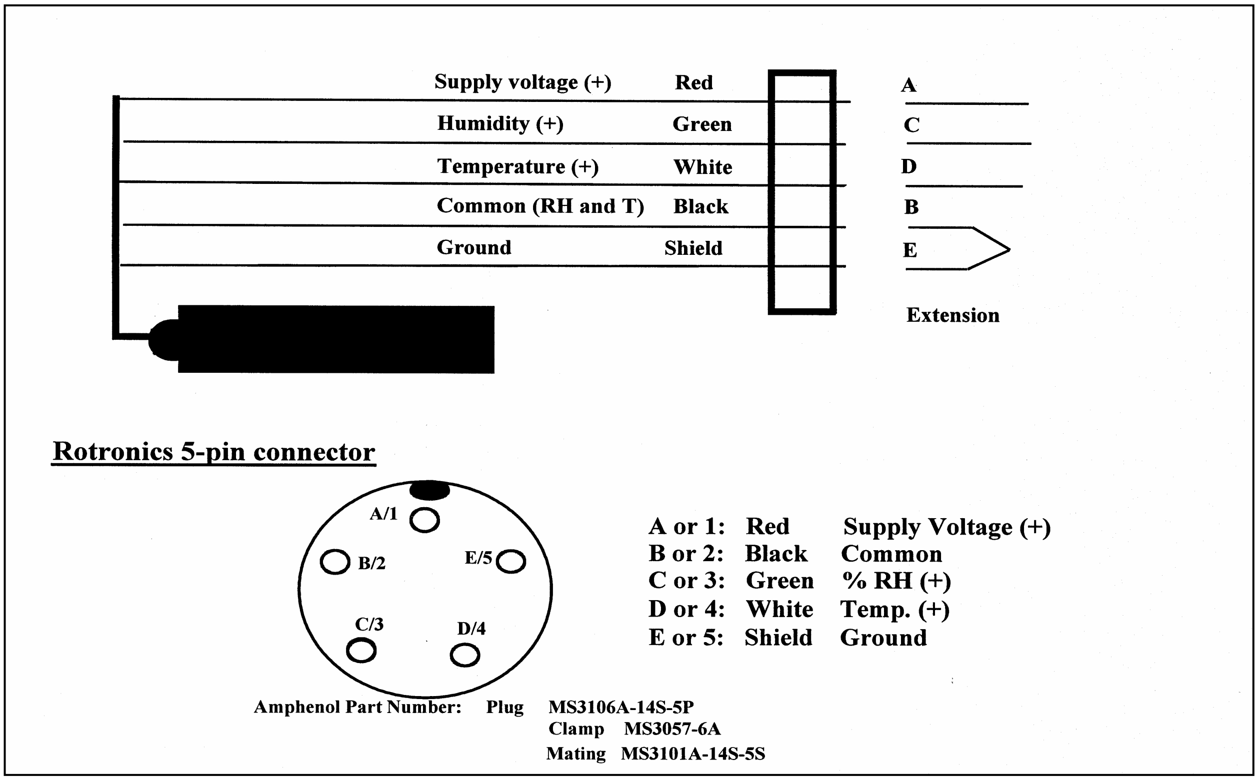

Figure 4-2. Rotronics AT/RH Sensor Wiring Diagram.

Table 4-1

Specifications of Rotronics AT/RH Sensor

SPECIFICATIONS

Humidity Sensor	ROTRONIC HYGROMER™ C94
Temperature Sensor	Pt100 RTD
Humidity Measuring Range	0..100% RH
Temperature Measuring Range	See Temperature Limits
Temperature Limits	-40..+60°C
Humidity Output Signal (linear)	0..1.0 VDC = 0..100% RH
Temperature Output Signal (linear)	Standard: -0.4..0.6 VDC = -40..+60°C Optional: 0.0..1.0 VDC = -40..+60°C Optional: 0.0..1.0 VDC = -30..+70°C
Minimum Load per Output	1000 Ω
Accuracy (at 20..25°C)	±1% RH from 0 to 100% RH* ±0.3°C
Repeatability	±0.3% RH and ±0.1°C
Humidity Sensor Stability	better than 1% RH over a year
Response Time (without filter)	10 seconds (% RH and temperature)
Calibration Potentiometers	35, 80% RH and RH min. Tmin and Tmax
Supply Voltage	4.8 to 26.5 VDC (MP-101A) 4.8 to 30.0 VDC (MP-601A)
Max. Current Consumption	10 mA (MP-101A) 2.5 mA when powered with 12 VDC or less (MP-601A)
Connector	MP 101A-C4: 4-pin CANNON MP 101A-C5: 5-pin CANNON MP 101A-T7: 7-pin TUCHEL
Cable Length	MP 101A-C4 or C5: 6.5 ft (2 m) MP 101A-T7: connector is on the probe
Sensor Protection	Standard (MP-101A): foam filter MF25C Optional (MP-101A): wire mesh filter SP-W25 Standard (MP-601A): D25 wire mesh filter Optional (MP-601A): MF25-MP foam filter
Weight	70..700g (0.15..1.50 lb)

* When calibrated against highest quality reference standards. Both factory calibration and field calibration with ROTRONIC standards result in ±1.5%RH accuracy or better.

Accessories (order separately)

Natural Aspiration Shield	SMP-41002
Motor Aspirated Shield	MAS-41003 (12 VDC, 75 mA)
Calibration Device	EM25

MP 101A - 03/18/94
MP 601A- 07/24/95

4.4 POST-MAINTENANCE CALIBRATION CHECKS

After completing all maintenance and adjustment activities, initiate a post-maintenance calibration check as described in Section 4.1 and record them as the post-maintenance values.

4.5 DOCUMENTATION

Sensor calibrations require several levels of documentation:

CALIBRATION FORMS	Field calibration forms or the computer laptop Excel spreadsheet should be completed entirely. Where possible, use the Excel spreadsheet so that both a hard copy and digital record of the calibration are maintained. Review and sign all calibration forms.
LOG NOTES	A summary of results and maintenance performed must be included in the station log notes. Note any abnormalities in sensor or calibration operation that could affect the quality of data.
SENSOR MAINTENANCE CARD	The sensor maintenance cards for both the existing and replacement sensors must be completed by the field specialist.
CALIBRATION STICKER	An ARS laboratory calibration sticker should exist on the replacement sensor, marking the date the instrument was calibrated and the name of the technician who calibrated it.

Figure 4-3. ARS Calibration Sticker.

TRIP REPORT	The calibration is thoroughly documented in a written site trip report.

5.0 REFERENCES

Rotronics, Inc., 1995, MP-601A Instruction Manual, July.

Rotronics, Inc., 1994, MP-101A Instruction Manual. March.

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QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

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OTHER		

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REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
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	Reviewed; no changes necessary.	November 2010	G. Mercer

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1.0 PURPOSE AND APPLICABILITY

The purpose of calibration and maintenance is to assure quality data capture and minimize data loss by performing and documenting scheduled operational checks and preventive maintenance. This technical instruction (TI) provides specific details for routine calibration and maintenance of Vaisala HMP 45AC ambient temperature/relative humidity (AT/RH) sensors. The purpose of the calibration is to ensure that the sensor accuracy under normal operating conditions is within specified manufacturer's or project accuracy limits.

Experienced technicians using this TI, Standard Operating Procedure (SOP) 3150, *Calibration and Routine Maintenance of Meteorological Monitoring Systems*, and the manufacturer’s instrument manual should be able to adjust the equipment to fully meet all defined specifications.

This TI is intended for use by field specialists who understand general instrument operational concepts and have their own National Institute of Standards and Technology (NIST) certified equipment.

Calibrations are required under any of the following circumstances:

- Upon acceptance testing of a new instrument
- Upon installation or removal of the instrument at a field station
- Whenever control limits are exceeded
- Prior to any corrective action, service, or maintenance to any portion of the instrument that affects its operational principle
- At a maximum interval of 6 months

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Establish the project-specific calibration and maintenance schedule and coordinate with the client as necessary.
- Establish the calibration reporting protocol to satisfy client requirements.
- Review calibration results.
- Identify inconsistencies in calibration results and initiate corrective action as required.
- Review and approve any changes to calibration procedures.

2.2 FIELD SPECIALIST

The field specialist shall:

- Perform required calibrations and maintenance as described in this TI.
- Document all calibration results and maintenance procedures performed.

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment and materials are required for AT/RH sensor calibration:

- A calibrated reference AT/RH sensor
- A replacement sensor
- A portable datalogger (Campbell 21XL or similar)
- Appropriate audit parositic aspirator
- Digital voltmeter (4-1/2 digit)
- Sensor maintenance cards
- Field service tools
- Station log book or DataView
- Temperature, delta temperature, and relative humidity calibration form
- Pen or pencil
- Laptop computer loaded with Excel workbook (Calibrations.XLT) and CALCU program software
- ARS calibration stickers

4.0 METHODS

The AT/RH or RH system must be checked (pre-maintenance calibration) before servicing any system components. Throughout the calibration and maintenance period, the datalogger, calibration forms, DataView, and strip chart (if used) must be annotated to indicate that data taken during the calibration period should not be included as standard observations.

After performing system adjustments and maintenance, the system again needs to be dynamically checked (post-maintenance calibration) to ensure proper operation of the sensors. The pre-and post-maintenance calibration techniques are identical. Do not perform any maintenance to the sensors until all pre-calibration checks are completed.

The procedures described in this TI are specific to Vaisala HMP 45AC AT/RH sensors. Calibration and maintenance include tasks that are detailed in the following five (5) major subsections:

4.1 Calibration Checks
4.2 Sensor Adjustments
4.3 Sensor Maintenance
4.4 Post-Maintenance Calibration Checks
4.5 Documentation

4.1 CALIBRATION CHECKS

A complete calibration check must be performed prior to (pre) and following (post) any maintenance activity. The calibration check procedures described below apply to both pre- or post-maintenance calibration checks. Refer to Figure 4-1, Temperature, Delta Temperature, and Relative Humidity Calibration Form (or similar), when performing calibration checks. Be sure to indicate on the form whether the calibration is pre- or post-maintenance and note all maintenance activities or replaced components in the "Comments" field. The form is available as an Excel spreadsheet and should be used for both pre- and post- maintenance checks. Results of each calibration should be in both hardcopy and digital form.

Calibration checks are performed semiannually. Should any operational check be out of suggested tolerance, complete the calibration check before any maintenance or adjustments are made. The following operational checks should be performed:

ANNOTATE DATA RECORDS

Make an entry in the station log book indicating the date and time (beginning and ending) of the calibration and maintenance procedures. “Down” the appropriate channels on the DAS or set the calibration flag as appropriate for the DAS being used.

Complete the following fields on the calibration form: network and station name; current date; name of technician performing the calibration, manufacturer, model, and serial number of the instrument, and date of the last calibration.

RECORD READINGS

Simultaneously record the pre-maintenance DVM and DAS of the sensor to be calibrated. Install the parositic aspirator onto the existing station aspirator.

The accuracy of the AT/RH or RH sensor response should be evaluated by comparing the ambient AT/RH or RH measured from the station against a reference AT/RH sensor.

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TEMPERATURE, DELTA TEMPERATURE AND RELATIVE HUMIDITY CALIBRATION FORM

Network:	Park:	Site:	Date: 06/26/02	Date of Last Site Visit:
				Field Specialist:

Reference Thermometer S/N: test12		Calibration Date: test12
Relative Humidity Reference S/N: test9		Calibration Date: test9

TEMPERATURE / DELTA TEMPERATURE

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.		
Model #		
Serial #		
Translator Serial #		

PRE-MAINTENANCE SENSOR RESPONSE

BATH TEMP (° C)	TEMPERATURE		Difference (° C)	Pass/Fail	Δ TEMPERATURE		Difference (° C)	Pass/Fail
	DVM (volts)	DAS (° C)			DVM (volts)	DAS (° C)		
	Maximum Difference:				Maximum Difference:			

PRE- TRANSLATOR CARD RESPONSE

SETTING	TEMPERATURE		Δ TEMPERATURE	
	DVM (volts)	DAS (° C)	DVM (volts)	DAS (° C)
Zero				
Span				

POST MAINTENANCE SENSOR RESPONSE

BATH TEMP (° C)	TEMPERATURE		Difference (° C)	Pass/Fail	Δ TEMPERATURE		Difference (° C)	Pass/Fail
	DVM (volts)	DAS (° C)			DVM (volts)	DAS (° C)		
	Maximum Difference:				Maximum Difference:			

POST TRANSLATOR CARD RESPONSE

SETTING	TEMPERATURE		Δ TEMPERATURE	
	DVM (volts)	DAS (° C)	DVM (volts)	DAS (° C)
Zero				
Span				

Pre-Maint Temperature Comments:	
Post Maint Temperature Comments:	

RELATIVE HUMIDITY

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.		
Model #		
Serial #		

PRE-MAINTENANCE SENSOR RESPONSE

HOUR	DAS	T.STD	% Difference	Pass/Fail
10:00				
11:00				
12:00				
13:00				
14:00				
15:00				
Average ABS % Difference:				
Maximum % Difference:				

POST MAINTENANCE SENSOR RESPONSE

HOUR	DAS	T.STD	% Difference	Pass/Fail
10:00				
11:00				
12:00				
13:00				
14:00				
15:00				
Average ABS % Difference:				
Maximum % Difference:				

Pre-Maint Relative Humidity Comments:	
Post Maint Relative Humidity Comments:	

Figure 4-1. Temperature, Delta Temperature, and Relative Humidity Calibration Form.

CALIBRATE SENSOR

Calibrate the sensor as follows:

- Install the reference sensor and attach leads to the portable datalogger. Use the following program for the 21XL. Allow the reference sensor to record for as long as practical (3 to 12 hours recommended). Retrieve the data and compare to hourly averages of the existing sensor.

<u>Air Temperature/Relative Humidity/Solar Radiation Audit Program</u>

```
*Table 1 Program
          01: 60  Execution Interval (seconds)

1:  Volts (SE)  (P1)
          1:  1            Reps
          2:  1            1000 mV Slow Range
          3:  1            SE Channel
          4:  1            Loc REF AT
          5:  .10000       Multi
          6:  __30         Offset

2:  Volts (SE)  (P1)
          1:  1            Reps
          2:  5            5000 mV Slow Range
          3:  2            SE Channel
          4:  2            Loc REF RH
          5:  .10000       Mult
          6:  0.0          Offset

3:  Volt (Diff)  (P2)
          1:  1            Reps
          2:  2            15 mV Slow Range
          3:  2            DIFF Channel
          4:  3            Loc REF SOLAR
          5:  x.xxx        Mult
          6:  0.0          Offset
          Note: x.xxx = calibration constant for reference radiometer.

4:  If time is  (P92)
          1:  0000         Minutes into a
          2:  0060         Minute Interval
          3:  10           Set Output Flag High

5:  Real Time  (P77)
          1:  0110         Day, Hour/Minute (midnight = 0000)

6:  Average  (P71)
          1:  3            Reps
          2:  1            Loc REF RH AND SOLAR
```

CALIBRATE SENSOR (continued)

WIRING AT/RH CABLE TO 21XL DATALOGGER

RED	+12 VOLTS
WHITE	1 HIGH
GREEN	1 LOW
BLACK	GROUND
SHIELD	GROUND

WIRING SOLAR RADIATION TO 21XL DATALOGGER

RED	2H
BLACK	2L

- Record the calculated AT and RH values as the reference values listed on the calibration form, then record the corresponding datalogger and DVM values.

4.1.1 Evaluation of Air Temperature and Relative Humidity Checks

Evaluate the results of the air temperature and relative humidity calibration check, and verify that the air temperature sensor is within 1°C and the relative humidity value is within ±5% of the reference values.

4.2 SENSOR REPLACEMENT

Any sensor that has operated in the field for 5 or more months should be replaced with a laboratory-calibrated sensor. The replacement sensor operation should be verified by a post-maintenance calibration check (see Section 4.4). The replaced sensor should be submitted for ARS calibration immediately upon return from the field.

4.3 SYSTEM MAINTENANCE

The following corrective actions are appropriate if the above checks reveal that the station AT/RH response is beyond the tolerance discussed in Section 4.1.1:

WIRING INSPECTION AND REPAIR — Inspect all AT/RH wiring for abrasions, cuts, or loose connections. Inspect all connector pins for possible corrosion, and repair as required.

AT/RH OR RH SENSOR — Field adjustment or repair of the Vaisala HMP 45AC sensor is not recommended. If the sensor response is outside of specification, or if the sensor has been on-site for 5 or more months, replace it with a laboratory-calibrated unit, then continue with the post-maintenance calibration procedures.

4.4 POST-MAINTENANCE CALIBRATION CHECKS

After completing all maintenance and adjustment activities, initiate a post-maintenance calibration check as described in Section 4.1 and record them as the post-maintenance values.

4.5 DOCUMENTATION

Sensor calibrations require several levels of documentation:

CALIBRATION FORMS	Field calibration forms or the computer laptop Excel spreadsheet should be completed entirely. Where possible, use the Excel spreadsheet so that both a hard copy and digital record of the calibration are maintained. Review and sign all calibration forms.
LOG NOTES	A summary of results and maintenance performed must be included in the station log notes. Note any abnormalities in sensor or calibration operation that could affect the quality of data.
SENSOR MAINTENANCE CARD	The sensor maintenance cards for both the existing and replacement sensors must be completed by the field specialist.
CALIBRATION STICKER	An ARS laboratory calibration sticker should exist on the replacement sensor, marking the date the instrument was calibrated and the name of the technician who calibrated it.

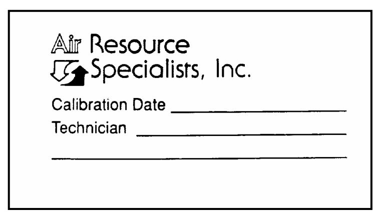

Figure 4-2. ARS Calibration Sticker.

TRIP REPORT	The calibration is thoroughly documented in a written site trip report.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**FIELD CALIBRATION AND ROUTINE MAINTENANCE OF R.M. YOUNG SOLAR RADIATION SENSORS**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3150-2120**
DATE	**JUNE 2002**

AUTHORIZATIONS

TITLE	NAME	SIGNATURE
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QA MANAGER	Gloria S. Mercer	
OTHER		

REVISION HISTORY

REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
	Reviewed; no changes necessary.	June 2003	G. Mercer
	Reviewed; no changes necessary.	June 2004	G. Mercer
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	Reviewed; no changes necessary.	June 2010	G. Mercer
	Reviewed; no changes necessary.	June 2011	G. Mercer

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LIST OF FIGURES

1.0 PURPOSE AND APPLICABILITY

The purpose of calibration and maintenance is to assure quality data capture and minimize data loss by performing and documenting scheduled operational checks and preventive maintenance. This technical instruction (TI) provides specific details for routine calibration and maintenance of R.M. Young Solar Radiation Systems 70201. The purpose of the calibration is to ensure that the sensor accuracy under normal operating conditions is within specified manufacturer's or project accuracy limits.

Experienced technicians using this TI, Standard Operating Procedure (SOP) 3150, *Calibration and Routine Maintenance of Meteorological Monitoring Systems*, and the manufacturer's instrument manual should be able to adjust the equipment to fully meet all defined specifications.

This TI is intended for use by field specialists who understand general instrument operational concepts and have their own National Institute of Standards and Technology (NIST) certified equipment.

Calibrations are required under any of the following circumstances:

- Upon acceptance testing of a new instrument
- Upon installation or removal of the instrument at a field station
- Whenever control limits are exceeded
- Prior to any corrective action, service, or maintenance to any portion of the instrument that affects its operational principle
- At a maximum interval of 6 months

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Establish the project-specific calibration and maintenance schedule and coordinate with the client as necessary.
- Establish the calibration reporting protocol to satisfy client requirements.
- Review calibration results.
- Identify inconsistencies in calibration results and initiate corrective action as required.
- Review and approve any changes to calibration procedures.

2.2 FIELD SPECIALIST

The field specialist shall:

- Perform required calibrations and maintenance as described in this TI.
- Document all calibration results and maintenance procedures performed.

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment and materials are required for AT/RH sensor calibration:

- A calibrated reference solar sensor
- A replacement sensor
- A portable datalogger (Campbell 21X or similar)
- Digital voltmeter (4-1/2 digit)
- Sensor maintenance cards
- Field service tools
- Station log book or DataView
- Solar Radiation and CASTNet Flow Calibration Form
- Pen or pencil
- Laptop computer loaded with Excel workbook (Calibrations.XLT) and CALCU program software
- ARS calibration stickers

4.0 METHODS

The solar system must be checked (pre-maintenance calibration) before servicing any system components. Throughout the calibration and maintenance period, the datalogger, calibration forms, DataView, and strip chart (if used) must be annotated to indicate that data taken during the calibration period should not be included as standard observations.

After performing system adjustments and maintenance, the system again needs to be dynamically checked (post-maintenance calibration) to ensure proper operation of the sensors. The pre-and post-maintenance calibration techniques are identical. Do not perform any maintenance to the sensors until all pre-calibration checks are completed.

The procedures described in this TI are specific to R.M. Young Solar Radiation System (70201). Calibration and maintenance include tasks that are detailed in the following five (5) major subsections:

4.1 Calibration Checks
4.2 Sensor Adjustments
4.3 Sensor Maintenance
4.4 Post-Maintenance Calibration Checks
4.5 Documentation

4.1 CALIBRATION CHECKS

A complete calibration check must be performed prior to (pre) and following (post) any maintenance activity. The calibration check procedures described below apply to both pre- or post-maintenance calibration checks. Refer to Figure 4-1, Wetness, Precipitation, and Barometric Pressure Calibration Form (or similar), when performing calibration checks. Be sure to indicate on the form whether the calibration is pre- or post-maintenance and note all maintenance activities or replaced components in the "Comments" field. The form is available as an Excel spreadsheet and should be used for both pre- and post- maintenance checks. Results of each calibration should be in both hardcopy and digital form.

Calibration checks are performed semiannually. Should any operational check be out of suggested tolerance, complete the calibration check before any maintenance or adjustments are made. The following operational checks should be performed:

ANNOTATE DATA RECORDS	Make an entry in the station log book or DataView indicating the date and time (beginning and ending) of the calibration and maintenance procedures. "Down" the appropriate channels on the DAS or set the calibration flag as appropriate for the DAS being used. Complete the following fields on the calibration form: network and station name; current date; name of technician performing the calibration, manufacturer, model, and serial number of the instrument, and date of the last calibration.
RECORD READINGS	The accuracy of the solar sensor response should be evaluated by comparing the ambient solar measured from the station against a reference solar sensor.

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SOLAR RADIATION AND CASTNET FLOW CALIBRATION FORM

Network:	Park:	Site:	Date: 06/26/02	Date of Last Site Visit:
				Field Specialist:

Solar Radiation Reference S/N: test10	Reference Factor: 95.64(W/m2)	Calibration Date: test10
Flow Standard Reference S/N: test6		Calibration Date: test6

SOLAR RADIATION

SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.		
Model #		
Serial #		
Translator Serial #		

TRANSLATOR CARD

SETTING	PRE-MAINTENANCE		POST MAINTENANCE	
	DVM (volts)	DAS (W/m2)	DVM (volts)	DAS (W/m2)
Zero				
Span				

SENSOR RESPONSE

HOUR	PRE-MAINTENANCE			HOUR	POST MAINTENANCE		
	DAS (W/m2)	T.STD	% Difference		DAS (W/m2)	T.STD	% Difference
12:00				12:00			
13:00				13:00			
14:00				14:00			
15:00				15:00			
16:00				16:00			
17:00				17:00			
	Average % Difference:				Average % Difference:		
	Pass/Fail:				Pass/Fail:		

Pre-Maint Solar Radiation Comments:	
Post Maint Solar Radiation Comments:	

CASTNet FLOW

SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.		
Model #		
Serial #		

SENSOR RESPONSE

Target Flow (slpm)	PRE-MAINTENANCE						POST MAINTENANCE					
	MFC Display	DAS (slpm)	Actual Bios Flow (slpm)	Difference (slpm)	Difference	Pass/Fail	MFC Display	DAS (slpm)	Actual Bios Flow (slpm)	Difference (slpm)	Difference	Pass/Fail
Pump On Bios Attached Filter Removed												
Pump Off Reference Bios Attached Filter Removed						N/A						N/A
Leak Check Pump On Filter Removed Bios Removed			N/A		N/A				N/A		N/A	

Pre-Maint CASTNet Flow Comments:	
Post Maint CASTNet Flow Comments:	

Figure 4-1. Solar Radiation and CASTNet Flow Calibration Form.

CALIBRATE SENSOR

Calibrate the sensor as follows:

- Install the reference sensor and attach leads to the portable datalogger. Use the following program for the 21XL. Allow the reference sensor to record for as long as practical (3 to 12 hours recommended). Retrieve the data and compare to hourly averages of the existing sensor.

Relative Humidity/Solar Radiation Audit Program

```
*Table 1 Program
        01: 60  Execution Interval (seconds)

1:  Volts (SE)  (P1)
        1:  1               Reps
        2:  5               5000 mV Slow Range
        3:  1               SE Channel
        4:  1               Loc REF RH
        5:  .10000          Mult
        6:  0.0             Offset

2:  Volt (Diff)  (P2)
        1:  1               Reps
        2:  2               15 mV Slow Range
        3:  2               DIFF Channel
        4:  2               Loc REF SOLAR
        5:  1.0             Mult
        6:  0.0             Offset

3:  If time is  (P92)
        1:  0000            Minutes into a
        2:  0060            Minute Interval
        3:  10              Set Output Flag High

4:  Real Time  (P77)
        1:  0110            Day, Hour/Minute (midnight = 0000)

5:  Average  (P71)
        1:  2               Reps
        2:  1               Loc REF RH AND SOLAR
```

WIRING RH CABLE TO 21XL DATALOGGER

RED	+12 VOLTS
GREEN	1 HIGH
BLACK	GROUND
SHIELD	GROUND

WIRING SOLAR RADIATION TO 21XL DATALOGGER

RED	2H
BLACK	2L

CALIBRATE SENSOR (continued)	• Record the calculated solar values as the reference value listed on the calibration form.

4.1.1 Evaluation of Solar Radiation Checks

Evaluate the results of the solar radiation calibration check, and verify that the station solar value is within ±5% of the calculated reference value.

4.2 SENSOR REPLACEMENT

Any sensor that has operated in the field for 12 or more months should be replaced with a laboratory-calibrated sensor. The replacement sensor operation should be verified by a post-maintenance calibration check (see Section 4.4). The replaced sensor should be submitted for ARS calibration immediately upon return from the field.

4.3 SYSTEM MAINTENANCE

The following corrective actions are appropriate if the above checks reveal that the station solar response is beyond the tolerance discussed in Section 4.1.1:

WIRING INSPECTION AND REPAIR	Inspect all solar wiring for abrasions, cuts, or loose connections. Inspect all connector pins for possible corrosion, and repair as required.
SOLAR SENSOR	Field adjustment or repair of the R M Young Solar Radiation System sensor is not recommended. If the sensor response is outside of specification, or if the sensor has been on-site for 12 or more months, replace it with a laboratory-calibrated unit, then continue with the post-maintenance calibration procedures.

4.4 POST-MAINTENANCE CALIBRATION CHECKS

After completing all maintenance and adjustment activities, initiate a post-maintenance calibration check as described in Section 4.1 and record them as the post-maintenance values.

4.5 DOCUMENTATION

Sensor calibrations require several levels of documentation:

CALIBRATION FORMS	Field calibration forms or the computer laptop Excel spreadsheet should be completed entirely. Where possible, use the Excel spreadsheet so that both a hard copy and digital record of the calibration are maintained. Review and sign all calibration forms.

LOG NOTES

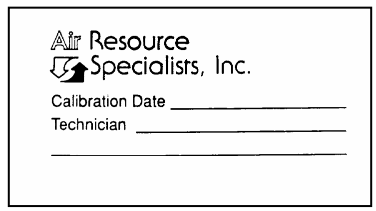
A summary of results and maintenance performed must be included in the station log notes. Note any abnormalities in sensor or calibration operation that could affect the quality of data.

SENSOR MAINTENANCE CARD

The sensor maintenance cards for both the existing and replacement sensors must be completed by the field specialist.

CALIBRATION STICKER

An ARS laboratory calibration sticker should exist on the replacement sensor, marking the date the instrument was calibrated and the name of the technician who calibrated it.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Calibration Date ____________________

Technician ____________________

____

Figure 4-2. ARS Calibration Sticker.

TRIP REPORT

The calibration is thoroughly documented in a written site trip report.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**FIELD CALIBRATION AND ROUTINE MAINTENANCE OF LI-COR MODEL LI-200 PYRANOMETERS**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3150-2123**
DATE	**SEPTEMBER 2005**

AUTHORIZATIONS		
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QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
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	Reviewed; no changes necessary.	September 2007	G. Mercer
	Reviewed; no changes necessary.	September 2008	G. Mercer
	Reviewed; no changes necessary.	September 2009	G. Mercer
	Reviewed; no changes necessary.	September 2010	G. Mercer
	Reviewed; no changes necessary.	September 2011	G. Mercer

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LIST OF FIGURES

1.0 PURPOSE AND APPLICABILITY

The purpose of calibration and maintenance is to assure quality data capture and minimize data loss by performing and documenting scheduled operational checks and preventive maintenance. This technical instruction (TI) provides specific details for routine calibration and maintenance of a LI-COR model LI-200 pyranometer. The purpose of the calibration is to ensure that the sensor accuracy under normal operating conditions is within specified manufacturer's or project accuracy limits.

Experienced technicians using this TI, Standard Operating Procedure (SOP) 3150, *Calibration and Routine Maintenance of Meteorological Monitoring Systems*, and the manufacturer's instrument manual should be able to adjust the equipment to fully meet all defined specifications.

This TI is intended for use by field specialists who understand general instrument operational concepts and have their own National Institute of Standards and Technology (NIST) certified equipment.

Calibrations are required under any of the following circumstances:

- Upon acceptance testing of a new instrument
- Upon installation or removal of the instrument at a field station
- Whenever control limits are exceeded
- Prior to any corrective action, service, or maintenance to any portion of the instrument that affects its operational principle
- At a maximum interval of six months

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Establish the project-specific calibration and maintenance schedule and coordinate with the client as necessary.
- Establish the calibration reporting protocol to satisfy client requirements.
- Review calibration results.
- Identify inconsistencies in calibration results and initiate corrective action as required.
- Review and approve any changes to calibration procedures.

2.2 FIELD SPECIALIST

The field specialist shall:

- Perform required calibrations and maintenance as described in this TI.
- Document all calibration results and maintenance procedures performed.

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment and materials are required for AT/RH sensor calibration:

- A calibrated reference solar sensor
- A replacement sensor
- A portable datalogger (Campbell 21X or similar)
- Digital voltmeter (4-1/2 digit)
- Sensor maintenance cards
- Field service tools
- Station log book or DataView
- Calibration forms
- Pen or pencil
- Laptop computer loaded with Excel calibration forms
- ARS calibration stickers

4.0 METHODS

The solar system must be checked (pre-maintenance calibration) before servicing any system components. Throughout the calibration and maintenance period, the datalogger, calibration forms, DataView, and strip chart (if used) must be annotated to indicate that data taken during the calibration period should not be included as standard observations.

After performing system adjustments and maintenance, the system again needs to be dynamically checked (post-maintenance calibration) to ensure proper operation of the sensors. The pre-and post-maintenance calibration techniques are identical. Do not perform any maintenance to the sensors until all pre-calibration checks are completed.

The procedures described in this TI are specific to LI-COR model LI-200 pyranometer. Calibration and maintenance include tasks that are detailed in the following five (5) major subsections:

4.1 Calibration Checks
4.2 Sensor Adjustments
4.3 Sensor Maintenance
4.4 Post-Maintenance Calibration Checks
4.5 Documentation

4.1 CALIBRATION CHECKS

A complete calibration check must be performed prior to (pre) and following (post) any maintenance activity. The calibration check procedures described below apply to both pre- or post-maintenance calibration checks. Refer to Figure 4-1, Solar Radiation and Net Radiation Calibration Form (or similar), when performing calibration checks. Be sure to indicate on the form whether the calibration is pre- or post-maintenance and note all maintenance activities or replaced components in the "Comments" field. The form is available as an Excel spreadsheet and should be used for both pre- and post- maintenance checks. Results of each calibration should be in both hardcopy and digital form.

Calibration checks are performed semiannually. Should any operational check be out of suggested tolerance, complete the calibration check before any maintenance or adjustments are made. The following operational checks should be performed:

ANNOTATE DATA RECORDS	Make an entry in the station log book or DataView indicating the date and time (beginning and ending) of the calibration and maintenance procedures. "Down" the appropriate channels on the data acquisition system (DAS) or set the calibration flag as appropriate for the DAS being used. Complete the following fields on the calibration form: network and station name; current date; name of technician performing the calibration, manufacturer, model, and serial number of the instrument, and date of the last calibration.
RECORD READINGS	The accuracy of the solar sensor response should be evaluated by comparing the ambient solar measured from the station against a reference solar sensor.

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SOLAR RADIATION AND NET RADIATION CALIBRATION FORM

Network:	Location:	Site:	Date: 05/19/05	Date of Last Site Visit:
				Field Specialist:

Solar Radiation Reference S/N: PY12080	Reference Factor: 95.64(W/m2)	Calibration Date: 04/11/03
High Flow Standard Reference S/N: N/A		Calibration Date: 01/02/04

SOLAR RADIATION

SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.		
Model #		
Serial #		
Translator Serial #		

TRANSLATOR CARD

SETTING	PRE-MAINTENANCE		POST MAINTENANCE	
	DVM (volts)	DAS (W/m2)	DVM (volts)	DAS (W/m2)
Zero				
Span				

SENSOR RESPONSE

HOUR	PRE-MAINTENANCE			HOUR	POST MAINTENANCE		
	DAS (W/m2)	T.STD	% Difference		DAS (W/m2)	T.STD	% Difference
12:00				12:00			
13:00				13:00			
14:00				14:00			
15:00				15:00			
16:00				16:00			
17:00				17:00			
	Average % Difference:				Average % Difference:		
	Pass/Fail:				Pass/Fail:		

Pre-Maint Solar Radiation Comments:	
Post Maint Solar Radiation Comments:	

NET RADIATION

SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.	Kipp and Zonen	Kipp and Zonen
Model #	NR LITE	NR LITE
Serial #		
Translator Serial #		

TRANSLATOR CARD

SETTING	PRE-MAINTENANCE		POST MAINTENANCE	
	DVM (volts)	DAS (W/m2)	DVM (volts)	DAS (W/m2)
Zero				
Span				

SENSOR RESPONSE

HOUR	PRE-MAINTENANCE			HOUR	POST MAINTENANCE		
	DAS (W/m2)	T.STD	% Difference		DAS (W/m2)	T.STD	% Difference
12:00				12:00			
13:00				13:00			
14:00				14:00			
15:00				15:00			
16:00				16:00			
17:00				17:00			
	Average % Difference:				Average % Difference:		
	Pass/Fail:				Pass/Fail:		

Pre-Maint Net Radiation Comments:	
Post Maint Net Radiation Comments:	

Figure 4-1. Solar Radiation and Net Radiation Calibration Form.

CALIBRATE SENSOR

Calibrate the sensor as follows:

- Install the reference sensor and attach leads to the portable datalogger. Use the following program for the 21XL. Allow the reference sensor to record for as long as practical (3 to 12 hours recommended). Retrieve the data and compare to hourly averages of the existing sensor.

<u>Relative Humidity/Solar Radiation Audit Program</u>

```
*Table 1 Program
        01: 60  Execution Interval (seconds)

1:  Volts (SE)  (P1)
        1:  1           Reps
        2:  5           5000 mV Slow Range
        3:  1           SE Channel
        4:  1           Loc REF RH
        5:  .10000      Mult
        6:  0.0         Offset

2:  Volt (Diff)  (P2)
        1:  1           Reps
        2:  2           15 mV Slow Range
        3:  2           DIFF Channel
        4:  2           Loc REF SOLAR
        5:  1.0         Mult
        6:  0.0         Offset

3:  If time is  (P92)
        1:  0000        Minutes into a
        2:  0060        Minute Interval
        3:  10          Set Output Flag High

4:  Real Time  (P77)
        1:  0110        Day, Hour/Minute (midnight = 0000)

5:  Average  (P71)
        1:  2           Reps
        2:  1           Loc REF RH AND SOLAR
```

WIRING RH CABLE TO 21XL DATALOGGER

RED	+12 VOLTS
GREEN	1 HIGH
BLACK	GROUND
SHIELD	GROUND

WIRING SOLAR RADIATION TO 21XL DATALOGGER

RED	2H
BLACK	2L

CALIBRATE SENSOR (continued)	• Record the calculated solar values as the reference value listed on the calibration form.

4.1.1 Evaluation of Solar Radiation Checks

Evaluate the results of the solar radiation calibration check, and verify that the station solar value is within ±5% of the calculated reference value.

4.2 SENSOR REPLACEMENT

Any sensor that has operated in the field for 12 or more months should be replaced with a laboratory-calibrated sensor. The replacement sensor operation should be verified by a post-maintenance calibration check (see Section 4.4). The replaced sensor should be submitted for ARS calibration immediately upon return from the field.

4.3 SYSTEM MAINTENANCE

The following corrective actions are appropriate if the above checks reveal that the station solar response is beyond the tolerance discussed in Section 4.1.1:

WIRING INSPECTION AND REPAIR	Inspect all solar wiring for abrasions, cuts, or loose connections. Inspect all connector pins for possible corrosion, and repair as required.
SOLAR SENSOR	Field adjustment or repair of the LI-COR model LI-200 pyranometer is not recommended. If the sensor response is outside of specification, or if the sensor has been on-site for 12 or more months, replace it with a laboratory-calibrated unit, then continue with the post-maintenance calibration procedures.

4.4 POST-MAINTENANCE CALIBRATION CHECKS

After completing all maintenance and adjustment activities, initiate a post-maintenance calibration check as described in Section 4.1 and record them as the post-maintenance values.

4.5 DOCUMENTATION

Sensor calibrations require several levels of documentation:

CALIBRATION FORMS	Field calibration forms or the computer laptop Excel spreadsheet should be completed entirely. Where possible, use the Excel spreadsheet so that both a hard copy and digital record of the calibration are maintained. Review and sign all calibration forms.

LOG NOTES

A summary of results and maintenance performed must be included in the station log notes. Note any abnormalities in sensor or calibration operation that could affect the quality of data.

SENSOR MAINTENANCE CARD

The sensor maintenance cards for both the existing and replacement sensors must be completed by the field specialist.

CALIBRATION STICKER

An ARS laboratory calibration sticker should exist on the replacement sensor, marking the date the instrument was calibrated and the name of the technician who calibrated it.

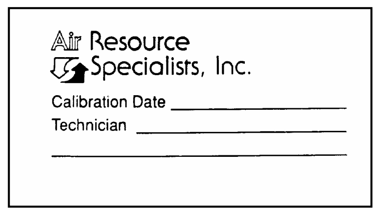

Figure 4-2. ARS Calibration Sticker.

TRIP REPORT

The calibration is thoroughly documented in a written site trip report.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**FIELD CALIBRATION AND ROUTINE MAINTENANCE OF A TIPPING BUCKET RAIN GAUGE**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3150-2130**
DATE	**JUNE 2002**

AUTHORIZATIONS		
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PROGRAM MANAGER	David L. Dietrich	David L. Dietrich
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
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1.0	Revised to include all types of tipping gauges.	April 2006	G. Mercer
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	Reviewed; no changes necessary.	April 2010	G. Mercer
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1.0 PURPOSE AND APPLICABILITY

The purpose of calibration and maintenance is to assure quality data capture and minimize data loss by performing and documenting scheduled operational checks and preventive maintenance. This technical instruction (TI) provides specific details for routine calibration and maintenance of any tipping bucket-type precipitation gauge. The purpose of the calibration is to ensure that the gauge accuracy under normal operating conditions is within specified manufacturer's or project accuracy limits.

Experienced technicians using this TI, Standard Operating Procedure (SOP) 3150, *Calibration and Routine Maintenance of Meteorological Monitoring Systems*, and the manufacturer's instrument manual should be able to adjust the equipment to fully meet all defined specifications.

This TI is intended for use by field specialists who understand general instrument operational concepts and have their own National Institute of Standards and Technology (NIST) certified equipment.

Calibrations are required under any of the following circumstances:

- Upon acceptance testing of a new instrument
- Upon installation or removal of the instrument at a field station
- Whenever control limits are exceeded
- Prior to any corrective action, service, or maintenance to any portion of the instrument that affects its operational principle
- At a maximum interval of 6 months

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Establish the project-specific calibration and maintenance schedule and coordinate with the client as necessary.
- Establish the calibration reporting protocol to satisfy client requirements.
- Review calibration results.
- Identify inconsistencies in calibration results and initiate corrective action as required.
- Review and approve any changes to calibration procedures.

2.2 FIELD SPECIALIST

The field specialist shall:

- Perform required calibrations and maintenance as described in this TI.
- Document all calibration results and maintenance procedures performed.

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment and materials are required for a tipping bucket rain gauge:

- Drip bottle
- Digital voltmeter (4-1/2 digit)
- Sensor maintenance cards
- Field service tools
- Station log book or DataView
- Wetness, Precipitation, and Barometric Pressure Calibration Form
- Pen or pencil
- Laptop computer loaded with Excel workbook (Calibrations.XLT)
- ARS calibration stickers

4.0 METHODS

The tipping bucket precipitation gauge system must be checked (pre-maintenance calibration) before servicing any system components. Throughout the calibration and maintenance period, the datalogger, calibration forms, DataView, and strip chart (if used) must be annotated to indicate that data taken during the calibration period should not be included as standard observations.

After performing system adjustments and maintenance, the system again needs to be dynamically checked (post-maintenance calibration) to ensure proper operation of the sensors. The pre-and post-maintenance calibration techniques are identical. Do not perform any maintenance to the sensors until all pre-calibration checks are completed.

The procedures described in this TI are applicable to any tipping bucket precipitation gauge. Calibration and maintenance include tasks that are detailed in the following five (5) major subsections:

4.1 Calibration Checks
4.2 Sensor Adjustments
4.3 Sensor Maintenance
4.4 Post-Maintenance Calibration Checks
4.5 Documentation

4.1 CALIBRATION CHECKS

A complete calibration check must be performed prior to (pre) and following (post) any maintenance activity. The calibration check procedures described below apply to both pre- or post-maintenance calibration checks. Refer to Figure 4-1, Wetness, Precipitation, and Barometric Pressure Calibration Form (or similar), when performing calibration checks. Be sure to indicate on the form whether the calibration is pre- or post-maintenance and note all maintenance activities or replaced components in the “Comments” field. The form is available as an Excel spreadsheet and should be used for both pre- and post- maintenance checks. Results of each calibration should be in both hardcopy and digital form.

Calibration checks are performed semiannually. Should any operational check be out of suggested tolerance, complete the calibration check before any maintenance or adjustments are made. The following operational checks should be performed:

ANNOTATE DATA RECORDS

Make an entry in the station log book indicating the date and time (beginning and ending) of the calibration and maintenance procedures. “Down” the appropriate channels on the DAS or set the calibration flag as appropriate for the DAS being used.

Complete the following fields on Wetness, Precipitation, and Barometric Pressure Calibration Form: network and station name; current date; name of technician performing the calibration, manufacturer, model, and serial number of the instrument, and date of the last calibration.

RECORD READINGS

Record the pre-maintenance DAS value of the sensor to be calibrated. Install the drip bottle calibrator onto the gauge.

The accuracy of the precipitation gauge response should be evaluated by comparing the response to the expected value as indicated in Table 4-1.

Air Resource Specialists, Inc.

WETNESS, PRECIPITATION AND BAROMETRIC PRESSURE CALIBRATION FORM

Network:	Location:	Site:	Date: 03/22/06	Date of Last Site Visit:
				Field Specialist:

Barometric Pressure Reference S/N: 0725		Calibration Date: 01/28/02
Precipitation Reference S/N: 2909	Calibration Volume: 900 ml	Calibration Date: 01/04/04

WETNESS

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.		
Model #		
Serial #		

PRE-MAINTENANCE SENSOR RESPONSE

	DVM (volts)	DAS	LED (ON/OFF)	Pass/Fail
DRY			off	
WET			on	

POST MAINTENANCE SENSOR RESPONSE

	DVM (volts)	DAS	LED (ON/OFF)	Pass/Fail
DRY			off	
WET			on	

Pre-Maint Wetness Comments:	
Post Maint Wetness Comments:	

PRECIPITATION

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.	Other	Other
Model #		
Serial #		
Inlet Diameter		

Reference

Calibration Volume	Inlet Diameter	mm	mm/tip
900 cc	6.06	48.3	4.73
	8.00	27.8	8.23
	9.66	19.0	4.73
	Novalynx 260-2500	27.8	8.24
936 cc	6.06	50.3	4.73
	8.00	28.9	8.23
	9.66	19.8	4.73
	Novalynx 260-2500	28.9	8.24

PRE-MAINTENANCE					POST MAINTENANCE				
Cal Volume (ml)	Designated value in mm	mm	% Difference	Pass/Fail	Cal Volume (ml)	Designated value in mm	mm	% Difference	Pass/Fail
900					900				

Pre-Maint Precipitation Comments:	
Post Maint Precipitation Comments:	

BAROMETRIC PRESSURE

SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.		
Model #		
Serial #		

SENSOR RESPONSE

PRE-MAINTENANCE					POST MAINTENANCE				
Reference	DVM (Volts)	DAS (mm Hg)	Difference	Pass/Fail	Reference	DVM (Volts)	DAS (mm Hg)	Difference	Pass/Fail
Maximum:					Maximum:				

Pre-Maint Barometric Pressure Comments:	
Post Maint Barometric Pressure Comments:	

20051021

Figure 4-1. Wetness, Precipitation, and Barometric Pressure Calibration Form.

Table 4-1

Tipping Bucket-Type Rain Gauges
Manufacturer Calibration Values

Gauge	Inlet Diameter / Model #	mm/Tip	Tips/900cc	mm/900cc	Tips/936cc	mm/936cc
Texas Electronics	6.06”	4.73	483	48.3	503	50.3
Texas Electronics	8.00”	8.23	278	27.8	289	28.9
Texas Electronics	9.66”	4.73	190	19.0	198	19.8
NovaLynx	260-2500	8.24	278	27.8	289	28.9
R.M. Young	52202 52203	2.0	450	45.0	468	46.8

4.1.1 Evaluation of Precipitation Gauge Checks

Evaluate the results of the precipitation gauge calibration check, and verify that the gauge is within ±5% of the calculated reference value.

4.2 SYSTEM MAINTENANCE

The following corrective actions are appropriate if the above checks reveal that the station precipitation gauge response is beyond the tolerance discussed in Section 4.1.1:

WIRING INSPECTION AND REPAIR — Inspect all precipitation gauge wiring for abrasions, cuts, or loose connections. Inspect all connector pins for possible corrosion, and repair as required.

PRECIPITATION GAUGE — Field adjustment of the tipping bucket rain gauge is recommended if the gauge response is outside of specification. To check the calibration of the gauge or to recalibrate, the following procedure should be used: Using a pipet, allow the value of water indicated in Table 4-1 to pass through the inner funnel to the tipping bucket. The bucket should tip. Check the alternate bucket in the same manner. If both buckets tip when filled with indicated values of water, the gauge is in proper calibration (Note: before starting the calibration, the buckets should be wet). If the buckets do not tip, recalibrate as follows:

PRECIPITATION GAUGE (continued)

1. Release the lock nuts on the cup adjustments.
2. Move the adjustment screws down to a position that would place the bucket far out of calibration.
3. Introduce the tip value of water as indicated in Table 4-1.
4. Turn the cup adjustment screw up until the bucket assembly tips. Tighten the lock nut.
5. Repeat this procedure for the opposite bucket.
6. Repeat the process several times to insure proper calibration.

After installation and calibration (if necessary) replace the cover on the gauge.

4.3 POST-MAINTENANCE CALIBRATION CHECKS

After completing all maintenance and adjustment activities, initiate a post-maintenance calibration check as described in Section 4.1 and record them as the post-maintenance values.

4.4 DOCUMENTATION

Sensor calibrations require several levels of documentation:

CALIBRATION FORMS

Field calibration forms or the computer laptop Excel spreadsheet should be completed entirely. Where possible, use the Excel spreadsheet so that both a hard copy and digital record of the calibration are maintained. Review and sign all calibration forms.

LOG NOTES

A summary of results and maintenance performed must be included in the station log notes. Note any abnormalities in sensor or calibration operation that could affect the quality of data.

CALIBRATION STICKER

An ARS laboratory calibration sticker should exist on the gauge, marking the date the instrument was calibrated and the name of the technician who calibrated it.

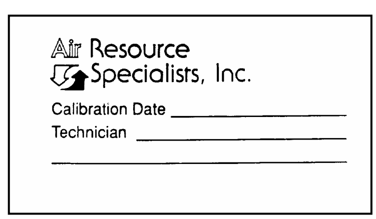

Figure 4-2. ARS Calibration Sticker.

TRIP REPORT

The calibration is thoroughly documented in a written site trip report.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**FIELD CALIBRATION AND ROUTINE MAINTENANCE OF R.M. YOUNG MODEL 58101 WETNESS SENSORS**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3150-2150**
DATE	**SEPTEMBER 2005**

AUTHORIZATIONS

TITLE	NAME	SIGNATURE
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PROGRAM MANAGER	David L. Dietrich	David L. Dietrich
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OTHER		

REVISION HISTORY

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1.0 PURPOSE AND APPLICABILITY

The purpose of calibration and maintenance is to assure quality data capture and minimize data loss by performing and documenting scheduled operational checks and preventive maintenance. This technical instruction (TI) provides specific details for routine calibration and maintenance of an R.M. Young model 58101 wetness sensor. The purpose of the calibration is to ensure that the sensor accuracy under normal operating conditions is within specified manufacturer's or project accuracy limits.

Experienced technicians using this TI, Standard Operating Procedure (SOP) 3150, *Calibration and Routine Maintenance of Meteorological Monitoring Systems*, and the manufacturer's instrument manual should be able to adjust the equipment to fully meet all defined specifications.

This TI is intended for use by field specialists who understand general instrument operational concepts and have their own National Institute of Standards and Technology (NIST) certified equipment.

Calibrations are required under any of the following circumstances:

- Upon acceptance testing of a new instrument
- Upon installation or removal of the instrument at a field station
- Whenever control limits are exceeded
- Prior to any corrective action, service, or maintenance to any portion of the instrument that affects its operational principle
- At a maximum interval of six months

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Establish the project-specific calibration and maintenance schedule and coordinate with the client as necessary.
- Establish the calibration reporting protocol to satisfy client requirements.
- Review calibration results.
- Identify inconsistencies in calibration results and initiate corrective action as required.
- Review and approve any changes to calibration procedures.

2.2 FIELD SPECIALIST

The field specialist shall:

- Perform required calibrations and maintenance as described in this TI.
- Document all calibration results and maintenance procedures performed.

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment and materials are required for AT/RH sensor calibration:

- A resistance decade box
- A replacement wetness sensor
- Digital voltmeter (4-1/2 digit)
- Sensor maintenance cards
- Field service tools
- Station log book or DataView
- Pen or pencil
- Laptop computer loaded with Excel calibration forms
- ARS calibration stickers
- Water (small amount)
- Kimwipe

4.0 METHODS

The R.M. Young model 58101 wetness sensor is designed to monitor dew or rain that would collect upon the native vegetation. When the sensor's artificial "leaf" gets wet, the sensor output changes from 0.00 VDC to 1.00 VDC. Adjustments to the sensor include the sensitivity adjustment, which defines how much moisture is required to indicate wet, and the voltage adjustment, which adjusts the instrument's 1.00 VDC output.

The wetness system must be checked (pre-maintenance calibration) before servicing any system components. Throughout the calibration and maintenance period, the datalogger, calibration forms, DataView, and strip chart (if used) must be annotated to indicate that data taken during the calibration period should not be included as standard observations.

After performing system adjustments and maintenance, the system again needs to be dynamically checked (post-maintenance calibration) to ensure proper operation of the sensors. The pre-and post-maintenance calibration techniques are identical. Do not perform any maintenance to the sensors until all pre-calibration checks are completed.

The procedures described in this TI are specific to R.M. Young model 58101 wetness sensors. Calibration and maintenance include tasks that are detailed in the following five (5) major subsections:

4.1 Calibration Checks
4.2 Sensor Adjustments/Replacement
4.3 Sensor Maintenance
4.4 Post-Maintenance Calibration Checks
4.5 Documentation

4.1 CALIBRATION CHECKS

A complete calibration check must be performed prior to (pre) and following (post) any maintenance activity. The calibration check procedures described below apply to both pre- or post-maintenance calibration checks. Refer to Figure 4-1, Wetness, Precipitation, and Barometric Pressure Calibration Form (or similar), when performing calibration checks. Be sure to indicate on the form whether the calibration is pre- or post-maintenance and note all maintenance activities or replaced components in the "Comments" field. The form is available as an Excel spreadsheet and should be used for both pre- and post- maintenance checks. Results of each calibration should be in both hardcopy and digital form.

Calibration checks are performed semiannually. Should any operational check be out of suggested tolerance, complete the calibration check before any maintenance or adjustments are made. The following operational checks should be performed:

ANNOTATE DATA RECORDS

Make an entry in the station log book or DataView indicating the date and time (beginning and ending) of the calibration and maintenance procedures. "Down" the appropriate channels on the data acquisition system (DAS) or set the calibration flag as appropriate for the DAS being used.

Complete the following fields on the calibration form: network and station name; current date; name of technician performing the calibration, manufacturer, model, and serial number of the instrument, and date of the last calibration.

RECORD PRE-MAINTENANCE READINGS

The accuracy of the wetness sensor response should be evaluated by observing the wetness sensor output when dry (0.00 VDC) and when wet (1.00 VDC). Wet the sensor using a damp Kimwipe; the red LED sensor should be on and the voltage should be 1.00 VDC.

4.2 SENSOR ADJUSTMENTS/REPLACEMENT

Any sensor that is not able to be adjusted as described or exhibits other problems should be replaced.

Air Resource Specialists, Inc.

WETNESS, PRECIPITATION AND BAROMETRIC PRESSURE CALIBRATION FORM

Network:	Location:	Site:	Date:	Date of Last Site Visit:
				Field Specialist:

Barometric Pressure Reference S/N: test		Calibration Date:	
Precipitation Reference S/N: N/A	Calibration Volume: 936 ml	Calibration Date:	

WETNESS

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.		
Model #		
Serial #		

PRE-MAINTENANCE SENSOR RESPONSE

	DVM (volts)	DAS	LED (ON/OFF)	Pass/Fail
DRY			off	
WET			on	

POST MAINTENANCE SENSOR RESPONSE

	DVM (volts)	DAS	LED (ON/OFF)	Pass/Fail
DRY			off	
WET			on	

Pre-Maint Wetness Comments:	
Post Maint Wetness Comments:	

PRECIPITATION

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Mfg.	Climatronics	Climatronics
Model #	100508	100508
Serial #		

PRE-MAINTENANCE					POST MAINTENANCE				
Cal Volume (ml)	Target # of Tips	# of Tips	% Difference	Pass/Fail	Cal Volume (ml)	Target # of Tips	# of Tips	% Difference	Pass/Fail
936	206				936	198			

Pre-Maint Precipitation Comments:	
Post Maint Precipitation Comments:	

BAROMETRIC PRESSURE

SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.	Visalia	Visalia
Model #	mm Hg	mm Hg
Serial #		

SENSOR RESPONSE

PRE-MAINTENANCE					POST MAINTENANCE				
Reference	DVM (Volts)	DAS (mm Hg)	Difference	Pass/Fail	Reference	DVM (Volts)	DAS (mm Hg)	Difference	Pass/Fail
Maximum:					Maximum:				

Pre-Maint Barometric Pressure Comments:	
Post Maint Barometric Pressure Comments:	

Figure 4-1. Wetness, Precipitation, and Barometric Pressure Calibration Form.

4.3 SENSOR MAINTENANCE

The following actions should be taken during each sensor check.

CALIBRATE SENSOR	Remove the cover from the sensor and insert leads from the decade box into the calibration jack. Adjust the decade box to 240 Kohms and adjust the sensitivity potentiometer until the LED illuminates. Check the sensor's voltage output and adjust to 1.00 VDC. Remove the decade box and replace the sensor cover.
RECORD POST-MAINTENANCE READINGS	Record the sensor's response on the calibration worksheet for dry and wet conditions, similar to the pre-maintenance checks.

4.4 POST-MAINTENANCE CALIBRATION CHECKS

After completing all maintenance and adjustment activities, initiate a post-maintenance calibration check as described in Section 4.1 and record them as the post-maintenance values.

4.5 DOCUMENTATION

Sensor calibrations require several levels of documentation:

CALIBRATION FORMS	Field calibration forms or the computer laptop Excel spreadsheet should be completed entirely. Where possible, use the Excel spreadsheet so that both a hard copy and digital record of the calibration are maintained. Review and sign all calibration forms.
LOG NOTES	A summary of results and maintenance performed must be included in the station log notes. Note any abnormalities in sensor or calibration operation that could affect the quality of data.
SENSOR MAINTENANCE CARD	The sensor maintenance cards for both the existing and replacement sensors must be completed by the field specialist.
CALIBRATION STICKER	An ARS laboratory calibration sticker should exist on the replacement sensor, marking the date the instrument was calibrated and the name of the technician who calibrated it.

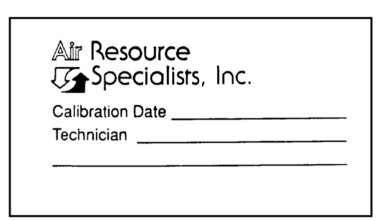

Figure 4-2. ARS Calibration Sticker.

TRIP REPORT	The calibration is thoroughly documented in a written site trip report.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
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TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3160**
DATE	**AUGUST 1990**

AUTHORIZATIONS

TITLE	NAME	SIGNATURE
ORIGINATOR	John F. Faust	John F. Faust
PROJECT MANAGER	John F. Faust	John F. Faust
PROGRAM MANAGER	Joe Adlhoch	[illegible]
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**CALIBRATION OF DATA ACQUISITION SYSTEMS**
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TITLE	NAME	SIGNATURE
ORIGINATOR	John F. Faust	John F. Faust
PROJECT MANAGER	John F. Faust	John F. Faust
PROGRAM MANAGER	Joe Adlhoch	[illegible]
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	Reviewed; no changes necessary.	November 2009	G. Mercer
	Reviewed; no changes necessary.	November 2010	G. Mercer

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1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) is a guide to document the relationship between the analog inputs to a data acquisition system (DAS) and the values recorded and outputted by the DAS. This SOP applies to modern microprocessor-based datalogging systems. Detailed manufacturer's specific DAS procedures are not included in this SOP. Separate technical instructions (TIs) are developed for each specific DAS.

A data acquisition system is generally referred to the measurement and recording devices that monitor and/or control various instruments and sensors. The DAS log discrete readings, averaged values, or events from the sensing instrument. Examples of data acquisition components include: dataloggers, strip chart recorders, printers, magnetic storage devices, modems, terminals, and data collection platforms (DCPs).

DAS calibrations are required under any of the following circumstances:

- Upon acceptance testing of a new instrument
- Upon installation or removal of the instrument at a field station
- Whenever control limits are exceeded
- Prior to any corrective action, service, or maintenance to any portion of the instrument that affects its operational principle
- At a maximum interval of six months

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Establish the project-specific calibration schedule and coordinate with the client as necessary.
- Establish the calibration reporting protocol to satisfy client requirements.
- Review calibration results.
- Identify inconsistencies in calibration results and initiate corrective action as required.

2.2 FIELD SPECIALIST

The field specialist shall:

- Perform required calibrations as described in this SOP.
- Verify that the calibration standards are in good working order and are in current calibration.
- Document all calibration results and maintenance procedures performed.

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment is required for DAS calibration:

- Voltage source calibrator (capable of outputting a range of values the covers the input range of the DAS)
- Digital voltmeter (4 ½ digit)
- Interconnect cabling
- Manufacturer’s instrument manual
- Instrument-specific technical instruction regarding calibrating the DAS
- DAS calibration form (required only if the DAS is not connected to a printer)
- Pen or pencil
- Field service tools
- Station log book

4.0 METHODS

Calibration tasks are detailed in the following four (4) subsections:

4.1 Preparation for Calibration
4.2 Calibration Checks
4.3 Post-Maintenance Calibration Checks
4.4 Documentation

4.1 PREPARATION FOR CALIBRATION

Before performing a calibration check, ensure adequate preparation of the operation environment, calibration device, and the DAS by determining the following:

- The station is at the proper temperature.
- Instruments are adequately warmed up.
- Calibration documentation is current, complete, and available.
- All required support tools, diagnostic equipment, supplies, and calibration forms are available.

4.2 CALIBRATION CHECKS

It is important that all analog input channels of the datalogger be calibrated during the same procedure. The most complete calibration of a DAS would document how the input voltages are handled through the scaling, conversion, and recording functions of the DAS. The input voltages will be compared to the results logged on the storage media used for data reporting. All functions of the system should be tested (if practical) as they are applied in operational logging at the site.

ANNOTATE DATA RECORDS — Make an entry in the station log book and annotate the strip chart recorder and data acquisition system (DAS) indicating the date and time (beginning and ending) of the calibration procedure.

It is standard to test the calibration of a DAS at 10 voltage values equally spaced over the range of the instrument. The following steps describe the 10-point calibration procedure.

CONNECT VOLTAGE SOURCE — For efficiency, arrange a wiring harness so that all datalogger analog inputs can be subjected simultaneously to the same voltage source. Connect a calibrated voltmeter to the voltage source to verify the reference voltage.

SHORT INPUTS — Short all analog inputs to signal ground and scan all channels. This value is the zero (0.000) voltage input.

SELECT VOLTAGES — Select nine additional upscale voltage values that evenly challenge the entire measurement range of the datalogger analog input channels. Select each voltage sequentially, noting the individual channel response to each voltage. Verify the designated input voltage with the voltmeter.

COMPARE VOLTAGES — Compare the voltages recorded on each DAS channel to the voltmeter verified input voltage. If the difference between DAS response and voltmeter measured input is greater than 0.1% VDC, the DAS analog to digital converter will require service and/or adjustment. See Table 4-1 for acceptable DAS response. Refer to Figure 4-1 for an example of an annotated printer output that documents a DAS calibration.

Table 4-1

Acceptable Datalogger Accuracy Values

Channel High Input (VDC)	0.1% Tolerance (VDC)
0.100	0.0001
1.000	0.001
5.000	0.005
10.00	0.01

4.3 POST-MAINTENANCE CALIBRATION CHECKS

After completing any adjustment or maintenance, initiate a post-maintenance calibration check as described in Section 4.2.

	SO2	O3	CAL	VWD	VWS	SWS	TMP	DPT	VDAS Input VDC
08:35:55	.001D	.000D	.001D	.000D	.000D	.000D	.000D	.000D	.000
08:36:20	.200D	.200D	.201D	.200D	.200D	.200D	.200D	.200D	.200
08:36:30	.400D	.400D	.400D	.400D	.400D	.400D	.400D	.400D	.400
08:36:40	.601D	.601D	.602D	.600D	.600D	.600D	.600D	.600D	.600
08:36:50	.801D	.800D	.802D	.800D	.800D	.800D	.800D	.800D	.800
08:37:00	1.000D	.999D	1.001D	1.000D	1.000D	1.000D	1.000D	1.000D	1.000
08:37:10	1.023D	1.023D	1.023D	1.498D	1.500D	1.500D	1.500D	1.500D	1.500
08:37:20	1.023D	1.023D	1.023D	2.000D	2.000D	2.000D	2.000D	2.000D	2.000
08:37:35	1.023D	1.023D	1.023D	2.500D	2.498D	2.498D	2.498D	2.498D	2.500
08:37:45	1.023D	1.023D	1.023D	3.000D	3.000D	3.000D	3.000D	3.000D	3.000
08:37:55	1.023D	1.023D	1.023D	3.500D	3.500D	3.500D	3.500D	3.500D	3.500
08:38:05	1.023D	1.023D	1.023D	4.003D	4.000D	4.000D	4.000D	4.000D	4.000
08:38:15	1.023D	1.023D	1.023D	4.503D	4.503D	4.503D	4.503D	4.503D	4.503
08:38:25	1.023D	1.023D	1.023D	5.003D	5.003D	5.003D	5.003D	5.003D	5.000

>V

	SOL	STP	REF	PWR	Das Input VDC
08:39:00	5.003D	1.023D	1.023D	4.998D	5.000
08:39:11	4.503D	1.023D	1.023D	4.498D	4.500
08:39:23	4.503D	1.023D	1.023D	4.498D	
08:39:30	4.003D	1.023D	1.023D	4.000D	4.000
08:39:37	3.500D	1.023D	1.023D	3.498D	3.500
08:39:40	3.000D	1.023D	1.023D	2.998D	3.000
08:39:55	2.493D	1.023D	1.023D	2.495D	2.500
08:40:05	2.493D	1.023D	1.023D	2.495D	
08:40:13	2.000D	1.023D	1.023D	1.998D	2.000
08:40:37	1.500D	1.023D	1.023D	1.495D	1.500
08:40:44	1.500D	1.023D	1.023D	1.495D	
08:40:53	1.000D	1.000D	1.001D	.998D	1.000
08:41:09	.800D	.800D	.802D	.800D	.800
08:41:15	.800D	.800D	.802D	.800D	
08:41:21	.603D	.601D	.602D	.600D	.600
08:41:27	.603D	.601D	.602D	.600D	
08:41:36	.400D	.400D	.400D	.400D	.400
08:41:46	.400D	.400D	.400D	.400D	
08:41:50	.200D	.200D	.200D	.200D	.200
08:41:55	.200D	.200D	.201D	.200D	
08:42:03	.200D	.200D	.201D	.200D	
08:42:06	.000D	.000D	.001D	.000D	.000
08:42:10	.000D	.001D	.000D	.003D	

Figure 4-1. Annotated Printer Output Documenting a DAS Calibration.

4.4 DOCUMENTATION

DAS calibrations require several levels of documentation:

CALIBRATION FORMS: Record all channel voltage responses on a DAS calibration form. Record the voltmeter measured values as the designated input voltages.

As an alternative to transcribing the data on a separate form, an on-site printer connected to the DAS can be used to record the channel voltage responses. The digital voltmeter measured input voltage values can be written adjacent to the printed DAS values for comparison. This technique will reduce the possibility of transcription errors.

LOG NOTES: An entry is made in the station log book to document the calibration.

CALIBRATION STICKER: An ARS calibration sticker is placed on the DAS, marking the date the instrument was certified and the name of the technician who calibrated it.

Figure 4-2. ARS Calibration Sticker.

TRIP REPORT: Complete all summary documentation, attach to the calibration form or printed record, and submit with the site trip report.

Air Resource Specialists, Inc.
1901 Sharp Point Drive, Suite E
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Phone: 970-484-7941
Fax: 970-484-3423

QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**CALIBRATION OF ESC 8816 OR 8832 ANALOG INPUT CARD**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3160-2100**
DATE	**APRIL 2006**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
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PROJECT MANAGER	John F. Faust	John F. Faust
PROGRAM MANAGER	David L. Dietrich	David L. Dietrich
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
	Reviewed; no changes necessary.	April 2007	G. Mercer
	Reviewed; no changes necessary.	April 2008	G. Mercer
	Reviewed; no changes necessary.	April 2009	G. Mercer
	Reviewed; no changes necessary.	April 2010	G. Mercer
	Reviewed; no changes necessary.	April 2011	G. Mercer

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LIST OF FIGURES

1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the specific procedures for calibrating an ESC 8816/8832 analog voltage input card. Calibration of current input, digital input, or other interface cards are discussed in other TIs.

Calibrations are required under any of the following circumstances:

- Upon acceptance testing of a new instrument
- Upon installation or removal of the instrument at a field station
- Whenever control limits are exceeded
- Prior to any corrective action, service, or maintenance to any portion of the instrument that affects its operational principle
- At a maximum interval of six months

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Establish the project-specific calibration schedule and coordinate with the client as necessary.
- Establish the calibration reporting protocol to satisfy client requirements.
- Review calibration results.
- Identify inconsistencies in calibration results and initiate corrective action as required.
- Review and approve any changes to calibration procedures.

2.2 FIELD SPECIALIST

The field specialist shall:

- Perform required calibrations and maintenance as described in this TI.
- Document all calibration results and maintenance procedures performed.

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment and materials are required for ESC analog input card calibration:

- Voltage source calibrator (capable of outputting a range of values that covers the input range of the DAS)
- Digital voltmeter (4 ½ digit)
- Calibration harness
- Interconnect cabling
- Manufacturer's instrument manual
- Technical Instruction 3160-2100
- Calibration Form
- Pen or pencil
- Field service tools
- Station logbook or DataView
- ARS calibration stickers

4.0 METHODS

Calibration (adjustment) of the analog voltage input card is not possible. Only verification (calibration check) of the card is possible. Cards found out of tolerance must be returned to ESC for repair.

Calibration checks are detailed in the following four (4) subsections:

4.1 Preparation for Calibration
4.2 Calibration Checks
4.3 Post-Maintenance Calibration Checks
4.4 Documentation

4.1 PREPARATION FOR CALIBRATION

Before performing a calibration check, ensure adequate preparation of the operation environment, calibration device, and the input card by determining the following:

- The station is at the proper temperature.

- Instruments are adequately warmed up.
- Calibration documentation is current, complete, and available.
- All required support tools, diagnostic equipment, supplies, and calibration forms are available.

4.2 CALIBRATION CHECKS

It is important that all analog input channels of the datalogger be calibrated during the same procedure. The input voltages will be compared to the results logged on the storage media used for data reporting.

ANNOTATE DATA RECORDS	Make an entry in the station log book and annotate the strip chart recorder and data acquisition system (DAS) indicating the date and time (beginning and ending) of the calibration procedure.

It is standard to test the calibration of a DAS at 10 voltage values equally spaced over the range of the instrument. The following steps describe the 10-point calibration procedure.

BUILD CALIBRATION HARNESS	Build a calibration harness to allow input of known voltages to all eight analog inputs of each card under test at one time. Common all input lows and connect to the negative voltage supply. Common all input highs and connect to the positive voltage supply. Program the datalogger so each analog input full scale is 100 mv.
APPLY VOLTAGE	Apply 10% of the full scale value (10 mv) to the calibration harness and record the datalogger voltage response for each channel. An example calibration form is presented as Figure 4-1.
SELECT ADDITIONAL VOLTAGES	Repeat this procedures for 20% through 90% of the full scale selected. If needed, reprogram the datalogger for other full scale ranges and apply known voltages and record as before.
COMPARE VOLTAGES	A successful calibration is when all values for a channel are within 0.1% of the full scale of the range under test. Channels that do not pass may either be indicated as so on the calibration sticker and not used, or returned to ESC for repair.

4.3 POST-MAINTENANCE CALIBRATION CHECKS

After completing any adjustment or maintenance, initiate a post-maintenance calibration check as described in Section 4.2.

Air Resource Specialists, Inc.

ESC Voltage Analog Input Card
Calibration Check Form

Date ___________________________

Technician _____________________

ESC Datalogger S/N _______________ DVM Model ______________ S/N ____________________

Last Calibration Date _____________________

Voltage (circle one) 100 mv 1.000 v 5.000 v 10.00 v

Channel	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**	**70%**	**80%**	**90%**	**Full Scale**
1										
2										
3										
4										
5										
6										
7										
8										

Acceptable Accuracy Values

Channel Input	**Tolerance**
100 mv	± 0.1 mv
1.000 v	± 0.001 v
5.000 v	± 0.005 v
10.00 v	± 0.010 v

N:\project\ars\forms\NPSAIR\ESC Calibration Check Form.doc (03/06)

Figure 4-1. ESC Voltage Analog Input Card Calibration Check Form.

4.4 DOCUMENTATION

Datalogger calibrations require several levels of documentation:

CALIBRATION FORMS

Record all channel voltage responses on a calibration form. Record the voltmeter measured values as the designated input voltages.

LOG NOTES

An entry is made in the station log book to document the calibration.

CALIBRATION STICKER

An ARS calibration sticker is placed on the datalogger, marking the date the instrument was certified and the name of the technician who calibrated it. Also indicate the channels and ranges calibrated.

Figure 4-2. ARS Calibration Sticker.

TRIP REPORT

Complete all summary documentation, attach to the calibration form or printed record, and submit with the site trip report.

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1901 Sharp Point Drive, Suite E
Fort Collins, CO 80525
Phone: 970-484-7941
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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**STATION OPERATOR MAINTENANCE PROCEDURES FOR METEOROLOGICAL MONITORING SITES USING THE DATAVIEW SYSTEM**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3176**
DATE	**JANUARY 2001**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Gloria S. Mercer	Gloria S. Mercer
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PROGRAM MANAGER	David L. Dietrich	[illegible]
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY			
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	Reviewed; no changes necessary.	January 2002	G. Mercer
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	Reviewed; no changes necessary.	January 2009	G. Mercer
	-- continued --		G. Mercer

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ORIGINATOR	Gloria S. Mercer	Gloria S. Mercer
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QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
	Reviewed; no changes necessary.	January 2010	G. Mercer
	Reviewed; no changes necessary.	January 2011	G. Mercer

TABLE OF CONTENTS

1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) describes the steps of routine site operator maintenance visits to meteorological monitoring sites that may monitor any or all of the following parameters:

- Wind speed (horizontal and/or vertical)
- Wind direction (horizontal and/or vertical)
- Temperature (including delta temperature)
- Relative humidity
- Solar radiation
- Wetness
- Precipitation

The primary purpose of routine site operator maintenance is to assure quality data capture and minimize data loss by performing weekly operational checks and system integrity checks of meteorological sensors, the data acquisition system, and support equipment.

This SOP serves as a guideline for the site operator to verify the:

- Integrity of tower and support structures
- Alignment and stability of sensors and mounts
- Integrity of power, telephone, and/or radio link
- Operational integrity of the datalogger
- Operational integrity of sensors, as compared to observed meteorological conditions

The operator must thoroughly document the results of each site visit by annotating the digital station log in the DataView system. Because monitoring sites have different configurations, specific Checklist Instructions (CIs) are commonly prepared for individual sites or monitoring networks. The following CIs provide detailed information regarding specific operator procedures (this list is subject to change with the addition or change of site configurations):

- CI 3176-3100 *Weekly Station Visit Wind Speed / Wind Direction Sensor (Climatronics)*
- CI 3176-3101 *Weekly Station Visit Wind Speed / Wind Direction Sensor (R.M. Young)*
- CI 3176-3102 *Weekly Station Visit Wind Speed / Wind Direction Sensor (R.M. Young cups)*
- CI 3176-3103 *Weekly Station Visit Wind Speed / Wind Direction Sensor (Climatronics – No Translator)*

- CI 3176-3105 *Weekly Station Visit Temperature (Climatronics)*
- CI 3176-3110 *Weekly Station Visit Temperature / Delta Temperature Sensor (Climatronics)*
- CI 3176-3111 *Weekly Station Visit Temperature / Delta Temperature Sensor (R.M. Young)*
- CI 3176-3115 *Weekly Station Visit Air Temperature and Relative Humidity Sensor (Rotronics)*
- CI 3176-3116 *Weekly Station Visit Air Temperature and Relative Humidity Sensor (Vaisala)*
- CI 3176-3120 *Weekly Station Visit Relative Humidity Sensor (Rotronics)*
- CI 3176-3121 *Weekly Station Visit Relative Humidity Sensor (Vaisala)*
- CI 3176-3130 *Weekly Station Visit Solar Radiation Sensor (Climatronics)*
- CI 3176-3131 *Weekly Station Visit Solar Radiation Sensor (R.M. Young)*
- CI 3176-3132 *Weekly Station Visit Solar Radiation Sensor (Licor)*
- CI 3176-3140 *Weekly Station Visit Wetness Sensor (R.M. Young)*
- CI 3176-3150 *Weekly Station Visit Precipitation Sensor (Climatronics)*
- CI 3176-3151 *Weekly Station Visit Precipitation Sensor (Texas Electronics)*
- CI 3176-3153 *Weekly Station Visit Precipitation Sensor (R.M. Young)*
- CI 3176-3160 *Weekly Station Visit Barometric Pressure Sensor (Various)*

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall coordinate with the station operator, his/her supervisor, and ARS field specialist, concerning the schedule and requirements for routine and emergency maintenance.

2.2 FIELD SPECIALIST

The field specialist shall:

- Coordinate with the station operator, his/her supervisor, and project manager concerning the schedule and requirements for routine and emergency maintenance.

- Train the station operator in all phases of the routine and emergency maintenance visit.

- Provide technical support to the station operator via telephone to identify instrument problems and initiate instrument repairs.

- Document all technical support given to the station operator.

- Load revisions to the DataView system as they are released.

2.3 STATION OPERATOR

The station operator shall:

- Coordinate with his/her supervisor, project manager, and ARS field specialist concerning the schedule and requirements for routine and emergency maintenance.
- Perform all procedures described in site- or network-specific CIs.
- Thoroughly document all procedures performed during each site visit.
- Report any noted inconsistencies immediately to the field specialist.

3.0 REQUIRED EQUIPMENT AND MATERIALS

Site visits are generally performed weekly. Equipment needed for a weekly visit includes:

- Keys for the shelter or support system internal lock and padlocks
- A Site Operator's Manual that includes site- or network-specific CIs, and other site- or network-specific documentation

4.0 METHODS

The station operator will perform weekly site visits. The observations recorded during these visits verify the operation of the monitoring system. The station operator may also be called upon to perform troubleshooting, simple maintenance, and sensor replacements in consultation with the field specialist.

This section includes three (3) major subsections:

4.1 Weekly Visits
4.2 Troubleshooting, Maintenance, and Instrument Replacement
4.3 Documentation

4.1 WEEKLY VISITS

The station operator will make weekly observations at the site. Sites may have different configurations and DataView is customized for each site's instrumentation. While completing the DataView CIs, the operator will make some or all of the following observations:

WIND SPEED AND DIRECTION	Inspect the wind sensor for damage. Compare current wind speed and direction measurements to observed ambient conditions.
TEMPERATURE/ DELTA TEMPERATURE	Verify that the temperature sensor housing aspirator fan is operational. Compare current temperature and delta temperature measurements to observed ambient conditions.

RELATIVE HUMIDITY	Compare the current relative humidity measurement to observed ambient conditions.
SOLAR RADIATION	Inspect the solar radiation sensor for dirt or snow and clean if necessary. Compare the current solar radiation measurement to observed ambient conditions.
WETNESS	Wet test the sensor with water (except during precipitation events or if the sensor is wet).
PRECIPITATION	Inspect the precipitation gauge collection funnel for snow or debris. Tip the mechanism 10 times.
BAROMETRIC PRESSURE	Compare the current barometric pressure to trends from recent weather activity. Inspect the sensor and tubing for abrasions, cracks, or other defects.

The station operator should promptly report any noted inconsistencies to the field specialist.

4.2 TROUBLESHOOTING, MAINTENANCE, AND INSTRUMENT REPLACEMENT

If a malfunction of any monitoring component occurs, or if any of the readings do not make sense, the station operator should call the Operation Support Center (1-800-344-5423) to report any discrepancy. A field technician will instruct the station operator on troubleshooting procedures.

TROUBLESHOOTING	If a potential malfunction or other inconsistency is noted, the station operator will be directed to perform a series of troubleshooting procedures. The use of certain tools or diagnostic equipment (most frequently a digital voltmeter) will be required. The field specialist will step the station operator through the proper procedures by telephone, fax, or electronic mail. Typical procedures may include continuity checks, supply voltage checks, bearing observations, datalogger interrogation, or specific instrument performance observations. The operator will be asked to thoroughly record his/her findings and relate them to the field specialist for further action.
MAINTENANCE	The station operator may be asked to perform certain mechanical, electrical, electronic, or datalogger program maintenance as directed by the field specialist. Typical maintenance tasks could include tightening tower guy wires, replacing backup batteries, resetting a power line breaker, or restarting system components. All maintenance must be thoroughly documented and the results related to the field specialist.

SENSOR REPLACEMENT

Under the field specialist's direction, the station operator may be asked to replace a malfunctioning sensor with a pre-calibrated unit. The unit would be calibrated on-site at a later date by the field specialist. All replacement steps will be reviewed by telephone with the station operator. Instrument-specific manuals or other diagrams or descriptions will be referenced as appropriate. All sensor replacement procedures including the sensor type, make, serial number, and date and time of replacement must be documented.

4.3 DOCUMENTATION

Weekly operator checks entered in the Checklist Instructions are automatically documented in the DataView station log. Any additional troubleshooting, maintenance, or sensor replacement actions must be documented in the station log using DataView.

In the event of a DataView computer malfunction, the operator must manually complete a hard copy version of each Checklist Instruction. These paper hard copies exist in the Site Operator's Manual. Upon completion, the site operator must mail or fax the completed forms to:

Air Resource Specialists, Inc.
Attn: IMC
1901 Sharp Point Drive Suite E
Fort Collins, CO 80525
Fax: 970/484-3423

Checklist Instruction - Weekly Station Visit

- **Wind Speed/Wind Direction Sensor (Climatronics)**

Checklist Instruction Number: **3176-3100**

Revision Number / Date: **3 / January 2011** **(last reviewed Jan. 2011)**

Objective: Weekly checks of the wind speed and wind direction are performed to verify the operational integrity of the sensors and sampling system and to verify that collected data appear reasonable.

---

1. Inspect the wind sensors for damage. Report any damage to the OSC.

From the ground, inspect the Climatronics wind vane and anemometer. Look for damage to the aluminum cups or direction vane and make certain that the sensors turn smoothly. Report any damage to the Operation Support Center.

2. Note the current wind speed and wind direction measurements and compare them to your observations of ambient conditions.

From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu.

```
ESC 88xx v5.31   ID:BL        Real-Time Display Menu        08/06/97   14:59:27

    V  Display Raw Readings
    R  Display Readings w/units
    F  Display Readings w/flags
    B  Display Last Base Avg
    C  Continuous Avg Report
    L  Show LARGE TEXT Display
    I  Display Digital Inputs
    O  Display Digital Outputs
    A  Display Analog Outputs
```

Press <**R**> for Display Readings w/units.

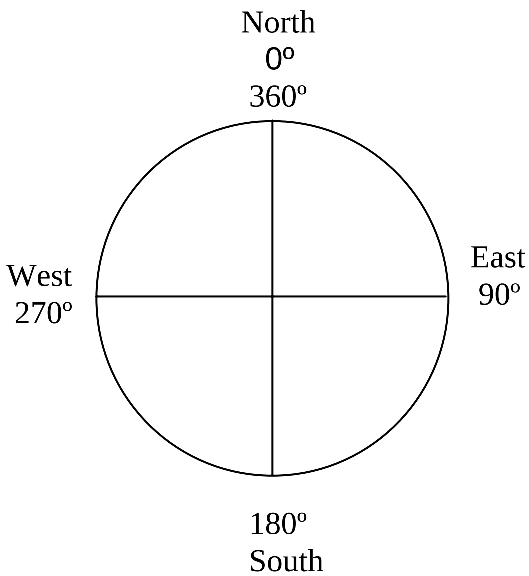
```
ESC 88xx v5.31   ID:BL      Real Time Engineering Units      08/06/97   14:59:27

      O3     = 38.23      (PPB     )
      O3 CAL= 1.434       (PPB     )
      O3 R8  = 38.23      (PPB     )
      VWD    = 46.61      (DEG     )
      SIG    = 46.61      (DEG     )
      VWS    = 0.6261     (M/S     )
      SWS    = 0.6261     (M/S     )
      PWS    = 2.036      (M/S     )
      TMP    = 3.399      (DGC     )
      DTP    = 0.06188    (DGC     )
      SOL    = 100.3      (WMS     )
      RNF    = 0          (MM      )
      RH     = 66.83      (%       )
      WET    = 100.4      (+/-     )
      FLW    = 3.008      (SLPM    )
      STP    = 21.48      (DGC     )
```

Watch the VWD (vector wind direction) and SWS (scalar wind speed) for several updates to identify any current trends. Then observe the conditions outside the shelter. Compare what you see with the readings on the datalogger. Does it make sense? If not, call the Operation Support Center to report the discrepancy.

Remember: The VWD is reported as the direction the wind is blowing from.

Note: With experience you will develop an "eye" for judging whether the wind readings are representative of ambient conditions. The following figure and table may help in your effort.



Wind Speed	
m/s	mph
1.0	2.2
5.0	11.2
10.0	22.4
15.0	33.6
20.0	44.7

Report conditions that affect data validity (e.g., ice or damage to the sensor) in the logbook.

3. Take the VWD, VWS, and SWS offline in preparation to check the translator calibration responses.

To ensure that only ambient winds are recorded, it is necessary to mark the VWD, VWS, and SWS channels offline. Wind data marked in this manner are automatically excluded from the hourly average.

Begin at the Home Menu as shown below. Remember, pressing <**Esc**> several times returns to the Home Menu.

```
ESC 88xx v5.31  ID:BL         Home Menu          08/06/97  14:59:27

    H Help Screen
    L Login/Set User Level
    C Configuration Menu
    D Real-Time Display Menu
    R Report Generation Menu
    G Graph Generation Menu
    S Status Menu
    O Log Out/Exit
    X Serial Como to Port
```

Press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL      Configuration Menu       08/06/97  14:59:27

    P Set Passwords
    S Configure System Parameters
    D Configure (Data) Channels
    C Configure Calibrations
    A Configure Alarms
    O Configure Analog Outputs
    K Configure Math Constants
    E Configure Dig. Event Program
    R Configure Digital I/O
    1 Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31  ID:BL    Channel Configuration Menu     08/06/97  14:59:27


    N Enter New Configuration
    C Change Old Configuration
    D Delete Old Configuration
    M Disable/Mark Channel Offline
    E Enable/Mark Channel Online
    I Put Channel In Maint.
    O Take Channel Out of Maint.
```

Press <**M**> for Disable/Mark Channel Offline:

```
ESC 88xx v5.31   ID:BL    Choose(Space Toggle/Enter Select)   08/06/97   14:59:27

    O3     [01]
    O3CAL  [02]
    O3R8   [03]
    VWD    [04]
    SIG    [05]
    VWS    [06]
    SWS    [07]
    PWS    [08]
    TMP    [09]
    DTP    [10]
    SOL    [11]
    RNF    [12]
    RH     [13]
    WET    [14]
    FLW    [15]
    STP    [16]
```

Use the ↑ and ↓ keys to navigate and the spacebar to select the VWD, VWS, and SWS channels for offline status. The VWD, VWS, and SWS channels should be marked with a ">" indicating imminent offline status. Press <**Enter**> to take the marked channel offline.

```
ESC 88xx v5.31   ID:BL     Choose(Space Toggle/Enter Select)   08/06/97   14:59:27

     O3        [01]
     O3CAL     [02]
     O3R8      [03]
   > VWD       [04]
     SIG       [05]
   > VWS       [06]
   > SWS       [07]
     PWS       [08]
     TMP       [09]
     DTP       [10]
     SOL       [11]
     RNF       [12]
     RH        [13]
     WET       [14]
     FLW       [15]
     STP       [16]
```

Check the status of the VWD, VWS, and SWS channels by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu**.** Press <**F**> to display the data channels with flags (or, press **<F6>** in any menu to display flags). VWD, VWS, and SWS should be flagged with a *D* to the right to indicate offline status. The offline time is automatically recorded in the logbook when this step is completed.

4. Set the mode switch on the F-460 wind translator from OPER. to ZERO. Verify that the VWD zero response is between –2º and +2º and the SWS zero response is between 0.2 and 0.3 m/s.

The mode selector switch on the F-460 translator is normally in the OPER. position. The translator can be verified by setting the mode switch to ZERO and SPAN and comparing the responses to the limits above.

Set the F-460 mode selector switch to ZERO. Observe the VWD and SWS until both have stabilized. Compare the observation to the limits. VWD must be between -2º and +2º. SWS must be between 0.2 and 0.3 m/s. Call the Operation Support Center if the response is out of tolerance.

5. Set the mode switch on the F-460 wind translator from ZERO to SPAN. Verify that the VWD span response is between 358º and 362º and the SWS span response is between 24 and 26 m/s.

Set the F-460 mode selector switch to SPAN. Observe the VWD and SWS until both have stabilized. Compare the observation to the limits. VWD must be between 358º and 362º. SWS must be between 24 and 26 m/s. Call the Operation Support Center if the response is out of tolerance.

6. Set the mode switch to OPER.

7. Bring the VWD, VWS, and SWS channels back online.

Bring the VWD, VWS, and SWS channels online by beginning at the Home Menu of the ESC datalogger. Remember that pressing <**Esc**> several times will return you eventually to the Home Menu.

```
ESC 88xx v5.31   ID:BL          Home Menu          08/06/97   14:59:27

    H  Help Screen
    L  Login/Set User Level
    C  Configuration Menu
    D  Real-Time Display Menu
    R  Report Generation Menu
    G  Graph Generation Menu
    S  Status Menu
    O  Log Out/Exit
    X  Serial Como to Port
```

Press <**C**> for Configuration Menu:

```
ESC 88xx v5.31   ID:BL         Configuration Menu         08/06/97    14:59:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31  ID:BL    Channel Configuration Menu     08/06/97     14:59:27

    N  Enter New Configuration
    C  Change Old Configuration
    D  Delete Old Configuration
    M  Disable/Mark Channel Offline
    E  Enable/Mark Channel Online
    I  Put Channel In Maint.
    O  Take Channel Out of Maint.
```

Press <**E**> for Enable/Mark Channel Online. VWD, VWS, and SWS should be the only channels displayed.

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)   08/06/97  14:59:27

  > VWD      [04]
    VWS      [06]
    SWS      [07]
```

Use the ↑ and ↓ keys to navigate and the spacebar to select a channel. Repeat the process until all channels are marked as shown below. Press <**Enter**> to put the selected channels online.

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)   08/06/97  14:59:27


   >VWD      [04]
   >VWS      [06]
   > SWS     [07]
```

Check the status of the VWD, VWS, and SWS channels by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> once to display the data channels with flags (or, press **<F6>** in any menu to display flags). VWD, VWS, and SWS will no longer by marked with flags indicating online status; a *P* may be in the flag column for each channel indicating a purge period programmed to allow for the time it takes for ambient conditions to prevail. The *P* flag should clear within one minute. The online time is automatically recorded in the logbook when this step is completed.

Checklist Instruction - Weekly Station Visit

- **Wind Speed/Wind Direction Sensor (R.M. Young Wind Monitor)**

Checklist Instruction Number: **3176-3101**

Revision Number / Date: **3 / January 2011** **(last reviewed Jan. 2011)**

Objective: Weekly checks of the wind speed and wind direction are performed to verify the operational integrity of the sensors and sampling system and to verify that collected data appear reasonable.

---

1. Inspect the wind sensor for physical damage. Report any damage to the OSC.

From the ground, inspect the R.M. Young wind sensor propeller/vane assembly. Look for damage to the plastic propeller and make certain that the propeller is turning smoothly. Look for other circumstances that could affect data validity such as an accumulation of ice. Report any damage to the Operation Support Center and enter your observations in the logbook.

2. Compare the current wind speed and wind direction measurements to your observations of ambient conditions.

From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu.

```
ESC 88xx v5.31   ID:BL       Real-Time Display Menu        08/06/97     14:59:27

    V  Display Raw Readings
    R  Display Readings w/units
    F  Display Readings w/flags
    B  Display Last Base Avg
    C  Continuous Avg Report
    L  Show LARGE TEXT Display
    I  Display Digital Inputs
    O  Display Digital Outputs
    A  Display Analog Outputs
```

Press <**R**> for Display Readings w/units.

```
ESC 88xx v5.31  ID:BL    Real Time Engineering Units        08/06/97  14:59:27

         O3 = 38.23     (PPB     )
      O3CAL = 1.434     (PPB     )
       O3R8 = 38.23     (PPB     )
        VWD = 46.61     (DEG     )
        SIG = 46.61     (DEG     )
        VWS = 0.6261    (M/S     )
        SWS = 0.6261    (M/S     )
        PWS = 2.036     (M/S     )
        TMP = 3.399     (DGC     )
        DTP = 0.06188   (DGC     )
        SOL = 100.3     (WMS     )
        RNF = 0         (MM      )
         RH = 66.83     (%       )
        WET = 100.4     (+/-     )
        FLW = 3.008     (SLPM    )
        STP = 21.48     (DGC     )
```

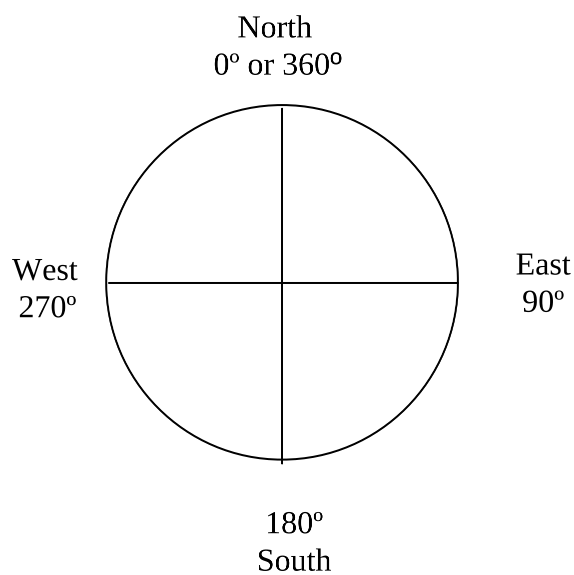
Watch the VWD (vector wind direction) and SWS (scalar wind speed) for several updates to identify any current trends. Then observe the conditions outside the shelter. Compare what you see with the readings on the datalogger. Does it make sense? If not, call the Operation Support Center to report the discrepancy.

Remember: The VWD is reported as the direction wind is blowing from.

Note: With experience you will develop an “eye” for judging whether the wind readings are representative of the ambient conditions. The following table and figure may help in your effort.

Wind Speed

m/s	mph
1.0	2.2
5.0	11.2
10.0	22.4
15.0	33.6
20.0	44.7



Checklist Instruction - Weekly Station Visit

- **Wind Speed/Wind Direction Sensor (Climatronics-No Translator)**

Checklist Instruction Number: **3176-3103**

Revision Number / Date: **0 / April 2006** **(last reviewed Apr. 2011)**

Objective: Weekly checks of the wind speed and wind direction are performed to verify the operational integrity of the sensors and sampling system and to verify that collected data appear reasonable.

---

1. Inspect the wind sensors for damage. Report any damage to the OSC.

From the ground, inspect the Climatronics wind vane and anemometer. Look for damage to the aluminum cups or direction vane and make certain that the sensors turn smoothly. Report any damage to the Operation Support Center (OSC).

2. Note the current wind speed and wind direction measurements and compare them to your observations of ambient conditions.

From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu.

```
ESC 88xx v5.31   ID:BL       Real-Time Display Menu       08/06/97   14:59:27

    V  Display Raw Readings
    R  Display Readings w/units
    F  Display Readings w/flags
    B  Display Last Base Avg
    C  Continuous Avg Report
    L  Show LARGE TEXT Display
    I  Display Digital Inputs
    O  Display Digital Outputs
    A  Display Analog Outputs
```

Press <**R**> for Display Readings w/units.

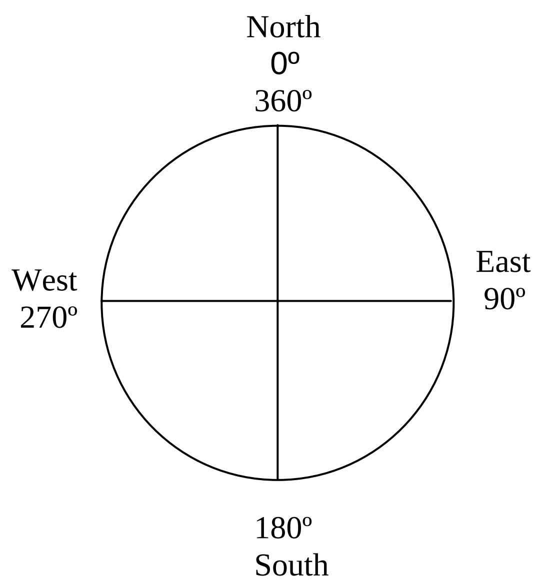
```
ESC 88xx v5.31   ID:BL     Real Time Engineering Units      08/06/97   14:59:27

      O3     = 38.23      (PPB     )
      O3 CAL= 1.434       (PPB     )
      O3 R8  = 38.23      (PPB     )
      VWD    = 46.61      (DEG     )
      SIG    = 46.61      (DEG     )
      VWS    = 0.6261     (M/S     )
      SWS    = 0.6261     (M/S     )
      PWS    = 2.036      (M/S     )
      TMP    = 3.399      (DGC     )
      DTP    = 0.06188    (DGC     )
      SOL    = 100.3      (WMS     )
      RNF    = 0          (MM      )
      RH     = 66.83      (%       )
      WET    = 100.4      (+/-     )
      FLW    = 3.008      (SLPM    )
      STP    = 21.48      (DGC     )
```

Watch the VWD (vector wind direction) and SWS (scalar wind speed) for several updates to identify any current trends. Then observe the conditions outside the shelter. Compare what you see with the readings on the datalogger. Does it make sense? If not, call the OSC to report the discrepancy.

Remember: The VWD is reported as the direction the wind is blowing from.

Note: With experience you will develop an "eye" for judging whether the wind readings are representative of ambient conditions. The following figure and table may help in your effort.



Wind Speed	
m/s	mph
1.0	2.2
5.0	11.2
10.0	22.4
15.0	33.6
20.0	44.7

Report conditions that affect data validity (e.g., ice or damage to the sensor) in the logbook.

Checklist Instruction - Weekly Station Visit

- **Temperature/Delta Temperature Sensor (Climatronics)**

Checklist Instruction Number: **3176-3110**

Revision Number / Date: **3 / January 2011** **(last reviewed Jan. 2011)**

Objective: Weekly checks of the temperature and delta temperature system are performed to verify the operational integrity of the temperature sensors and aspirators, and to verify that collected data appear reasonable.

---

1. Verify that the lower temperature sensor housing aspirator fan is operational.

Two ambient air temperature sensor housings are on the meteorological tower. The first is positioned at 10 meters above ground level and houses the primary temperature sensor represented by the channel name TMP in the datalogger. The second housing contains the sensor that measures air temperature at 2 meters above ground level. The delta temperature, or DTP as labeled in the datalogger, is derived from subtracting 2-meter temperature from 10-meter temperature (top minus bottom).

Both temperature sensors have a fan aspirated housing. The 2-meter housing is close enough to the ground that the fan can be heard. Listen for the sound of the fan. If it has failed, call the Operation Support Center.

2. Note the current temperature and delta temperature measurements and compare to your observation of ambient conditions.

From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu.

```
ESC 88xx v5.31   ID:BL       Real-Time Display Menu        08/06/97  14:59:27

    V  Display Raw Readings
    R  Display Readings w/units
    F  Display Readings w/flags
    B  Display Last Base Avg
    C  Continuous Avg Report
    L  Show LARGE TEXT Display
    I  Display Digital Inputs
    O  Display Digital Outputs
    A  Display Analog Outputs
```

Press <**R**> for Display Readings w/units:

```
ESC 88xx v5.31  ID:BL    Real-Time Engineering Uints     08/06/97  14:59:27

      O3= 38.23          (PPB     )
      O3 CAL= 1.434      (PPB     )
      O3 R8= 38.23       (PPB     )
      VWD= 46.61         (DEG     )
      SIG= 46.61         (DEG     )
      VWS= 0.6261        (M/S     )
      SWS= 0.6261        (M/S     )
      PWS= 2.036         (M/S     )
      TMP= 3.399         (DGC     )
      DTP= 0.06188       (DGC     )
      SOL= 100.3         (WMS     )
      RNF= 0             (MM      )
      RH= 66.83          (%       )
      WET= 100.4         (+/-     )
      FLW= 3.008         (SLPM    )
      STP= 21.48         (DGC     )
```

Watch the TMP and DTP reading for several updates to identify the current values. Delta temperature should be between -5º C and +5º C or beyond at some sites. Negative values are typical on bright sunny days, closer to zero on cloudy days, and positive numbers at night. Snow cover, complex terrain, and high winds will affect typical values.

Observe the conditions outside the shelter. Compare what you see with the reading on the datalogger. Does it make sense? If not, call the Operation Support Center to report the discrepancy.

Note: With experience you will develop a feel for judging whether the TMP reading is representative of the ambient observation. Remember that the sun can make it seem warmer and wind can make it seem cooler. Use the conversion chart below for help.

Temperature	
ºC	ºF
-30	-22
-20	-4
-10	14
0	32
10	50
20	68
30	86
40	104

Report conditions that affect validity (e.g., aspirator fan failure) in the logbook.

3. Take the TMP and DTP offline in preparation to check the translator calibration responses.

To ensure that only ambient temperatures are recorded in the hourly average, it is necessary to mark the TMP and DTP channels offline. Temperature data marked in this manner are automatically excluded from the hourly average.

Begin at the Home Menu as shown below. Remember, pressing <**Esc**> several times returns to the Home Menu.

```
ESC 88xx v5.31   ID:BL          Home Menu          08/06/97   14:59:27

    H  Help Screen
    L  Login/Set User Level
    C  Configuration Menu
    D  Real-Time Display Menu
    R  Report Generation Menu
    G  Graph Generation Menu
    S  Status Menu
    O  Log Out/Exit
    X  Serial Como to Port
```

Press <**C**> for Configuration Menu:

```
ESC 88xx v5.31   ID:BL       Configuration Menu       08/06/97   14:59:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31   ID:BL     Channel Configuration Menu     08/06/97   14:59:27

    N  Enter New Configuration
    C  Change Old Configuration
    D  Delete Old Configuration
    M  Disable/Mark Channel Offline
    E  Enable/Mark Channel Online
    I  Put Channel In Maint.
    O  Take Channel Out of Maint.
```

Press <**M**> for Disable/Mark Channel Offline:

```
ESC 88xx v5.31   ID:BL     Choose(Space Toggle/Enter Select)    08/06/97 14:59:27

    O3     [01]
    O3CAL  [02]
    O3R8   [03]
    VWD    [04]
    SIG    [05]
    VWS    [06]
    SWS    [07]
    TMP    [08]
    DTP    [09]
    SOL    [10]
    RNF    [11]
    WET    [12]
    FLW    [13]
    STP    [14]
```

Use the ↑ and ↓ keys to navigate and the spacebar to select the TMP and DTP channels for offline status. The TMP and DTP channels should be marked with a ">" indicating imminent offline status. Press <**Enter**> to take the marked channel offline.

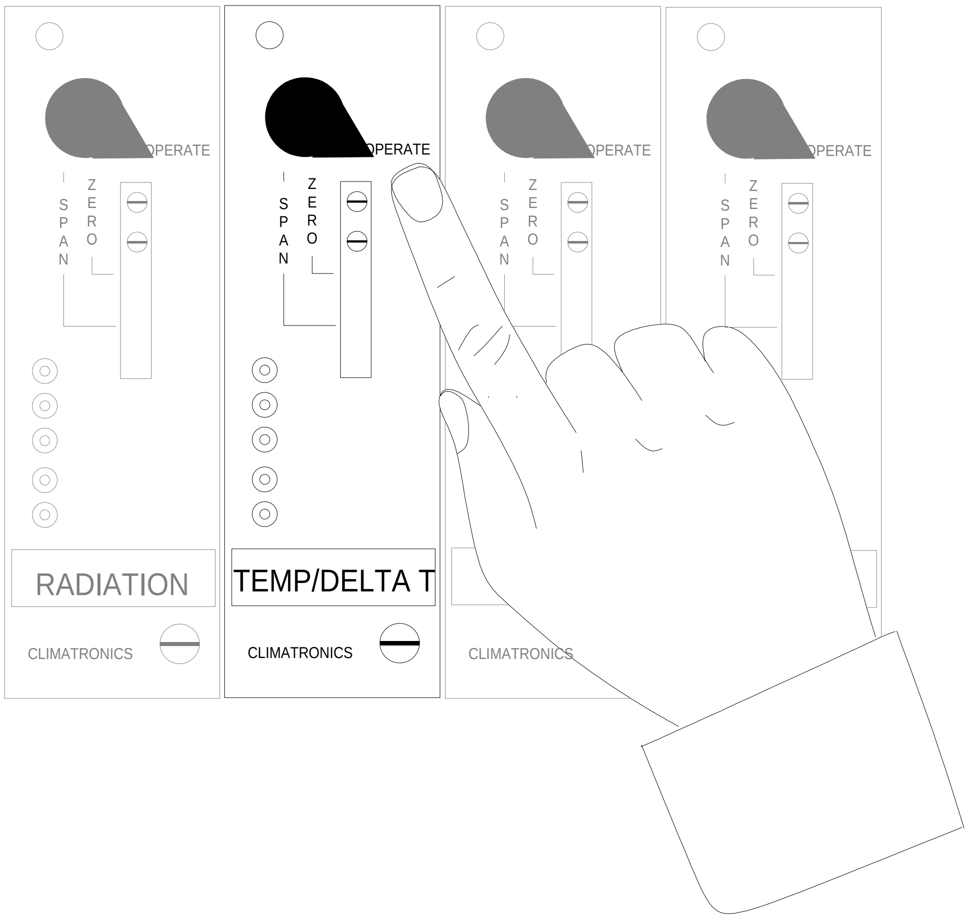
```
ESC 88xx v5.31   ID:BL     Choose(Space Toggle/Enter Select)    08/06/97   14:59:27

     O3        [01]
    O3CAL      [02]
    O3R8       [03]
     VWD       [04]
    SIG        [05]
     VWS       [06]
     SWS       [07]
  > TMP        [08]
  > DTP        [09]
    SOL        [10]
    RNF        [11]
    WET        [12]
    FLW        [13]
    STP        [14]
```

Check the status of the TMP and DTP channels by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu**.** Press <**F**> to display the data channels with flags (or, press **<F6>** in any menu to display flags). TMP and DTP should be marked with a *D* flag to the right to indicate offline status. The offline time is automatically recorded in the logbook when this step is completed.

4. Set the mode switch on the TEMP/DELTA TEMP translator from OPER. to ZERO. Verify that the TMP and DTP zero responses are within the ranges indicated on the sticker affixed to the translator.

The mode selector switch on the temp/Δtemp translator is normally in the OPERATE position. The calibration of the translator can be verified by setting the mode switch to ZERO and SPAN and comparing the responses to the limits below.



Set the temp/Δtemp mode selector switch to ZERO. Observe the TMP and DTP until both have stabilized. Compare the values to those indicated on the sticker affixed to the translator card. Call the Operation Support Center if the response is out of tolerance.

5. Set the mode switch on the TEMP/DELTA TEMP translator from ZERO to SPAN. Verify that the TMP and DTP span responses are within the ranges indicated on the calibration sticker affixed to the front of the translator.

Set the temp/delta temp mode selector switch to SPAN. Observe the TMP and DTP until both have stabilized. Compare the observation to the limits. The ranges are indicated on the sticker affixed to the front of the translator. Call the Operation Support Center if the response is out of tolerance.

6. Set the mode switch to OPER.

7. Bring the TMP and DTP channels back online.

Bring the TMP and DTP channels online by beginning at the Home Menu of the ESC datalogger. Remember that pressing <**Esc**> several times you will eventually return to the Home Menu.

```
ESC 88xx v5.31  ID:BL         Home Menu          08/06/97  14:59:27

    H  Help Screen
    L  Login/Set User Level
    C  Configuration Menu
    D  Real-Time Display Menu
    R  Report Generation Menu
    G  Graph Generation Menu
    S  Status Menu
    O  Log Out/Exit
    X  Serial Como to Port
```

Press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL      Configuration Menu       08/06/97  14:59:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31  ID:BL    Channel Configuration Menu     08/06/97  14:59:27

    N  Enter New Configuration
    C  Change Old Configuration
    D  Delete Old Configuration
    M  Disable/Mark Channel Offline
    E  Enable/Mark Channel Online
    I  Put Channel In Maint.
    O  Take Channel Out of Maint.
```

Press <**E**> for Enable/Mark Channel Online. TMP and DTP should be the only channels displayed.

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)   08/06/97  14:59:27

 > TMP      [04]
   DTP      [06]
```

Use the ↑ and ↓ keys to navigate and the spacebar to select a channel. Press the <**Spacebar**> to select both for online status. Press <**Enter**> to put the selected channels online.

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)   08/06/97  14:59:27

  >TMP      [04]
  >DTP      [06]
```

Check the status of the TMP and DTP channels by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> once to display the data channels with flags (or, press **<F6>** in any menu to display flags). TMP and DTP will no longer by marked with a flag indicating online status, or a *P* will be in the flag column for each indicating a purge period programmed to allow for the time it takes for ambient conditions to prevail. The *P* flag should clear within one minute. The online time will automatically recorded in the logbook when this step is completed.

Checklist Instruction - Weekly Station Visit

- **Temperature/Delta Temperature Sensor (R.M. Young)**

Checklist Instruction Number: **3176-3111**

Revision Number / Date: **2 /January 2006** **(last reviewed Jan. 2011)**

Objective: Weekly checks of the temperature/delta temperature system are performed to verify the operational integrity of the temperature sensors and aspirators, and to verify that collected data appear reasonable.

---

1. Verify that the lower temperature sensor housing aspirator fan is operational.

Two ambient air temperature sensor housings are mounted to the meteorological tower. The first is positioned at 10 meters above ground level and houses the primary temperature sensor represented by the channel name TMP in the datalogger. The second housing contains the sensor that measures air temperature at 2 meters above ground level. The delta temperature is derived by subtracting 2-meter temperature from 10-meter temperature (top minus bottom) and is represented by the channel name DTP in the datalogger.

Both temperature sensors have a fan aspirated housing. The 2-meter housing is close enough to the ground that the fan can be heard. Listen for the sound of the fan. If it has failed, call the Operation Support Center and enter your observations in the logbook.

2. Compare current TMP and DTP measurements to your observation of ambient conditions.

From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31   ID:BL       Real-Time Display Menu       08/06/97  14:59:27

    V  Display Raw Readings
    R  Display Readings w/units
    F  Display Readings w/flags
    B  Display Last Base Avg
    C  Continuous Avg Report
    L  Show LARGE TEXT Display
    I  Display Digital Inputs
    O  Display Digital Outputs
    A  Display Analog Outputs
```

Press <**R**> for Display Readings w/units:

```
ESC 88xx v5.31  ID:BL    Real-Time Engineering Uints     08/06/97  14:59:27

          O3 = 38.23     (PPB     )
       O3CAL = 1.434     (PPB     )
        O3R8 = 38.23     (PPB     )
         VWD = 46.61     (DEG     )
         SIG = 46.61     (DEG     )
         VWS = 0.6261    (M/S     )
         SWS = 0.6261    (M/S     )
         PWS = 2.036     (M/S     )
         TMP = 3.399     (DGC     )
         DTP = 0.06188   (DGC     )
         SOL = 100.3     (WMS     )
         RNF = 0         (MM      )
          RH = 66.83     (%       )
         WET = 100.4     (+/-     )
         FLW = 3.008     (SLPM    )
         STP = 21.48     (DGC     )
```

Watch the TMP and DTP reading for several updates to identify the current values. Delta temperature should be between -5º C and +5º C. Negative values are typical on bright sunny days, closer to zero on cloudy days, and positive values at night. Snow cover, complex terrain, and high winds will affect typical values.

Observe the conditions outside the shelter. Compare what you see with the reading on the datalogger. Does it make sense? If not, call the OSC to report the discrepancy and enter your observations in the logbook.

Note: With experience you will develop a feel for judging whether the TMP reading is representative of the ambient observation. Remember that the sun can make it seem warmer and wind can make it seem cooler. Use the conversion chart below for assistance.

Temperature	
ºC	ºF
-30	-22
-20	-4
-10	14
0	32
10	50
20	68
30	86
40	104

Report any conditions that affect validity (e.g., aspirator fan failure) in the logbook.

Checklist Instruction - Weekly Station Visit

• Air Temperature and Relative Humidity Sensor (Rotronics)

Checklist Instruction Number: **3176-3115**

Revision Number / Date: **1 / January 2006** **(last reviewed Jan. 2011)**

Objective: Weekly checks of the air temperature and relative humidity system are performed to verify the operational integrity of the relative humidity sensor and aspirator, and to verify that collected data appear reasonable.

---

1. Verify the air temperature and relative humidity sensor housing is operational.

An air temperature/relative humidity sensor aspirator housing is mounted to the meteorological tower. In most cases this aspirator is forced-aspirated by a fan. If the aspirator is the fan-type, listen for the fan's operation.

If a "natural aspirated" fan is in use, make sure it is secure and in good condition. Call the Operation Support Center if problems are detected.

2. Compare the current air temperature and relative humidity measurement to your observation of ambient conditions.

From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31   ID:BL        Real-Time Display Menu        08/06/97   14:59:27

    V  Display Raw Readings
    R  Display Readings w/units
    F  Display Readings w/flags
    B  Display Last Base Avg
    C  Continuous Avg Report
    L  Show LARGE TEXT Display
    I  Display Digital Inputs
    O  Display Digital Outputs
    A  Display Analog Outputs
```

Press <**R**> for Display Readings w/units:

```
ESC 88xx v5.31  ID:BL    Real-Time Engineering Units     08/06/97  14:59:27

          O3 = 38.23     (PPB     )
       O3CAL = 1.434     (PPB     )
        O3R8 = 38.23     (PPB     )
         VWD = 46.61     (DEG     )
         SIG = 46.61     (DEG     )
         VWS = 0.6261    (M/S     )
         SWS = 0.6261    (M/S     )
         PWS = 2.036     (M/S     )
         TMP = 3.399     (DGC     )
         SOL = 100.3     (WMS     )
         RNF = 0         (MM      )
          RH = 66.83     (%       )
         STP = 21.48     (DGC     )
```

Watch the TMP (air temperature) and RH (relative humidity) reading for several updates to identify any current trends. Observe the conditions outside the shelter. Compare what you see with the reading on the datalogger. Does it make sense? If not, call the Operation Support Center to report any discrepancy and enter your observations in the logbook. Also note any other conditions that could affect validity of the air temperature or relative humidity data and enter your observations in the logbook.

Checklist Instruction - Weekly Station Visit

• Air Temperature and Relative Humidity Sensor (Vaisala)

Checklist Instruction Number: **3176-3116**

Revision Number / Date: **1 / January 2006** **(last reviewed Jan. 2011)**

Objective: Weekly checks of the air temperature and relative humidity system are performed to verify the operational integrity of the relative humidity sensor and aspirator, and to verify that collected data appear reasonable.

---

1. Verify the air temperature and relative humidity sensor housing is operational.

An air temperature/relative humidity sensor aspirator housing is mounted to the meteorological tower. In most cases this aspirator is forced-aspirated by a fan. If the aspirator is the fan-type, listen for the fan's operation.

If a "natural aspirated" fan is in use, make sure it is secure and in good condition. Call the Operation Support Center if problems are detected.

2. Compare the current air temperature and relative humidity measurement to your observation of ambient conditions.

From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31   ID:BL       Real-Time Display Menu        08/06/97  14:59:27

    V  Display Raw Readings
    R  Display Readings w/units
    F  Display Readings w/flags
    B  Display Last Base Avg
    C  Continuous Avg Report
    L  Show LARGE TEXT Display
    I  Display Digital Inputs
    O  Display Digital Outputs
    A  Display Analog Outputs
```

Press <**R**> for Display Readings w/units:

```
ESC 88xx v5.31  ID:BL    Real-Time Engineering Units     08/06/97  14:59:27

          O3 = 38.23     (PPB     )
       O3CAL = 1.434     (PPB     )
        O3R8 = 38.23     (PPB     )
         VWD = 46.61     (DEG     )
         SIG = 46.61     (DEG     )
         VWS = 0.6261    (M/S     )
         SWS = 0.6261    (M/S     )
         PWS = 2.036     (M/S     )
         TMP = 3.399     (DGC     )
         SOL = 100.3     (WMS     )
         RNF = 0         (MM      )
          RH = 66.83     (%       )
         STP = 21.48     (DGC     )
```

Watch the TMP (air temperature) and RH (relative humidity) reading for several updates to identify any current trends. Observe the conditions outside the shelter. Compare what you see with the reading on the datalogger. Does it make sense? If not, call the Operation Support Center to report any discrepancy and enter your observations in the logbook. Also note any other conditions that could affect validity of the air temperature or relative humidity data and enter your observations in the logbook.

Checklist Instruction - Weekly Station Visit

- **Relative Humidity Sensor (Rotronics)**

Checklist Instruction Number: **3176-3120**

Revision Number / Date: **2 / January 2011** **(last reviewed Jan. 2011)**

Objective: Weekly checks of the relative humidity system are performed to verify the operational integrity of the relative humidity sensor and aspirator, and to verify that collected data appear reasonable.

---

1. Verify the air temperature and relative humidity sensor housing is operational.

An air temperature/relative humidity sensor aspirator housing is mounted to the meteorological tower. In most cases this aspirator is forced-aspirated by a fan. If the aspirator is the fan-type, listen for the fan's operation.

If a "natural aspirated" fan is in use, make sure it is secure and in good condition. Call the Operation Support Center if problems are detected.

2. Compare the current relative humidity measurement to your observation of ambient conditions.

From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31   ID:BL       Real-Time Display Menu       08/06/97  14:59:27

    V  Display Raw Readings
    R  Display Readings w/units
    F  Display Readings w/flags
    B  Display Last Base Avg
    C  Continuous Avg Report
    L  Show LARGE TEXT Display
    I  Display Digital Inputs
    O  Display Digital Outputs
    A  Display Analog Outputs
```

Press <**R**> for Display Readings w/units:

```
ESC 88xx v5.31  ID:BL    Real-Time Engineering Uints     08/06/97  14:59:27

          O3 = 38.23     (PPB     )
       O3CAL = 1.434     (PPB     )
        O3R8 = 38.23     (PPB     )
         VWD = 46.61     (DEG     )
         SIG = 46.61     (DEG     )
         VWS = 0.6261    (M/S     )
         SWS = 0.6261    (M/S     )
         PWS = 2.036     (M/S     )
         TMP = 3.399     (DGC     )
         DTP = 0.06188   (DGC     )
         SOL = 100.3     (WMS     )
         RNF = 0         (MM      )
          RH = 66.83     (%       )
         WET = 100.4     (+/-     )
         FLW = 3.008     (SLPM    )
         STP = 21.48     (DGC     )
```

Watch the RH (relative humidity) reading for several updates to identify any current trends. Observe the conditions outside the shelter. Compare what you see with the reading on the datalogger. Does it make sense? If not, call the Operation Support Center to report any discrepancy and enter your observations in the logbook. Also note any other conditions that could affect validity of the relative humidity data and enter your observations in the logbook.

Checklist Instruction - Weekly Station Visit

- **Relative Humidity Sensor (Vaisala)**

Checklist Instruction Number: **3176-3121**

Revision Number / Date: **2 / January 2011** **(last reviewed Jan. 2011)**

Objective: Weekly checks of the relative humidity system are performed to verify the operational integrity of the relative humidity senso and aspirator, and to verify that collected data appear reasonable.

---

1. Verify the air temperature and relative humidity sensor housing is operational.

An air temperature/relative humidity sensor aspirator housing is mounted to the meteorological tower. In most cases this aspirator is forced-aspirated by a fan. If the aspirator is the fan-type, listen for the fan's operation.

If a "natural aspirated" fan is in use, make sure it is secure and in good condition. Call the Operation Support Center if problems are detected.

2. Compare the current relative humidity measurement to your observation of ambient conditions.

From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31   ID:BL       Real-Time Display Menu        08/06/97  14:59:27

    V  Display Raw Readings
    R  Display Readings w/units
    F  Display Readings w/flags
    B  Display Last Base Avg
    C  Continuous Avg Report
    L  Show LARGE TEXT Display
    I  Display Digital Inputs
    O  Display Digital Outputs
    A  Display Analog Outputs
```

Press <**R**> for Display Readings w/units:

```
ESC 88xx v5.31   ID:BL    Real-Time Engineering Units     08/06/97  14:59:27

           O3 = 38.23     (PPB      )
        O3CAL = 1.434     (PPB      )
         O3R8 = 38.23     (PPB      )
          VWD = 46.61     (DEG      )
          SIG = 46.61     (DEG      )
          VWS = 0.6261    (M/S      )
          SWS = 0.6261    (M/S      )
          PWS = 2.036     (M/S      )
          TMP = 3.399     (DGC      )
          DTP = 0.06188   (DGC      )
          SOL = 100.3     (WMS      )
          RNF = 0         (MM       )
           RH = 66.83     (%        )
          WET = 100.4     (+/-      )
          FLW = 3.008     (SLPM     )
          STP = 21.48     (DGC      )
```

Watch the RH (relative humidity) reading for several updates to identify any current trends. Observe the conditions outside the shelter. Compare what you see with the reading on the datalogger. Does it make sense? If not, call the Operation Support Center to report any discrepancy and enter your observations in the logbook. Also note any other conditions that could affect validity of the relative humidity data and enter your observations in the logbook.

Checklist Instruction - Weekly Station Visit

- **Solar Radiation Sensor (Climatronics)**

Checklist Instruction Number: **3176-3130**

Revision Number / Date: **2 / January 2011** **(last reviewed Jan. 2011)**

Objective: Weekly checks of the solar radiation system are performed to verify the operational integrity of the solar radiation system, to clean the sensor, and to verify that collected data appear reasonable.

1. Inspect the solar radiation sensor for dirt or snow if your sensor is at a height to reach. Clean the sensor if required.

Locate your solar radiation sensor; most air quality station sensors are on the tower. Inspect the sensor for dirt, snow, etc. The sensor can be cleaned with a broom to remove snow or a Kimwipe with water to remove dirt.

2. Note the current solar radiation measurement and compare it to your observations of ambient conditions.

From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31   ID:BL       Real-Time Display Menu        08/06/97   14:59:27

      V      Display Raw Readings
      R      Display Readings w/units
      F      Display Readings w/flags
      B      Display Last Base Avg
      C      Continuous Avg Report
      L      Show LARGE TEXT Display
      I      Display Digital Inputs
      O      Display Digital Outputs
      A      Display Analog Outputs
```

Press <**R**> for Display Readings w/units:

```
ESC 88xx v5.31   ID:BL     Display Last Base Avg.     08/06/97      14:59:27

      O3= 38.23          (PPB      )
      O3 CAL= 1.434      (PPB      )
      O3 R8= 38.23       (PPB      )
      VWD= 46.61         (DEG      )
      SIG= 46.61         (DEG      )
      VWS= 0.6261        (M/S      )
      SWS= 0.6261        (M/S      )
      PWS= 2.036         (M/S      )
      TMP= 3.399         (DGC      )
      DTP= 0.06188       (DGC      )
      SOL= 100.3         (WMS      )
      RNF= 0             (MM       )
      RH= 66.83          (%        )
      WET= 100.4         (+/-      )
      FLW= 3.008         (SLPM     )
      STP= 21.48         (DGC      )
```

Watch the SOL (solar radiation) reading for several updates to identify any current trends. Observe the conditions outside the shelter. Compare what you see with the reading on the datalogger. Does it make sense? If not, call the Operation Support Center to report the discrepancy.

Note: With experience you will develop and “eye” for judging whether the SOL reading is representative of the ambient observation. Remember that the solar radiation varies with time of day, sky conditions, and season.

Report conditions that affect data validity (e.g., snow found on the sensor) in the logbook.

3. Take the SOL offline in preparation to check the translator responses.

To ensure that only ambient solar conditions are included in the hourly average, it is necessary to mark the SOL channel offline. Solar radiation data marked in this manner are automatically excluded from the hourly averages.

Begin at the Home Menu as shown below. Remember, pressing <**Esc**> several times returns to the Home Menu.

```
ESC 88xx v5.31  ID:BL         Home Menu          08/06/97     14:59:27

      H      Help Screen
      L      Login/Set User Level
      C      Configuration Menu
      D      Real-Time Display Menu
      R      Report Generation Menu
      G      Graph Generation Menu
      S      Status Menu
      O      Log Out/Exit
      X      Serial Como to Port
```

Press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL      Configuration Menu      08/06/97  14:59:27

      P      Set Passwords
      S      Configure System Parameters
      D      Configure (Data) Channels
      C      Configure Calibrations
      A      Configure Alarms
      O      Configure Analog Outputs
      K      Configure Math Constants
      E      Configure Dig. Event Program
      R      Configure Digital I/O
      1      Configure Serial Protocols
```

Press <**D**>, for Configure (Data) Channels:

```
ESC 88xx v5.31  ID:BL    Channel Configuration Menu    08/06/97  14:59:27

      N      Enter New Configuration
      C      Change Old Configuration
      D      Delete Old Configuration
      M      Disable/Mark Channel Offline
      E      Enable/Mark Channel Online
      I      Put Channel In Maint.
      O      Take Channel Out of Maint.
```

Press <**M**> for Disable/Mark Channel Offline:

```
ESC 88xx v5.31   ID:BL    Choose(Space Toggle/Enter Select)    08/06/97  4:59:27

       O3      [01]
       O3CAL   [02]
       O3R8    [03]
       VWD     [04]
       SIG     [05]
       VWS     [06]
       SWS     [07]
       TMP     [08]
       DTP     [09]
       SOL     [10]
       RNF     [11]
       WET     [12]
       FLW     [13]
       STP     [14]
```

Use the ↑ and ↓ keys to navigate and the spacebar to select the SOL channel for offline status. The channel should be marked with a ">" indicating imminent offline status. Press <**Enter**> to take the marked channel offline.

```
ESC 88xx v5.31   ID:BL    Choose(Space Toggle/Enter Select)    08/06/97  4:59:27

       O3             [01]
       O3CAL          [02]
       O3R8           [03]
       VWD            [04]
       SIG            [05]
       VWS            [06]
       SWS            [07]
       TMP            [08]
       DTP            [09]
  >    SOL            [10]
       RNF            [11]
       WET            [12]
       FLW            [13]
       STP            [14]
```

Check the status of the SOL channel by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu**.** Press <**F**> to display the data channels with flags (or, press **<F6>** in any menu to display flags). SOL should be marked with a *D* flag to the right to indicate offline status. The offline time will be recorded in the logbook automatically when this step is complete.

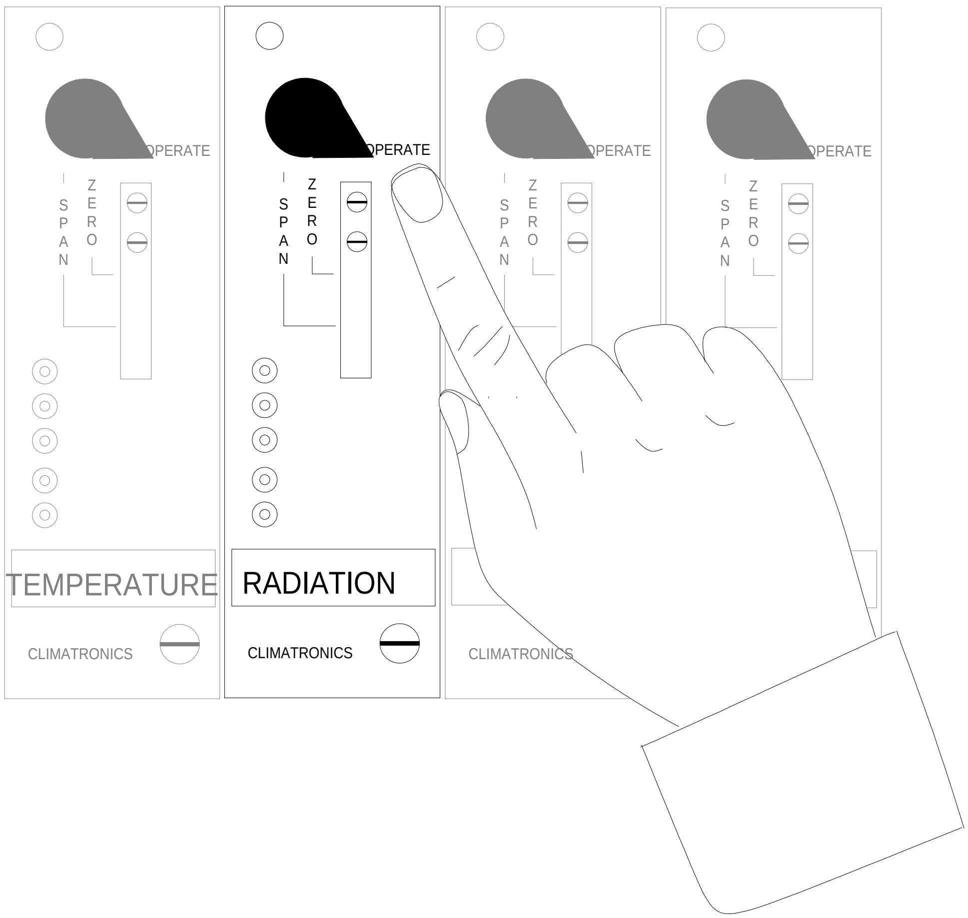
4. Set the mode selector switch on the RADIATION translator from OPER. to ZERO. Verify that the SOL zero response is between –5 and +5.

The mode selector switch on the radiation translator is normally in the OPER. position. The calibration of the translator can be verified by setting the mode selector switch to ZERO and SPAN and comparing the responses to the limits below.

Set the mode selector switch to ZERO. Observe the SOL until stabilized. Compare the observation to the limits. SOL must be between -5 and +5.

5. Set the mode switch on the RADIATION translator from ZERO to SPAN. Verify that the SOL span response is between 1391 and 1401.

Set the mode selector switch to SPAN. Observe until stabilized. Compare the observation to the limits. SOL must be within 1391 and 1401. Call the Operation Support Center if the response is out of tolerance.



6. Set the mode switch to OPER.

7. Bring the SOL channel back online.

Bring the SOL channel online by beginning at the Home Menu of the ESC datalogger. Remember that pressing <**Esc**> several times you will return eventually to the Home Menu.

```
ESC 88xx v5.31   ID:BL          Home Menu            08/06/97   14:59:27

       H      Help Screen
       L      Login/Set User Level
       C      Configuration Menu
       D      Real-Time Display Menu
       R      Report Generation Menu
       G      Graph Generation Menu
       S      Status Menu
       O      Log Out/Exit
       X      Serial Como to Port
```

Press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL      Configuration Menu       08/06/97  14:59:27

      P      Set Passwords
      S      Configure System Parameters
      D      Configure (Data) Channels
      C      Configure Calibrations
      A      Configure Alarms
      O      Configure Analog Outputs
      K      Configure Math Constants
      E      Configure Dig. Event Program
      R      Configure Digital I/O
      1      Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31  ID:BL    Channel Configuration Menu     08/06/97  14:59:27

      N      Enter New Configuration
      C      Change Old Configuration
      D      Delete Old Configuration
      M      Disable/Mark Channel Offline
      E      Enable/Mark Channel Online
      I      Put Channel In Maint.
      O      Take Channel Out of Maint.
```

Press <**E**> for Enable/Mark Channel Online. SOL should be the only channel displayed.

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)    08/06/97  4:59:27

  >    SOL    [04]
```

Use the ↑ and ↓ keys to navigate and the spacebar to select a channel. Press <**Enter**> to put the selected channel online.

Check the status of the SOL channel by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> once to display the data channels with flags (or, press **<F6>** in any menu to display flags). SOL will no longer by marked with a flag indicating online status; a *P* may be in the flag column indicating a purge period programmed to allow for the time it takes for ambient conditions to prevail. The *P* flag should clear within one minute. The online time will automatically recorded in the logbook when this step is completed.

Checklist Instruction - Weekly Station Visit

- **Solar Radiation Sensor (R.M. Young)**

Checklist Instruction Number: **3176-3131**

Revision Number / Date: **2 / January 2011** **(last reviewed Jan. 2011)**

Objective: Weekly checks of the solar radiation system are performed to verify the operational integrity of the solar radiation system, to clean the sensor, and to verify that collected data appear reasonable.

---

1. Inspect the solar radiation sensor for dirt or snow if your sensor is at a height to reach. Clean the sensor if required. Also check the leveling bubble.

Locate your solar radiation sensor; most air quality station sensors are on a tower. Inspect the sensor for dirt, snow, etc. If the sensor can be reached, carefully remove snow from the sensor and clean the sensor with a water-dampened Kimwipe to remove dust and dirt. Also check the leveling bubble to verify it is level.

2. Compare the current solar radiation measurement to your observations of ambient conditions.

From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31   ID:BL       Real-Time Display Menu        08/06/97  14:59:27

    V  Display Raw Readings
    R  Display Readings w/units
    F  Display Readings w/flags
    B  Display Last Base Avg
    C  Continuous Avg Report
    L  Show LARGE TEXT Display
    I  Display Digital Inputs
    O  Display Digital Outputs
    A  Display Analog Outputs
```

Press <**R**> for Display Readings w/units:

```
ESC 88xx v5.31  ID:BL    Display Last Base Avg.    08/06/97  14:59:27

          O3 = 38.23     (PPB     )
       O3CAL = 1.434     (PPB     )
        O3R8 = 38.23     (PPB     )
         VWD = 46.61     (DEG     )
         SIG = 46.61     (DEG     )
         VWS = 0.6261    (M/S     )
         SWS = 0.6261    (M/S     )
         PWS = 2.036     (M/S     )
         TMP = 3.399     (DGC     )
         DTP = 0.06188   (DGC     )
         SOL = 100.3     (WMS     )
         RNF = 0         (MM      )
          RH = 66.83     (%       )
         WET = 100.4     (+/-     )
         FLW = 3.008     (SLPM    )
         STP = 21.48     (DGC     )
```

Watch the SOL (solar radiation) reading for several updates to identify any current trends. Observe the conditions outside the shelter. Compare what you see with the reading on the datalogger. Does it make sense? If not, call the Operation Support Center to report the discrepancy and enter your observations in the logbook.

Note: With experience you will develop and “eye” for judging whether the SOL reading is representative of the ambient observation. Remember that the solar radiation varies with time of day, sky conditions, and season.

Report any conditions that affect data validity (e.g., snow found on the sensor) in the logbook.

Checklist Instruction - Weekly Station Visit

- **Solar Radiation Sensor (Licor)**

Checklist Instruction Number: **3176-3132**

Revision Number / Date: **2 / January 2011** **(last reviewed Jan. 2011)**

Objective: Weekly checks of the solar radiation system are performed to verify the operational integrity of the solar radiation system, to clean the sensor, and to verify that collected data appear reasonable.

---

1. Inspect the solar radiation sensor for dirt or snow if your sensor is at a height to reach. Clean the sensor if required. Also check leveling bubble.

Locate your solar radiation sensor; most air quality station sensors are on a tower. Inspect the sensor for dirt, snow, etc. If the sensor can be reached, carefully remove snow from the sensor and clean the sensor with a water-dampened Kimwipe to remove dust and dirt. Also check the leveling bubble to verify it is level.

2. Compare the current solar radiation measurement to your observations of ambient conditions.

From the Home Menu on the ESC datalogger, press <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31  ID:BL       Real-Time Display Menu        08/06/97  14:59:27

    V Display Raw Readings
    R Display Readings w/units
    F Display Readings w/flags
    B Display Last Base Avg
    C Continuous Avg Report
    L Show LARGE TEXT Display
    I Display Digital Inputs
    O Display Digital Outputs
    A Display Analog Outputs
```

Press <**R**> for Display Readings w/units:

```
ESC 88xx v5.31   ID:BL     Display Last Base Avg.     08/06/97  14:59:27

          O3 = 38.23     (PPB     )
       O3CAL = 1.434     (PPB     )
        O3R8 = 38.23     (PPB     )
         VWD = 46.61     (DEG     )
         SIG = 46.61     (DEG     )
         VWS = 0.6261    (M/S     )
         SWS = 0.6261    (M/S     )
         PWS = 2.036     (M/S     )
         TMP = 3.399     (DGC     )
         DTP = 0.06188   (DGC     )
         SOL = 100.3     (WMS     )
         RNF = 0         (MM      )
          RH = 66.83     (%       )
         WET = 100.4     (+/-     )
         FLW = 3.008     (SLPM    )
         STP = 21.48     (DGC     )
```

Watch the SOL (solar radiation) reading for several updates to identify any current trends. Observe the conditions outside the shelter. Compare what you see with the reading on the datalogger. Does it make sense? If not, call the Operation Support Center to report the discrepancy and enter your observations in the logbook.

Note: With experience you will develop and “eye” for judging whether the SOL reading is representative of the ambient observation. Remember that the solar radiation varies with time of day, sky conditions, and season.

Report any conditions that affect data validity (e.g., snow found on the sensor) in the logbook.

Checklist Instruction - Weekly Station Visit

- **Precipitation Sensor (Climatronics)**

Checklist Instruction Number: **3176-3150**

Revision Number / Date: **3 / January 2011** **(last reviewed Jan. 2011)**

Objective: Weekly checks of the precipitation system (tipping bucket rain gauge) are performed to verify the operational integrity of the system, inspect and clean the funnel if necessary, verify the operation of the tipping mechanism and heater, and to verify that collected data appear reasonable.

---

1. Take the RNF (rainfall or precipitation) channel offline for operational checks.

The checks required to assure proper precipitation gauge operation will generate false RNF readings; therefore, the RNF channel must be taken offline.

From the Home Menu on the ESC datalogger, press <**C**> for Configuration Menu:

```
ESC 88xx v5.31   ID:BL       Configuration Menu        08/06/97  14:59:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31   ID:BL     Channel Configuration Menu      08/06/97  14:59:27

    N  Enter New Configuration
    C  Change Old Configuration
    D  Delete Old Configuration
    M  Disable/Mark Channel Offline
    E  Enable/Mark Channel Online
    I  Put Channel In Maint.
    O  Take Channel Out of Maint.
```

Press <**M**> for Disable/Mark Channel Offline:

```
ESC 88xx v5.31   ID:BL     Choose(Space Toggle/Enter Select)     08/06/97   4:59:27

    O3       [01]
    O3CA     [02]
    O3R8     [03]
    VWD      [04]
    SIG      [05]
    VWS      [06]
    SWS      [07]
    TMP      [08]
    DTP      [09]
    SOL      [10]
    RNF      [11]
    WET      [12]
    FLW      [13]
    STP      [14]
```

Use the ↑ and ↓ keys and the spacebar to select the RNF channel for offline status. The RNF channel should be marked with a ">" indicating imminent offline status. Press <**Enter**> to take the marked channel offline.

```
ESC 88xx v5.31   ID:BL     Choose(Space Toggle/Enter Select)     08/06/97   4:59:27

    O3       [01]
    O3CA     [02]
    O3R8     [03]
    VWD      [04]
    SIG      [05]
    VWS      [06]
    SWS      [07]
    TMP      [08]
    DTP      [09]
    SOL      [10]
  > RNF      [11]
    WET      [12]
    FLW      [13]
    STP      [14]
```

Check the status of the RNF channel by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> to display the data channels with flags (or, press **<F6>** in any menu to display flags). RNF should be marked with a *D* flag to the right to indicate offline status. The offline time will automatically be recorded in the logbook when this step is completed.

2. Inspect the precipitation gauge collection funnel for snow or debris.

Inspect the collection funnel and remove any foreign objects (e.g., leaves, bugs, etc.) call the Operation Support Center if there is unmelted snow in the funnel. This indicates a failure of the heating system. Record significant findings in the logbook.

3. Once a month perform a calibration check.

Verify the channel is still down and start the check just after the top of the hour. Fill the graduated cylinder with water. Place the black calibration funnel into the sensor and pour water from the graduated cylinder into the black funnel. At the completion of the check and in the next hour, log into the datalogger and check the RNF total. The value/result should be between 9.1 and 11.1. Remove the funnel after the check has completed.

4. Bring the RNF back online and record the value.

From the Home Menu press <**C**> for Configuration Menu:

```
ESC 88xx v5.31   ID:BL        Configuration Menu        08/06/97   14:59:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31   ID:BL      Channel Configuration Menu      08/06/97   14:59:27

    N  Enter New Configuration
    C  Change Old Configuration
    D  Delete Old Configuration
    M  Disable/Mark Channel Offline
    E  Enable/Mark Channel Online
    I  Put Channel In Maint.
    O  Take Channel Out of Maint.
```

Press <**E**> for Enable/Mark Channel Online:

```
ESC 88xx v5.31   ID:BL      Choose(Space Toggle/Enter Select)    08/06/97   14:59:27

    RNF     [11]
```

Press ↑ and ↓ to highlight a channel(s). Press the <**Spacebar**> to select it for online status. Press <**Enter**> to put the marked channel(s) online.

Check the status of the RNF channel by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> to display the data channels with flags. RNF should be marked with a *D* flag to the right to indicate offline status that will clear after one minute. The online time will automatically be recorded in the logbook when this task is completed. Enter the total value of the 10-tip check onto the checklist. The value will automatically be entered into the logbook when this step is completed.

Checklist Instruction - Weekly Station Visit

- **Precipitation Sensor (Texas Electronics)**

Checklist Instruction Number: **3176-3151**

Revision Number / Date: **2 / January 2011** **(last reviewed Jan. 2011)**

Objective: Weekly checks of the precipitation system (tipping bucket rain gauge) are performed to verify the operational integrity of the system, inspect and clean the funnel if necessary, verify the operation of the tipping mechanism and heater, and to verify that collected data appear reasonable.

---

1. Take the RNF (rainfall or precipitation) channel offline for operational checks.

The checks required to assure proper precipitation gauge operation will generate false RNF readings; therefore, the RNF channel must be taken offline.

From the Home Menu on the ESC datalogger, press <**C**> for Configuration Menu:

```
ESC 88xx v5.31   ID:BL       Configuration Menu        08/06/97  14:59:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88x v5.31   ID:BL     Channel Configuration Menu     08/06/97  14:59:27

    N  Enter New Configuration
    C  Change Old Configuration
    D  Delete Old Configuration
    M  Disable/Mark Channel Offline
    E  Enable/Mark Channel Online
    I  Put Channel In Maint.
    O  Take Channel Out of Maint.
```

Press <**M**> for Disable/Mark Channel Offline:

```
ESC 88xx v5.31   ID:BL     Choose(Space Toggle/Enter Select)     08/06/97   4:59:27

    O3       [01]
    O3CA     [02]
    O3R8     [03]
    VWD      [04]
    SIG      [05]
    VWS      [06]
    SWS      [07]
    TMP      [08]
    DTP      [09]
    SOL      [10]
    RNF      [11]
    WET      [12]
    FLW      [13]
    STP      [14]
```

Use the ↑ and ↓ keys and the spacebar to select the RNF channel for offline status. The RNF channel should be marked with a ">" indicating imminent offline status. Press <**Enter**> to take the marked channel offline.

```
ESC 88xx v5.31   ID:BL     Choose(Space Toggle/Enter Select)    08/06/97   14:59:27

    O3       [01]
    O3CA     [02]
    O3R8     [03]
    VWD      [04]
    SIG      [05]
    VWS      [06]
    SWS      [07]
    TMP      [08]
    DTP      [09]
    SOL      [10]
  > RNF      [11]
    WET      [12]
    FLW      [13]
    STP      [14]
```

Check the status of the RNF channel by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> to display the data channels with flags (or, press **<F6>** in any menu to display flags). RNF should be marked with a *D* flag to the right to indicate offline status. The offline time will automatically be recorded in the logbook when this step is completed.

2. Inspect the precipitation gauge collection funnel for snow or debris.

Inspect the collection funnel and remove any foreign objects (e.g., leaves, bugs, etc.) call the Operation Support Center if there is unmelted snow in the funnel. This indicates a failure of the heating system. Record significant findings in the logbook.

3. Once a month perform a calibration check.

Verify the channel is still down and start the check just after the top of the hour. Fill the graduated cylinder with water. Place the black calibration funnel into the sensor and pour water from the graduated cylinder into the black funnel. At the completion of the check and in the next hour, log into the datalogger and check the RNF total. The value/result should be between 9.1 and 11.1. Remove the funnel after the check has completed.

4. Bring the RNF back online and record the value.

From the Home Menu press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL      Configuration Menu      08/06/97  14:59:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31  ID:BL    Channel Configuration Menu    08/06/97  14:59:27

    N  Enter New Configuration
    C  Change Old Configuration
    D  Delete Old Configuration
    M  Disable/Mark Channel Offline
    E  Enable/Mark Channel Online
    I  Put Channel In Maint.
    O  Take Channel Out of Maint.
```

Press <**E**> for Enable/Mark Channel Online:

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)    08/06/97  4:59:27

    RNF    [11]
```

Press ↑ and ↓ to highlight a channel(s). Press the <**Spacebar**> to select it for online status. Press <**Enter**> to put the marked channel(s) online.

Check the status of the RNF channel by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> to display the data channels with flags. RNF should be marked with a *D* flag to the right to indicate offline status that will clear after one minute. The online time will automatically be recorded in the logbook when this task is completed. Enter the total value of the 10-tip check onto the checklist. The value will automatically be entered into the logbook when this step is completed.

Checklist Instruction - Weekly Station Visit

- **Precipitation Sensor (RM Young)**

Checklist Instruction Number: **3176-3153**

Revision Number / Date: **1 / March 2011** **(last reviewed Mar. 2011)**

Objective: Weekly checks of the precipitation system (tipping bucket rain gauge) are performed to verify the operational integrity of the system, inspect and clean the funnel if necessary, and to verify that collected data appear reasonable.

---

1. Review RNF data since last visit and compare values with known precipitation events.

Verify actual precipitation events (rain or snow) that have occurred since your last visit were recorded by the ESC datalogger, and/or displayed on STKPLOT in DataView.

If the data appear reasonable, complete Step 2 of this checklist and bypass Steps 3 through 5. If data appear to be missing, complete all steps of this checklist.

2. Inspect the precipitation gauge collection funnel for snow or debris.

Inspect the collection funnel and remove any foreign objects (e.g., leaves, bugs, etc.) call the Operation Support Center if there is unmelted snow in the funnel. This indicates a failure of the heating system. Record significant findings in the logbook.

3. Take the RNF channel offline for operational checks.

If data appear to be missing verify rain gauge operations, but first the RNF channel must be taken offline.

From the Home Menu on the ESC datalogger, press <**C**> for Configuration Menu:

```
ESC 88xx v5.31   ID:BL        Configuration Menu        08/06/97   14:59:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31  ID:BL    Channel Configuration Menu     08/06/97  14:59:27

    N  Enter New Configuration
    C  Change Old Configuration
    D  Delete Old Configuration
    M  Disable/Mark Channel Offline
    E  Enable/Mark Channel Online
    I  Put Channel In Maint.
    O  Take Channel Out of Maint.
```

Press <**M**> for Disable/Mark Channel Offline:

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)    08/06/97  4:59:27

    O3      [01]
    O3CA    [02]
    O3R8    [03]
    VWD     [04]
    SIG     [05]
    VWS     [06]
    SWS     [07]
    TMP     [08]
    DTP     [09]
    SOL     [10]
    RNF     [11]
    WET     [12]
    FLW     [13]
    STP     [14]
```

Use the ↑ and ↓ keys and the spacebar to select the RNF channel for offline status. The RNF channel should be marked with a “>” indicating imminent offline status. Press <**Enter**> to take the marked channel offline.

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)    08/06/97  4:59:27

    O3      [01]
    O3CA    [02]
    O3R8    [03]
    VWD     [04]
    SIG     [05]
    VWS     [06]
    SWS     [07]
    TMP     [08]
    DTP     [09]
    SOL     [10]
  > RNF     [11]
    WET     [12]
    FLW     [13]
    STP     [14]
```

Check the status of the RNF channel by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> to display the data channels with flags (or, press **<F6>** in any menu to display flags). RNF should be marked with a *D* flag to the right to indicate offline status. The offline time will automatically be recorded in the logbook when this step is completed.

4. Pour water into the precipitation gauge, observe results.

From the Home Menu select <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31   ID:BL       Real Time Display Menu        08/06/97   14:59:27

    V  Display Raw Readings
    R  Display Readings w/units
    F  Display Readings w/flags
    B  Display Last Base Avg
    C  Continuous Avg Report
    L  Show LARGE TEXT Display
    I  Display Digital Inputs
    O  Display Digital Outputs
    A  Display Analog Outputs
```

Press <**C**> for Continuous Avg Report:

```
ESC 88xx v5.31   ID:BL       Continuous Avg Report Setup        08/06/97   14:59:27


    Average Interval                    :  1m
    Show Channels                       :  O3,O3CAL,RNF



    # of Flags to Report                :  02
    Use Decimal Positioner?             :  Y
    Start Continuous Report
```

Enter a **1** and then **m** for the Average Interval if it has not defaulted to the 1m. Use the ↑ and ↓ keys and the spacebar to select Show Channels. Type **RNF** if it is not already displayed. Navigate down to Start Continuous Report and press <**Enter**>.

```
              TIME            O3            O3CAL          RNF

           10/19 11:19       41.             -1.            0.0
```

The data line will update and append once per minute. This screen allows the operator to leave the shelter, pour water into the rain gauge and return to the shelter to read the resulting “precipitation.”

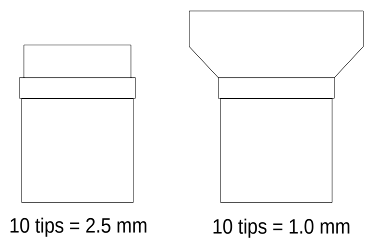
Slowly pour a small volume of water (~20ml) into the rain gauge. Listen carefully for the buckeyes to tip. Attempt to count the number of tips. 20ml of water should result in 10 tips (2 ml/tip).

Back in the shelter, the ESC screen will have updated and will report the tips as precipitation.

```
TIME            O3     O3CAL      RNF

10/19 11:30     41.    -1.         0.0
10/19 11:31     41.    -1.         0.0
10/19 11:32     40.    -1.         0.0
10/19 11:33     42.    -1.         1.0
10/19 11:34     41.    -1.         0.0
```

To be certain that all the tips were collected in the displayed one minute updates, wait long enough for an update of 0.0 to appear for RNF. The tips may have been recorded over one or two minutes. The total precipitation response is the sum of the one minute updates. The total should be 1.0mm (.1mm/tip) for 20ml of water. Call the OSC if the results are different than above.



5. Bring the RNF back online and record the results.

From the Home Menu press <**C**> for Configuration Menu:

```
ESC 88xx v5.31   ID:BL       Configuration Menu       08/06/97   14:59:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31  ID:BL    Channel Configuration Menu     08/06/97  14:59:27

    N  Enter New Configuration
    C  Change Old Configuration
    D  Delete Old Configuration
    M  Disable/Mark Channel Offline
    E  Enable/Mark Channel Online
    I  Put Channel In Maint.
    O  Take Channel Out of Maint.
```

Press <**E**> for Enable/Mark Channel Online:

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)   08/06/97  14:59:27

    RNF    [11]
```

Press ↑ and ↓ to highlight a channel(s). Press the <**Spacebar**> to select it for online status. Press <**Enter**> to put the marked channel(s) online.

Check the status of the RNF channel by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> to display the data channels with flags (or, press **<F6>** in any menu to display flags). RNF should be marked with a *D* flag to the right to indicate offline status that will clear after one minute. The online time will automatically be recorded in the logbook when this task is completed. Enter the results of the test in the logbook.

Checklist Instruction – Monthly Check

- **Precipitation Sensor (Various)**

Checklist Instruction Number: **3176-3155**

Revision Number / Date: **2 / August 2009** **(last reviewed Aug. 2011)**

Objective: Monthly checks of the precipitation system (tipping bucket rain gauge) are performed to verify the operational integrity of the system. Monthly checks should be performed under dry conditions (no precipitation) at temperatures above freezing.

---

1. Take the RNF (rainfall or precipitation) channel offline for operational checks.

The checks required to assure proper precipitation gauge operation will generate false RNF readings; therefore, the RNF channel must be taken offline.

From the Home Menu on the ESC datalogger, press <**C**> for Configuration Menu:

```
ESC 88xx v5.31   ID:BL       Configuration Menu        08/06/97   14:59:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31   ID:BL     Channel Configuration Menu     08/06/97   14:59:27

    N  Enter New Configuration
    C  Change Old Configuration
    D  Delete Old Configuration
    M  Disable/Mark Channel Offline
    E  Enable/Mark Channel Online
    I  Put Channel In Maint.
    O  Take Channel Out of Maint.
```

Press <**M**> for Disable/Mark Channel Offline:

```
ESC 88xx v5.31   ID:BL     Choose(Space Toggle/Enter Select)     08/06/97   4:59:27

    O3       [01]
    O3CA     [02]
    O3R8     [03]
    VWD      [04]
    SIG      [05]
    VWS      [06]
    SWS      [07]
    TMP      [08]
    DTP      [09]
    SOL      [10]
    RNF      [11]
    WET      [12]
    FLW      [13]
    STP      [14]
```

Use the ↑ and ↓ keys and the spacebar to select the RNF channel for offline status. The RNF channel should be marked with a ">" indicating imminent offline status. Press <**Enter**> to take the marked channel offline.

```
ESC 88xx v5.31   ID:BL     Choose(Space Toggle/Enter Select)     08/06/97   4:59:27

    O3       [01]
    O3CA     [02]
    O3R8     [03]
    VWD      [04]
    SIG      [05]
    VWS      [06]
    SWS      [07]
    TMP      [08]
    DTP      [09]
    SOL      [10]
  > RNF      [11]
    WET      [12]
    FLW      [13]
    STP      [14]
```

Check the status of the RNF channel by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> to display the data channels with flags. RNF should be marked with a *D* flag to the right to indicate offline status. The offline time will automatically be recorded in the logbook when this step is completed.

2. Inspect the precipitation gauge collection funnel for debris or snow.

Inspect the leaf screen (if present) and collection funnel and remove any foreign objects (e.g., dirt, leaves, bugs, etc.). Call the Operation Support Center if there is unmelted snow in the funnel. This indicates a failure of the heating system. Record significant findings in the logbook.

3. Fill graduated cylinder with water and pour into black calibration funnel.

The rain gauge calibration kit consists of a plastic graduated cylinder and a black calibration funnel. First inspect the black calibration funnel to ensure that it is clean and free from dust and particles that could clog the drip nozzle. If the nozzle is blocked, use the nozzle cleaning wire provided with the calibration kit. Place the cylinder on a level surface and fill it with clean water. The pre-drilled hole will allow the cylinder to fill to exactly 465mL. When the water has finished dripping from the hole, place your thumb over the hole to prevent spillage, and carry the graduated cylinder and the black calibration funnel to the rain gauge. Place the black calibration funnel in the gauge (remove leaf screen if present) and pour the entire contents of the cylinder into the calibration funnel. The black calibration funnel with the brass (#65) nozzle will drip the water into the rain gauge at a controlled rate. The funnel will empty in approximately 25 minutes.

4. Record the RNF value after the top of the hour.

The funnel will take approximately 25 minutes to empty. The results of the calibration check must be retrieved from the datalogger after the hour is completed. Note if the calibration crosses over the top of the hour, you must add the values recorded in both hours.

From the Home Menu press <**R**> for Report Generation Menu:

```
ESC 88xx v5.31   ID:??              Report Menu                01/01/08   15:55:21

    A  Report Averages
    C  Report Calibrations
    L  Summarize Last Cals
    Q  Autoprint Data Channel (s)
    D  Autoprint Daily Report
    Z  Autoprint Calibration (s)
    R  Daily Averages Report
    T  Daily Calibrations Report
```

Press <**A**> for Report Averages:

```
ESC 88xx v5.31   ID:??         Report Averages Screen          01/01/08   15:56:27

    Average Interval              :  1h
    Show Channels                 :  RNF
    Start Time                    :  01/01/08
    # of Flags to Report          :  02
    Use Decimal Positioner?       :  N
    (Printer) Report Length       :  22
    (Printer) Page Length         :  22
    View On Screen
    Report to Printer
```

Arrow down to highlight the channels in “Show Channels” and enter **RNF**. Respond to the rest of the fields with the <Enter> key and the rainfall totals since midnight will display on the screen.

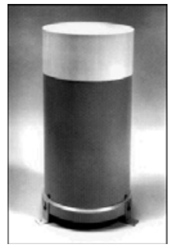
```
ESC 88xx v5.31   ID:??            Rainfall Totals             01/01/08  14:59:27

     01/01/08  00:00        0
     01/01/08  01:00        0
     01/01/08  02:00        0
     01/01/08  03:00        0
     01/01/08  04:00        0
     01/01/08  05:00        0
     01/01/08  06:00        0
     01/01/08  07:00        0
     01/01/08  08:00        0
     01/01/08  09:00        9.8
     01/01/08  10:00        -9999. <N
     01/01/08  11:00        -9999. <N
     ...
```

The most recent completed hour should display the volume measured in mm. Enter this value on the DataView checklist instruction. The value should be within the acceptable range of expected values displayed below for specific rain gauge types. If the value is outside of the expected range call the Operations Support Center.

Instrument	Funnel Diameter	Diagram	Expected Response to 480 ml of Water
Climatronics Model 100508 or Texas Electronics Model TR-525MM-L	9.66” (24.5 cm) (catchment area 471 cm^2)		in millimeters 10.1 mm ± 1 mm (9.1 mm to 11.1 mm) in inches 0.4 inches ±.04 inches (0.36 inches to .44 inches)
Climatronics Model 100097 or Novalynx Model 260-2500	8” (20.3 cm) (catchment area 324 cm^2)		in millimeters 14.8 mm ± 1.48 mm (13.32 mm to 16.28 mm) in inches .58 inches ± .06 inches (.52 inches to .64 inches)
R.M. Young Model 52202	7” (18 cm) (catchment area 200 cm^2)		in millimeters 24 mm ± 2.4 mm (21.6 mm to 26.4 mm) in inches 0.94 inches ± 0.09 inches (0.85 inches to 1.03 inches)

-- continued --

Instrument	Funnel Diameter	Diagram	Expected Response to 480 ml of Water
Met One Model 385	12”		in millimeters 6.6 mm ± 0.6 mm (6.0 mm to 7.3 mm)
Texas Electronics Model TR-525I-HT	6.06” (154 mm)		in millimeters 25.8 mm ± 2.6 mm (23.2 to 28.3 mm)

5. Bring the RNF back online.

From the Home Menu press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL      Configuration Menu       08/06/97  14:59:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88xx v5.31  ID:BL    Channel Configuration Menu     08/06/97  14:59:27

    N  Enter New Configuration
    C  Change Old Configuration
    D  Delete Old Configuration
    M  Disable/Mark Channel Offline
    E  Enable/Mark Channel Online
    I  Put Channel In Maint.
    O  Take Channel Out of Maint.
```

Press <**E**> for Enable/Mark Channel Online:

```
ESC 88xx v5.31  ID:BL    Choose(Space Toggle/Enter Select)   08/06/97  14:59:27

    RNF    [11]
```

Press ↑ and ↓ to highlight a channel(s). Press the <**Spacebar**> to select it for online status. Press <**Enter**> to put the marked channel(s) online.

Check the status of the RNF channel by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> to display the data channels with flags. RNF should be marked with a *D* flag to the right to indicate offline status that will clear after one minute. The online time will automatically be recorded in the logbook when this task is completed. Enter the results of the test in the logbook.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES

TITLE	**STATION OPERATOR MAINTENANCE PROCEDURES FOR GASEOUS MONITORING SITES USING THE DATAVIEW SYSTEM**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3178**
DATE	**JANUARY 2001**

AUTHORIZATIONS

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REVISION HISTORY

0.0	Initial version.	January 2001	G. Mercer
	Reviewed; no changes necessary.	January 2002	G. Mercer
0.1	Add references for CO and NOx analyzers	July 2002	G. Mercer
	Reviewed; no changes necessary.	July 2003	G. Mercer
	Reviewed; no changes necessary.	July 2004	G. Mercer
	Reviewed; no changes necessary.	July 2005	G. Mercer
0.2	Updated specific CI file names.	July 2006	G. Mercer
	Reviewed; no changes necessary.	July 2007	G. Mercer
	Reviewed; no changes necessary.	July 2008	G. Mercer
	Reviewed; no changes necessary.	July 2009	G. Mercer
0.3	Updated list of CI file names.	July 2010	G. Mercer
	Reviewed; no changes necessary.	July 2011	G. Mercer
0.4	Updated specific CI file names.	July 2012	G. Mercer

TABLE OF CONTENTS

1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) describes the steps of routine site operator maintenance visits to gaseous monitoring sites that may monitor ozone (O_3), sulfur dioxide (SO_2), carbon monoxide (CO), or oxides of nitrogen (NO_x).

The primary purpose of routine site operator maintenance is to assure quality data capture and minimize data loss by performing weekly operational checks and system integrity checks of gaseous analyzers, the data acquisition system, and support equipment.

This SOP serves as a guideline for the site operator to verify the:

- Automated analyzer checks are within specifications
- Analyzer routine maintenance is completed
- Integrity of power, telephone, and/or radio link
- Integrity of the datalogger

The operator must thoroughly document the results of each site visit by annotating the digital station log in the DataView system. Because monitoring sites have different configurations, specific Checklist Instructions (CIs) are commonly prepared for individual sites or monitoring networks. The following CIs provide detailed information regarding specific operator procedures (this list is subject to change with the addition or change of site configurations):

- CI 3178-3114 *Weekly Station Visit Oxides of Nitrogen Analyzer (TEI 42iTL, Sulfur Dioxide Analyzer (TEI 43iTL), Carbon Monoxide Analyzer (TEI 48iTLE), Ozone Analyzer (TEI 49i), Ozone Calibrator (TEI 49i), Gas Dilution Calibrator (TEI 146i)*
- CI 3178-3115 *Weekly Station Visit Ozone Analyzer (TEI 49C) Ozone Calibrator (TEI 49C)*
- CI 3178-3116 *Weekly Station Visit Ozone Analyzer (TEI 49C) Ozone Calibrator (TEI 49C) CASTNet Dry Deposition*
- CI 3178-3117 *Weekly Station Visit Sulfur Dioxide Analyzer (TEI 43C), Carbon Monoxide Analyzer (TEI 48C), Oxides of Nitrogen Analyzer (TEI 42C) Gas Dilution Calibrator (TEI 146C)*
- CI 3178-3118 *Weekly Station Visit Oxides of Nitrogen Analyzer (TEI 42C), Sulfur Dioxide Analyzer (TEI 43C), Carbon Monoxide Analyzer (TEI 48C), Ozone Analyzer (TEI 49C), Ozone Calibrator (TEI 49C), and Gas Dilution Calibrator (TEI 146C)*
- CI 3178-3119 *Weekly Station Visit Oxides of Nitrogen Analyzer (TEI 42CTL), Sulfur Dioxide Analyzer (TEI 43CTL), Carbon Monoxide Analyzer (TEI 48CTLE), Carbon Dioxide Analyzer (TEI 41C), Ozone Analyzer (TEI 49C), Ozone Calibrator (TEI 49C), and Gas Dilution Calibrator (TEI 146C)*

- CI 3178-3120 *Weekly Station Visit Oxides of Nitrogen Analyzer (TEI 42C and 42i), Sulfur Dioxide Analyzer (TEI 43C and 43i), Ozone Analyzer (TEI 49C and 49i), Ozone Calibrator (TEI 49C and 49i), and Gas Dilution Calibrator (TEI 146C and 146i)*
- CI 3178-3123 *Weekly Station Visit Ozone Analyzer (API 400E) Ozone Calibrator (API 703E)*
- CI 3178-3125 *Station Visit Ozone Analyzer (2B Technologies, Model 202) Gas Dilution Calibrator (API M700E/M700EU)*
- CI 3178-3127 *Weekly Station Visit Ozone Analyzer (2B Technologies), Meteorology*
- CI 3178-3128 *Weekly Station Visit Ozone Analyzer (2B Technologies, Simultaneous Ozone Analyzer (2B Technologies), Meteorology, CASTNet Dry Deposition*
- CI 3178-3129 *Weekly Station Visit Ozone Analyzer (2B Technologies), Simultaneous Ozone Analyzer (2B Technologies), Meteorology*
- CI 3178-3130 *Weekly Station Visit Carbon Monoxide Analyzer (TEI48C) and Gas Dilution Calibrator (TEI 146C)*
- CI 3178-3140 *Weekly Station Visit Ozone Analyzer (TEI 49C), Ozone Calibrator (TEI 49C), Oxides of Nitrogen Analyzer (TEI 42C), Gas Dilution Calibrator (TEI 146C)*
- CI 3178-3154 *Weekly Station Visit Sulfur Dioxide Analyzer (TEI 43CTL), Gas Dilution Calibrator (TEI 146)*
- CI 3178-3157 *Weekly Station Visit Oxides of Nitrogen Analyzer (TEI 42C), Gas Dilution Calibrator (TEI 146C)*
- CI 3178-3158 *Station Visit Oxides of Nitrogen Analyzer (API M200E/M200EU) Gas Dilution Calibrator (API M700E/M700EU)*
- CI 3178-3311 *Multipoint Calibration Ozone Analyzer (TEI 49, 49C, 49i) Ozone Calibrator (TEI 146C, 146i)*
- CI 3178-3315 *Multipoint Calibration Ozone Analyzer (TEI 49C) Ozone Calibrator (TEI 49C)*
- CI3178-3330 *Multipoint Calibration Carbon Monoxide Analyzer (TEI 48C, 48i, 48iTL) and TEI 146C Calibrator*
- CI 3178-3340 *Multipoint Calibration Oxides of Nitrogen Analyzer (TEI 42C) Gas Calibrator (TEI 146C)*
- CI 3178-3350 *Multipoint Calibration Sulfur Dioxide Analyzer (TEI 43C, 43i, 43TL) Dynamic Gas Calibrator (TEI 146C or 146i) Auto 3-point Multipoint*
- CI 3178-3351 *Multipoint Calibration Sulfur Dioxide Analyzer (TEI 43C) (0-500 ppb Range) Dynamic Gas Calibrator (TEI 146C)*
- CI 3178-3352 *Multipoint Calibration Sulfur Dioxide Analyzer (TEI 43C) (0-500 ppb Range) Dynamic Gas Calibrator (TEI 146)*

- CI 3178-3353 *Multipoint Calibration Sulfur Dioxide Analyzer (TEI 43C) (0-100 ppb Range) Dynamic Gas Calibrator (TEI 146)*
- CI 3178-3354 *Multipoint Calibration Sulfur Dioxide Analyzer (TEI 43CTL) (0-50 ppb Range) Dynamic Gas Calibrator (TEI 146)*
- CI 3178-3355 *Multipoint Calibration Sulfur Dioxide Analyzer (TEI 43C) Dynamic Gas Calibrator (TEI 146C) Auto 5-point Multipoint*
- CI 3178-3356 *Multipoint Calibration Sulfur Dioxide Analyzer (TEI 43C) (760-840 ppb Range) Dynamic Gas Calibrator (TEI 146)*

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall coordinate with the station operator, his/her supervisor, and ARS field specialist concerning the schedule and requirements for routine and emergency maintenance.

2.2 FIELD SPECIALIST

The field specialist shall:

- Coordinate with the station operator, his/her supervisor, and project manager concerning the schedule and requirements for routine and emergency maintenance.
- Train the station operator in all phases of the routine and emergency maintenance visit.
- Provide technical support to the station operator via telephone to assure high quality site visits and identification and resolution of instrument problems.
- Document all technical support given to the station operator.
- Load revisions to the DataView system as they are released.

2.3 STATION OPERATOR

The station operator shall:

- Coordinate with his/her supervisor, project manager, and ARS field specialist concerning the schedule and requirements for routine and emergency maintenance.
- Perform all procedures described in site- or network-specific CIs.
- Thoroughly document all procedures performed during each site visit.
- Report any noted inconsistencies immediately to the field specialist.

3.0 REQUIRED EQUIPMENT AND MATERIALS

Site visits are generally performed weekly. Equipment needed for a weekly visit includes:

- Keys for the shelter or support system internal lock and padlocks
- A Site Operator's Manual that includes site- or network-specific CIs, and other site- or network-specific documentation

4.0 METHODS

The station operator will perform weekly site visits. The observations recorded during these visits verify the operation of the monitoring system. The station operator may also be called upon to perform troubleshooting, simple maintenance, and sensor replacements in consultation with the field specialist.

This section includes three (3) major subsections:

4.1 Weekly Visits
4.2 Troubleshooting, Maintenance, and Instrument Replacement
4.3 Documentation

4.1 WEEKLY VISITS

The station operator will make weekly observations at the site. Sites may have different configurations and DataView is customized for each site's instrumentation. While completing the DataView CIs, the operator will make some or all of the following observations:

OZONE (O_3) — Verify that the ozone analyzer is functioning properly. Check the ozone particulate filter weekly and change if necessary (at least every two weeks).

A monthly multipoint calibration is also performed as a more comprehensive check of the instrument's condition.

SULFUR DIOXIDE (SO_2) — Verify that the sulfur dioxide analyzer is functioning properly. Verify that the gas dilution calibrator is functioning properly. Change the sulfur dioxide filter every two weeks.

A monthly multipoint calibration is also performed as a more comprehensive check of the instrument's condition.

CARBON MONOXIDE (CO) — Verify that the carbon monoxide analyzer is functioning properly. Verify that the gas dilution calibrator is functioning properly. Change the carbon monoxide filter every two weeks.

A monthly multipoint calibration is also performed as a more comprehensive check of the instrument's condition.

OXIDES OF NITROGEN (NO_X) Verify that the oxides of nitrogen analyzer is functioning properly. Verify that the gas dilution calibrator is functioning properly. Change the oxides of nitrogen filter every two weeks.

A monthly multipoint calibration is also performed as a more comprehensive check of the instrument's condition.

The station operator should promptly report any noted inconsistencies to the field specialist.

4.2 TROUBLESHOOTING, MAINTENANCE, AND INSTRUMENT REPLACEMENT

If a malfunction of any monitoring component occurs, or if any of the readings do not make sense, the station operator should call the Operation Support Center (1-970-484-7941) to report any discrepancy. A field technician will instruct the station operator on troubleshooting procedures.

TROUBLESHOOTING If a potential malfunction or other inconsistency is noted, the station operator will be directed to perform a series of troubleshooting procedures. The use of certain tools or diagnostic equipment (most frequently a digital voltmeter) will be required. The field specialist will step the station operator through the proper procedures by telephone, fax, or electronic mail. Typical procedures may include continuity checks, supply voltage checks, bearing observations, datalogger interrogation, or specific instrument performance observations. The operator will be asked to thoroughly record his/her findings and relate them to the field specialist for further action.

MAINTENANCE The station operator may be asked to perform certain mechanical, electrical, electronic, or datalogger program maintenance as directed by the field specialist. Typical maintenance tasks could include tightening tower guy wires, replacing backup batteries, resetting a power line breaker, or restarting system components. All maintenance must be thoroughly documented and the results related to the field specialist.

ANALYZER REPLACEMENT Under the field specialist's direction, the station operator may be asked to replace a malfunctioning sensor with a pre-calibrated unit. The unit would be subsequently calibrated on-site at a later date by the field specialist. All replacement steps will be reviewed by telephone with the station operator. Instrument-specific manuals or other diagrams or descriptions will be referenced as appropriate. All sensor replacement procedures including the sensor type, make, serial number, and date and time of replacement must be documented.

4.3 DOCUMENTATION

Weekly operator checks entered in the Checklist Instructions are automatically documented in the DataView station log. Any additional troubleshooting, maintenance, or sensor replacement actions must be documented in the station log using DataView.

In the event of a DataView computer malfunction, the operator must manually complete a hard copy version of each Checklist Instruction. These paper hard copies exist in the Site Operator's Manual. Upon completion, the site operator must mail or fax the completed forms to:

Air Resource Specialists, Inc.
Attn: IMC
1901 Sharp Point Drive Suite E
Fort Collins, CO 80525
Fax: 970/484-3423

Checklist Instruction - Weekly Station Visit

- **Ozone Analyzer (TEI 49*i*)**
- **Ozone Calibrator (TEI 49*i*)**
- **CASTNet Dry Deposition**

Checklist Instruction Number: **3178-3112**

Revision Number / Date: **0 / July 2012**

Objective: Weekly checks of the ozone instrumentation and the CASTNet dry deposition filter pack are to:

- Verify that the ozone analyzer is functioning properly.
- Check the analyzer particulate filter in the orange holder and change if necessary. The filter must be changed no less than every two weeks.
- Perform a leak check on the ozone analyzer sample manifold.
- Change the CASTNet dry deposition filter pack, verify the operational integrity of the filter pack system, complete the SSRF, and return the exposed filter pack and SSRF to the CASTNet contractor.

---

1. Check for an alarm condition on the front panel of the ozone analyzer. Report alarms to the OSC.

Alarm conditions are indicated on the TEI 49*i* ozone analyzer with a “bell symbol” in the front panel display, as shown below:

	CONCENTRATION		
O3			62.7 PPB
		16:45	
RANGE	AVG	DIAGS	ALARM

To list specific alarms, press the Alarm softkey on the analyzer to access the Alarm screen:

```
                CONCENTRATION

O3                                    67.0 PPB
                   12:16
ALARMS:
  ALARMS DETECTED                            1
 >O3 LAMP TEMP                              OK
  LAMP TEMP                                 OK
  BENCH TEMP                               LOW
  PRESSURE                                  OK
  FLOW A                                    OK
  FLOW B                                    OK↓

RANGE       AVG       DIAGS       ALARM
```

Call the Operation Support Center to report and resolve the alarms that have been flagged on the right side of the display. Record the significant actions related to the alarms in the site logbook. Press the Run (▶) button once to return to the Run mode when diagnostics are completed.

2. Take the ozone analyzer and flow offline and shut off the CASTNet flow pump and hour meter.

To ensure that only ambient and flow data are recorded in the hourly average, it is necessary to mark the O_3, O3CAL, and FLW channels offline. Data marked in this manner are automatically excluded from the valid data set.

To access the Login Screen of the ESC datalogger press <**Esc**> on the keyboard a couple of times until the Home Menu is displayed:

```
ESC 88XX v5.31  ID:RM              Home Menu              04/26/02  11:30:27

    H   Help Screen
    L   Login/Set User Level


    O   Log Out/Exit
```

Press <**L**> for Login/Set User Level:

```
ESC 88XX v5.31  ID:RM             Login Screen            04/26/02  11:30:27

    Enter Password                   **************
```

Login by typing user name and password on the keyboard then press <**Enter**>. The datalogger display will look similar to:

```
ESC 88XX v5.31  ID:RM              Home Menu              04/26/02  11:30:27

    H  Help Screen
    L  Login/Set User Level
    C  Configuration Menu
    D  Real-Time Display Menu
    R  Report Generation Menu
    G  Graph Generation Menu
    S  Status Menu
    O  Log Out/Exit
    X  Serial Como to Port
```

Press <**C**> for Configuration Menu:

```
ESC 88XX v5.31  ID:RM           Configuration Menu        04/26/02  11:30:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88XX v5.31  ID:RM        Channel Configuration Menu    04/26/02   11:30:27

    N  Enter New Configuration
    C  Change Old Configuration
    D  Delete Old Configuration
    M  Disable/Mark Channel Offline
    E  Enable/Mark Channel Online
    I  Put Channel In Maint.
    O  Take Channel Out of Maint.
```

Press <**M**> for Disable/Mark Channel Offline:

```
ESC 88XX v5.31  ID:RM    Choose(Space Toggle/Enter Select)  04/26/02  11:30:27

    O3     [01]
    O3CAL  [02]
    O3R8   [03]
    VWD    [04]
    SIG    [05]
    VWS    [06]
    SWS    [07]
    TMP    [08]
    DTP    [09]
    SOL    [10]
    RNF    [11]
    WET    [12]
    FLW    [13]
    STP    [14]
```

Use the ↑ and ↓ keys to navigate and the spacebar to select the O3, O3CAL, and FLW channels for offline status. The channels should be marked with a ">" indicating imminent offline status. Press <**Enter**> to take the marked channels offline.

Check the status of the channels by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu**.** Press <**F**> to display the data channels with flags. O3, O3CAL, FLW should be marked with a *D* flag to the right to indicate offline status. The offline time is automatically recorded in the logbook when this step is complete.

Switch off the pump and the hour meter for the CASTNet flow system. The labeled switches are located below the CASTNet flow box.

3. Tip the dry deposition tower and replace the analyzer particulate filter in the orange holder every two weeks or as needed.

Lower the flow tower only during good weather (e.g., no electrical storms, high winds, heavy ice buildup, or obvious tower damage). First remove the locking pin to allow the tower to be lowered. Then gently control its descent with the attached rope. Secure the tower by tying the rope to the base.

The dry deposition filter and particulate filter resides in the "pothead" at the top of the tower. The particulate filter is in a Teflon housing with an orange tightening ring. Look through the “T” at the bottom for obvious fine debris or discoloration on the filter. If the filter is unfit for another week of service, it must be changed. Install a clean filter when it is visibly dirty or once every 2 weeks, whichever comes first.

The filter protects the sample inlet system from particulate that could contaminate and subsequently reduce the ambient ozone concentrations. Proper filter inspection and replacement is key in maintaining accurate readings of ambient ozone concentrations.

To open the particulate filter holder, loosen the orange tightening ring from the filter housing using the dark green filter wrenches supplied by the Operation Support Center.

Begin a filter change by removing and discarding the exposed filter. Using the provided tweezers remove a new 5μ Teflon filter from the envelope and install it into the filter housing. The 5μ filter envelope has an orange color code. Ensure that the filter remains clean during this process since contamination reduces the ozone concentrations in the sampling stream. Reassemble the filter holder and tighten the orange ring securely using the filter wrenches.

4. If a new analyzer particulate filter (orange holder) was installed, perform leak check of the ozone intake manifold system.

It is important to know that the inlet system does not have any leaks which could impact the air sample presented to the ozone analyzer. This simple procedure should be performed after each filter change. Carefully thread a Teflon plug (cap) onto the open port of the Teflon “tee” that is situated directly below the orange filter holder. Make sure the plug is tight.

Observe the pressure value on the 49*i* ozone analyzer. Do this by selecting **<DIAGS>, <Pressure>** from the analyzer front panel display. The pressure will be displayed in millimeters of mercury. The display should drop and come to rest at a value below 250 mm which will indicate a leak-free inlet system. Record the pressure value on the DataView checklist.

Should the pressure not drop below 250 mm Hg, initiate the following corrective action:

A) Tighten the orange filter holder with the green filter wrenches.

B) Tighten the Teflon nuts of the "tee" and filter holder in the pothead.

C) Tighten all Teflon nuts on the back of the analyzer and calibrator.

If this still does not result in a satisfactory leak check, please contact the monitoring support contractor.

Note: A pressure alarm may sound during this test. Disregard this alarm.

5. If a new analyzer particulate filter (orange holder) was installed, condition it by starting a DIAGSZ.

Following a filter change, a DIAGSZ is required to verify the integrity of the sampling system and to condition the new filter. From the ESC datalogger Home Menu, press <**C**> for Configuration Menu:

```
ESC 88XX v5.31  ID:RM          Configuration Menu          04/26/02  11:30:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**C**> again for Configure Calibrations:

```
ESC 88XX v5.31  ID:RM         Cal Configuration Menu       04/26/02  11:30:27

    N  Enter New Cal Configuration
    C  Change Old Cal Configuration
    D  Delete Old Cal Configuration
    S  Start a Calibration Program
    1  Start a Single Phase Cal
    A  Abort a Calibration Program
    Q  Quick Expected Value Editor
    I  Return to Interactive Cal
```

Press <**S**> for Start a Calibration Program:

```
ESC 88XX v5.31   ID:RM       Choose List (Enter to Select)    04/26/02  11:30:27


    PSZ
    DIAGSPAN
    DIAGZERO
    DIAGPREC
    DIAGSZ

     Refresh   Exit       GOTO END  GOTO TOP    Clr Keys    Select
```

From the Choose List Menu, use the ↑ and ↓ keys to highlight DIAGSZ. This is an ozone calibration sequence that begins with a 15-minute span phase and concludes with a 5-minute zero phase. The control of the calibration sequence is automatic. Press <**Enter**> and several things occur immediately. Pump noise in the shelter increases dramatically as the ozone calibrator (O3CAL) sample pump and the zero air pumps switch to on.

After 15 minutes the span phase will conclude and the zero phase will commence.

After 5 additional minutes, the zero will turn off and ambient collection will resume automatically. Before leaving the station, you will be asked to find and record the stored results.

6. Remove the exposed CASTNet dry deposition filter cartridge, perform a flow system leak check and complete last week's SSRF.

To confirm that all systems are in good operational condition and that filters are handled correctly, the operator is required to check each component and change filters weekly.

A mailing tube is sent to your site weekly by MACTEC E&C, in Gainesville, Florida. Each tube contains a sample filter pack enclosed in a Ziplock® bag and a Site Status Report Form (SSRF). Filters are generally changed each Tuesday. Call the Operation Support Center for exceptions.

Begin this week's filter change by completing last weeks SSRF. In the FILTER OFF column on last week's SSRF, record the dry deposition flow box rotameter reading observed at the middle of the ball.

Obtain the most recent Hourly Average for flow by starting at the Home Menu of the datalogger. Press <**R**> for Report Generation Menu. Then press <**R**> for Daily Averages Report. In the highlighted Show Channels field type "FLW" and press **<Enter>** four times to view the Daily Report to Screen.

```
ESC 88XX v5.31   ID:RM              Daily Report Screen       04/26/02  11:30:27

    Show Channels              :       FLW



    Start Time                 :       04/26/02 00:00:00
    # of Flags to Report       :       02
    Daily Report to Screen     :
    Daily Report to Printer    :
```

```
 Daily Average         04/26/02 11:30:27        JDay:  116    Logger ID: BL
    Report                      ROCKY MOUNTAIN NATIONAL PARK
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
Name:                       FLW
Channel Num:                15
Analog Input:               10
Units:                      SLPM
Full Scale:                    5 V
High Output:                5.89
Low Output:                 0.00
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
       - -
04/26 02:00                  3.00
04/26 03:00                  3.00
04/26 04:00                  3.00
04/26 05:00                  3.00
04/26 06:00                  3.00
04/26 07:00                  3.00
04/26 08:00                  3.00
04/26 09:00                  3.00
04/26 10:00                  3.00
04/26 11:00                -9999.<N
04/26 12:00                -9999.<N
04/26 13:00                -9999.<N
04/26 14:00                -9999.<N
```

Obtain the most recent datalogger HOURLY AVERAGE for FLW and record it in the FILTER OFF DAS FLOW (LPM) entry cell on the SSRF. In this example the most recent hourly average occurs at 10:00 and is 3.00.

Remove the CASTNet dry deposition filter.

A) Wearing clean vinyl gloves (provided by the Operation Support Center), remove the dry deposition filter pack from the tower by pulling back on the locking ring of the quick-disconnect. Once the filter is removed the quick-disconnect provides an airtight seal.

B) Insert the plastic caps that were saved in the shipping container to avoid contamination to the filter.

C) Place the filter pack in its Ziplock® bag.

D) Enter the date and time for FILTER OFF on last week's SSRF.

E) Remove your gloves and discard them.

F) Observe the current reading of the Mass Flow Controller (MFC) display. It should be close to zero. Record this value as the MFC (pump off) under FILTER OFF on last week's SSRF.

G) Turn on the pump to leak check the sampling system. Let the MFC value stabilize and record the value in the MFC LEAK CHECK box on last week's SSRF. The new value should also be close to zero. Call the OSC if the MFC (pump off) and the MFC LEAK CHECK are more than ± 0.03 different. Turn off the pump.

H) Record the hour meter reading as the ELAPSED TIME (HRS).

I) Record the expected ship date, then sign and date the form on the PREPARED BY line. At this point, last week's SSRF should be complete; the white, yellow, and gold copies and the filter you just removed can be packed in last week's mailing tube for shipment to MACTEC E&C. The pink copy remains in your stations file cabinet.

Inspect the plumbing for signs of obvious deterioration or moisture. If either is discovered, report your finding to the OSC.

7. Install new CASTNet dry deposition cartridge, raise the tower, and reset hour meter. Begin the new SSRF and turn on pump and hour meter.

Open the mailing tube containing this week's filter and a new SSRF. Enter the codes for the site name and number. The codes are found on the side of the filter housing and on the Chain of Custody label. Enter the date, followed by the day of the week in the VISIT DATE/DAY field. If the plumbing has not been disturbed you may enter your previous leak check results in the MFC LEAK CHECK cell in the FILTER ON column. Enter your name and the date on the SHIPMENT OPENED BY line.

Enter the filter pack number from the label on the filter pack housing. Back outside, release the vacuum at the filter quick-disconnect by pressing into the center of the connector until you hear a faint rush of air. Use a small clean screwdriver.

Put on clean vinyl gloves and remove the caps from the new filter pack. Seal the caps in the Ziplock® bag and store the bag in the mailing tube until next week.

Install the filter pack by pressing it into the fitting until you hear a "snap," indicating a secure connection. Discard the gloves.

Raise the tower slowly and secure it by inserting the locking pin.

Reset the hour meter to zero. Turn on the flow pump and the hour meter.

Enter the FILTER ON date and time on the new SSRF, using the Local Standard Time (LST) displayed by the datalogger. Ensure that the readout box LED display reaches the set point recorded on the calibration label affixed to the case.

8. Bring the O3, O3CAL, and FLW channels back online.

Bring the O3, O3CAL, and FLW channels online by beginning at the Home Menu of the ESC datalogger. Remember that pressing <**Esc**> several times will return you eventually to the Home Menu.

```
ESC 88XX v5.31  ID:RM                Home Menu              04/26/02  11:30:27

    H  Help Screen
    L  Login/Set User Level
    C  Configuration Menu
    D  Real-Time Display Menu
    R  Report Generation Menu
    G  Graph Generation Menu
    S  Status Menu
    O  Log Out/Exit
    X  Serial Como to Port
```

Press <**C**> for Configuration Menu:

```
ESC 88XX v5.31  ID:RM          Configuration Menu         04/26/02  11:30:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88XX v5.31  ID:RM       Channel Configuration Menu    04/26/02  11:30:27

    N  Enter New Configuration
    C  Change Old Configuration
    D  Delete Old Configuration
    M  Disable/Mark Channel Offline
    E  Enable/Mark Channel Online
    I  Put Channel In Maint.
    O  Take Channel Out of Maint.
```

Press <**E**> for Enable/Mark Channel Online. O3 and FLW should be the only channels displayed.

```
ESC 88XX v5.31  ID:RM    Choose(Space Toggle/Enter Select)  04/26/02  11:30:27

  > O3     [01]
    O3CAL  [02]
    FLW    [15]
```

Use the ↑ and ↓ keys to navigate and the spacebar to select a channel. Press the <**Spacebar**> to select both channels for online status. Press <**Enter**> to put the selected channels online.

```
ESC 88XX v5.31  ID:RM    Choose(Space Toggle/Enter Select)  04/26/02  11:30:27

   > O3     [01]
   > O3CAL  [02]
   > FLW    [15]
```

Check the status of the O3, O3CAL, and FLW channels by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> once to display the data channels with flags. O3, O3CAL, O3R8, and FLW will no longer be marked with a flag indicating online status; a *P* may be in the flag column for each indicating a purge period programmed to allow for the time it takes for ambient conditions to prevail. The *P* flag should clear within one minute. The online time will be recorded in the logbook when this step is complete.

Note: If the calibration sequence, DIAGSZ, is still active, O3, O3CAL, and O3R8 will be flagged with a *C*.

9-10. If a new analyzer particulate filter (orange holder) was installed and a DIAGSZ was activated enter the filter conditioning results for O3 and O3CAL.

From the Home Menu press <**R**> for Report Generation Menu:

```
ESC 88XX v5.31  ID:BL         Report Menu          08/06/97  14:59:27

    A Report Averages
    C Report Calibrations
    L Summarize Last Cals
    Q Autoprint Data Channel(s)
    D Autopring Daily Report
    Z Autoprint Calibration(s)
    R Daily Averages Report
    T Daily Calibrations Report
```

Press <**L**> for Summarize Last Cals. Navigate through the Last Cals using the <**D**> (down) or <**U**> (up) keys to find the DIAGSZ:

DIAGSZ	08/14 08:00	EXPECTED	ACTUAL	ERROR	UNITS	FLAGS
O3	SPAN	400	406.1	6.1	PPB	DC
	ZERO	0	-0.1956	0	PPB	DC
O3 CAL	SPAN	400	403.9	3.9	PPB	DC
	ZERO	0	1.0100	1.01	PPB	DC

Record the O3 and O3CAL from the ACTUAL column into the appropriate cells of the checklist. The result location has been highlighted in the graphic above.

O3ZERO	Value between -5 and +5 ppb
O3SPAN	Value within 10% of O3CAL SPAN
O3CAL ZERO	Value between -5 and +5 ppb
O3CAL SPAN	Value between 350 and 450 ppb

The checklist will prompt you to call the OSC if the results were not within tolerance.

Checklist Instruction - Weekly Station Visit

- **Ozone Analyzer (TEI 49C)**
- **Ozone Calibrator (TEI 49C)**
- **CASTNet Dry Deposition**

Checklist Instruction Number: **3178-3116**

Revision Number / Date: **4 / January 2006** **(last reviewed Jan. 2012)**

Objective: Weekly checks of the ozone instrumentation and the CASTNet dry deposition filter pack are to:

- Verify that the ozone analyzer is functioning properly.
- Check the analyzer particulate filter in the orange holder and change if necessary. The filter must be changed no less than every two weeks.
- Change the CASTNet dry deposition filter pack, verify the operational integrity of the filter pack system, complete the SSRF, and return the exposed filter pack and SSRF to the CASTNet contractor.

---

1. Check for an alarm condition on the front panel of the ozone analyzer. Report alarms to the OSC.

Alarm conditions are indicated on the TEI 49C ozone analyzer front panel display, as shown below:

```
O3 PPB                              67.0

                 ALARM           REMOTE
```

To list specific alarms, press the **MENU** button on the analyzer once to access the Main Menu*:*

```
MAIN MENU:                         10:25
> RANGE
  AVERAGING TIME
  CALIBRATION FACTORS
```

```
  CALIBRATION
  INSTRUMENT CONTROLS
  DIAGNOSTICS
  ALARM
```

Use the ↑ and ↓ buttons to move the cursor and press <**Enter**> once to access the Alarm Menu*:*

ALARMS DETECTED:	1
> BENCH TEMP	OK
BENCH LAMP TEMP	LOW
PRESSURE	OK
FLOW A	OK
FLOW B	OK
INTENSITY A	OK
INTENSITY B	OK
O3 CONC	OK

Call the Operation Support Center to report and resolve the alarms that have been flagged on the right side of the display. Record the significant actions related to the alarms in the site logbook. Press the **RUN** button once to return to the Run mode when diagnostics are completed.

2. Take the ozone analyzer and flow offline and shut off the CASTNet flow pump and hour meter.

To ensure that only ambient and flow data are recorded in the hourly average, it is necessary to mark the $O_{3,}$ O3CAL, and FLW channels offline. Data marked in this manner are automatically excluded from the valid data set.

To access the Login Screen of the ESC datalogger press <**Esc**> on the keyboard a couple of times until the Home Menu is displayed:

```
ESC 88XX v5.31   ID:RM            Home Menu            04/26/02   11:30:27

    H   Help Screen
    L   Login/Set User Level


    O   Log Out/Exit
```

Press <**L**> for Login/Set User Level:

```
ESC 88XX v5.31   ID:RM            Login Screen         04/26/02   11:30:27

    Enter Password                 **************
```

Login by typing user name and password on the keyboard then press <**Enter>**. The datalogger display will look similar to:

```
ESC 88XX v5.31  ID:RM             Home Menu             04/26/02  11:30:27

    H  Help Screen
    L  Login/Set User Level
    C  Configuration Menu
    D  Real-Time Display Menu
    R  Report Generation Menu
    G  Graph Generation Menu
    S  Status Menu
    O  Log Out/Exit
    X  Serial Como to Port
```

Press <**C**> for Configuration Menu:

```
ESC 88XX v5.31  ID:RM          Configuration Menu        04/26/02  11:30:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88XX v5.31  ID:RM       Channel Configuration Menu    04/26/02   11:30:27

    N  Enter New Configuration
    C  Change Old Configuration
    D  Delete Old Configuration
    M  Disable/Mark Channel Offline
    E  Enable/Mark Channel Online
    I  Put Channel In Maint.
    O  Take Channel Out of Maint.
```

Press <**M**> for Disable/Mark Channel Offline:

```
ESC 88XX v5.31  ID:RM    Choose(Space Toggle/Enter Select)  04/26/02  11:30:27

    O3     [01]
    O3CAL  [02]
    O3R8   [03]
    VWD    [04]
    SIG    [05]
    VWS    [06]
    SWS    [07]
    TMP    [08]
    DTP    [09]
    SOL    [10]
    RNF    [11]
    WET    [12]
    FLW    [13]
    STP    [14]
```

Use the ↑ and ↓ keys to navigate and the spacebar to select the O3, O3CAL, and FLW channels for offline status. The channels should be marked with a ">" indicating imminent offline status. Press <**Enter**> to take the marked channels offline.

Check the status of the channels by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu**.** Press <**F**> to display the data channels with flags. O3, O3CAL, FLW should be marked with a *D* flag to the right to indicate offline status. The offline time is automatically recorded in the logbook when this step is complete.

Switch off the pump and the hour meter for the CASTNet flow system. The labeled switches are located below the CASTNet flow box.

3. Tip the dry deposition tower and replace the analyzer particulate filter in the orange holder every two weeks or as needed.

Lower the flow tower only during good weather (e.g., no electrical storms, high winds, heavy ice buildup, or obvious tower damage). First remove the locking pin to allow the tower to be lowered. Then gently control its descent with the attached rope. Secure the tower by tying the rope to the base.

The dry deposition filter and particulate filter resides in the "pothead" at the top of the tower. The particulate filter is in a Teflon housing with an orange tightening ring. Look through the “T” at the bottom for obvious fine debris or discoloration on the filter. If the filter is unfit for another week of service, it must be changed. Install a clean filter when it is visibly dirty or once every 2 weeks, whichever comes first.

The filter protects the sample inlet system from particulate that could contaminate and subsequently reduce the ambient ozone concentrations. Proper filter inspection and replacement is key in maintaining accurate readings of ambient ozone concentrations.

To open the particulate filter holder, loosen the orange tightening ring from the filter housing using the dark green filter wrenches supplied by the Operation Support Center.

Begin a filter change by removing and discarding the exposed filter. Using the provided tweezers remove a new 5μ Teflon filter from the envelope and install it into the filter housing. The 5μ filter envelope has an orange color code. Ensure that the filter remains clean during this process since contamination reduces the ozone concentrations in the sampling stream. Reassemble the filter holder and tighten the orange ring securely using the filter wrenches.

4. If a new analyzer particulate filter (orange holder) was installed, condition it by starting a DIAGSZ.

Following a filter change, a DIAGSZ is required to verify the integrity of the sampling system and to condition the new filter. From the ESC datalogger Home Menu, press <**C**> for Configuration Menu:

```
ESC 88XX v5.31  ID:RM          Configuration Menu          04/26/02  11:30:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**C**> again for Configure Calibrations:

```
ESC 88XX v5.31  ID:RM         Cal Configuration Menu       04/26/02  11:30:27

    N  Enter New Cal Configuration
    C  Change Old Cal Configuration
    D  Delete Old Cal Configuration
    S  Start a Calibration Program
    1  Start a Single Phase Cal
    A  Abort a Calibration Program
    Q  Quick Expected Value Editor
    I  Return to Interactive Cal
```

Press <**S**> for Start a Calibration Program:

```
ESC 88XX v5.31  ID:RM      Choose List (Enter to Select)   04/26/02  11:30:27


    PSZ
    DIAGSPAN
    DIAGZERO
    DIAGPREC
    DIAGSZ


     Refresh  Exit      GOTO END  GOTO TOP   Clr Keys    Select
```

From the Choose List Menu, use the ↑ and ↓ keys to highlight DIAGSZ. This is an ozone calibration sequence that begins with a 15-minute span phase and concludes with a 5-minute zero phase. The control of the calibration sequence is automatic. Press <**Enter**> and several things occur immediately. Pump noise in the shelter increases dramatically as the ozone calibrator (O3CAL) sample pump and the zero air pumps switch to on.

After 15 minutes the span phase will conclude and the zero phase will commence.

After 5 additional minutes, the zero will turn off and ambient collection will resume automatically. Before leaving the station, you will be asked to find and record the stored results.

5. Remove the exposed CASTNet dry deposition filter cartridge, perform a flow system leak check and complete last week's SSRF.

To confirm that all systems are in good operational condition and that filters are handled correctly, the operator is required to check each component and change filters weekly.

A mailing tube is sent to your site weekly by MACTEC E&C, in Gainesville, Florida. Each tube contains a sample filter pack enclosed in a Ziplock® bag and a Site Status Report Form (SSRF). Filters are generally changed each Tuesday. Call the Operation Support Center for exceptions.

Begin this week's filter change by completing last weeks SSRF. In the FILTER OFF column on last week's SSRF, record the dry deposition flow box rotameter reading observed at the middle of the ball.

Obtain the most recent Hourly Average for flow by starting at the Home Menu of the datalogger. Press <**R**> for Report Generation Menu. Then press <**R**> for Daily Averages Report. In the highlighted Show Channels field type "FLW" and press **<Enter>** four times to view the Daily Report to Screen.

```
ESC 88XX v5.31   ID:RM            Daily Report Screen        04/26/02   11:30:27

    Show Channels              :        FLW


    Start Time                 :        04/26/02 00:00:00
    # of Flags to Report       :        02
    Daily Report to Screen     :
    Daily Report to Printer    :
```

```
 Daily Average           04/26/02 11:30:27        JDay:  116    Logger ID: BL
    Report                        ROCKY MOUNTAIN NATIONAL PARK
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
- -
Name:                            FLW
Channel Num:                     15
Analog Input:                    10
Units:                           SLPM
Full Scale:                         5 V
High Output:                     5.89
Low Output:                      0.00
- - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
       - -
04/26 00:00                       3.00
04/26 01:00                       3.00
04/26 02:00                       3.00
04/26 03:00                       3.00
04/26 04:00                       3.00
04/26 05:00                       3.00
04/26 06:00                       3.00
04/26 07:00                       3.00
04/26 08:00                       3.00
04/26 09:00                       3.00
04/26 10:00                       3.00
04/26 11:00                     -9999.<N
04/26 12:00                     -9999.<N
04/26 13:00                     -9999.<N
04/26 14:00                     -9999.<N
```

Obtain the most recent datalogger HOURLY AVERAGE for FLW and record it in the FILTER OFF DAS FLOW (LPM) entry cell on the SSRF. In this example the most recent hourly average occurs at 10:00 and is 3.00.

Remove the CASTNet dry deposition filter.

A) Wearing clean vinyl gloves (provided by the Operation Support Center), remove the dry deposition filter pack from the tower by pulling back on the locking ring of the quick-disconnect. Once the filter is removed the quick-disconnect provides an airtight seal.

B) Insert the plastic caps that were saved in the shipping container to avoid contamination to the filter.

C) Place the filter pack in its Ziplock® bag.

D) Enter the date and time for FILTER OFF on last week's SSRF.

E) Remove your gloves and discard them.

F) Observe the current reading of the Mass Flow Controller (MFC) display. It should be close to zero. Record this value as the MFC (pump off) under FILTER OFF on last week's SSRF.

G) Turn on the pump to leak check the sampling system. Let the MFC value stabilize and record the value in the MFC LEAK CHECK box on last week's SSRF. The new value should also be close to zero. Call the OSC if the MFC (pump off) and the MFC LEAK CHECK are more than ± 0.03 different. Turn off the pump.

H) Record the hour meter reading as the ELAPSED TIME (HRS).

I) Record the expected ship date, then sign and date the form on the PREPARED BY line. At this point, last week's SSRF should be complete; the white, yellow, and gold copies and the filter you just removed can be packed in last week's mailing tube for shipment to MACTEC E&C. The pink copy <u>remains</u> in your stations file cabinet.

Inspect the plumbing for signs of obvious deterioration or moisture. If either is discovered, report your finding to the OSC.

6. Install new CASTNet dry deposition cartridge, raise the tower, and reset hour meter. Begin the new SSRF and turn on pump and hour meter.

Open the mailing tube containing this week's filter and a new SSRF. Enter the codes for the site name and number. The codes are found on the side of the filter housing and on the Chain of Custody label. Enter the date, followed by the day of the week in the VISIT DATE/DAY field. If the plumbing has not been disturbed you may enter your previous leak check results in the MFC LEAK CHECK cell in the FILTER ON column. Enter your name and the date on the SHIPMENT OPENED BY line.

Enter the filter pack number from the label on the filter pack housing. Back outside, release the vacuum at the filter quick-disconnect by pressing into the center of the connector until you hear a faint rush of air. Use a small clean screwdriver.

Put on clean vinyl gloves and remove the caps from the new filter pack. Seal the caps in the Ziplock® bag and store the bag in the mailing tube until next week.

Install the filter pack by pressing it into the fitting until you hear a "snap," indicating a secure connection. Discard the gloves.

Raise the tower slowly and secure it by inserting the locking pin.

Reset the hour meter to zero. Turn on the flow pump and the hour meter.

Enter the FILTER ON date and time on the new SSRF, using the Local Standard Time (LST) displayed by the datalogger. Ensure that the readout box LED display reaches the set point recorded on the calibration label affixed to the case.

7. Bring the O3, O3CAL, and FLW channels back online.

Bring the O3, O3CAL, and FLW channels online by beginning at the Home Menu of the ESC datalogger. Remember that pressing <**Esc**> several times will return you eventually to the Home Menu.

```
ESC 88XX v5.31   ID:RM              Home Menu              04/26/02   11:30:27

    H  Help Screen
    L  Login/Set User Level
    C  Configuration Menu
    D  Real-Time Display Menu
    R  Report Generation Menu
    G  Graph Generation Menu
    S  Status Menu
    O  Log Out/Exit
    X  Serial Como to Port
```

Press <**C**> for Configuration Menu:

```
ESC 88XX v5.31   ID:RM          Configuration Menu         04/26/02   11:30:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**D**> for Configure (Data) Channels:

```
ESC 88XX v5.31  ID:RM        Channel Configuration Menu    04/26/02  11:30:27

    N Enter New Configuration
    C Change Old Configuration
    D Delete Old Configuration
    M Disable/Mark Channel Offline
    E Enable/Mark Channel Online
    I Put Channel In Maint.
    O Take Channel Out of Maint.
```

Press <**E**> for Enable/Mark Channel Online. O3 and FLW should be the only channels displayed.

```
ESC 88XX v5.31  ID:RM    Choose(Space Toggle/Enter Select)  04/26/02  11:30:27

  > O3      [01]
    O3CAL   [02]
    FLW     [15]
```

Use the ↑ and ↓ keys to navigate and the spacebar to select a channel. Press the <**Spacebar**> to select both channels for online status. Press <**Enter**> to put the selected channels online.

```
ESC 88XX v5.31  ID:RM    Choose(Space Toggle/Enter Select)  04/26/02  11:30:27

   > O3      [01]
   > O3CAL   [02]
   > FLW     [15]
```

Check the status of the O3, O3CAL, and FLW channels by pressing <**Esc**> several times until the Home Menu is displayed. Press <**D**> once to enter the Real-Time Display Menu. Press <**F**> once to display the data channels with flags. O3, O3CAL, O3R8, and FLW will no longer be marked with a flag indicating online status; a *P* may be in the flag column for each indicating a purge period programmed to allow for the time it takes for ambient conditions to prevail. The *P* flag should clear within one minute. The online time will be recorded in the logbook when this step is complete.

Note: If the calibration sequence, DIAGSZ, is still active, O3, O3CAL, and O3R8 will be flagged with a *C*.

8-9. If a new analyzer particulate filter (orange holder) was installed and a DIAGSZ was activated enter the filter conditioning results for O3 and O3CAL.

From the Home Menu press <**R**> for Report Generation Menu:

```
ESC 88XX v5.31   ID:BL          Report Menu          08/06/97   14:59:27

    A  Report Averages
    C  Report Calibrations
    L  Summarize Last Cals
    Q  Autoprint Data Channel(s)
    D  Autopring Daily Report
    Z  Autoprint Calibration(s)
    R  Daily Averages Report
    T  Daily Calibrations Report
```

Press <**L>** for Summarize Last Cals. Navigate through the Last Cals using the <**D**> (down) or <**U**> (up) keys to find the DIAGSZ:

DIAGSZ	08/14 08:00	EXPECTED	ACTUAL	ERROR	UNITS	FLAGS
O3	SPAN	400	406.1	6.1	PPB	DC
	ZERO	0	-0.1956	0	PPB	DC
O3 CAL	SPAN	400	403.9	3.9	PPB	DC
	ZERO	0	1.0100	1.01	PPB	DC

Record the O3 and O3CAL from the ACTUAL column into the appropriate cells of the checklist. The result location has been highlighted in the graphic above.

O3ZERO	Value between -5 and +5 ppb
O3SPAN	Value within 10% of O3CAL SPAN
O3CAL ZERO	Value between -5 and +5 ppb
O3CAL SPAN	Value between 350 and 450 ppb

The checklist will prompt you to call the OSC if the results were not within tolerance.

Checklist Instruction - Multipoint Calibration

- **Ozone Analyzer (TEI 49C)**
- **Ozone Calibrator (TEI 49C)**

Checklist Instruction Number: **3178-3315**

Revision Number / Date: **2 / July 2012** **(last reviewed July 2012)**

Objective: Monthly multipoint calibrations are performed to provide a more comprehensive check of the instrument's condition and verify the ozone analyzer's response to ozone free (zero) air and three (3) upscale ozone concentrations:

- 360 to 440 ppb
- 150 to 200 ppb
- 50 to 80 ppb

---

1. Start a DIAGZERO sequence from the ESC datalogger.

From the ESC datalogger Home Menu, press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL      Configuration Menu       08/06/97  14:59:27

    P Set Passwords
    S Configure System Parameters
    D Configure (Data) Channels
    C Configure Calibrations
    A Configure Alarms
    O Configure Analog Outputs
    K Configure Math Constants
    E Configure Dig. Event Program
    R Configure Digital I/O
    1 Configure Serial Protocols
```

Press <**C**> again for Configure Calibrations:

```
ESC 88xx v5.31  ID:BL     Cal Configuration Menu     08/06/97  14:59:27

    N Enter New Cal Configuration
    C Change Old Cal Configuration
    D Delete Old Cal Configuration
    S Start a Calibration Program
    1 Start a Single Phase Cal
    A Abort a Calibration Program
    Q Quick Expected Value Editor
    I Return to Interactive Cal
```

Press <**S**> for Start a Calibration Program:

```
ESC 88xx v5.31  ID:BL    Choose List (Enter to Select)     08/06/97  14:59:27


    PSZ
    DIAGSPAN
    DIAGZERO
    DIAGPREC
    DIAGSZ

     F2       <ESC>      TAB        CTRL-K     CTRL-R      Arrows
     Refresh  Exit       GOTO END   GOTO TOP   Clr Keys    Select
```

From the Choose List Menu, use the ↑ and ↓ keys to highlight DIAGZERO. This is an ozone calibration sequence that initiates a 30-minute zero. The control of the calibration sequence is automatic. Press <**Enter**> and several things occur immediately. Pump noise in the shelter increases dramatically as the ozone calibrator (O3CAL) sample pump and the zero air pump switch on. The alarm on the front panel of the ozone calibrator should go off within a few seconds. Inspect the front panel of the ozone analyzer and the ozone calibrator. If either panel is displaying an alarm, abort the multipoint calibration and call the Operation Support Center for diagnostic support. Restart the multipoint when the alarms have been resolved.

Press <**Esc**> several times to return to the datalogger Home Menu.

From the Home Menu, select <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31  ID:BL      Real-Time Display Menu       08/06/97  14:59:27

    V  Display Raw Readings
    R  Display Readings w/units
    F  Display Readings w/flags
    B  Display Last Base Avg
    C  Continuous Avg Report
    L  Show LARGE TEXT Display
    I  Display Digital Inputs
    O  Display Digital Outputs
    A  Display Analog Outputs
```

Press <**C**> for Continuous Avg Report:

```
ESC 88xx v5.31  ID:BL      Continuous Avg Report Setup       08/06/97  14:59:27


    Average Interval                    :  1m
    Show Channels                       :  O3,O3CAL,RNF


    # of Flags to Report                :  02
    Use Decimal Positioner?             :  Y
    Start Continuous Report
```

Enter a <**1**> and then <**m**> for the Average Interval if it has not defaulted to the 1m. Arrow down to Show Channels. Type **O3** and **O3CAL** if it is not already displayed. Arrow down to Start Continuous Report and press <**Enter**>.

TIME	O3	O3CAL	RNF
08/06 14:59	41.<C	-1.<C	0.0

2. **Check for an alarm condition on the front panel of the ozone analyzer. Report alarms to the OSC before proceeding with the multipoint calibration.**

   Alarm conditions are indicated on the TEI 49C ozone analyzer front panel display, as shown below:

O3 PPB		0.0
ZERO	ALARM	REMOTE

3. **Check for an alarm condition on the display of the ozone calibrator. The display should not show an alarm condition during the DIAGZERO. Report alarms to the OSC before proceeding with the multipoint calibration.**

   Previous to the initiation of the DIAGZERO sequence, the normal TEI 49C ozone calibrator front panel will display an alarm condition as shown below:

O3 PPB		0.0
	ALARM	REMOTE

   When the DIAGZERO sequence has been initiated, the ozone calibrator sample pump will start and the alarm condition will no longer be visible. As the flow rate approaches its set point, the ALARM indicator will be replaced with and indication of the time of day as shown below:

O3 PPB		0.0
	10:25	REMOTE

   Note: The time of day need not be correct for the calibrator to operate properly.

   If the alarm condition persists after one minute into the DIAGZERO calibration sequence, call the Operation Support Center.

4. Observe the continuous average report for several minutes. When five or more 1-minute updates indicate a stable zero response, +5ppb to –5ppb, record the last 1-minute averages for O3 and O3CAL.

After several minutes the Continuous Average Report will display the arrays of 1-minute updates for O3 and O3CAL.

```
TIME                   O3    O3CAL     RNF

10/19 11:30            41.<C -1.<C     0.0
10/19 11:31             4.<C -0.<C     0.0
10/19 11:32             0.<C -1.<C     0.0
10/19 11:33            -1.<C  1.<C     0.0
10/19 11:34             0.<C  1.<C     0.0
```

Once the following conditions have been met:

1. The last five 1-minute averages of O3 are in the range of +5ppb to –5ppb.
2. The last five 1-minute averages of O3CAL are in the range of +5ppb to –5ppb.

Record the last 1-minute average of O3 and O3CAL. If the conditions are not met, even after several more minutes, do not proceed further with the multipoint calibration. Call the OSC for diagnostic support.

If the zero values were successful and recorded, abort the DIAGZERO.

Press <**Esc**> several times to return to the Home Menu. Press <**C**> for the Configuration Menu:

```
ESC 88xx v5.31  ID:BL      Configuration Menu       08/06/97  14:59:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**C**> again for Configure Calibrations:

```
ESC 88xx v5.31  ID:BL     Cal Configuration Menu     08/06/97  14:59:27

    N  Enter New Cal Configuration
    C  Change Old Cal Configuration
    D  Delete Old Cal Configuration
    S  Start a Calibration Program
    1  Start a Single Phase Cal
    A  Abort a Calibration Program
    Q  Quick Expected Value Editor
    I  Return to Interactive Cal
```

Press <**A**> for Abort a Calibration Program:

```
ESC 88xx v5.31  ID:BL    Choose List (Enter to Select)     08/06/97  14:59:27


    PSZ
    DIAGSPAN
    DIAGZERO
    DIAGPREC
    DIAGSZ


     F2        <ESC>      TAB        CTRL-K     CTRL-R      Arrows
     Refresh   Exit       GOTO END   GOTO TOP   Clr Keys    Select
```

From the Choose List Menu, use the ↑ and ↓ keys to highlight DIAGZERO.

Press <**Enter**> and the zero air pump and ozone calibrator pump turn off. The alarm condition should reappear on the front panel of the ozone calibrator.

5. Start a DIAGSPAN.

From the ESC datalogger Home Menu, press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL      Configuration Menu      08/06/97  14:59:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**C**> again for Configure Calibrations:

```
ESC 88xx v5.31  ID:BL     Cal Configuration Menu     08/06/97  14:59:27

    N Enter New Cal Configuration
    C Change Old Cal Configuration
    D Delete Old Cal Configuration
    S Start a Calibration Program
    1 Start a Single Phase Cal
    A Abort a Calibration Program
    Q Quick Expected Value Editor
    I Return to Interactive Cal
```

Press <**S**> for Start a Calibration Program:

```
ESC 88xx v5.31  ID:BL    Choose List (Enter to Select)     08/06/97  14:59:27


    PSZ
    DIAGSPAN
    DIAGZERO
    DIAGPREC
    DIAGSZ


     F2        <ESC>     TAB       CTRL-K     CTRL-R      Arrows
     Refresh   Exit      GOTO END  GOTO TOP   Clr Keys    Select
```

From the Choose List Menu, use the ↑ and ↓ keys to highlight DIAGSPAN. This is an ozone calibration sequence that initiates an ozone span. The control of the calibration sequence is automatic. Press <**Enter**>.

Note: Incase of MDI error message, wait 1 minute before starting DIAGSPAN.

6. Observe the Continuous Average Report for several minutes. When five or more 1-minute updates indicate a stable span response, 360ppb to 440ppb, record the last 1-minute averages for O3 and O3CAL.

From the Home Menu, press <**D**> for the Real-Time Display Menu:

Press <**C**> for Continuous Avg Report:

```
ESC 88xx v5.31  ID:BL      Continuous Avg Report Setup     08/06/97  14:59:27


    Average Interval                    : 1m
    Show Channels                       : O3,O3CAL,RNF


    # of Flags to Report                : 02
    Use Decimal Positioner?             : Y
    Start Continuous Report
```

Enter a <**1**> and then <**m**> for the Average Interval if it has not defaulted to the 1m. Arrow down to Show Channels. Type **O3** and **O3CAL** if it is not already displayed. Arrow down to Start Continuous Report and press <**Enter**>.

```
TIME                    O3            O3CAL          RNF

08/06/99 14:59:27       41.<C           -1.<C          0.0
```

After several minutes the Continuous Average Report will display the arrays of 1-minute updates for O3 and O3CAL.

```
TIME                      O3    O3CAL     RNF

10/19 11:30               41.<C   -1.<C    0.0
10/19 11:31              350.<C  361.<C    0.0
10/19 11:32              401.<C  400.<C    0.0
10/19 11:33              402.<C  400.<C    1.0
10/19 11:34              401.<C  401.<C    0.0
```

Once the following conditions have been met:

1. The last five 1-minute averages of O3 are within the range of 360ppb to 440ppb.
2. The difference between O3 and O3CAL for each of the last five averages is less than 25ppb.

Record the last 1-minute average of O3 and O3CAL on the checklist. If the conditions are not met, even after several more minutes, call the Operation Support Center for assistance.

7. Adjust the O3 analyzer LEVEL2, downward to generate a concentration between 150ppb and 200ppb. Record the results from the Continuous Average Reports after the event has stabilized.

From the front panel of the O3 analyzer, navigate through the menus to reduce the ozone concentration. Start from the Run screen.

```
O3 PPB                              401.

                ALARM          REMOTE
```

Press the **MENU** button once.

```
MAIN MENU: 10:25
> RANGE
  AVERAGING TIME
  CALIBRATION FACTORS

  CALIBRATION
  INSTRUMENT CONTROLS
  DIAGNOSTICS
  ALARM
```

Use the ↑ and ↓ buttons to navigate and position the cursor next to INSTRUMENT CONTROLS. Press <**Enter**> once to enter the Instrument Controls Menu.

```
INSTRUMENT CONTROLS:
> TEMP CORRECTION
  PRESSURE CORRECTION
  OZONATOR SOLENOID
  OZONATOR LEVEL 1
  OZONATOR LEVEL2

  SCREEN BRIGHTNESS
  SERVICE MODE
  TIME
  DATE
```

Use the ↑ and ↓ buttons to navigate and position the cursor next to LEVEL2. Press <**Enter**> once to enter the LEVEL2 adjustment screen.

```
  O3PPB                    401.
  LEVEL2                  44.1%

  ↑↓   INC/DEC
```

Use the ↑ and ↓ buttons to decrease the power to the ozone generator. The power is expressed as a percentage. Normal lag time between and adjustment and a stable ozone reading is about one minute. Wait for the ozone reading to stabilize. Further adjust the power up or down until the ozone concentration stabilizes between 150ppb and 200ppb.

Watch the Continuous Average Report on the datalogger for several minutes. When five or more 1-minute updates indicate a stable response, record the last 1-minute updates for O3 and O3CAL on the checklist.

8. Adjust the O3 analyzer LEVEL2, downward to generate a concentration between 50ppb and 80ppb. Record the results from the Continuous Average Reports after the event has stabilized.

Use the ↑ and ↓ buttons to decrease the power to the ozone generator. The power is expressed as a percentage. Normal lag time between and adjustment and a stable ozone reading is about one minute. Wait for the ozone reading to stabilize. Further adjust the power up or down until the ozone concentration stabilizes between 50ppb and 80ppb.

Watch the Continuous Average Report on the datalogger for several minutes. When fivee or more 1-minute updates indicate a stable response, record the last 1-minute updates for O3 and O3CAL on the checklist.

The multipoint is complete.

9. Press the RUN button on the O3 analyzer to return to the RUN screen. Abort the DIAGSPAN on the datalogger.

Press the **RUN** button once on the O3 analyzer. This returns the analyzer to the Run screen and resets LEVEL2 to the previous set point percentage for normal spans.

Abort to DIAGSPAN and return the analyzer to ambient sampling by pressing <**Esc**> on the datalogger keyboard several times, to return to the Home Menu. From the ESC datalogger Home Menu, press <**C**> for Configuration Menu.

```
ESC 88xx v5.31   ID:BL       Configuration Menu       08/06/97  14:59:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**C**> again for Configure Calibrations:

```
ESC 88xx v5.31   ID:BL      Cal Configuration Menu     08/06/97  14:59:27

    N  Enter New Cal Configuration
    C  Change Old Cal Configuration
    D  Delete Old Cal Configuration
    S  Start a Calibration Program
    1  Start a Single Phase Cal
    A  Abort a Calibration Program
    Q  Quick Expected Value Editor
    I  Return to Interactive Cal
```

Press <**A**> for Abort a Calibration Program:

```
ESC 88xx v5.31  ID:BL    Choose List (Enter to Select)     08/06/97  14:59:27


    PSZ
    DIAGSPAN
    DIAGZERO
    DIAGPREC
    DIAGSZ


     F2        <ESC>     TAB       CTRL-K     CTRL-R      Arrows
     Refresh   Exit      GOTO END  GOTO TOP   Clr Keys    Select
```

From the Choose List Menu, use the ↑ and ↓ keys to highlight DIAGSPAN. The DIAGSPAN ceases immediately.

10. Review the results. Call the Operation Support Center to discuss the multipoint results.

Select View Results on the checklist.

The multipoint calibration summary, displays the zero and three upscale point results, an X-Y plot of the results, the linear regression results and a pass/fail indicator. Call the Operation Support Center to discuss the results of the multipoint check.

Checklist Instruction - Multipoint Calibration

- **Ozone Analyzer (TEI 49*i*)**
- **Ozone Calibrator (TEI 49*i*)**

Checklist Instruction Number: **3178-3316**

Revision Number / Date: **0 / July 2012** **(last reviewed July 2012)**

Objective: Monthly multipoint calibrations are performed to provide a more comprehensive check of the instrument's condition and verify the ozone analyzer's response to ozone free (zero) air and three (3) upscale ozone concentrations:

- 360 to 440 ppb
- 150 to 200 ppb
- 50 to 80 ppb

1. Start a DIAGZERO sequence from the ESC datalogger.

From the ESC datalogger Home Menu, press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL      Configuration Menu       08/06/97  14:59:27

    P Set Passwords
    S Configure System Parameters
    D Configure (Data) Channels
    C Configure Calibrations
    A Configure Alarms
    O Configure Analog Outputs
    K Configure Math Constants
    E Configure Dig. Event Program
    R Configure Digital I/O
    1 Configure Serial Protocols
```

Press <**C**> again for Configure Calibrations:

```
ESC 88xx v5.31  ID:BL     Cal Configuration Menu     08/06/97  14:59:27

    N Enter New Cal Configuration
    C Change Old Cal Configuration
    D Delete Old Cal Configuration
    S Start a Calibration Program
    1 Start a Single Phase Cal
    A Abort a Calibration Program
    Q Quick Expected Value Editor
    I Return to Interactive Cal
```

Press <**S**> for Start a Calibration Program:

```
ESC 88xx v5.31  ID:BL    Choose List (Enter to Select)     08/06/97  14:59:27


    PSZ
    DIAGSPAN
    DIAGZERO
    DIAGPREC
    DIAGSZ

     F2        <ESC>      TAB        CTRL-K      CTRL-R      Arrows
     Refresh   Exit       GOTO END   GOTO TOP    Clr Keys    Select
```

From the Choose List Menu, use the ↑ and ↓ keys to highlight DIAGZERO. This is an ozone calibration sequence that initiates a 30-minute zero. The control of the calibration sequence is automatic. Press <**Enter**> and several things occur immediately. Pump noise in the shelter increases dramatically as the ozone calibrator (O3CAL) sample pump and the zero air pump switch on. The alarm on the front panel of the ozone calibrator should go off within a few seconds. Inspect the front panel of the ozone analyzer and the ozone calibrator. If either panel is displaying an alarm, abort the multipoint calibration and call the Operation Support Center for diagnostic support. Restart the multipoint when the alarms have been resolved.

Press <**Esc**> several times to return to the datalogger Home Menu.

From the Home Menu, select <**D**> for Real-Time Display Menu:

```
ESC 88xx v5.31  ID:BL      Real-Time Display Menu       08/06/97  14:59:27

    V  Display Raw Readings
    R  Display Readings w/units
    F  Display Readings w/flags
    B  Display Last Base Avg
    C  Continuous Avg Report
    L  Show LARGE TEXT Display
    I  Display Digital Inputs
    O  Display Digital Outputs
    A  Display Analog Outputs
```

Press <**C**> for Continuous Avg Report:

```
ESC 88xx v5.31  ID:BL      Continuous Avg Report Setup       08/06/97  14:59:27


    Average Interval                   :  1m
    Show Channels                      :  O3,O3CAL,RNF


    # of Flags to Report               :  02
    Use Decimal Positioner?            :  Y
    Start Continuous Report
```

Enter a <**1**> and then <**m**> for the Average Interval if it has not defaulted to the 1m. Arrow down to Show Channels. Type **O3** and **O3CAL** if it is not already displayed. Arrow down to Start Continuous Report and press <**Enter**>.

```
TIME                 O3          O3CAL        RNF
08/06 14:59          41.<C        -1.<C        0.0
```

2. Check for an alarm condition on the front panel of the ozone analyzer. Report alarms to the OSC before proceeding with the multipoint calibration.

Alarm conditions are indicated on the TEI 49*i* ozone analyzer with a “bell symbol” in the front panel display, as shown below:

```
CONCENTRATION

O3                              62.7 PPB

              16:45

RANGE     AVG     DIAGS     ALARM
```

3. Check for an alarm condition on the display of the ozone calibrator. The display should not show an alarm condition during the DIAGZERO. Report alarms to the OSC before proceeding with the multipoint calibration.

Previous to the initiation of the DIAGZERO sequence, the normal TEI 49*i* ozone calibrator front panel will display an alarm condition as shown below:

```
CONCENTRATION

O3                              62.7 PPB

              16:45

RANGE     AVG     DIAGS     ALARM
```

When the DIAGZERO sequence has been initiated, the ozone calibrator sample pump will start and the alarm condition will no longer be met. As the flow rate approaches its set point, the ALARM indicator will disappear.

```
CONCENTRATION

O3                              62.7 PPB

              16:45

RANGE     AVG     DIAGS     ALARM
```

If the alarm condition persists after one minute into the DIAGZERO calibration sequence, call the Operation Support Center.

4. Observe the continuous average report for several minutes. When five or more 1-minute updates indicate a stable zero response, +5ppb to –5ppb, record the last 1-minute averages for O3 and O3CAL.

After several minutes the Continuous Average Report will display the arrays of 1-minute updates for O3 and O3CAL.

```
TIME                   O3    O3CAL     RNF

10/19 11:30           41.<C -1.<C     0.0
10/19 11:31            4.<C -0.<C     0.0
10/19 11:32            0.<C -1.<C     0.0
10/19 11:33           -1.<C  1.<C     0.0
10/19 11:34            0.<C  1.<C     0.0
```

Once the following conditions have been met:

1. The last five 1-minute averages of O3 are in the range of +5ppb to –5ppb.
2. The last five 1-minute averages of O3CAL are in the range of +5ppb to –5ppb.

Record the last 1-minute average of O3 and O3CAL. If the conditions are not met, even after several more minutes, do not proceed further with the multipoint calibration. Call the OSC for diagnostic support.

If the zero values were successful and recorded, abort the DIAGZERO.

Press <**Esc**> several times to return to the Home Menu. Press <**C**> for the Configuration Menu:

```
ESC 88xx v5.31  ID:BL      Configuration Menu      08/06/97  14:59:27

    P  Set Passwords
    S  Configure System Parameters
    D  Configure (Data) Channels
    C  Configure Calibrations
    A  Configure Alarms
    O  Configure Analog Outputs
    K  Configure Math Constants
    E  Configure Dig. Event Program
    R  Configure Digital I/O
    1  Configure Serial Protocols
```

Press <**C**> again for Configure Calibrations:

```
ESC 88xx v5.31  ID:BL      Cal Configuration Menu     08/06/97  14:59:27

    N Enter New Cal Configuration
    C Change Old Cal Configuration
    D Delete Old Cal Configuration
    S Start a Calibration Program
    1 Start a Single Phase Cal
    A Abort a Calibration Program
    Q Quick Expected Value Editor
    I Return to Interactive Cal
```

Press <**A**> for Abort a Calibration Program:

```
ESC 88xx v5.31  ID:BL     Choose List (Enter to Select)     08/06/97  14:59:27


    PSZ
    DIAGSPAN
    DIAGZERO
    DIAGPREC
    DIAGSZ


     F2       <ESC>     TAB       CTRL-K     CTRL-R     Arrows
     Refresh  Exit      GOTO END  GOTO TOP   Clr Keys   Select
```

From the Choose List Menu, use the ↑ and ↓ keys to highlight DIAGZERO.

Press <**Enter**> and the zero air pump and ozone calibrator pump turn off. The alarm condition should reappear on the front panel of the ozone calibrator.

5. Start a DIAGSPAN.

From the ESC datalogger Home Menu, press <**C**> for Configuration Menu:

```
ESC 88xx v5.31  ID:BL       Configuration Menu       08/06/97  14:59:27

    P Set Passwords
    S Configure System Parameters
    D Configure (Data) Channels
    C Configure Calibrations
    A Configure Alarms
    O Configure Analog Outputs
    K Configure Math Constants
    E Configure Dig. Event Program
    R Configure Digital I/O
    1 Configure Serial Protocols
```

Press <**C**> again for Configure Calibrations:

```
ESC 88xx v5.31   ID:BL      Cal Configuration Menu      08/06/97   14:59:27

    N  Enter New Cal Configuration
    C  Change Old Cal Configuration
    D  Delete Old Cal Configuration
    S  Start a Calibration Program
    1  Start a Single Phase Cal
    A  Abort a Calibration Program
    Q  Quick Expected Value Editor
    I  Return to Interactive Cal
```

Press <**S**> for Start a Calibration Program:

```
ESC 88xx v5.31   ID:BL     Choose List (Enter to Select)      08/06/97   14:59:27


    PSZ
    DIAGSPAN
    DIAGZERO
    DIAGPREC
    DIAGSZ


     F2        <ESC>      TAB       CTRL-K     CTRL-R      Arrows
     Refresh   Exit       GOTO END  GOTO TOP   Clr Keys    Select
```

From the Choose List Menu, use the ↑ and ↓ keys to highlight DIAGSPAN. This is an ozone calibration sequence that initiates an ozone span. The control of the calibration sequence is automatic. Press <**Enter**>.

Note: In case of MDI error message, wait 1 minute before starting DIAGSPAN.

6. Observe the Continuous Average Report for several minutes. When five or more 1-minute updates indicate a stable span response, 360ppb to 440ppb, record the last 1-minute averages for O3 and O3CAL.

From the Home Menu, press <**D**> for the Real-Time Display Menu:

Press <**C**> for Continuous Avg Report:

```
ESC 88xx v5.31   ID:BL       Continuous Avg Report Setup      08/06/97   14:59:27


    Average Interval                         :  1m
    Show Channels                            :  O3,O3CAL,RNF


    # of Flags to Report                     :  02
    Use Decimal Positioner?                  :  Y
    Start Continuous Report
```

Enter a <**1**> and then <**m**> for the Average Interval if it has not defaulted to the 1m. Arrow down to Show Channels. Type **O3** and **O3CAL** if it is not already displayed. Arrow down to Start Continuous Report and press <**Enter**>.

```
TIME                      O3           O3CAL          RNF
08/06/99 14:59:27         41.<C          -1.<C          0.0
```

After several minutes the Continuous Average Report will display the arrays of 1-minute updates for O3 and O3CAL.

```
TIME                      O3     O3CAL     RNF
10/19 11:30               41.<C   -1.<C    0.0
10/19 11:31              350.<C  361.<C    0.0
10/19 11:32              401.<C  400.<C    0.0
10/19 11:33              402.<C  400.<C    1.0
10/19 11:34              401.<C  401.<C    0.0
```

Once the following conditions have been met:

1. The last five 1-minute averages of O3 are within the range of 360ppb to 440ppb.
2. The difference between O3 and O3CAL for each of the last five averages is less than 25ppb.

Record the last 1-minute average of O3 and O3CAL on the checklist. If the conditions are not met, even after several more minutes, call the Operation Support Center for assistance.

7. Select the O3 analyzer CUSTOM LEVEL3 to generate a concentration between 150ppb and 200ppb. Record the results from the Continuous Average Reports after the event has stabilized.

From the front panel of the O3 analyzer, navigate through the menus to reduce the ozone concentration. Start from the Run screen.

```
CONCENTRATION

O3                                62.7 PPB

                16:45

RANGE      AVG       DIAGS      ALARM
```

Press the **MENU** ( ) button once.

```
              CONCENTRATION
O3                              67.0PPB

SAMPLE     10:16
MAIN MENU:
>RANGE
 AVERAGING TIME
 CALIBRATION FACTORS
 CALIBRATION
 INSTRUMENT CONTROLS
 DIAGNOSTICS
 ALARMS                              ↓
```

Use the ↑ and ↓ buttons to navigate and position the cursor next to INSTRUMENT CONTROLS. Press <**Enter**> once to enter the Instrument Controls Menu.

```
              CONCENTRATION
O3                              67.0PPB

SAMPLE     10:16
INSTRUMENT CONTROLS:
>CUSTOM LEVELS
 OZONATOR SOLENOID
 CYCLE TIME
 TEMPERATURE COMPENSATION
 PRESSURE COMPENSATION
 DATALOGGING SETTINGS
 COMMUNICATION SETTINGS              ↓
```

Use the ↑ and ↓ buttons to navigate and position the cursor next to CUSTOM LEVELS. Press <**Enter**> once.

```
              CONCENTRATION
O3                              67.0PPB

CUSTOM O3 LEVELS:
>LEVEL 1                        17.5%
 LEVEL 2                        35.9%
 LEVEL 3                        22.4%
 LEVEL 4                        16.0%
 LEVEL 5                        18.2%
```

Use the ↑ and ↓ buttons to select different percentages of power to the ozone generator. The power is expressed as a percentage. Normal lag time between and adjustment and a stable ozone reading is about one minute. Wait for the ozone reading to stabilize. Further adjust the power up or down until the ozone concentration stabilizes between 150ppb and 200ppb.

Watch the Continuous Average Report on the datalogger for several minutes. When five or more 1-minute updates indicate a stable response, record the last 1-minute updates for O3 and O3CAL on the checklist.

8. Adjust the O3 analyzer CUSTOM LEVEL 3 downward to generate a concentration between 50ppb and 80ppb. Record the results from the Continuous Average Reports after the event has stabilized.

Use the ↑ and ↓ buttons to decrease the power to the ozone generator. The power is expressed as a percentage. Normal lag time between and adjustment and a stable ozone reading is about one minute. Wait for the ozone reading to stabilize. Further adjust the power up or down until the ozone concentration stabilizes between 50ppb and 80ppb.

Watch the Continuous Average Report on the datalogger for several minutes. When five or more 1-minute updates indicate a stable response, record the last 1-minute updates for O3 and O3CAL on the checklist.

The multipoint is complete.

9. Press the RUN button on the O3 analyzer to return to the RUN screen. Abort the DIAGSPAN on the datalogger.

Press the **RUN** button once on the O3 analyzer. This returns the analyzer to the Run screen and resets LEVEL2 to the previous set point percentage for normal spans.

Abort to DIAGSPAN and return the analyzer to ambient sampling by pressing <**Esc**> on the datalogger keyboard several times, to return to the Home Menu. From the ESC datalogger Home Menu, press <**C**> for Configuration Menu.

```
ESC 88xx v5.31  ID:BL      Configuration Menu       08/06/97  14:59:27

    P Set Passwords
    S Configure System Parameters
    D Configure (Data) Channels
    C Configure Calibrations
    A Configure Alarms
    O Configure Analog Outputs
    K Configure Math Constants
    E Configure Dig. Event Program
    R Configure Digital I/O
    1 Configure Serial Protocols
```

Press <**C**> again for Configure Calibrations:

```
ESC 88xx v5.31  ID:BL     Cal Configuration Menu     08/06/97  14:59:27

    N  Enter New Cal Configuration
    C  Change Old Cal Configuration
    D  Delete Old Cal Configuration
    S  Start a Calibration Program
    1  Start a Single Phase Cal
    A  Abort a Calibration Program
    Q  Quick Expected Value Editor
    I  Return to Interactive Cal
```

Press <**A**> for Abort a Calibration Program:

```
ESC 88xx v5.31  ID:BL    Choose List (Enter to Select)     08/06/97  14:59:27


    PSZ
    DIAGSPAN
    DIAGZERO
    DIAGPREC
    DIAGSZ


     F2        <ESC>      TAB        CTRL-K     CTRL-R      Arrows
     Refresh   Exit       GOTO END   GOTO TOP   Clr Keys    Select
```

From the Choose List Menu, use the ↑ and ↓ keys to highlight DIAGSPAN. The DIAGSPAN ceases immediately.

10. Review the results. Call the Operation Support Center to discuss the multipoint results.

Select View Results on the checklist.

The multipoint calibration summary, displays the zero and three upscale point results, an X-Y plot of the results, the linear regression results and a pass/fail indicator. Call the Operation Support Center to discuss the results of the multipoint check.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**CALIBRATION OF MASS FLOWMETERS AND MASS FLOW CONTROLLERS**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3180**
DATE	**JUNE 1990**

AUTHORIZATIONS

TITLE	NAME	SIGNATURE
ORIGINATOR	John F. Faust	John F. Faust
PROJECT MANAGER	John F. Faust	John F. Faust
PROGRAM MANAGER	Joe Adlhoch	[illegible]
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY

REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
	Reviewed; no changes necessary.	June 1995	G. Mercer
	Reviewed; no changes necessary.	June 1996	G. Mercer
	Reviewed; no changes necessary.	June 1997	G. Mercer
1.0	Added procedures and updated format.	April 1998	G. Mercer
	Reviewed; no changes necessary.	April 1999	G. Mercer
	Reviewed; no changes necessary.	April 2000	G. Mercer
	Reviewed; no changes necessary.	April 2001	G. Mercer
	Reviewed; no changes necessary.	April 2002	G. Mercer
	-- continued --		

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TITLE	NAME	SIGNATURE
ORIGINATOR	John F. Faust	John F. Faust
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PROGRAM MANAGER	Joe Adlhoch	
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OTHER		

REVISION HISTORY

REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
	Reviewed; no changes necessary.	April 2003	G. Mercer
	Reviewed; no changes necessary.	April 2004	G. Mercer
2.0	Added BIOS International DC-Lite DC-Lite	November 2004	G. Mercer
	Reviewed; no changes necessary.	November 2005	G. Mercer
	Reviewed; no changes necessary.	November 2006	G. Mercer
	Reviewed; no changes necessary.	November 2007	G. Mercer
	Reviewed; no changes necessary.	November 2008	G. Mercer
	Reviewed; no changes necessary.	November 2009	G. Mercer
	-- continued --		

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PROJECT MANAGER	John F. Faust	John F. Faust
PROGRAM MANAGER	Joe Adlhoch	
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY

REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
	Reviewed; no changes necessary.	November 2010	G. Mercer
	Reviewed; no changes necessary.	November 2011	G. Mercer

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1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) is a guide to calibration of mass flowmeters and controllers. The mass flowmeters/controllers are most commonly associated with gas dilution calibrators. Accurate calibration of mass flowmeters/controllers is essential for the correct determination of designated gas concentrations.

Mass flowmeters/controllers may be located in portable "reference" gas dilution systems, within on-site calibrators, or independent systems. This SOP is not manufacturer-specific, and will apply to any common mass flowmeter/controller. Mass flowmeters/controllers must be calibrated quarterly.

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Establish the calibration reporting protocol to satisfy client requirements.
- Review calibration results.
- Identify inconsistencies in calibration results and initiate corrective action as required.

2.2 FIELD SPECIALIST

The field specialist shall:

- Perform required calibrations as described in this SOP.
- Verify that the calibration standards are in good working order and are in current calibration.
- Document all calibration results and maintenance procedures performed.

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment may be required for mass flowmeter/controller calibration:

- Primary flow standard:
  - Bubble tube flowmeter (Hastings HBM-1), or
  - Mini-Buck calibrator Model M-5, or
  - BIOS International DC-2 DryCal calibrator, or
  - BIOS International DryCal DC-Lite and DryCal Nexus NS DC-Lite accessory module, or
- Calibrated mass flowmeter transfer standard
- Zero air supply

- Thermometer
- Stop watch
- Laboratory barometer
- Vapor pressure of water chart
- Mass flowmeter/controller calibration forms
- Calculator capable of linear regression analysis
- Laptop computer loaded with Excel spreadsheet (NPS.XLT) and CALCU program software
- Manufacturer's instrument manual
- Pen or pencil
- Field service tools
- Station log book

4.0 METHODS

Calibration tasks are detailed in the following four (4) subsections:

4.1 Preparation for Calibration
4.2 Calibration Checks
4.3 Post-Maintenance Calibration Checks
4.4 Documentation

4.1 PREPARATION FOR CALIBRATION

Before performing a calibration check, ensure adequate preparation of the operation environment by determining the following:

- Calibration documentation is current, complete, and available.
- All required support tools, diagnostic equipment, supplies, and calibration forms are available.

4.2 CALIBRATION CHECKS

Mass flowmeters/controllers may be calibrated with either a primary flow standard (Hastings HBM-1, mini-Buck M-5, BIOS International DryCal DC-2, or BIOS International DryCal Lite) or by comparison to a transfer standard (calibrated mass flowmeter/controller). The use of each device requires slightly different techniques. All results will be corrected to standard temperature and pressure (298 °K and 760 mmHg).

ANNOTATE DATA RECORDS

Make an entry in the station log book and annotate the strip chart recorder and data acquisition system (DAS) indicating the date and time (beginning and ending) of the calibration procedure.

If a mass flow controller is calibrated with its controlling set point set to maximum flow, the controller will operate precisely like a mass flowmeter. Therefore, the following text will refer only to mass flowmeters, but will apply directly to the calibration of a mass flow controller with its set point at maximum flow.

4.2.1 Calibration by Hastings HBM-1 Bubble Tube Set

This flow calibration device requires the use of a stop watch to calculate the rate of air flow through the bubble tube. The procedures are:

DETERMINE CORRECTION FACTOR

Determine the factor for correcting flows to standard temperature and pressure by:

- Measuring and recording the ambient temperature in °C.
- Measuring and recording the uncorrected barometric pressure (station pressure).
- Determining the vapor pressure of water by using Table 4-1.

Table 4-1

Vapor Pressure of Water Over a Common Range of Temperature

Degrees C	Degrees K	mmHg
15	288	13
16	289	14
17	290	15
18	291	16
19	292	17
20	293	18
21	294	19
22	295	20
23	296	21
24	297	22
25	298	24
26	299	25
27	300	27
28	301	28
29	302	30
30	303	32
31	304	34
32	305	36

Source: Handbook of Chemistry and Physics, 68th Edition, 1987-88, p. D-189.

DETERMINE CORRECTION FACTOR (continued)

- Completing the formula:

$$CF = \frac{Pamb - PH_2O}{Pstd} \times \frac{Tstd}{Tamb}$$

where:

CF	=	correction factor
$Pamb$	=	uncorrected barometric pressure in mmHg
PH_2O	=	vapor pressure of water in mmHg
$Pstd$	=	standard pressure of 760 mmHg
$Tstd$	=	standard temperature of 298°K
$Tamb$	=	ambient temperature in °K (°C + 273)

RECORD CORRECTION FACTOR

Record the correction factor on the flowmeter calibration by bubble tube calibration form (Figure 4-1).

ESTABLISH AIR FLOW

Establish a steady air flow through the mass flowmeter with a zero air supply and into the bubble tube.

INITIATE BUBBLE

Initiate a soap bubble, and time its travel between the graduated lines on the bubble tube with a stop watch.

RECORD TIME

Record the time in minutes (decimal representation), the volume of the bubble tube (in cc's), and the mass flowmeter digital value on the flowmeter calibration by bubble form.

REPEAT

Repeat each point three times and average the results.

ADJUST AIR FLOW

Adjust the air flow for at least five different points equally spaced throughout the range of the flowmeter and repeat the above three steps, beginning with initiating a bubble.

CALCULATE FLOW RATE

Calculate the flow rate by:

- Dividing the Δ volume by the time in minutes to determine *Qamb* (flow rate at ambient conditions).

- Multiplying *Qamb* by *CF* to determine *Qstp* (flow rate in cc/min corrected to 298°K and 760 mmHg).

- Repeat for each flow point.

DETERMINE CORRELATION

Determine the slope, intercept, and correlation factor for *Qstp* versus the mass flowmeter digital value. Accept no calibration with a correlation of less than .999.

MASS FLOW METER CALIBRATION BY BUBBLE FLOW METER

Network	Station	Date	By:
Calibration Gas	Last Calibration		
Test Flow Meter: Mfg	Model	S/N	
Reference Instrument: Mfg	Model	S/N	Range -
To be used with Following Instrument: Mfg	Model	S/N	

Bubble Flow Meter							Test Flow Meter
Tube size (cc)	ΔV (cc)	Δt (min)	Amb. Press. (in)	Amb. Temp (°C)	Correct Factor	Flow Rate (QSTP)	Indicated

Remarks

Signature ______________________________

Figure 4-1. Example Mass Flowmeter Calibration by Bubble Tube Calibration Form.

RECORD VALUES	Record the slope and intercept as:

$$Mass\ Flowmeter\ Display = (Qstp \times Slope) + Intercept$$

$$Qstp = (Mass\ Flowmeter\ Display - Intercept) / Slope$$

4.2.2 Calibration by Mini-Buck Calibrator (Model M-5)

This calibration procedure does not require the use of a stop watch because *Qamb* (flow rate at ambient conditions) is calculated by the device. The procedures are:

DETERMINE CORRECTION FACTOR	Determine the correction factor as in Section 4.2.1, and record n the flowmeter calibration by mini-Buck calibrator calibration form (Figure 4-2).
ESTABLISH AIR FLOW	Establish a steady air flow through the mass flowmeter with a zero air supply and into the mini-Buck calibrator.
INITIATE BUBBLE	Initiate a bubble and record the mini-Buck calibrator output and the mass flowmeter digital value on the calibration form.
REPEAT	Repeat each point three times and average *Qamb*.
ADJUST AIR FLOW	Adjust the air flow for at least five different points equally spaced throughout the range of the flowmeter and repeat the above two steps beginning with initiating a bubble.
CALCULATE	Calculate *Qstp* as in Section 4.2.1, "Calculate Flow Rate," "Determine Correlation," and "Record Values."

4.2.3 Calibration by Transfer Standard (Calibrated Mass Flow Controller)

The procedures to calibrate a mass flowmeter/controller using a transfer standard are:

ESTABLISH AIR FLOW	Establish a steady air flow through the mass flowmeter with a zero air supply and into the transfer standard.
DETERMINE FLOW RATE	Determine and record *Qstp* from the transfer standard linear regression and record the mass flowmeter digital display.
ADJUST AIR FLOW	Adjust the air flow for at least five different points equally spaced throughout the range of the flowmeter and repeat the above step.
COMPLETE FORM	Complete the calibration by transfer standard calibration form (Figure 4-3) by following Section 4.2.1, steps "Determine Correlation" and "Record Values."

MASS FLOW METER CALIBRATION BY MINI BUCK CALIBRATOR

Network	Station	Date	By:
Calibration Gas		Last Calibration	
Test Flow Meter: Mfg	Model	S/N	
Reference Instrument: Mfg	Model	S/N	Range -
To be used with Following Instrument: Mfg	Model	S/N	

Mini Buck Calibrator					Test Flow Meter
Q Ambient (cc/min)	Ambient Pressure (mm Hg)	Ambient Temp. Deg. C	Correction Factor	Flow Rate (QTSP)	Indicated Flow (cc/min)
Remarks					

Signature ______________________________

Figure 4-2. Example Mass Flowmeter Calibration by Mini-Buck Calibrator Calibration Form.

MASS FLOW METER CALIBRATION BY TRANSFER STANDARD

Network	Station	Date	By:
Calibration Gas	Last Calibration		
Test Flow Meter: Mfg	Model	S/N	
Reference Instrument: Mfg	Model	S/N	Range -
To be used with Following Instrument: Mfg	Model	S/N	

Transfer Standard		Test Flow Meter
Display	QTSP (cc/min)	Indicated Flow (cc/min)

Remarks

Signature ______________________________

Figure 4-3. Example Mass Flowmeter Calibration by Transfer Standard Calibration Form.

4.2.4 Calibration by BIOS International DryCal DC-2

This calibration procedure utilizes the internal temperature and pressure sensors inside the DC-2 calibrator to calculate standard flow rates. The procedures are:

SELECT FLOW CELL	Select the appropriate flow cell and install upon the DC-2 base.
ESTABLISH AIR FLOW	Establish a steady air flow through the mass flowmeter and into the DC-2 calibrator.
INITIATE SAMPLES	Turn the DC-2 on, select **RUN**, and push **ENTER**. Push **BURST** to initiate 10 flow rate samples. Record the resulting standard flow rate average (“SAvg”) on the calibration by BIOS International calibrator calibration form (Figure 4-4).
ADJUST AIR FLOW	Adjust the air flow for at least five different points equally spaced throughout the range of the flowmeter and repeat the above two steps.

4.2.5 Calibration by BIOS International DryCal DC-Lite and DryCal Nexus NS DC-Lite Accessory Module

The DryCal DC-Lite is a similar instrument as the DryCal DC-2, however, it only measures and displays volumetric (actual) flows. The DryCal Nexus is required to convert volumetric flow rates to standard conditions. These components must be connected and turned on in a specific sequence, or they may not operate. To calibrate:

MAKE CONNECTIONS	Connect the DryCal DC-Lite flowmeter to the DryCal Nexus as described below and illustrated in Figure 4-5. Using the supplied DB25 cable, connect the DryCal DC-Lite to the DryCal Nexus connector labeled “DryCal.” Using the appropriate tubing, connect the output of the flowmeter to be calibrated to the DryCal Nexus (either side), then connect the DryCal Nexus to the inlet port of the DryCal DC-Lite.
TURN ON	Turn on the combination using the ON button of the DryCal DC-Lite. The display on the DC-Lite should indicate “:Nexus Control”. Press the READ button on the Nexus to initiate flow measurements.
ESTABLISH AIR FLOW	Establish a steady air flow through the mass flowmeter and into the DC-Lite calibrator.
INITIATE AUTO MODE	Hold the READ button down during a measurement to initiate AUTO mode. In Auto Mode, 10 measurements will be averaged and displayed. Record the results on Figure 4-4.

ADJUST AIR FLOW — Adjust the air flow for at least five different points equally spaced throughout the range of the flowmeter and repeat the above two steps.

TURN OFF — The DryCal DC-Lite has no OFF button. It powers down in 5 minutes of no action or 60 minutes when connected to the Nexus control unit.

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GAS DILUTION CALIBRATOR
CALIBRATION FORM

Network:	Location:	Site:	Date: 10/27/04	Date of Last Site Visit:
				Field Specialist:

High Flow Standard Reference: BIOS, DC2	High Flow Standard Reference S/N: N/A	Calibration Date: 01/02/04
Low Flow Standard Reference: BIOS, DC2	Low Flow Standard Reference S/N: N/A	Calibration Date: 01/03/04

Mass Flow Device (Dilution Air)

Mfg:	S/N:	Range:
Calibration Gas:		

This primary standard automatically corrects to standard flow.

FLOW METER DATA

Calibration Point	Display (y)	Flow SCCPM (x)
1		
2		
3		
4		
5		
6		

Linear Regression

Parameter	Air Flow Controller	Pass/Fail
Slope (m)		N/A
Y Intercept (b)		N/A
Correlation Coefficient (r)		

Display Volts = (Flow SCCPM * m) + b
Flow SCCPM = (Display Volts - b) / m

Mass Flow Device (Gas 1)

Mfg:	S/N:	Range:
Calibration Gas:		

This primary standard automatically corrects to standard flow.

FLOW METER DATA

Calibration Point	Display (y)	Flow SCCPM (x)
1		
2		
3		
4		
5		
6		

Linear Regression

Parameter	Gas Flow Controller	Pass/Fail
Slope (m)		N/A
Y Intercept (b)		N/A
Correlation Coefficient (r)		

Display Volts = (Flow SCCPM * m) + b
Flow SCCPM = (Display Volts -b) / m

MFC/MFM Comments:	

Figure 4-4. Example Mass Flowmeter Calibration by BIOS International Calibrator Calibration Form.

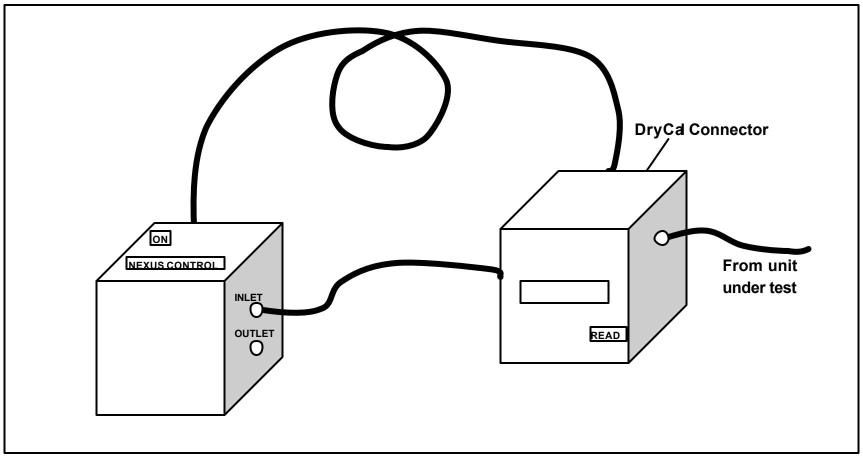

Figure 4-5. DryCal DC-Lite and Nexus Connection Diagram.

4.3 POST-MAINTENANCE CALIBRATION CHECKS

After completing any adjustment or maintenance, initiate a post-maintenance calibration check as described in Section 4.2.

4.4 DOCUMENTATION

Mass flowmeter/controller calibrations require several levels of documentation:

CALIBRATION FORMS — Calibration forms or the computer laptop Excel spreadsheet should be completed entirely. Where possible, use the Excel spreadsheet so that both a hard copy and digital record of the calibration are maintained. Review and sign all calibration forms.

LOG NOTES — An entry is made in the station log book to document the calibration.

CALIBRATION STICKER — An ARS calibration sticker is placed on the mass flowmeter or controller, marking the date the instrument was certified and the name of the technician who calibrated it.

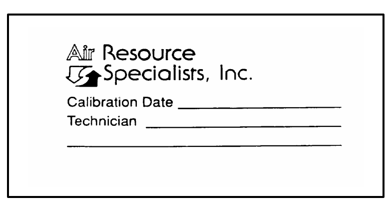

Figure 4-6. ARS Calibration Sticker.

TRIP REPORT Complete all summary documentation, attach to the calibration form or printed record, and submit with the site trip report.

5.0 DEFINITIONS

Correction Factor (CF): A value used to convert Qamb to Qstp.

Mass Flowmeter: A flow measuring device that determines flow rate by means of measuring the mass (molecular weight0 of a gas flowing past a point. The mass flowmeter's measured output is self-correcting for changing temperature and pressure.

Mass Flow Controller: A mass flowmeter that incorporates a metering valve to control the flow of gas.

Qstp: A flow rate referenced to standard conditions of 298°K and 760 mmHg.

Qamb: A flow rate referenced to ambient temperature and pressure.

Transfer Standard: A mass flowmeter that is under current calibration.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES

TITLE	**CALIBRATION AND ROUTINE MAINTENANCE OF CASTNET FILTER PACK FLOW SYSTEMS**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3180-2100**
DATE	**AUGUST 2012**

AUTHORIZATIONS

Originator	John F. Faust	John F. Faust
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REVISION HISTORY

0.0	Initial version.	August 2012	G. Mercer

TABLE OF CONTENTS

LIST OF FIGURES

1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the steps for maintaining sampling equipment, verifying flow rate, and adjusting the flow rate of instrumentation operated for the Clean Air Status and Trends Network (CASTNet). It is referenced from SOP 3180, *Calibration of Mass Flowmeters and Mass Flow Controllers*. The primary purpose of performing routine instrument servicing checks is to assure quality data capture and minimize data loss. The U.S. Environmental Protection Agency (EPA) CASTNet program directs for twice-annual flow calibrations of the filter pack monitoring system.

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Establish the project-specific calibration schedule and coordinate with the client as necessary.
- Establish the calibration reporting protocol to satisfy client requirements.
- Review calibration results.
- Identify inconsistencies in calibration results and initiate corrective action as required.

2.2 FIELD SPECIALIST

The field specialist shall:

- Perform required calibrations and maintenance as described in this TI.
- Verify that the calibration standards are in good working order and are in current calibration.
- Document all calibration results and maintenance procedures performed.

3.0 REQUIRED EQUIPMENT AND MATERIALS

Equipment and materials required for calibration include:

- An authoritative flow standard (BIOS Definer 220 or equivalent)
- A quick-disconnect interface connector for pot-head
- A pump rebuild kit
- Electronic flow check and flow calibration forms
- Keys for the monitoring shelter or support system internal lock and padlocks
- A copy of this TI
- A complete field tool kit
- Latex or similar-type gloves

4.0 METHODS

The procedures described in this TI are specific to CASTNet filter pack systems. This section includes three major subsections:

- 4.1 System Calibration
- 4.2 System Maintenance
- 4.3 Documentation

4.1 SYSTEM CALIBRATION

PREPARE FOR CALIBRATION AND DOCUMENT EXISTING CONDITIONS

Mark the flow channel off-line and wear clean gloves when handling the filter packs.

Enter the identifying information on the electronic CASTNet Flow Check Form (see Figure 4-1), and record the data acquisition system (DAS) flow, mass flow controller (MFC) readout value, and rotameter value.

ANNOTATE DATA RECORDS

Without adjusting any components of the flow system, record the DAS flow value and MFC flow display value. Turn off the flow pump and record the local time and the time displayed on the elapsed time meter on the Flow Check Form.

REMOVE FILTER AND PERFORM LEAK CHECK

Lower the flow tower, remove the filter pack (using clean gloves), and store the filter pack in a clean, plastic bag.

Removal of the filter will cause the quick release fitting to cap (or seal) the inlet line. Then:

- Record the <u>Zero Values</u> (pump off) from all displays and the rotameter (center of ball) on the check form.
- Perform a <u>Leak Check</u> by turning pump on, allow the readings to stabilize, and record values from all displays on the check form.

An unacceptable leak check (a leak is present) is if the difference between the measured Zero Value on the MFC display and the Leak Check Value is greater than 0.10 slpm. If a leak in the system is indicated, maintenance must be performed to find and eliminate the leak.

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CASTNET FLOW CHECK FORM

Network: NPS	Location: Big Bend	Site: BIBE-KB	Date: 02/01/12	Date of Last Site Visit: 07/06/11
				Field Specialist: Valvur, Martin

High Flow Standard (BIOS) Reference S/N: 120798	Cell #:	Calibration Date: 11/09/10

MFC SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.	Tylan	Tylan
Model #	FC280SAV-45	FC280SAV-45
Serial #	AW9403018	AW9403018

	PREVIOUS DAS LINEAR REGRESSION	FLOW CALIBRATION LINEAR REGRESSION
Date	07/06/11	02/01/12
MFC Display Set Point	3.04	3.04
Slope	1.08748	1.08748
Intercept	-0.23501	-0.23501

PUMP IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.	Thomas	Thomas
Model #	107CAB18	107CAB18
Serial #	N/A	N/A

Standard Temp. and Pressure (STP)

TEMP (° C)	PRESSURE (mmHg)
25	760

FLOW CHECK

ITEM	PRE MAINTENANCE	POST MAINTENANCE
Vacuum	20" hg	
DAS Flow (Operating)	3	2.99
MFC Flow Value (Operating)	3.04	3.04
BIOS SLPM	2.96	2.98

ITEM	AS FOUND	AS LEFT
DAS Full Scale	5.37	5.37
DAS Zero	0.07	0.07
Flow Target	3.0	3.0

PRE-MAINTENANCE SENSOR RESPONSE

ACTION	BIOS (SLPM)	MFC Display	Rotometer Flow	DAS Flow Value (SLPM)	MFC VOLTS DC	Target Flow Points		Difference		PASS/FAIL
						1.5 SLPM	3.0 SLPM	SLPM	%	
Zero (pump off)	0.000	-0.01	0.00	0.094	0.023	N/A	N/A			
Leak Test	0.000	0.02	0.00	0.100	0.029	N/A	N/A	0.0056		PASS
Point 1 (low)	2.108	2.15	2.18	2.134	1.947	0.75 to 1.00 lpm	2.00 to 2.25 lpm	0.0257	1.2%	PASS
Point 2 (target)	2.961	3.04	3.05	2.990	2.755	1.50 lpm	3.00 lpm	0.0294	1.0%	PASS
Point 3 (high)	3.868	3.97	4.10	3.888	3.602	2.00 to 2.25 lpm	3.75 to 4.00 lpm	0.0196	0.5%	PASS
Max Flow Test	4.001	4.13	4.20	4.035	3.741	2.50 lpm	4.00 lpm	0.0338	0.8%	PASS

		Calibration Required?
Point 1 (low) % Difference	1.2%	NOT REQUIRED
Point 2 (target) % Difference	1.0%	NOT REQUIRED
Point 3 (high) % Difference	0.5%	NOT REQUIRED

*Note: A calibration is required if the difference between the transfer standard and the DAS value is greater than +/- 2.0% at the target setting or greater than +/- 2.5% at either the low or high point.

MFC Zero/Leak Test Diff:	0.03
Leak Present?	NO

*Note: A leak is present if the difference between the zero and leak test value is greater than 0.10 lpm

POST MAINTENANCE SENSOR RESPONSE

ACTION	BIOS (SLPM)	MFC Display	Rotometer Flow	DAS Flow Value (SLPM)	MFC VOLTS DC	Target Flow Points		Difference		PASS/FAIL
						1.5 SLPM	3.0 SLPM	SLPM	%	
Zero (pump off)	0.000	-0.01	0.00	0.096	0.025	N/A	N/A			
Leak Test	0.000	0.02	0.00	0.102	0.031	N/A	N/A	0.00534		PASS
Point 1 (low)	2.224	2.25	2.30	2.234	2.042	0.75 to 1.00 lpm	2.00 to 2.25 lpm	0.0102	0.5%	PASS
Point 2 (target)	2.983	3.04	3.05	2.990	2.755	1.50 lpm	3.00 lpm	0.007	0.2%	PASS
Point 3 (high)	3.881	3.97	4.10	3.887	3.601	2.00 to 2.25 lpm	3.75 to 4.00 lpm	0.006	0.2%	PASS
Max Flow Test	4.054	4.15	4.20	4.063	3.767	2.50 lpm	4.00 lpm	0.0086	0.2%	PASS

Pre-Maint CASTNet Flow Comments:	Rebuilt pump between pre and post flow check.
Post Maint CASTNet Flow Comments:	

Figure 4-1. Example CASTNet Flow Check Form.

CHECK AS-FOUND FLOW

Connect the primary standard (BIOS) to the inlet line. Turn on the pump and allow all readings to stabilize.

Record the following data on the electronic spreadsheet (record all flows in standard temperature and pressure):

- BIOS SAVG flow
- MFC display flow
- Datalogger flow and voltage
- Rotameter flow (center of ball)

Note that the target flowrates are either 1.50 slpm or 3.00 slpm depending on the station configuration.

With the BIOS in place, adjust the site MFC to within the following flow ranges as indicated on the datalogger display. The max flow point tests the pump capacity.

Point	Category	For a 1.5 lpm Nominal Flow	For a 3.0 lpm Nominal Flow
1	Low	0.75 to 1.00 slpm	2.00 to 2.25 slpm
2	Nominal	1.50 slpm	3.00 slpm
3	High	2.00 to 2.25 slpm	3.75 to 4.00 slpm
Max Flow	Max	>2.5 slpm	>4 slpm

At each point, record the data on the Flow Check Form.

EVALUATE AS-FOUND RESULTS

If the flow as displayed on the datalogger is off by more than ±2.0% from the BIOS standard SAVG flow at the nominal setting, or off by more than ±2.5% at either the high or low points, a complete calibration is required. **The flow check form will indicate if a flow calibration is required.**

PERFORM AND DOCUMENT CALIBRATION

If the flow check determines that a calibration of the flow system is required, perform the calibration:

- Complete five flow rates (ranges suggested on the form).
- The form will calculate new full-scale and zero-scale values for the datalogger.
- Enter and save these values on the datalogger.

Document all findings on the CASTNet Flow Calibration Form (see Figure 4-2).

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CASTNET FLOW CALIBRATION FORM

Network: NPS	Location: Big Bend	Site: BIBE-KB	Date: 02/01/12	Date of Last Site Visit: 07/06/11
				Field Specialist: Valvur, Martin

High Flow Standard (BIOS) Reference S/N: 120798	Cell #:	Calibration Date: 11/09/10

MFC SENSOR IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.	Tylan	Tylan
Model #	FC280SAV-45	FC280SAV-45
Serial #	AW9403018	AW9403018

PUMP IDENTIFICATION

	PRE-MAINTENANCE	POST MAINTENANCE
Mfg.	Thomas	Thomas
Model #	107CAB18	107CAB18
Serial #	N/A	N/A

Standard Temp. and Pressure (STP)

TEMP (º C)	PRESSURE (mmHg)
25	760

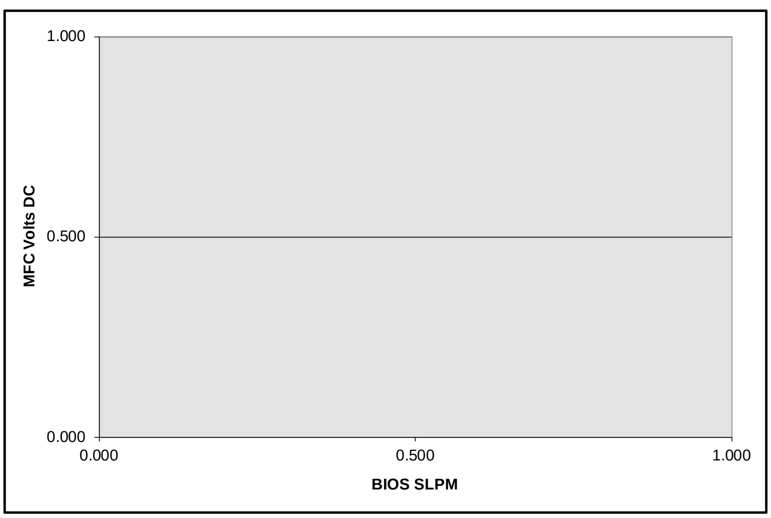
CASTNET FLOW CALIBRATION

ACTION	BIOS (SLPM)	MFC Display	DAS Flow Value (SLPM)	MFC VOLTS DC	Target Flow Points	
					1.5 SLPM	3.0 SLPM
Zero (pump off)					0 lpm	0 lpm
Leak Test					0 lpm	0 lpm
Point 1					1.00 lpm	2.00 lpm
Point 2					1.25 lpm	2.50 lpm
Point 3					1.50 lpm	3.00 lpm
Point 4					1.75 lpm	3.50 lpm
Point 5					2.00 lpm	4.00 lpm

RESULTS

Linear Regression			
Parameter	MFC	DAS	MFC VOLTS DC
Slope			
Y Intercept			
Correlation Coefficient			

MFC Set Point		Zero/FS Set Point	
1.5 slpm	3.0 slpm	Zero	Full Scale



Pre-Maint CASTNet Flow Comments:	
Post Maint CASTNet Flow Comments:	

Figure 4-2. Example CASTNet Flow Calibration Form.

4.2 SYSTEM MAINTENANCE

SYSTEM MAINTENANCE

Scheduled system maintenance includes:

- Each station visit
  - Check the condition of the tubing to the inlet filter. Replace if interior damage or contamination exists.
  - Check that all quick releases function properly.
- Twice each year
  - Change or rebuild the flow pump.
- Annually
  - Replace the Balston filter on the pump.
  - Replace the rotameter (the first visit of each year).

RECALIBRATE SYSTEM

If, after performing initial calibration, the calibration form indicates the system must be re-calibrated, proceed to the Flow Calibration form and document all findings on the form.

POST-MAINTENANCE CHECKS

Return to the original Flow Calibration Form and complete the post-maintenance checks on the bottom of the form.

Review the results, and if satisfactory, the calibration is complete.

Replace the filter pack, set the proper flow rate, raise the flow tower, and bring the datalogger channel back on-line.

4.3 DOCUMENTATION

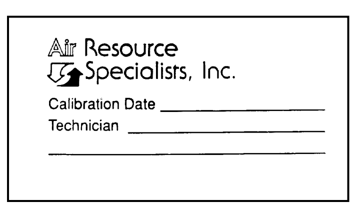
Flow calibrations require the following levels of documentation:

CALIBRATION FORMS

Calibration forms or the computer laptop Excel spreadsheet should be completed. Where possible, use the Excel spreadsheet so that both a hard copy and digital record of the calibration are maintained. Review and sign all flow check and flow calibration forms.

CALIBRATION STICKER

An ARS calibration sticker (see Figure 4-3) is placed on the analyzer, marking the date the instrument was certified and the name of the technician that calibrated it.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Specialists, Inc.
Calibration Date ______________
Technician ______________
____

Figure 4-3. Example ARS Calibration Sticker.

TRIP REPORT

The calibration is thoroughly documented in a written site trip report.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**CERTIFICATION OF OZONE TRANSFER STANDARDS**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3300**
DATE	**JUNE 1990**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	John F. Faust	John F. Faust
PROJECT MANAGER	John F. Faust	John F. Faust
PROGRAM MANAGER	Joe Adlhoch	
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY

REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
	Reviewed; no changes necessary.	June 1995	G. Mercer
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1.0	Changes to format/orig'r/update forms.	February 1997	G. Mercer
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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
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AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	John F. Faust	John F. Faust
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REVISION HISTORY			
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	Reviewed; no changes necessary.	February 2003	G. Mercer
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	Reviewed; no changes necessary.	November 2007	G. Mercer
	Reviewed; no changes necessary.	November 2008	G. Mercer
	Reviewed; no changes necessary.	November 2009	G. Mercer
	Reviewed; no changes necessary.	November 2010	G. Mercer

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1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) serves as a guide for transferring the certificate of authority from a verified ozone UV photometer (primary standard) or certified ozone transfer standard to a candidate ozone transfer standard. This SOP also serves as a guide to re-certify a previously certified ozone transfer standard. This procedure is for photometer-based ozone analyzers only, not stand-alone ozone generating sources.

Because ozone (O_3) cannot be reliably stored, O_3 concentrations for analyzer calibration purposes must be generated and carefully assayed on-site. Transfer standards are used to assay generated O_3 concentrations used for calibrations.

Ozone transfer standards are required to be certified or re-certified under any of the following circumstances:

- Upon acceptance testing of a new instrument
- After any corrective action, service, or maintenance to any portion of the instrument that affects its operational principle
- Once per calendar quarter

All standards will be traceable to the National Institute of Standards and Technology (NIST). Transfer standards will be maintained according to *Transfer Standards for the Calibration of Ambient Air Monitoring Analyzers for Ozone* (EPA-600/4-79-056).

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Oversee and ensure certification is performed according to the required schedule.
- Review certification results.
- Review and approve any changes to certification procedures.
- Identify inconsistencies in certification results and initiate corrective action.

2.2 LABORATORY TECHNICIAN

The laboratory technician shall:

- Perform required certifications as described in this SOP and manufacturer's instrument manuals.
- Document all certification results and procedures performed.

3.0 REQUIRED EQUIPMENT AND MATERIALS

Certifications should be conducted in a properly equipped laboratory where external, potentially influencing variables can be minimized. Required equipment includes:

- A UV photometer (primary standard) under current verification

  or

- An ozone transfer standard under current certification
- Strip chart recorder
- Digital voltmeter (4-1/2 digit)
- A candidate ozone transfer standard
- Pen or pencil
- Instrument-specific manufacturer's manual
- Ozone Transfer Standard Certification Worksheets
- Laptop computer loaded with Excel spreadsheet form (O3cert.xls) and CALCU program software
- ARS calibration stickers

4.0 METHODS

Certification of candidate ozone transfer standards requires a six-point calibration check performed on six different days (six-by-six calibration). The days need not be consecutive. Success of the certification process is determined by statistical analysis of the calibration check results. Ozone transfer standard certifications are valid for 90 days and require re-certification quarterly.

Re-certification involves one six-point calibration check. Data from the most recent six-point calibration checks are subjected to analysis to determine the success of the re-certification. A moving (rolling) average of results is calculated and maintained each quarter. Should an ozone transfer standard fail re-certification, or should its certification lapse, the entire certification process must be repeated, starting with a new six-by-six calibration check procedure.

This section is presented in the following four (4) major subsections:

4.1 Preparation for Ozone Transfer Standard Certification
4.2 Certification (six-by-six) of an Ozone Transfer Standard
4.3 Re-certification of an Ozone Transfer Standard
4.4 Documentation

4.1 PREPARATION FOR OZONE TRANSFER STANDARD CERTIFICATION

Transfer standard certifications are critical, lengthy (six day) operations that require careful attention to detail and record keeping. Certification should be performed in a properly equipped laboratory where external variables can be kept to a minimum. Personnel performing the certifications need to be experienced technicians familiar with the operation of UV photometric-based ozone analyzers.

Preparation for transfer standard certification involves the following procedures:

CONFIGURE STANDARDS	Configure the primary (or certified transfer) standard and candidate transfer standard(s) for operation.
CONFIGURE TEFLON TUBING	Configure clean Teflon tubing so the candidate transfer standard is assaying ozone concentrations generated from the primary (or certified transfer) standard. Be certain flows generated by the primary (or certified transfer) standard satisfy the demands of the photometers.
CONNECT STRIP CHART RECORDER	Connect a strip chart recorder to the candidate transfer standard to document the standard's response.
WARM UP INSTRUMENTS	Warm up the instruments for an adequate amount of time.
VERIFY DOCUMENTATION	Confirm that calibration documentation is current, complete, and available.

4.2 CERTIFICATION (SIX-BY-SIX) OF AN OZONE TRANSFER STANDARD

The following procedures detail the necessary steps to complete the six-by-six certification process. Re-certification procedures are identical to certification, but just one calibration check is required rather than six. The procedures assume that an ozone primary standard (UV photometer) is being used to transfer authority to a candidate transfer standard. The procedures are identical if a certified transfer standard is used in place of the ozone primary standard. An example Ozone Transfer Standard Certification Worksheet, used to record daily six-point checks, is presented as Figure 4-1.

4.2.1 Introduce Known Ozone Concentrations and Record Instrument Responses

RECORD PARAMETERS	Check all instrument-specific operational parameters for operation and record parameter values on a Ozone Transfer Standard Certification Worksheet.
INTRODUCE ZERO AIR	Direct a flow of zero air into the candidate transfer standard(s) and allow the value to stabilize (as indicated by the strip chart recording). Record the response on the calibration form. This point represents the zero response, the first of the six levels of known ozone concentration.

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OZONE TRANFER STANDARD CERTIFICATION

Date 1/18/05 **Client** USFS San Juan Forest **Tech.** MB

Z Air Make ARS **Model** lab

Serial Number 101 **Last Maintenance Date** 4/13/2004

PRIMARY	
Last Cal. Date	11/16/04
Manufacturer	TECO
Model	49C-PS
Serial Number	49CPS-75759380
Span Setting	N/A
A Frequency	98699
B Frequency	88948
Flow	.607/.546
Cell Temperature	30 C
Inst. Offset (ppm)	.000

Instrument to be Calibrated	
Last Cal. Date	NA
Manufacturer	TECO
Model	49
Serial Number	49-2175-201
Span Setting	500/50
A Frequency	100625
B Frequency	100247
Flow	.9/.9
Cell Temperature	35
Inst. Offset (ppm)	.000

POINT	INSTRUMENT	RESPONSE (PPB)					
	DATE	1/18/2005	4/13/2004	4/12/2004	4/11/2004	4/10/2004	4/9/2004
1	Primary	471	470	470	470	470	470
	Transfer	474	470	469	471	368	471
2	Primary	370	370	371	371	371	369
	Transfer	372	370	370	371	370	370
3	Primary	270	269	270	270	270	270
	Transfer	271	269	270	271	269	270
4	Primary	170	170	171	170	170	171
	Transfer	171	170	170	170	171	172
5	Primary	70	70	70	70	70	70
	Transfer	71	70	70	69	70	70
6	Primary	0	0	0	0	0	0
	Transfer	1	0	-1	1	1	0

SLOPE (m)	1.0022	1.0000	0.9999	1.0003	0.9947	1.0021
INTERCEPT (b)	0.8151	0.0000	-0.5747	0.1529	0.9313	0.0254
CORR (r)	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

	M	B	Sm	Sb
CURRENT	0.9999	0.2250	0.27%	56.25

QUALIFICATION STANDARDS: 1) Sm <=3.7% 2) Sb <=1500 3) 0.95 <= M <= 1.05

RECERTIFICATION PASS/FAIL: **PASS**

Rev. 5/10/00

Figure 4-1. Example Ozone Transfer Standard Certification Worksheet.

GENERATE OZONE — Consecutively generate the following concentrations of ozone from the primary standard and direct the flow into the candidate transfer standard. Allow sufficient time for each point to stabilize (as indicated by the strip chart recording). Concentrations to be generated include:

0.400 to 0.450 ppm
0.300 to 0.350 ppm
0.200 to 0.250 ppm
0.100 to 0.150 ppm
0.050 to 0.100 ppm

RECORD VALUES — As each point stabilizes, note and average five consecutive updates of both the primary standard and candidate transfer standard(s). Record the primary standard value on the calibration form as the primary ozone concentration and the candidate transfer standard as the transfer response.

REPEAT — Repeat the above procedures once a day for a total of six days.

4.2.2 Compile Certification Data

At the end of six days, information from each of the daily calibrations are compiled.

COMPLETE WORKSHEET — Complete the Ozone Transfer Standard Certification Worksheet. The worksheet calculates the following:

- Calculates the slope and intercept.
- Sums the slopes and intercepts and calculates the average.
- Calculates the standard deviation of the slopes and intercepts.
- Determines if the certification process was successful by comparing the results of the worksheet against the stated limits.

Slope must be between 0.95 and 1.05.
Intercept must be ≤ 3.0.
Standard deviation of slope must be $\leq 3.7\%$
Standard deviation of intercept must be ≤ 1.5.

TROUBLESHOOT — If certification is unsuccessful, troubleshoot the instrument, implement corrective action, and repeat the certification process.

4.3 RE-CERTIFICATION OF AN OZONE TRANSFER STANDARD

Re-certification of an ozone transfer standard requires only a single (one day) six-point check each quarter. All other re-certification procedures are identical to the certification procedures presented in Section 4.2.

Re-certification documentation procedures require using the most recent six calibration checks to determine certification success. Complete the Ozone Transfer Standard Certification Worksheet with the most recent calibration check first, followed by the five most recent calibration checks.

If the transfer standard does not pass the re-certification tests, the standard should be evaluated and serviced. At any time that a transfer standard fails the re-certification process, a new, complete six-by-six certification procedure must be initiated.

4.4 DOCUMENTATION

Transfer standard certification requires several levels of documentation:

CALIBRATION FORMS	Calibration forms or the computer laptop Excel spreadsheet should be completed entirely for each of the initial six days and any re-certifications. Where possible, use the Excel spreadsheet so that both a hard copy and digital record of the calibration are maintained. Review and sign all calibration forms.
STRIP CHARTS	Strip chart records should be annotated to clearly document standard response.
LOG NOTES	A copy of all log notes summarizing work performed and results of the certification. Note any abnormalities in standard operation.
CALIBRATION STICKER	An ARS calibration sticker is placed on the standard, marking the date the instrument was certified and the name of the technician who calibrated it.

Figure 4-2. ARS Calibration Sticker.

5.0 DEFINITIONS

CALIBRATOR - A device capable of generating concentrations of a pollutant (ozone). Calibrators may or may not be able to assay the concentration of pollutants produced.

CERTIFICATION - The procedure and methodology of transferring the authority of measurement from one device to another. In ozone monitoring, this procedure is commonly known as a "six-by-six" calibration referring to subjecting a candidate transfer standard to a six-point calibration check on six different days.

OZONE TRANSFER STANDARD - A device capable of accurately assaying concentrations of ozone. Ozone transfer standards are typically ozone analyzers that have been dedicated in their usage as transfer standards. Referring to a transfer standard implies that the device has already been "certified." Without certification, the device would have status of "calibrator."

PRIMARY STANDARD - a device that due to its mechanical configuration, is inherently accurate and requires no periodic calibration. It is an authority unto itself. Primary standards, however, do require "verification." Ozone primary standards must be UV photometer-based ozone analyzers that require no convertors, scrubbers, or consumable reagents. They have no provision for an electronic or mechanical adjustment of their measured output. An ozone primary standard is often referred to as a "UV photometer."

RE-CERTIFICATION - A single six-point calibration check of a previously-certified ozone transfer standard. Ozone transfer standards are required to be re-certified quarterly in order to maintain authority.

VERIFICATION - A six-point calibration check of a candidate ozone primary standard by an ozone primary standard. This verification takes only one day, and is required on a yearly basis.

6.0 REFERENCES

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

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**INFORMATION MANAGEMENT CENTER (IMC) CONCEPT AND CONFIGURATION FOR THE NATIONAL PARK SERVICE GASEOUS POLLUTANT MONITORING PROGRAM**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3340**
DATE	**MARCH 1999**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Betsy Davis-Noland	Betsy Davis-Noland
SECTION MANAGER	Jessica Ward	Jessica Ward
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
NPS COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Update respon./equipment, add CASTNet.	January 2001	G. Mercer
	Reviewed; no changes necessary.	January 2002	G. Mercer
	Reviewed; no changes necessary.	January 2003	G. Mercer
2.0	Redefined staff positions/updated computer equip.	January 2004	G. Mercer
2.1	Modify collection/validation flowchart.	May 2004	G. Mercer
2.2	Change AIRS to AQS.	May 2005	G. Mercer
2.3	Software versions and miscellaneous changes	February 2006	G. Mercer
3.0	Update IMC software table, etc.	January 2007	G. Mercer
	-- continued --		

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ORIGINATOR	Betsy Davis-Noland	Betsy Davis-Noland
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REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
4.0	Update computer eqpmt, perf. measures, etc.	January 2008	G. Mercer
4.1	Update software used.	January 2009	G. Mercer
4.2	Updated hardware and software used.	February 2010	G. Mercer
	Reviewed; no changes necessary.	April 2011	G. Mercer

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1.0 PURPOSE AND APPLICABILITY

The Gaseous Pollutant Monitoring Program (GPMP) is a major component of the National Park Service (NPS) air quality program and is coordinated by the NPS Air Resources Division (ARD). Network sites have traditionally monitored a combination of gaseous pollutants, particulates, and meteorological parameters. Dry deposition monitoring systems, operated under Clean Air Status and Trends Network (CASTNet) protocol, are located at most sites. Data collected from the network consist of over 95 million hourly averages collected from over 150 network sites. The Information Management Center (IMC) manages this data warehouse and current network data handling including data collection, validation, reporting, and archive. This document provides an overview of the IMC configuration and concepts. Other documents including standard operating procedures (SOPs), technical instructions (TIs), and technical references provide details of each function of the IMC. Table 1-1 is a list of current documents in this set.

Table 1-1

IMC-Related Standard Operating Procedures (SOP),
Technical Instructions (TI), and Reference Documents (REF)

Type	Number	Title
SOP	3340	Information Management Center (IMC) Concept and Configuration
SOP	3345	Day to Day Network Operations Technical Support for the National Park Service Gaseous and Meteorological Monitoring Program
SOP	3350	Collection of Ambient Air Quality and Meteorological Monitoring Data
TI	3350-4000	Collection of Ambient Air Quality and Meteorological Monitoring Data via Telephone Modem
TI	3350-4005	Collection of DataView Files via Telephone Modem
SOP	3450	Ambient Air Quality and Meteorological Monitoring Data Validation
TI	3450-5000	Ambient Air Quality and Meteorological Monitoring Data - Level 0 Validation
TI	3450-5010	Ambient Air Quality and Meteorological Monitoring Data - Preliminary Validation
TI	3450-5020	Ambient Air Quality and Meteorological Monitoring Data - Final Validation
SOP	3550	Ambient Air Quality and Meteorological Monitoring Data Reporting
TI	3550-5000	Ambient Air Quality and Meteorological Monitoring Data Monthly Reporting
TI	3550-5100	Ambient Air Quality and Meteorological Monitoring Data Annual Reporting
TI	3550-5200	Handling Requests for Ambient Air Quality and Meteorological Monitoring Data
TI	3550-5300	Submitting Ambient Air Quality and Meteorological Monitoring Data to the EPA AQS Database
SOP	3650	Maintenance Responsibilities for the Ambient Air Quality Data Base Management System (AQDBMS)
REF	ARS	Air Quality Data Base Management System (AQDBMS) User’s Guide
REF	ARS	Air Quality Data Base Management System (AQDBMS) Database Manager/Programmer’s Guide
REF	ARS	STKWIN User Documentation

2.0 RESPONSIBILITIES

IMC technical staff ensure successful operation of the IMC and provide timely network data management that meets NPS performance requirements. This section lists the responsibilities of the IMC staff positions. Figure 2-1 is an organizational chart of IMC staff.

Figure 2-1. IMC Staff Organization.

2.1 NPS ARD STAFF

NPS ARD staff shall:

- Participate in monthly data and operational reviews with ARS personnel.
- Review and comment on all data reports.
- Evaluate and approve data requests.
- Provide guidance and direction in all aspects of data handling and quality assurance.
- Consult with IMC and field operations staff to resolve data related problems or questions.

2.2 PROGRAM MANAGER

The program manger has the overall responsibility, accountability, and authority for the IMC. The program manager shall:

- Oversee that all project objectives are met on schedule, including data collection, validation, reporting, archive, and other products and technical requirements.
- Assign duties to the information management section manager and IMC technical staff, and review the section manager's performance.
- Coordinate and review all quality assurance/quality control aspects of the program.
- Participate in monthly data and operational reviews with the contracting officer's technical representative (COTR), NPS ARD personnel, and ARS personnel.

2.3 INFORMATION MANAGEMENT SECTION MANAGER

The information management section manager oversees the IMC and verifies that day-to-day tasks are completed to ensure timely, quality data collection, validation, reporting, and archiving. The section manager shall:

- Assign duties to the IMC data analysts and review the data analysts' performance.
- Coordinate the overall information management effort to ensure that all components of the IMC are fully functional.
- Assign the database manager, programmers, or computer systems support staff to meet the needs of the IMC. This includes system hardware, software, and communications components.
- Participate in and/or direct overall IMC planning and procedures formulation and documentation including SOPs and TIs.
- Participate in monthly data and operational reviews with the program manager, IMC staff, and other project participants as appropriate.
- Participate in monthly CASTNet conference calls.

- Oversee all aspects of the data validation process and perform a final data review each month.
- Summarize IMC-related progress and forward items to the technical assistant for inclusion in project progress reports.

2.4 IMC DATA ANALYSTS

The team of data analysts perform the following tasks to collect, validate, report, and archive all network data:

- Ensure that the workstation used for automatic data collection is properly configured.
- Review the status of automatic data collection each morning (including reviewing daily error and diagnostic printouts).
- Inform the network operations staff of any observed, site-related data or communications inconsistencies.
- Review collected data files.
- Compile and document site specifications and configurations
- Blank-fill missing data as necessary.
- Review all trip report field documentation and maintain the master field documentation forms.
- Collect, review, and log DataView and manual site documentation.
- Document issues and review Electronic Status Board entries and inform field operations staff of noted inconsistencies.
- Validate all data according to established protocols.
- Review and annotate stackplots.
- Cross-check annotated stackplots prepared by fellow data analysts.
- Review annotated stackplots with the field specialist.
- Enter validation codes in the AQDBMS based on stackplot annotations.
- Update the Data Validation Log in the AQDBMS.
- Hand enter or enter reduced data from other sources (strip charts, printouts, or digital data) as required.
- Update information in the AQDBMS site configuration tables and stackplot configuration files.
- Post a combination of validated plots and raw, annotated stackplots for the plot reviews.
- Prepare national gaseous and meteorological summaries for plot reviews.
- Participate in weekly program reviews and monthly plot reviews. Respond to questions posed during the plot review.

- Prepare all data reports.
- Respond to site operator or COTR comments on data reports.
- Compile all independent audit information performed by state agencies or other entities on GPMP sites.
- Fulfill all data requests as assigned.
- Submit all validated data to the EPA AQS database.
- Submit validated data from CASTNet sites to the EPA CASTNet contractor.
- Update database files to account for system configuration or site changes.
- Provide telephone support to site operators to resolve data communications and documentation problems.
- File hardcopy documentation and maintain hard copy site files.
- Prepare and distribute all hardcopy and digital archives.
- Create and update IMC-related SOPs and TIs.
- Manage and archive site photographs and site specification documentation.

2.5 DATABASE MANAGER AND SYSTEMS SUPPORT STAFF

The database manager is responsible for maintaining the IMC database and supervising ongoing development and maintenance of database applications by the systems support staff. In addition to the database manager, the systems support staff includes applications programmers, data communications specialists, and network administrators. The systems support staff shall:

- Design, develop, implement, test, and maintain database, data acquisition, data communications, site documentation (DataView), trip report forms, and applications software to meet evolving program needs.
- Ensure that all software licenses and updates are current.
- Perform database system maintenance as required.
- Train all ARS personnel on the use of database applications.
- Produce database archive and export records to ensure that contingency plans can be carried out if required.
- Coordinate with cooperating agencies such as states and with special study participants to regularly retrieve and process data files as appropriate.
- Research new and enhanced database and applications systems.
- Maintain and upgrade project and request Web site hardware configurations and software.

2.6 FIELD SPECIALISTS

The field specialists shall:

- Document field operations problems in the Site Status Log.
- Inform IMC staff of any changes in site configurations resulting from maintenance visits.
- Inform IMC staff of any equipment, data acquisition system or DataView malfunction, replacements, additions, or inconsistencies.
- Inform IMC staff of any data acquisition system or DataView program changes.
- Inform IMC staff of any inconsistencies or needed program changes on trip report documentation forms.
- Review stackplots and troubleshoot inconsistencies observed on the stackplots or identified by IMC staff.
- Provide assistance to the IMC for troubleshooting data collection problems.
- Provide assistance in troubleshooting on-site instrument problems.
- Meet weekly with IMC staff to discuss network issues.
- Review annotated stackplots with IMC staff.
- Participate in the monthly plot review.

2.7 SITE OPERATORS

The site operators shall:

- Enter all required site documentation in DataView.
- Telephone the IMC or field specialist if data collection or calibration problems are noted on site.
- Perform regular site maintenance and troubleshooting as required or directed by the field operations staff.

2.8 TECHNICAL ASSISTANT

The technical assistant shall:

- Enter appropriate information in the Site Status Log.
- Review and print trip reports, file copies in the IMC, and post .pdf files on the project Web Site.
- Compile and distribute weekly and quarterly progress reports.
- Assist with IMC correspondence.

2.9 QUALITY ASSURANCE MANAGER

The quality assurance manager shall:

- Coordinate with the IMC section manager and technical personnel for appropriate quality assurance document content.
- Coordinate annually, or as needed, review and updates of IMC-related SOPs and TIs.
- Review final documents and revisions for completeness and accuracy before approval.

3.0 REQUIRED EQUIPMENT AND MATERIALS

Dataloggers at each monitoring site automatically collect and store data from on-site instruments. Laptop computers installed at each site are used by the site operators to document weekly site calibration and maintenance visits using DataView software. IMC programs retrieve datalogger data daily and DataView station logs weekly via telephone or satellite modem and create ASCII files on the IMC computer network file server. The data and station logs are promptly loaded into an Oracle database, the primary data management tool for the centralized IMC. An Oracle database is maintained on a database server that allows multiple connections from client workstations. The workstations run commercial and custom software applications consisting primarily of MS-Windows object-oriented, graphical user interfaces, and efficient programs to validate, report, and archive data. The IMC also contains working files and archives of site documentation, hardcopy reports, and IMC-related correspondence. This section describes specific computer hardware, software, and other equipment requirements of the IMC.

3.1 MONITORING SITE DATA COLLECTION HARDWARE

Each monitoring site in the current network must be equipped with sufficient hardware to ensure accurate and timely data collection. Typically, the hardware configuration includes a datalogger connected to a telephone or satellite modem and a laptop computer with an internal modem. The datalogger stores data via analog or serial inputs from multiple gaseous pollutant analyzers, meteorological sensors, or other monitoring instrumentation. The laptop computer runs DataView software that is used by the operator to document the actions and results of weekly site visits. This information is consolidated by DataView into the station log. IMC software and modems are used to call the modems at each site, send specific commands to the datalogger and laptop computer, and transfer the data and station log to the IMC. IMC software and modems can also download data from other media such as FTP sites, centralized computers, e-mail files, or other services. Monitoring site hardware currently used in the network is presented in Table 3-1.

Table 3-1

Current IMC Computer Hardware Configuration

Monitoring Site Data Collection Hardware

Component	Manufacturer	Model	Communications Settings		Number of Inputs	
			Serial (Baud Rate) / IP	Error Checking	Analog	Serial
Datalogger	ESC	8816 / 8832	Varies	Yes	16	2
	Campbell Scientific	23X	Varies	Yes	12	4
Datalogger telephone modem	Various	N/A	Varies	Yes	-	-
DataView laptop	Various	Varies	Varies	Yes	-	-

Hardware Specifications for IMC Servers

Name	Manufacturer	Model	Processor(s)	RAM	Disk Space	Ethernet Speed	Services
Netware Server	IBM	xSeries 250	Xeon 700	4GB	72.8GB	1000mbs	File, Print
Oracle Server	HP Proliant	DL380 G5	Xeon 3.00 gHz	460GB	91GB	100mbs	File, Database
Firewall	McAfee	Firewall Enterprise 2009		-	-	100mbs	Firewall

Hardware Specifications for Workstations

User	Processor(s)	RAM	Disk Space	Network Card	Modem Baud Rate	Floppy Drive	CD Drive Speed
Database manager	Pentium IV 3.6	1.0GB	40GB	3Com Ethernet 100MB	56K	3.25	52x
IMC data processing staff	Pentium IV 2.8 gHz	512MB	40GB	3Com Ethernet 100MB	56K	3.25	52x

IMC Computer Support Hardware

Component	Manufacturer	Model	Function
High-quality laserjet printer	Hewlett-Packard	LaserJet 4300tn	Report tables and plots
Color laserjet printer	Xerox	Solid Ink Phaser 8550	Color report tables and plots
Write capable CD Drive	Sony	52x32x52	Data distribution and archive
T-1 Internet data connection	AT&T		Internet access
Data Backup	Arkeia	Network Backup Appliance	Database and flat file nighly backup

3.2 IMC COMPUTER HARDWARE

The IMC is built on client/server architecture in a local area network (LAN). The hardware consists primarily of servers and client workstations. Supporting hardware includes computer peripherals, such as printers, required by the IMC. Table 3-1 lists the current hardware and Figure 3-1 is a diagram of the current IMC computer hardware configuration. A brief description of each hardware category is provided below.

3.2.1 Servers

The IMC primarily requires the following three network servers:

1) File server for storing and retrieving program executables, ASCII data files, word processing documents, etc. (Netware Server)

2) Database server for managing a relational database management system (RDBMS) such as Oracle. (Oracle Server)

3) Internet communications server for transferring data to and from the EPA AQS database and other sources. (McAfee Firewall Enterprise 2009)

One or more servers in the network may handle these services. The servers have sufficient processing power, hard drive storage, random access memory (RAM), and network throughput to allow for efficient and secure data processing and warehousing and all other computer-related tasks of the IMC.

3.2.2 Workstations

The servers are accessed by networked workstations. Each workstation has sufficient processing power to efficiently run the software applications required to collect, validate, report, and archive the data.

3.2.3 Computer Support Hardware

A variety of computer peripherals are required to support IMC operations including printers, write-capable compact disc (CD) drives, modems, and other communications devices.

3.3 IMC COMPUTER SOFTWARE

The Air Quality Data Base Management System (AQDBMS) is a collection of commercial and custom software designed to run on client/server architecture in a local area network (LAN). Three categories of software exist in the AQDBMS:

1) The Oracle relational database management system.

2) Custom software for performing the day-to-day tasks of the IMC.

3) Support software for the computer operating systems, network communications, printing, and all other supporting tasks.

Table 3-2 lists the current IMC software by category. A brief description of each category is provided in the following subsections.

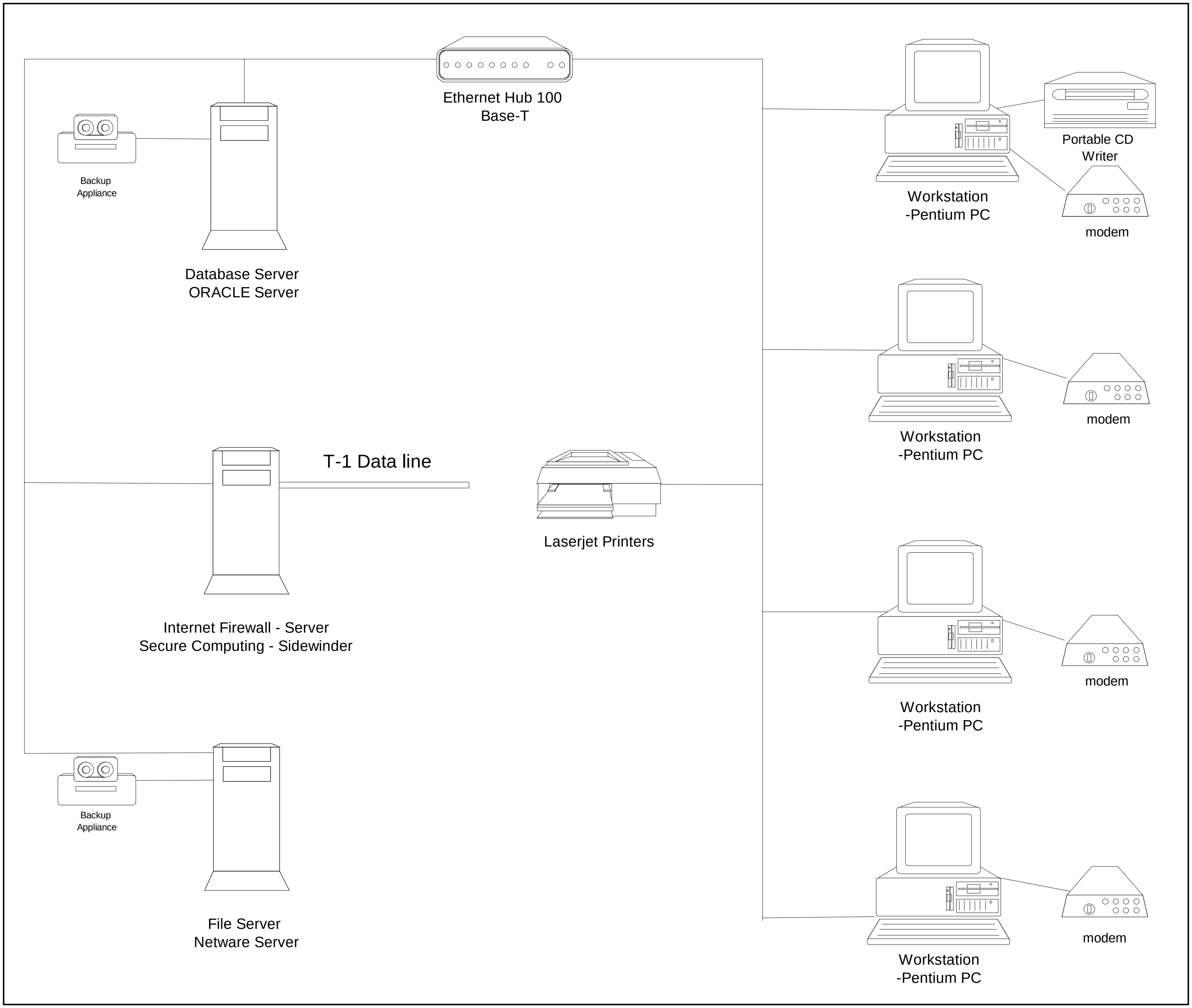

Figure 3-1. IMC Computer Hardware Configuration.

Table 3-2

Current IMC AQDBMS Software

Oracle Database System				
Program	Manufacturer	Version	Installed on	Function
Oracle Database 11g Standard One Edition for Linux	Oracle Corporation	11.1	Database server	Relational Database Management System
SQL Net TCP/IP	Oracle Corporation	11.1	Database server	Database networking
SQL*Net Listener	Oracle Corporation	11.1	Database server	Database networking
SQL*Net Client	Oracle Corporation	11.1	Client	Database networking
Oracle Enterprise Manager	Oracle Corporation	11.1	Client	Database administration and special processing
AQDBMS Commercial Software				
Program	Manufacturer	Version	Installed on	Function
DATA COLLECTION				
Crosstalk Mk.4	DCA	3.3	Client	Data logger support and data collection
HyperAccess	Hillgraeve	8.4	Client	Data logger support and data collection
PC208W	Campbell Scientific	3.3	Client	Data logger support and data collection
Loggernet	Campbell Scientific	3.1.1.0	Client	Data logger support and data collection
PcAnywhere	Symantec	10.5+	Client	Data collection and DataView support
AQDBMS Custom Software				
Program	Manufacturer	Source Code Language and Version	Installed on	Function
DATA COLLECTION				
Orbcomm	ARS	Visual Basic 6.6	Client	Acquire Orbcomm satellite data
TECO BAM	ARS	Visual Basic 6.6	Client	Acquire TECO BAM data
DATA VALIDATION AND REPORTING				
Datacoll	ARS	Visual Basic 6.6	Client	Acquire and prepare data for database import
FTM8816	ARS	Visual Basic 6.6	Client	Reformat ESC88xx data file
StackPlot	---	---	---	---
Diurnal Plot	---	---	---	Prepare diurnal data plot
Three-Year Summary Plot	---	---	---	Prepare three-year summary plot
Roseplot	---	---	---	Prepare wind and pollutant rose plots
Barchart	ARS	Visual Basic 6.6	Client	Prepare annual barcharts
AIRNow DataColl	ARS	Visual Basic 6.6	Client	Acquire, prepare, and upload hourly data to AIRNow and FTP sites
ARS utility programs	ARS	Visual Basic 6.6 and PowerBuilder 10	Client	Perform a variety of data acquisition, preparation, and uploading

-- continued --

Table 3-2 (continued)

Current IMC AQDBMS Software

Network Operating Systems and Support Software				
Component	Manufacturer	Version	Installed on	Function
Novell SUSE Linux Server	Novell	SLES 10	Database server	Network operating system
Novell Netware Server	Novell	6.5	File and e-mail servers	Network operating system
Novell Netware Client	Novell	4.91	Clients	Network operating system
Arkeia Backup Appliance	Arkeia	8.1.4	Database server	Server backup
HP LaserJet 4300 PCL 5e	Hewlett-Packard		Clients	Printer communications
HP LaserJet 4000 PCL 6	Hewlett-Packard		Clients	Printer communications
MS-Windows XP	Microsoft		Clients	PC operating system
MS-Word XP	Microsoft	XP (2002/2003)	Clients	Word processing reports
MapViewer	Golden Software	5	Clients	Report map production
WS-FTP PRO	Ipswitch	12	Clients	Data transmission
Scheduled Tasks	Microsoft	XP	Clients	Automatic data collection & startup
WINZIP	WinZip Computing	9	Clients	Data archive
UltraEdit	IDM Computer Solutions	9.2	Clients	Multiple functions
WARFTP Server	Open Source	1.7	AIRNow servers	Host FTP services

3.3.1 Oracle Relational Database Management System

The core of the IMC AQDBMS is the Oracle database. Oracle is a comprehensive relational database management system operating in a client/server environment. The Oracle database and Oracle networking programs reside on the database server. The database is accessed by network drivers installed on client workstations. The Oracle system also includes database administration utilities.

3.3.2 AQDBMS Custom Software

Because of the unique nature of NPS air quality data, custom software has been developed to perform the day-to-day tasks of collecting, validating, reporting, and archiving the data. The software has been developed primarily using Powersoft PowerBuilder and Microsoft Visual Basic development tools. Commercial utility programs are also used for certain functions.

3.3.3 Network Operating System and Support Software

The IMC AQDBMS operates in a client/server environment that handles system peripherals, network file management and sharing, word processing, e-mail, Internet access, system backup, data archive, and a variety of other computer services.

3.4 ADDITIONAL SUPPORT EQUIPMENT

In addition to computer hardware and software, the IMC maintains working hardcopy files for each site currently in the monitoring network. Paper documents stored in the IMC include site documentation, site-related correspondence, diagnostic plots, plots annotated with validation comments, monthly and annual reports, and other hardcopies related to current and recent past data. Adequate storage space is required for this information. The IMC is currently housed in an 800 square foot office with additional off-site storage. Active paper documents are filed in standard 4-drawer file cabinets. Archive paper documents, extending back five years, are stored in file cabinets in an ARS warehouse.

4.0 METHODS

This section presents an overview of the IMC, NPS Gaseous Pollutant Monitoring Program data quantity and quality objectives, and the methods used in the IMC to meet the data objectives. This section includes seven (7) major subsections:

4.1 IMC Concept and Overview
4.2 Data Quantity and Quality Objectives
4.3 AQDBMS Design Concept
4.4 Data Collection
4.5 Data Validation
4.6 Data Reporting
4.7 Data Archiving

4.1 IMC CONCEPT AND OVERVIEW

The IMC is a centralized data management center that includes the computer hardware, software, database, communications, facilities, and support systems required to efficiently and effectively manage all data for the NPS Gaseous Pollutant Monitoring Program. It has been designed to fully meet or exceed all of the requirements of the monitoring program.

The primary component of the IMC is the Air Quality Data Base Management System (AQDBMS). The AQDBMS consists of an Oracle database and custom software designed to process and report air quality data. Gaseous air pollution, meteorological, and supporting data are collected from dataloggers and DataView laptop computers by telephone modem, processed through three levels of validation, and reported via a variety of output products. Data and supporting field documentation are archived at all stages of the process. A flow diagram that illustrates the details of the process is provided as Figure 4-1. Further details of each stage in the process are briefly presented in the following subsections and in function-specific standard operating procedures and technical instructions (see Table 1-1).

4.2 DATA QUANTITY AND QUALITY OBJECTIVES

Performance criteria ensure uninterrupted, reliable, and quality assured operation of the NPS Gaseous Pollutant Monitoring Program. Table 4-1 summarizes the performance measures and goals for the network. The technical approach of the IMC recognizes the importance of these criteria and fully meets or exceeds the criteria within IMC control.

4.3 AQDBMS DESIGN CONCEPT

The AQDBMS is specifically designed to manage and report hourly network data and related site information data, validated data, diagnostic data, and parameter data that accommodate the many temporal, spatial, and functional variations found in the NPS network. The core of the AQDBMS is the Oracle database. Oracle is a comprehensive relational database management system (RDBMS). A *table* is the basic unit of data storage in an Oracle database. Table data are stored in *rows* (records) and *columns* (fields). Each table is related to one or more other tables by linking common columns. Relationships and other rules defined within the RDBMS are used to enforce data integrity. The AQDBMS database interface incorporates user-friendly site/date selection and editing screens for data maintenance, validation, and reporting. Table 4-2 presents a summary of current AQDBMS design specifications.

4.4 DATA COLLECTION

As shown in Figure 4-1, the data management flow begins with data collection. The AQDBMS maintains an integrated, comprehensive data collection module that performs daily automatic data polling of network sites via telephone. The data collection module also includes programs providing auxiliary data polling, data transmission error screening, and data transmission error recovery. Complete and accurate site configuration details are required for successful data collection.

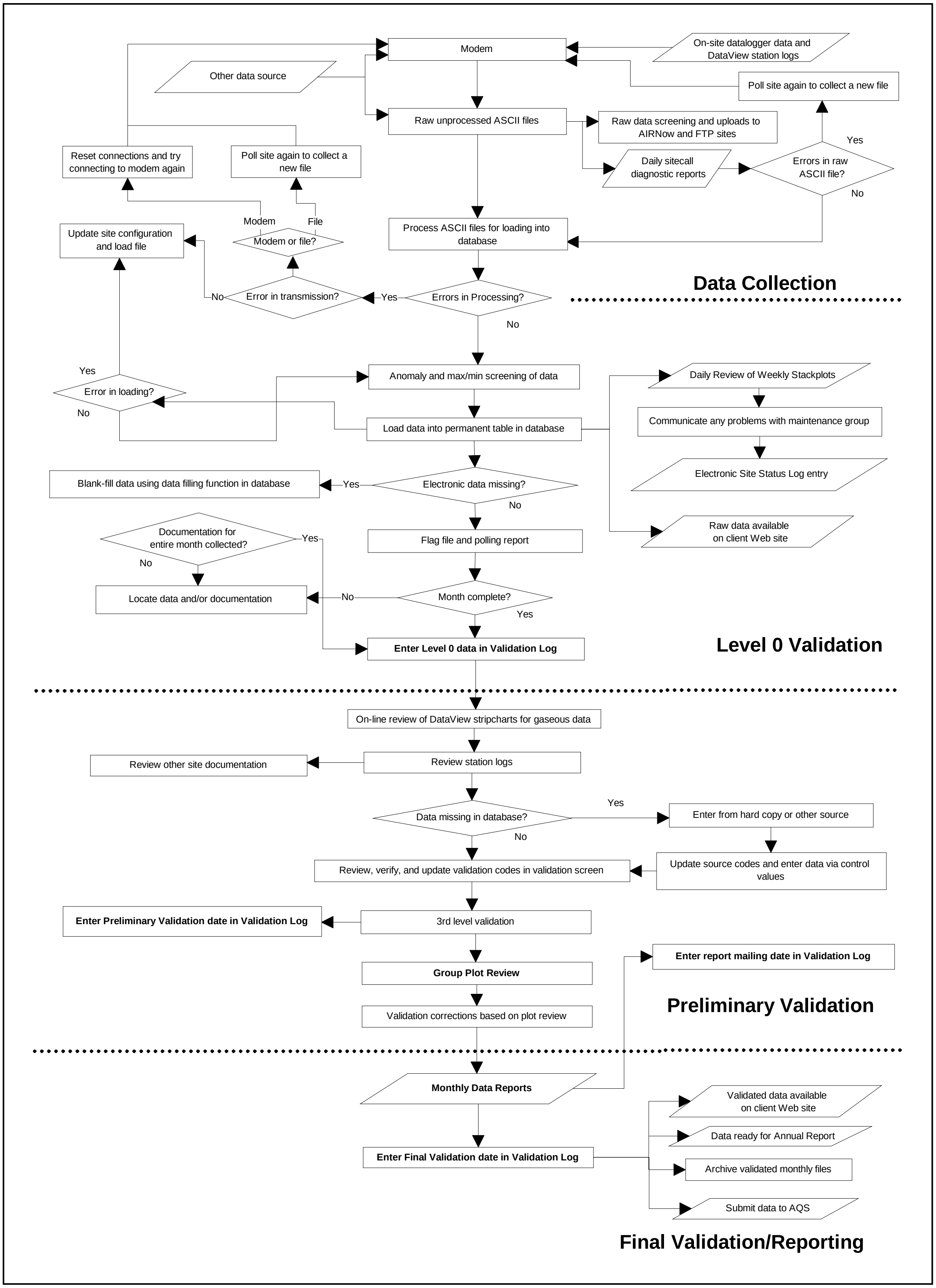

Figure 4-1. NPS Gaseous Pollutant Monitoring Program Data Collection, Validation, and Reporting Flow Diagram.

Table 4-1

Performance Measures and Goals for the NPS Gaseous Pollutant Monitoring Program

Performance Measure	Performance Goal
1. Performance of Monthly Calibrations for Pollutant Analyzers	**Number of Calibrations:** Ozone: 80% of sites conduct a minimum of 6 calibrations during Apr-Oct 100% of sites conduct a minimum of 3 calibrations during Nov-Mar Sulfur Dioxide: 100% of sites conduct a minimum of 8 calibrations per year **Calibration Results:** Absolute percent difference for 80% of all calibrations at each site are within 5%, 95% of all calibrations are within 10%, and 100% of all calibrations are within 15%. *Note: Absolute percent difference is defined as the absolute value of difference between the calibration's slope estimate and 1, expressed as a percent.*
2. Data Documentation by Site Operators	• DataView station logs that include all required site documentation are downloaded weekly from all sites. If an on-site DataView system fails, site operators are required to submit completed manual checklists by the 15th of each month. • 100% of all site documentation complete by the 15th of each month.
3. Instrument Problems	Initial response to all problems within 48 hours (or by the close of business Tuesday for problems occurring on weekends). Analyzers/Calibrators: Maximum instrument downtime $\leq$ 10 days. Status Board Entries: 100% entered within 1 working day. Site Visits: All problems identified during semiannual visits are resolved within 10 days.
4. Data Communications Problems	100% of problems corrected within 6 calendar days. 100% of sites polled at least weekly.
5. Precision Checks	97% of sites, at least once every 14 days.
6. Zero/Span Checks	97% of sites, at least once every 7 days.
7. Semiannual Site Visit Reports (also emergency site visits)	100% of reports for trips concluded during the proceeding month are included in progress reports and uploaded to the project Web site.
8. Data Capture	**Quarterly Criteria:** 100% of sites, $\geq$ 95% data capture.
9. Valid Data	**Quarterly Criteria:** 100% of sites, $\geq$ 90% of available hours considered valid.
10. Data Requests	75 of all requests handled satisfactorily within 3 days. All requests completed within 10 days.
11. Quality Assurance Performance Checks	80% of all audits (on a site-parameter basis) will have an average absolute percent difference of $\leq$ 5%. 95% of all audits (on a site-parameter basis) will have an average absolute percent difference of $\leq$ 10%. 100% of all audits will have an absolute percent difference of $\leq$ 15%. *Note: Average absolute percent difference is defined as the average of absolute difference (expressed as a percent based on the known value) for each audit point.*
12. AQS/PARS Submittals	Data from 100% of sites submitted within 90 days.
13. Preliminary Data Reports	All preliminary data reports submitted within 35 days of receipt of complete field documentation for the month.

Table 4-2

Current AQDBMS Design Specifications Summary

The database manages:

1. Hourly average network data:
   - Raw values as collected
   - Validated values in the same measurement units as collected
   - Validation codes
   - Data source codes
   - Validation progress log
   - Datalogger and screening flags

2. DataView station logs:
   - Manual log entries
   - Results of checklist procedures

3. Daily and weekly calibration network data:
   - Raw values as collected

4. Current and historical site information:
   - Name, abbreviation, AQS codes, location information
   - Datalogger configuration for current sites
   - Site Status Log

5. Parameter information:
   - Name, abbreviation, AQS codes, measurement units
   - Anomaly screening rules

The user interface provides:

1. Site and parameter information data entry/modification.
2. Site Status Log information data entry/modification.
3. Data loading from ASCII files and manual data entry, raw data review, and anomaly screening before moving to permanent database.
4. Data validation in a spreadsheet-like editing screen.
5. Batch printing of report tables and plots for selected sites/periods/parameters.
6. Creation of AQS transaction files.
7. Export of data to ASCII files.

4.5 DATA VALIDATION

Timely validation of network data using procedures that meet EPA standards is a primary goal of the IMC. The data validation process applies both automated and manual procedures to evaluate collected data against defined acceptance criteria. Site documentation (DataView station logs) and other pertinent network documentation are essential to the validation of the data. Each step of the validation process is carefully logged into electronic and manual validation log systems. Three levels of data validation are performed:

1) Level 0
2) Preliminary
3) Final

The following subsections summarize the activities performed at each progressive level of data validation. Only Final validation level data will meet all NPS and EPA validation requirements and be acceptable for submission to the NPS-validated data archives and the EPA AQS national database.

4.5.1 Level 0 Validation

Data are appended daily to the database and are subjected to an automatic anomaly screening routine. Weekly plots of hourly data are printed and reviewed by IMC staff and network operations staff. Once these steps have been taken for all data in a site/month and site station logs have been received by the IMC, Level 0 validation is complete.

4.5.2 Preliminary Validation

Preliminary validation is performed monthly by site. The following steps are taken during Preliminary validation:

- Support documents including station logs, Site Status Log entries, trip reports, daily summaries, SSRF forms, calibration results, and independent audit results are reviewed. Stripcharts of gaseous data are reviewed on-line by the IMC using DataView for all sites where interactive access is possible.
- Comments are written on the weekly plots from the support documentation review and validation codes are determined by the IMC staff.
- Data validation codes are entered interactively in the database.
- IMC, network operations, and NPS ARD personnel simultaneously review pollutant plots and a random sample of commented weekly plots and associated information in monthly plot review meetings.
- Data validation codes are modified based upon revisions or clarifications resulting from the plot review.

- Annotated plots and data validation codes are cross-checked by members of the IMC team.
- Preliminary data reports are generated and delivered electronically to the NPS ARD and to each site operator.

4.5.3 Final Validation

Final validation is considered complete on the date the preliminary reports are e-mailed. The following steps occur during the Final validation process:

- Responses from the plot review, final data analyst cross-checks, site operators, ARD staff, and other related parties are reviewed.
- Validation code changes are made if appropriate.
- A Final validation date is entered in the Data Validation Log.

Upon completion of this final step, the data are considered final. The validated data are ready to be formatted for submittal to the EPA AQS database and available for use by the NPS ARD or third-party users.

4.6 DATA REPORTING

Data reporting tasks of the IMC include preparing and distributing hardcopy reports and digital data, submission of hourly and precision and accuracy data to the EPA AQS database, (submission of CASTNet-related data to the CASTNet contractor), and standard and ad hoc data retrieval to accommodate NPS ARD-authorized internal or external data requests or scientific investigations. Table 4-3 lists the current standard IMC report products and tasks.

4.7 DATA ARCHIVING

Data are archived in the AQDBMS each night as a backup. Data in the form of raw files for each site for each day are also stored on the network drive for one year, and are backed up each night. These files are also archived to CD-ROM on a quarterly basis. Data back-ups and CD-ROMs are kept in both on-site and off-site locations. Raw and validated data on CD-ROM are also delivered quarterly to the NPS ARD.

Table 4-3

Current IMC Standard Report Products and Tasks

Deliverable Product/Task	Distribution List	Schedule
Weekly Progress Report	NPS ARD	Weekly by the second workday of each week.
Ozone “hit list”	NPS ARD	Monthly during the ozone season (April-October), generated from raw data within 5 days of the end of each month.
Monthly Data Reports (one for all sites in the program)	NPS ARD, site operators	Monthly, within 35 days of the end of the month of record.
Annual Data Reports (one for all sites in the program)	NPS ARD, site operators, ARFS, state, and regional air quality coordinators	Yearly, by July 31st of the year following.
Digital Data in ASCII files	NPS ARD	Quarterly, by 60 days following the end of the quarter.
CASTNet-related data	CASTNet contractor	Monthly, within 75 days of final validation.
EPA AQS data submittal	EPA AQS	Monthly, following final validation, 60 days from period of record.
Data requests	To requesting party	Within 3 days of request for validated data. Within 3 days of authorization by ARD if raw data.

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Fort Collins, CO 80525
Phone: 970-484-7941
Fax: 970-484-3423

QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**DAY-TO-DAY NETWORK OPERATIONS TECHNICAL SUPPORT FOR THE NATIONAL PARK SERVICE GASEOUS POLLUTANT MONITORING PROGRAM**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3345**
DATE	**SEPTEMBER 2000**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	David L. Dietrich	
PROJECT MANAGER	Jessica Ward	Jessica Ward
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
NPS COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
0.1	Change site document review procedures.	January 2001	G. Mercer
	Reviewed; no changes necessary.	January 2002	G. Mercer
	Reviewed; no changes necessary.	January 2003	G. Mercer
0.2	Updated plots/changed data tech to data analyst.	January 2004	G. Mercer
0.3	Minor text changes; delete operation notes.	January 2005	G. Mercer
	Reviewed; no changes necessary.	January 2006	G. Mercer
0.4	Changed weekly network review to every week.	January 2007	G. Mercer
0.5	Deleted reference to shipping records maintained in equipment inventory database.	January 2008	G. Mercer
	-- continued --		

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
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ORIGINATOR	David L. Dietrich	
PROJECT MANAGER	Jessica Ward	Jessica Ward
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
NPS COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Changed Site Status Log procedures.	January 2009	G. Mercer
1.1	Deleted flag file.	February 2010	G. Mercer
	Reviewed; no changes necessary.	April 2011	G. Mercer

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LIST OF FIGURES

1.0 PURPOSE AND APPLICABILITY

Maintaining the continuous operation of the National Park Service (NPS) Gaseous Pollutant Monitoring Program requires daily review of network data and operations and implementation of responsive, corrective actions when problems are noted. The purpose of this standard operating procedure (SOP) is to describe the day-to-day technical support provided by Information Management Center (IMC) and network operations staff to:

- Provide site operator telephone support.
- Perform routine daily, weekly, and monthly data and operational system reviews.
- Perform operational network documentation.
- Perform corrective actions.
- Inventory, distribute, and track network equipment and supplies.

2.0 RESPONSIBILITIES

2.1 IMC STAFF

2.1.1 IMC Section Manager

The IMC section manager's responsibilities include:

- Supervise the data analysts.
- Coordinate with ARS programming staff, regarding upgrades and repair of problems with products used in data review.

2.1.2 Data Analyst

The data analyst responsibilities include:

- Participate in weekly and monthly data reviews.
- Follow through from problems noted during monthly plot review and data validation.
- Print and review the daily datalogger report file.
- Review daily stackplots.
- Review daily calibration plots.
- Print, circulate, and file weekly stackplots.
- Print weekly calibration plots for maintenance personnel to review and file.
- Alert maintenance personnel of potential problems daily.
- Follow through from daily problems.
- Initiate weekly IMC/maintenance meetings.

- Maintain current site status log with any site problems.
- Enter trip report pre-calibration results.
- Enter any audit results.

2.2 NETWORK OPERATIONS STAFF

2.2.1 Network Operations Section Manger

Within the context of this SOP, the network operations section manager has responsibility to:

- Develop and revise technician-of-the-week (TOW) responsibilities as needed.
- Assign the TOW.
- Schedule TOW duties.
- Support and oversee TOW duties.
- Serve as TOW when scheduled.

2.2.2 Field Specialists and Technician-of-the-Week (TOW)

The field specialists will serve as TOWs as scheduled by the network operations section manager. TOW responsibilities are detailed in Section 4.0 and generally include:

- Review network data daily.
- Review results of automated calibrations daily.
- Update electronic Site Status Log with site problems and actions for problem resolution.
- Initiate contact with site operators when problems are recognized.
- Consult with site operators when they telephone.
- Document communication with site operators.
- Regularly interact with the IMC staff.
- Ship replacement systems or system components to a site, or malfunctioning instruments to an appropriate repair facility.

2.2.3 Technical Assistant

The technical assistant shall:

- Track status of shipped equipment.
- Maintain expendable site supply inventory.
- Print and file Daily Summary Reports.
- Organize photographs from ARS site visits.
- Maintain inventory of backup instrumentation and equipment.

3.0 REQUIRED EQUIPMENT AND MATERIALS

All IMC-related equipment and materials are fully described in SOP 3340, *Information Management Center (IMC) Concept and Configuration*. The hardware and software used to perform specific data validation functions are referenced in the technical instructions (TIs) that support that SOP.

4.0 METHODS

This section includes seven (7) major subsections:

- 4.1 Telephone Support – Scheduled and Unscheduled
- 4.2 Routine Data and Operational Systems Review
- 4.3 Operational Network Documentation
- 4.4 Corrective Actions
- 4.5 Coordination, Tracking, and Inventory Control of Government-Owned Equipment to and from Monitoring Sites or Other Repair Facilities
- 4.6 Maintenance and Distribution of Expendable Site Supplies
- 4.7 Maintenance and Distribution of Capital Equipment and Instrumentation

4.1 TELEPHONE SUPPORT - SCHEDULED AND UNSCHEDULED

At least one member of ARS' technical staff experienced with National Park Service network operations will be available during normal business hours (0800-1700 Mountain Time) to provide telephone assistance to site operators. Extended hours will be arranged when necessary. A telephone answering/message system will be in place when no employees are present. ARS will maintain a toll-free telephone number (1-800-344-5423) for site operators to ensure ease of access and encourage open communications. Operators are trained and encouraged to call if they have any questions or observe any problems or inconsistencies with data or site operations.

Telephone support will include, but not be limited to, the following:

- Assist operators in performing weekly preventive maintenance checks.
- Record and discuss results from monthly multipoint calibration checks.
- Assist operators in troubleshooting a system malfunction.
- Assist operators with all site and data documentation.
- Answer any DataView questions.
- Answer any standard operating procedure (SOP) and site visit checklist questions.
- Assist newly-assigned operators in understanding all technical requirements.
- Assist site operators with data interpretation.
- Coordinate semiannual site maintenance and training visits.

- Coordinate shipping and receiving of all consumable supplies, replacement parts, and equipment.
- Confirm with the operator that all site documentation is properly maintained.

Every call that results in a maintenance action or affects data validation will be logged on a Site Status Report (see Section 4.3). Required action will immediately be initiated (see Section 4.4). Quality site operators will be complimented, and positive constructive direction will be given to operators who encounter problems. The information on the Site Status Report will be entered daily on the Site Status Log by the technical assistant (see Section 4.3 for a description of the Site Status Log). All original copies of Site Status Reports will be filed chronologically by site.

4.2 ROUTINE DATA AND OPERATIONAL SYSTEMS REVIEW

4.2.1 Data Products

Critical to maintaining high data capture throughout the network is timely identification of instrument malfunctions, operator errors, or other circumstances that affect data validity. A primary method for problem identification is the routine review of recently collected data.

The previous day's data from each monitoring station is automatically polled daily by the IMC. (This procedure is described in SOP 3350, *Collection of Ambient Air Quality and Meteorological Monitoring Data and Site Documentation*). Important data troubleshooting products are automatically generated by the IMC. These products are used by the IMC and network operations staff to efficiently and expediently review the data and are briefly described below.

- Daily Datalogger Report is automatically generated and printed at the conclusion of daily automated polling. This report lists whether each station was successfully polled, displays the datalogger time against National Institute of Standards and Technology (NIST) time, and highlights any keyboard-entered messages from site operators. Figure 4-1 is an example of this report.

- Primary Data Stackplots for each site (displaying the previous seven days of primary data) are updated daily and available as computer displays or printouts. The data and control files used to produce these plots are maintained by the daily polling routines with each new day's data appended automatically. Stackplots may be reviewed at any time from any ARS terminal for all monitoring stations or specifically-selected stations. This type of plot shows the temporal variations of individual parameters and data interrelationships on the same page. In addition, hardcopy stackplots are generated each week, and archived by site for convenient and immediate access by network operations and IMC staff. An example Primary Data Stackplot is provided as Figure 4-2.

- Calibration Results Summary Stackplots of zero, span, and precision data for the previous 15 days are updated every morning. The support files for this product are also maintained by the daily polling routines. Application and use of these plots are similar to the Primary Data Stackplots above. An example 30-day Calibration Results Summary Stackplot is provided as Figure 4-3.

- Daily Summaries are available on-screen on-demand and are also printed for hardcopy archive. Each summary includes each hourly value for each parameter at a single site for a day. The magnitude and variations in hourly parameter values can be easily viewed using this product. The file also lists the calibrator results, power failure logs, and keyboard-entered messages entered by the site operator. An example Daily Summary is provided as Figure 4-4.

Daily and periodic data and support documentation reviews are performed by both IMC and network operations staff. These reviews and resulting actions are noted below.

Summary of Datalogger Time Accuracy

Site	Logger Julian Date	Logger Date mm/dd/yy	Logger Time hh:mm:ss	IMC Date mm/dd/yy	IMC Time hh:mm:ss	Days Diff. #	Time Diff. hh:mm:ss
ACMH	221	08/08/00	05:33:26	08/08/00	04:35:17	000	-00:01:51
BIBE	221	08/08/00	04:39:50	08/08/00	04:39:52	000	-00:00:02
CANY	221	08/08/00	03:47:05	08/08/00	04:47:11	000	-00:00:06
CHIR	221	08/08/00	03:51:30	08/08/00	04:52:34	000	-00:01:04
CRMO	221	08/08/00	03:53:55	08/08/00	04:58:57	000	-00:05:02
DENA	221	08/08/00	02:04:35	08/08/00	05:05:03	000	-00:00:28
DEVA	221	08/08/00	03:12:53	08/08/00	05:10:41	000	+00:02:12
EVER	221	08/08/00	06:17:08	08/08/00	05:16:54	000	+00:00:14
GLAC	221	08/08/00	04:22:02	08/08/00	05:22:32	000	-00:00:30
GRBA	221	08/08/00	03:26:28	08/08/00	05:27:58	000	-00:01:30
GRCA	221	08/08/00	04:32:31	08/08/00	05:33:15	000	-00:00:44
GSCC	221	08/08/00	06:38:59	08/08/00	05:38:41	000	+00:00:18
GSCD	221	08/08/00	06:43:46	08/08/00	05:43:47	000	-00:00:01
GSCM	221	08/08/00	06:48:52	08/08/00	05:48:50	000	+00:00:02
GSLR	221	08/08/00	06:54:20	08/08/00	05:54:06	000	+00:00:14
HATH	221	08/08/00	01:56:49	08/08/00	05:59:38	000	-00:02:49
HAVO	221	08/08/00	02:05:58	08/08/00	06:05:07	000	+00:00:51
JOYV	221	08/08/00	04:10:36	08/08/00	06:10:41	000	-00:00:05
LAVO	221	08/08/00	04:17:14	08/08/00	06:16:38	000	+00:00:36
MAHM	221	08/08/00	06:23:38	08/08/00	06:23:46	000	-00:00:08
MEVE	221	08/08/00	05:29:12	08/08/00	06:29:15	000	-00:00:03
MORA	221	08/08/00	04:36:20	08/08/00	06:34:56	000	+00:01:24
NOCA	221	08/08/00	04:38:50	08/08/00	06:41:07	000	-00:02:17
OLHR	221	08/08/00	04:46:45	08/08/00	06:47:28	000	-00:00:43
OLYM	221	08/08/00	04:51:39	08/08/00	06:52:08	000	-00:00:29
PINN	221	08/08/00	04:57:51	08/08/00	06:58:34	000	-00:00:43
ROMO	221	08/08/00	07:35:08	08/08/00	08:35:55	000	-00:00:47
SEAS	221	08/08/00	05:04:53	08/08/00	07:04:43	000	+00:00:10
SELK	221	08/08/00	05:08:05	08/08/00	07:08:37	000	-00:00:32
SELP	221	08/08/00	05:51:21	08/08/00	07:51:55	000	-00:00:34
TRVC	221	08/08/00	07:06:36	08/08/00	08:06:33	000	+00:00:03
VIIS							
VOYA	221	08/08/00	08:14:53	08/08/00	08:15:11	000	-00:00:18
YELL	221	08/08/00	07:22:50	08/08/00	08:21:52	000	+00:00:58
YOTD	221	08/08/00	06:30:04	08/08/00	08:30:28	000	-00:00:24

Central Messages Report

Site Timestamp Message

DEVA 08/04/00 16:14:27 FLW FIXED, FILTER WAS NOT FULLY LOCKED INTO IT'S BASE, GOOD THING IT DIDN'T FALL
EVER 08/02/00 12:04:30 CHANGED OFFSET FROM -13 TO -10. DDM-ARS.
LAVO 08/01/00 10:44:41 PERFORMING LAVO STATION CHECK. M.MAGNUSON
SEAS 08/01/00 09:32:50 WEEKLY STATION CHECK AND MULTIPOINT, DMM.
YOTD 08/04/00 11:52:53 REPLACED WETNESS SENSOR-IT WORKS! KATY/NPS

Operator Messages Report

Site Timestamp Message

HATH 07/31/00 10:14:16
HATH 07/31/00 10:17:49 Messages complete

Figure 4-1. Example Daily Datalogger Report.

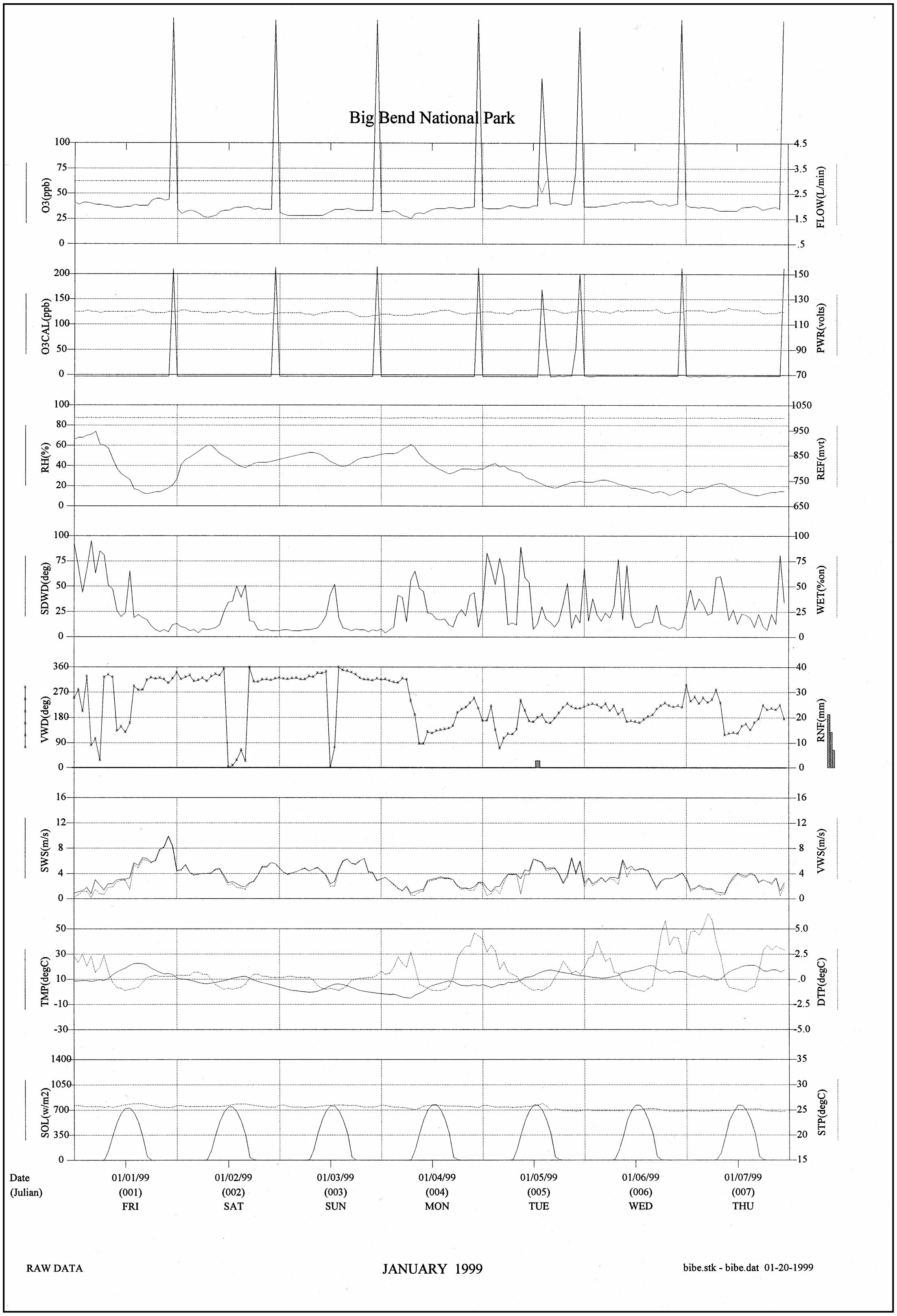

Figure 4-2. Example Primary Data Stackplot.

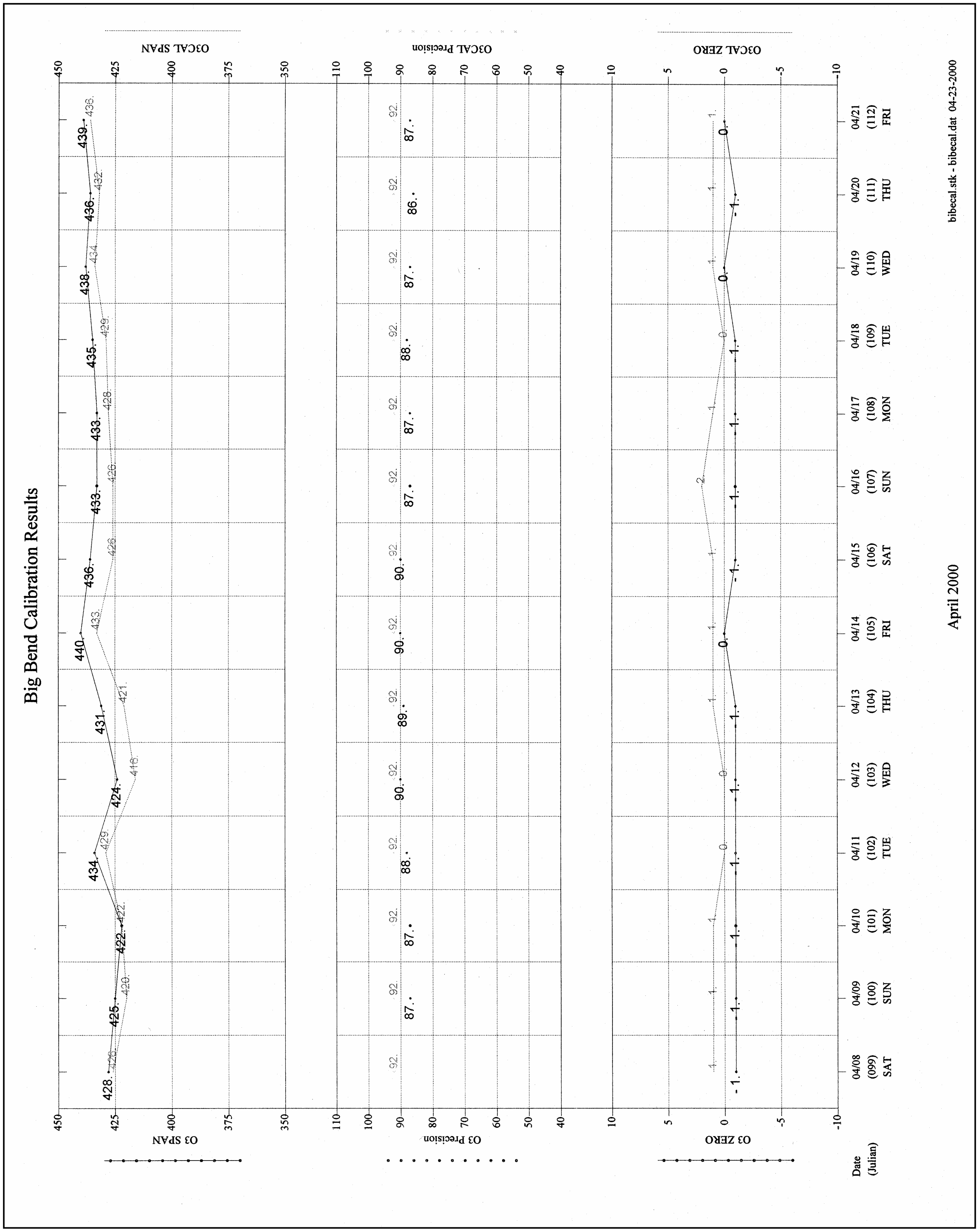

Figure 4-3. Example Calibration Results Summary Stackplot.

```
ESC 8816 Data Collection - lavo
Daily Average          12/27/99 04:35:37      JDay: 361          Logger ID: LV
   Report                 ESC 8816
--------------------------------------------------------------------------------
Name:                     O3          O3CAL         O3R8         VWD          SIG
Channel Num:               1             2            3            4            5
Analog Input:              1             2          N/A            3            3
Units:                    PPB           PPB          PPB          DEG          DEG
Full Scale:                1 V           1 V        N/A            5 V          5 V
High Output:             490.          980.         N/A         540.         540.
Low Output:              -10.          -20.         N/A           0.           0.
--------------------------------------------------------------------------------
12/26 00:00               32.            2.         34.>C        28.          42.
12/26 01:00               34.            2.         34.>C        23.          50.
12/26 20:00               34.            2.         34.         101.          34.
12/26 21:00              214.<C        207.<C       34.>C        97.          31.
--------------------------------------------------------------------------------
Minimum:                  29.            2.         31.          23.           7.
Maximum:                 214.<C        207.<C       35.>C       283.          82.
Average:                  40.<C         11.<C       33.>C        87.          39.
   Report                 ESC 8816
--------------------------------------------------------------------------------
Name:                     VWS           SWS          PWS          TMP          DTP
Channel Num:               6             7            8            9           10
Analog Input:              4             4          N/A            5            6
Units:                    M/S           M/S          M/S          DGC          DGC
Full Scale:                5 V           5 V        N/A            1 V          1 V
High Output:             50.0          50.0         N/A         50.0         -5.0
Low Output:               0.0           0.0         N/A        -30.0          5.0
--------------------------------------------------------------------------------
12/26 00:00               0.8           1.1          3.7          5.3          4.1
12/26 01:00               0.8           1.1          3.2          6.5          4.0
12/26 02:00               1.3           1.5          4.5          6.3          4.1
12/26 21:00               1.4           1.7          5.3          2.7          2.2
12/26 22:00               1.6           2.0          5.5          4.5          1.7
12/26 23:00               1.1           1.5          4.9          3.8          2.6
--------------------------------------------------------------------------------
Minimum:                  0.5           1.1          2.2         -1.6         -0.1
Maximum:                  2.4           3.0          7.7         10.2          4.1
Average:                  1.2           1.6          4.2          4.8          1.8
   Report                 ESC 8816
--------------------------------------------------------------------------------
Name:                     SOL           RNF           RH          WET          FLW
Channel Num:               11            12           13           14           15
Analog Input:              7             R1            8            9           10
Units:                    WMS            MM            %          +/-         SLPM
Full Scale:                5 V          N/A            1 V          1 V          5 V
High Output:            1396.           0.3         100.         100.         5.80
Low Output:                0.           0.0           0.           0.         0.00
--------------------------------------------------------------------------------
12/26 00:00                1.           0.0          30.           0.         3.00
12/26 01:00                1.           0.0          25.           0.         3.00
12/26 22:00                1.           0.0          32.           0.         3.00
12/26 23:00                1.           0.0          34.           5.         3.00
```

Figure 4-4.   Example Daily Summary.

4.2.2 Daily Data Review

Data are reviewed daily (Monday through Friday) by both IMC and network operations staff as described below:

IMC

The IMC data analysts review data daily and inform the network operations staff immediately of any noted anomalies. Notification of network operations is initially performed verbally. The procedures applied to review data daily are:

- Daily Datalogger Report - Stations not successfully polled automatically will be retried or manually polled by the IMC. This effort is the first priority of the IMC team every day. Stations that cannot be polled or require repeated manual polling will be reported to network operations for further investigation. Stations with datalogger times drifting beyond 2-minutes of NIST time will be reported to network operations for correction.

- Primary Data Stackplot - The stackplot for each site is reviewed on screen. Any noted anomalies are reported to network operations. This review is performed to identify unusual variations in hourly data or logger data flags. Specific types of data review that would indicate issues for further investigation by network operations are:

  - Solar Radiation - Nighttime values ≥ 14 W/m^2 or ≤ -14 W/m^2
  - RH - values >105 or <0
  - Ozone - values ≤ -5ppb
  - Instrument stuck at either zero or full scale
  - Instrument readings that do not vary for extended periods of time

- Calibration Results Summary Stackplots - The data analysts review the plots for value consistency. Any noted anomalies are reported to network operations.

Data analysts (or field specialists) enter site data issues into the electronic Site Status Log for documentation and evaluation. An entry will be made for each confirmed anomaly or inconsistency.

Network Operations

An ARS field specialist is assigned to review data, recognize problems, and initiate corrective action. This technician-of-the-week (TOW) has primary troubleshooting and telephone assistance responsibility for the entire assigned period, typically one week. Rotating this responsibility allows all network operations personnel to keep current on network concerns, while having time to encounter and resolve a range of problems and maintain contact with the site operators. This builds a more dynamic staff and adds to the depth of the institutional memory of the network operations staff. The loss of a staff member is far less crippling to the program with this broad level of cross-training. The TOW, section manager, or other assigned field specialist will review the following data summaries and plots daily. Any inconsistencies or anomalies noted by network operations review or identified by the IMC will be investigated by network operations.

- Daily Datalogger Report - These daily printouts are reviewed each morning. The accuracy of the logger time is verified and any time drift beyond two minutes of NIST time is corrected by calling and resetting the datalogger. Keyboard-entered messages from the site operator requesting supplies or identifying problems are noted and corrective actions are initiated.

- Primary Data Stackplot - The stackplot for each site is reviewed on-screen for data completeness, tolerance, and reasonability. Any noted inconsistencies initiate corrective actions by network operations.

- Calibration Results Summary Stackplots - These plots are reviewed for calibration timing and value consistency. Noted anomalies initiate corrective actions.

- Daily Summary - Network operations will view selected hourly data to help identify and troubleshoot problems noted during the daily data review. Network operations can also call any site with a DataView system to view detailed data plots and tables online.

Field specialists or data analysts enter site data issues into the electronic Site Status Log for documentation and evaluation. An entry will be made for each confirmed anomaly or inconsistency.

4.2.3 Weekly Review

Every week, IMC staff will meet with network operations staff (TOW and/or section manager) to review all network operations site by site. The discussion is led by going through the electronic Site Status Log to review resolved and unresolved problems. This discussion is supplemented by:

- IMC
  - Daily lists of problems
  - Previous week's unresolved issue list
  - Notes from site documentation reviews
  - Notes from validation procedures
  - Notes from monthly plot reviews
  - Stackplots
  - Calibration plots
  - Site documentation packets
  - Supplemental data summary plots and listings
  - National Performance Audit Program (NPAP) audit results or state audit results when available

- Network Operations
  - Electronic Site Status Log
  - Trip reports (calibration results are entered by the data analyst upon receipt)
  - Other notes and field specialist's comments
  - Supplemental data summary plots and listings

The results of the meeting will include identified further action items by network operations or IMC staff and documentation of resolved and unresolved problems. All actions will be noted in site-specific Site Status Logs.

4.2.4 Site Document Review

Site operators complete DataView checklists during their weekly station visits. These checklists, and supporting DataView plots and tables, require notation of specific tolerance values of instruments and support systems. The site operator should recognize out-of-tolerance conditions and call network operations for assistance. However, additional review of these entries by the IMC staff can identify a required maintenance action or prevent unnecessary instrument failure. These checklists are retrieved electronically from DataView sites by the IMC. The IMC data analysts will review the newly received documents for:

- Thoroughness of written lognotes.
- Any out-of-tolerance condition requiring immediate action.
- Any note or condition that should be addressed during a future semiannual maintenance visit.

Any noted inconsistencies will be documented in the Site Status Log and will prompt immediate corrective actions.

4.2.5 Monthly Review

Monthly review actions are based on the information gathered during validation procedures described in the following SOPs and TIs:

SOP 3450	*Ambient Air Quality and Meteorological Monitoring Data Validation*
TI 3450-5000	*Ambient Air Quality and Meteorological Monitoring Data – Level 0 Validation*
TI 3450-5010	*Ambient Air Quality and Meteorological Monitoring Data – Preliminary Validation*
TI 3450-5020	*Ambient Air Quality and Meteorological Monitoring Data – Final Validation*

Monthly network review is focused on the monthly plot review, which is a joint review of the commented weekly stackplots by IMC, network operations, and National Park Service Air Resource Division (NPS ARD) staff. Any problems discovered during the plot review will be addressed and appropriate actions will be taken by the IMC or network operations.

4.3 OPERATIONAL NETWORK DOCUMENTATION

4.3.1 Site Status Log

The electronic Site Status Log is an electronic bulletin board that provides a convenient and permanent record of field instrumentation problems, solutions, and other conditions that affect data quality. The Site Status Log is a component of the IMC Air Quality Database Management System (AQDBMS), and problems are entered or updated daily by network operations or IMC staff. The Site Status Log is available at *http://www.arssitestatuslog.com*, via authorized username and password, to allow field specialists access to data entries while on-site at a monitoring location.

Any inconsistency in the data or any other information pertinent to data validity noted by the field specialists (or TOW), IMC, or site operator will be manually documented in the electronic Site Status Log. An example Site Status Log is provided as Figure 4-5. It is the TOW's (or other field specialist's) or IMC staff's responsibility to complete a Site Status Log entry for every identified data anomaly or action that affects network operations and/or data validity. The entries should be clear, concise, and provide sufficient detail to accurately describe each problem or action.

Entries and updates will:

- Identify and document an ARS- or site operator-recognized problem.
- Record the shipping of replacement parts or sensors.
- Document and explain results of adjustments or repairs.
- Provide an up-to-date record of actions leading to the rectification of a problem.
- Provide a historical record of problems to assist in data validation.

Brief, informational trip reports will also be entered to highlight significant or unusual findings or to document instrument replacements or repairs after a semiannual or emergency site repair. An example Site Status Log display for Chiricahua National Monument is provided as Figure 4-5.

Copies of the Site Status Log unresolved problems by site are printed immediately following data entry and filed by site in the IMC. An option also exists in the logging system to have current entries e-mailed to appropriate staff for immediate notice.

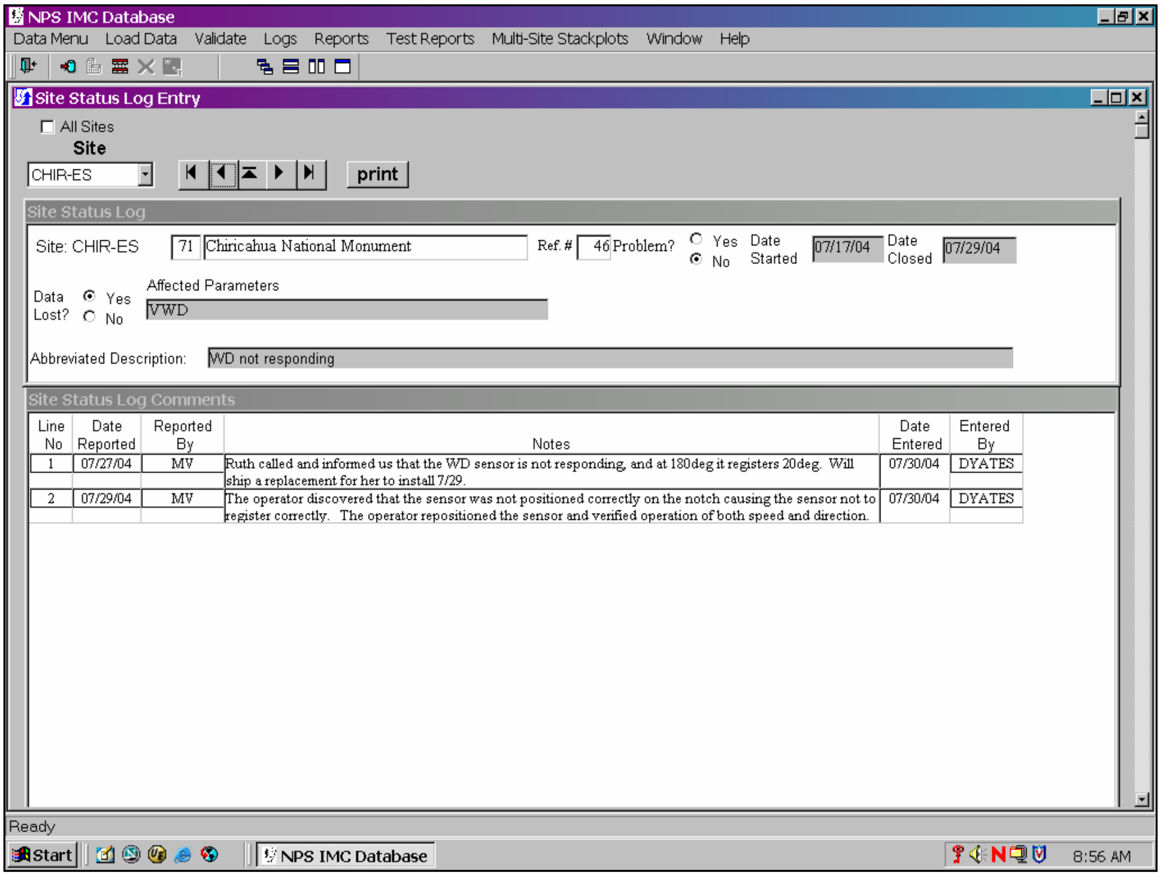

Figure 4-5 . Example Electronic Site Status Log Display.

4.4 CORRECTIVE ACTIONS

Network operations has the responsibility to expediently address and resolve network operation issues that affect data quantity and quality. Upon identification of a problem network operations staff will employ their technical skills to clarify, troubleshoot, and resolve network problems. All actions will be summarized on Site Status Logs. The corrective actions that will be used may include the following approaches or combinations of approaches depending on specific problems:

- Directly contact the datalogger by telephone modem to correct times, perform resets, change programs, adjust ranges, reschedule events, initiate events, or other logger control or communication functions.

- Directly contact the DataView system on-site to view detailed data plots and tables by parameters to help identify, troubleshoot, and resolve problems.

- Contact the site operator to perform troubleshooting sequences as directed by network operations to isolate a problem.

- Send repair or replacement parts or systems to a site operator for installation and provide written and verbal direction to ensure the repair or replacement is performed properly.

- At sites where smart analyzers (i.e., TEI "C" series instruments) are connected to a telephone modem, directly connect to the analyzer to perform troubleshooting, change ranges, or other analyzer related functions.

- Perform needed troubleshooting repairs, replacements, or additional operator training during the next scheduled site visit.

- Conduct an emergency site visit with the Contracting Officer's Technical Representative (COTR) approval to perform needed troubleshooting, repairs, or replacements.

4.5 COORDINATION, TRACKING, AND INVENTORY CONTROL OF GOVERNMENT-OWNED EQUIPMENT TO AND FROM MONITORING SITES OR OTHER REPAIR FACILITIES

When troubleshooting procedures indicate that a system or system component must be replaced, network operations staff will coordinate the overnight shipment of replacement parts to the site. Network operations staff will also coordinate the shipment of the malfunctioning unit to the appropriate repair facility. All repair or replacement efforts will be performed expediently to minimize data loss.

Shipping and receiving of all instrumentation and support hardware to and from sites will be thoroughly documented. All equipment will be tracked by name, serial number, shipping date, shipping method, and bar-coded tracking label. Any delays or losses in shipping will be expediently tracked and documented.

Permanent shipping and receiving records will be kept as hardcopy documents. Shipping documentation includes:

- Equipment Shipped Form
- Equipment Received Form
- Packing Documentation

The status of shipped equipment will be tracked by the technical assistant.

4.6 MAINTENANCE AND DISTRIBUTION OF EXPENDABLE SITE SUPPLIES

An inventory of expendable site supplies and common replacement parts will be maintained. Expendable supplies will be shipped periodically to the sites to ensure an adequate on-site inventory. All critical requests will be handled expediently.

A list of in-stock quantities of supplies and common replacement parts will be maintained. Inventory control will be tracked by hardcopy forms and Equipment Inventory Database entries. A current inventory listing will be included semiannually in the Monthly Progress Report or as requested. When the inventory stock falls below the desired level, replacement orders will be initiated.

The NPS ARD has traditionally purchased supplies of routine consumable and replacement items directly. It is assumed that the NPS ARD will continue this practice. A list of items to be purchased and suppliers will be provided quarterly by ARS to the NPS ARD. An example of this list is presented as Figure 4-6.

When unanticipated supplies are needed immediately, ARS will directly procure the required supplies. A funding contingency for emergency supplies will be included in the Cost Proposal.

4.7 MAINTENANCE AND DISTRIBUTION OF CAPITAL EQUIPMENT AND INSTRUMENTATION

Major system malfunctions, such as the failure of an air quality analyzer, meteorological sensor, or data acquisition system component, can occur. When operator repair is not a viable option due to failure complexity or time constraints, a backup system will be sent to the site. ARS will maintain this inventory of backup instrumentation and equipment. The status of the backup equipment inventory will be periodically reviewed with the COTR.

When instrumentation fails, it may not be cost-effective to repair certain aging systems. Therefore, to maintain adequate backup, it may be necessary to procure additional backup equipment. ARS will work with the COTR to identify the priorities and most appropriate methods of maintaining the backup equipment inventory. As directed by the COTR, ARS will procure and/or coordinate direct NPS procurement of identified capital equipment and instrumentation.

SPARE PARTS INVENTORY

Item	Type	Quantity In Stock/ On Order	Quantity Needed
Charcoal		6	
Gloves - Vinyl	Phoenix Anti-Static	1600	
Lamps - Generator	Dasibi	8	
	Monitor Labs	9	
Lamps - Photometer	Dasibi	10	**10***
	Monitor Labs	12	
Met Gear - Climatronics	Bearings (WS/WD)	120	
	Cups	7	
	Vanes	5	
	Potentiometers	10	
	Photo Chopper Assemblies	5	
	Dew Point Sensors	13	
Met Gear - Qualimetrics	Bearings (WS)	16	
	Bearings (WD)	20	
	Cups	6	
	Vanes	5	
	Potentiometers	3	
	Photo Chopper Assemblies	7	
	Dew Point Sensors	5	
Pumps	Monitor Labs	3	
	Dasibi - 5 liter	4	
	Dasibi - 3 liter	6	
	Thomas Pump & Mounts	7	
	Dasibi Pump Feet (Sets of 4)	8	
Ribbons	Panasonic KX-P150		10
	Panasonic KX-P115	2	
		6	
Scrubbers	Dasibi	15	
	Monitor Labs	12	
Silica Gel		6	
Solenoid Valves	Monitor Labs - 115 V	7	
	Dasibi - 24 V	9	
	Dasibi 115 V	12	
Tubing/Fittings	Tubing 1/8"	225'	
	Tubing 1/4"	75'	**200***
	Assorted Fittings	~50	
Teflon Filters (10 packs)	2 micron (47 mm)	25	**50***
	20 micron (50 mm)	0	**100***

*** Please order ASAP.**

Figure 4-6. Example Listing of Replacement and Consumable Parts.

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1901 Sharp Point Drive, Suite E
Fort Collins, CO 80525
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Fax: 970-484-3423

QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**COLLECTION OF AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA AND SITE DOCUMENTATION**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3350**
DATE	**MARCH 1999**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Betsy Davis-Noland	Betsy Davis-Noland
PROJECT MANAGER	Jessica Ward	Jessica Ward
PROGRAM MANAGER	David L. Dietrich	[illegible]
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change flowchart / add site documentation TI	January 2001	G. Mercer
	Reviewed; no changes necessary.	January 2002	G. Mercer
	Reviewed; no changes necessary.	January 2003	G. Mercer
1.1	Changed data technician to data analyst.	January 2004	G. Mercer
1.2	Modify collection/validation flowchart.	May 2004	G. Mercer
1.3	Added additional data collection methods.	May 2005	G. Mercer
	Reviewed; no changes necessary.	January 2006	G. Mercer
	Reviewed; no changes necessary.	January 2007	G. Mercer
	-- Continued --		

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**COLLECTION OF AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA AND SITE DOCUMENTATION**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3350**
DATE	**MARCH 1999**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Betsy Davis-Noland	Betsy Davis-Noland
PROJECT MANAGER	Jessica Ward	Jessica Ward
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.4	Changed station log collection to twice weekly.	January 2008	G. Mercer
	Reviewed; no changes necessary.	January 2009	G. Mercer
1.5	Changed data collection/validation flowchart.	February 2010	G. Mercer
	Reviewed; no changes necessary.	April 2011	G. Mercer

TABLE OF CONTENTS

LIST OF FIGURES

1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) outlines the steps taken by Air Resource Specialists', Inc. (ARS) Information Management Center (IMC) to collect ambient air quality and meteorological data and quality control documentation from network dataloggers, DataView computers, manual operational logs, and other data compilation systems. This information includes:

- Criteria pollutant parameters
- Meteorological parameters
- Diagnostic parameters and calibration results
- DataView or manual station logs

Successful data collection is the first step in the network data collection, validation, and reporting process illustrated in Figure 1-1. This SOP outlines the data collection process. For detailed instructions on data collection refer to the following technical instructions (TIs):

- TI 3350-4000 *Collection of Ambient Air Quality and Meteorological Monitoring Data via Modem*
- TI 3350-4005 *Collection of DataView Files via Telephone Modem*

2.0 RESPONSIBILITIES

Staff positions that have data collection responsibilities are:

- IMC data analyst
- Field specialist
- Site operator

Specific IMC staff data collection responsibilities are presented in the TIs that support this SOP (see previous Section 1.0).

3.0 REQUIRED EQUIPMENT AND MATERIALS

All IMC equipment and materials are fully described in SOP 3340, *Information Management Center (IMC) Concept and Configuration for the National Park Service Gaseous Pollutant Monitoring Program*, and SOP 3341, *Air Resource Specialist's, Inc. (ARS) Information Management Center (IMC) Concept and Configuration*. The hardware and software used to perform specific data collection functions are referenced in the TIs that support this SOP (see previous Section 1.0).

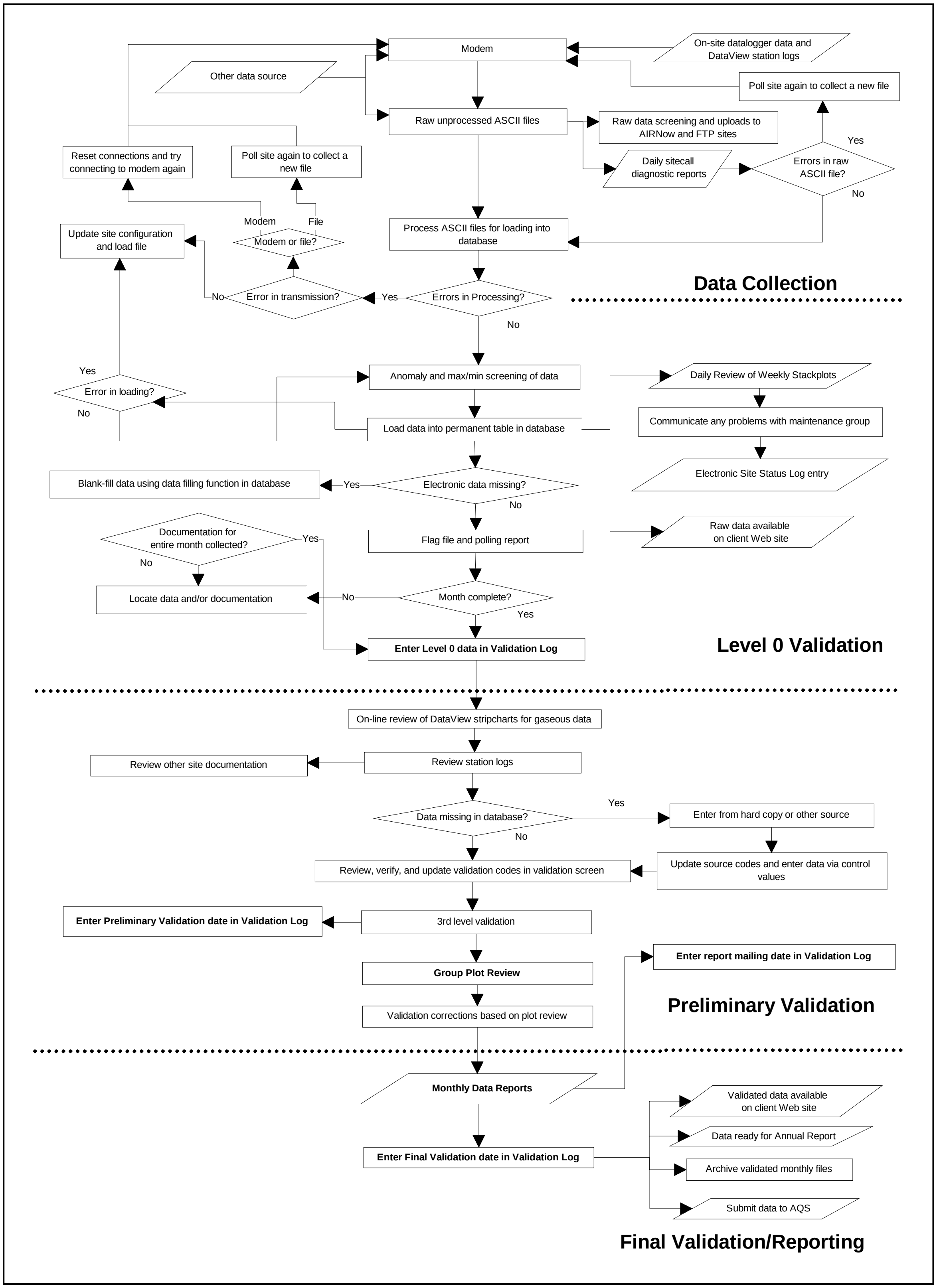

Figure 1-1. General Data Collection, Validation, and Reporting Flow Diagram. (Specific processes may vary by monitoring network).

4.0 METHODS

To assure complete, error-free data collection, data are usually logged on-site by a datalogger and collected daily via telephone modem or satellite modem (see the Data Collection section of Figure 1-1). DataView software runs on laptop computers and the information written by the software to the station log is collected weekly via telephone modem (see the Data Collection section of Figure 1-1). Occasionally, telephone lines to a site are not available or data cannot be directly collected by modem due to problems such as modem or telephone line malfunctions. If electronic data collection methods fail, the IMC will attempt to recover data from on-site DataView stripchart plots, printed data tables, DataView digital data files, or on-site data storage modules. Data text files can also be downloaded from an FTP site and reformatted for entry into the database. As a last resort, suitable data from third parties may be used. In the event of DataView failure or at sites where manual logs are most practical, station logs and other quality assurance documentation can be manually completed and mailed or faxed to the IMC.

To summarize, the IMC collects data by one of these methods:

- From a datalogger via telephone or satellite modem
- From an FTP site
- Reduced from DataView stripchart plots, printed data tables, or DataView digital data files
- On-site data storage devices (i.e., storage modules)
- Digital transmission from a third-party source

For detailed instructions on each method of data collection, refer to the technical instruction listed previously in Section 1.0.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**COLLECTION OF AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA VIA MODEM**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3350-4000**
DATE	**MARCH 1999**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Betsy Davis-Noland	
PROJECT MANAGER	Jessica Ward	Jessica Ward
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change all procedures for the DataView system	January 2001	G. Mercer
1.1	Added reference to 23X datalogger	July 2002	G. Mercer
	Reviewed; no changes necessary.	July 2003	G. Mercer
1.2	Changed data technician to data analyst.	January 2004	G. Mercer
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	Reviewed; no changes necessary.	January 2006	G. Mercer
	Reviewed; no changes necessary.	January 2007	G. Mercer
	-- Continued --		

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**COLLECTION OF AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA VIA MODEM**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3350-4000**
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AUTHORIZATIONS		
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REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
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2.2	Add StarBand satellite option/delete flag file.	February 2010	G. Mercer
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1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the steps taken by the Air Resource Specialists', Inc. (ARS) Information Management Center (IMC) to collect ambient air quality and meteorological data via telephone or satellite modems. The primary purpose of daily collection is to assure quality data capture and minimize data loss by:

- Calling the datalogger at each station via telephone or satellite modem and downloading the past day's data into site-specific daily files.
- Reformatting the site-specific daily files for loading into the Air Quality Data Base Management System (AQDBMS) Oracle database.
- Reviewing the daily error and diagnostic printouts to verify complete data collection or to identify problems.

As referenced from Standard Operating Procedure (SOP) 3350, *Collection of Ambient Air Quality and Meteorological Monitoring Data*, this TI is a guide for using custom data collection software to assure complete, error-free data collection from network dataloggers via modems.

2.0 RESPONSIBILITIES

2.1 DATA ANALYST

The data analyst shall on a daily basis:

- Set up and maintain the automatic data collection programs and support information.
- Ensure that the workstation used for automatic data collection is properly configured for daily data poll.
- Review the status of the automatic data collection each morning (including reviewing daily error and diagnostic printouts) to verify complete, error-free data collection, assure the integrity of the monitoring systems, or to identify problems and initiate corrective actions.
- Perform required daily retries.
- Review collected ASCII data files.
- Provide technical support to site operators via telephone.
- Ensure proper archive and storage of final raw data files.

2.2 FIELD SPECIALIST

The field specialist shall:

- Inform data analysts of any changes in site configurations resulting from maintenance visits.
- Inform data analysts of any equipment or data acquisition systems malfunction, replacements, additions, or inconsistencies.

- Inform data analysts of any data acquisition system program changes.
- Review stackplots and troubleshoot inconsistencies observed on the stackplots or identified by data analysts.
- Provide assistance to the IMC for troubleshooting data collection problems.
- Provide assistance in troubleshooting on-site instrument problems.

2.3 SITE OPERATOR

The site operator shall:

- Telephone the IMC or field specialist if data collection problems are noted on-site.
- Provide on-site assistance for troubleshooting data collection problems.

3.0 REQUIRED EQUIPMENT AND MATERIALS

Detailed descriptions of all IMC hardware and software and monitoring station hardware requirements are presented by category in SOP 3340, *Information Management Center (IMC) Concept and Configuration for the National Park Service Gaseous Pollutant Monitoring Program* and SOP 3341, *Air Resource Specialists', Inc. (ARS) Information Management Center (IMC) Concept and Configuration*. The IMC requires the following hardware and software to collect data from dataloggers via modems:

- Monitoring site data collection hardware

- IMC hardware:
  - Hardware specifications for IMC servers
  - Hardware specifications for workstations
  - Support hardware:
    - High-quality laser printer
    - Write-capable CD drive

- IMC computer support software:
  - AQDBMS custom software
  - Network operating system and support software

4.0 METHODS

This section includes six (6) major subsections:

4.1 Automatic Data Collection
4.2 Retry of Failed Data Collection Sites
4.3 Data Files Generated by the AQDBMS
4.4 Manual Data Collection via Telephone Modem From Datalogger
4.5 Daily Review of Data Directory Contents
4.6 Monthly Archival of Final Raw Data Files

A detailed flowchart of the entire data acquisition process is provided in Figure 4-1. Files generated by this process and their distribution are shown in Table 4-1.

4.1 AUTOMATIC DATA COLLECTION

Several methods exist for placing data into the Oracle database. Usually, hourly data are loaded through a series of automated processes. Currently, a Windows operating system utility called *System Agent* is utilized to launch the application with a command line argument at a scheduled time every night. The AQDBMS application detects the command line argument, automatically connects to the IMC database, and enables the auto polling function. A system timer queries the polling configuration tables continually to determine if it is time to poll any sites. When the query returns a result set of sites and polling configurations, the program loops through the list, calling the dataloggers and loading the data into the database.

Data can also be loaded for one site for one day at a time using the *Manual* command button in the polling window. Either way, the polling program issues a call to the site, captures data for the requested date and writes it to an ASCII file, reformats the ASCII file, and loads the data into the database. It also initiates error screening and writes error messages for data analyst review. The program retries calling sites up to two times if necessary. As data are being loaded for each site, the header columns of the ASCII file must match the datalogger column information stored in the Polling Line ID Table. Figure 4-2 shows the Polling interface.

Data collected from air quality stations without telephone or cellular phone access is accomplished via StarBand or ORBCOMM satellite. With StarBand systems, ARS connects directly to monitoring stations via the Internet using satellite modems. With ORBCOMM systems, ARS contracts with a service provider to recover files from the provider's FTP site. The files are then reformatted into files similar to telephone-collected data and imported into the AQDBMS.

Data can also be hand-entered or blank-filled in the Data Validation interface. Data entry forms for entering non-hourly aerosol data, precision check data, and data from audit reports are also available. To open the Polling window, select **Polling** from the Configuration frame.

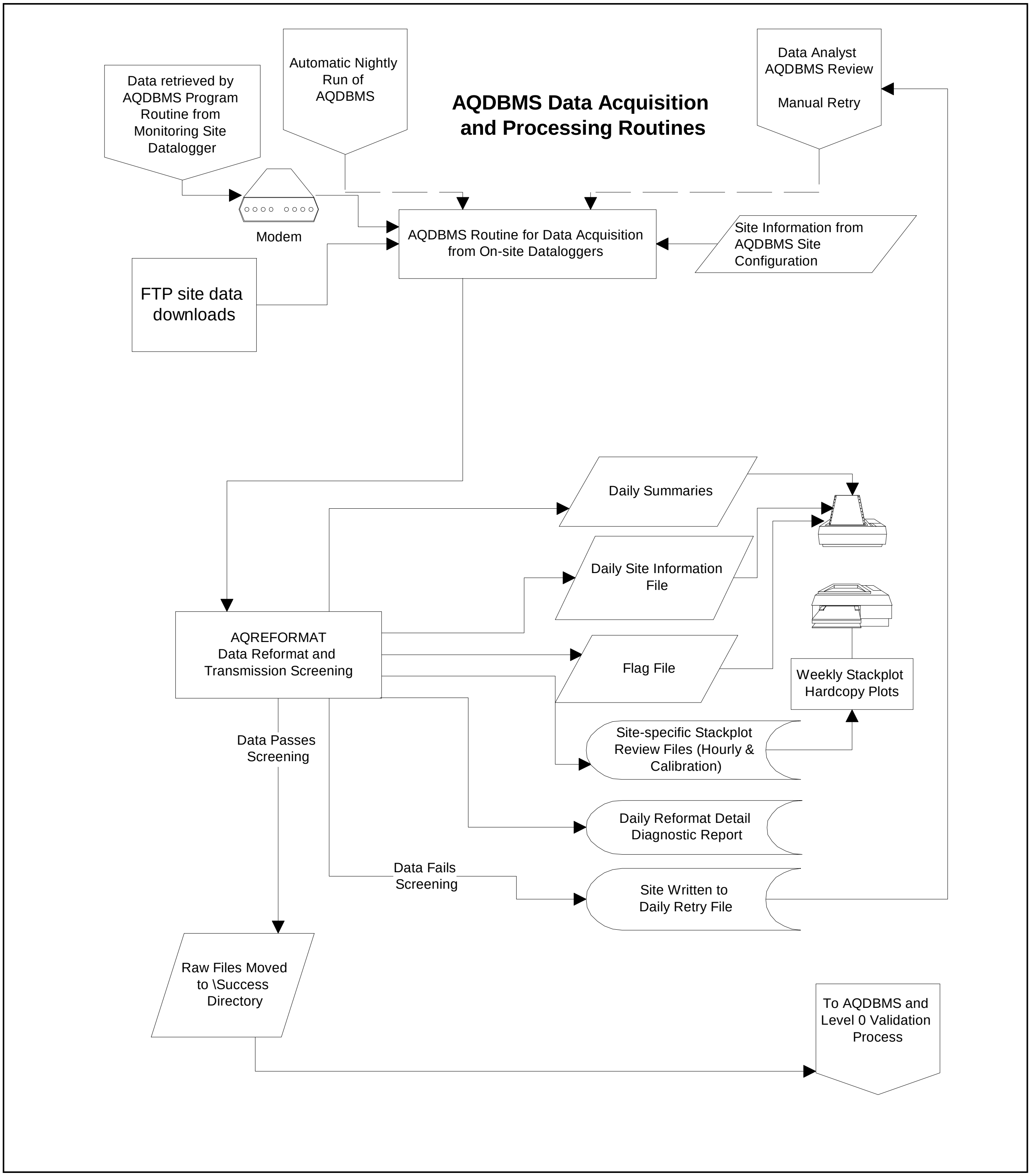

Figure 4-1. AQDBMS Data Acquisition and Processing Via Telephone Modem Detailed Flowchart.

Table 4-1

File Name and Directory Organization of Files Generated by AQDBMS Routines

File Type	File Description	Source(s)[1]	File Name(s)[2]	Directory Location[3]	Destination
Daily Site Information	Data Collection Summary[4]	AQDBMS	yyyymmdd.MES	ESC_sitecall\logs\ printed	LaserJet
Data Files	Raw datalogger output	AQDBMS	ssssjjj.yyyyR	ESC_SITECALL\ SUCCESS	Archived and Printed
Plot Files	Daily raw stackplot configuration and data files	AQDBMS	site.STK site.DAT	Stkplots\DailyReview Stkplots\DailyReview	Stackplot Stackplot

Notes:

[1] Refers to routines defined in Figure 4-1.

[2] File naming convention: (based on MS-DOS 8.3 file name format)

- mm = 2-digit month
- dd = 2-digit day
- yyyy = 4-digit year
- jjj = Julian day
- ERR = error report
- MES = detailed message report
- SUM = summary report
- ssss or site = 4-character site code
- RET = retry file
- SPN = span file
- DAT = stackplot data file
- D = hourly data import file
- L = calibration data import file

[3] Directory Location: The *AQDBMS* directory is currently located under N:\PROJECT\IMC\.

[4] Data Collection Summary, Logger Time Accuracy Summary, and Span File are used by the field specialist.

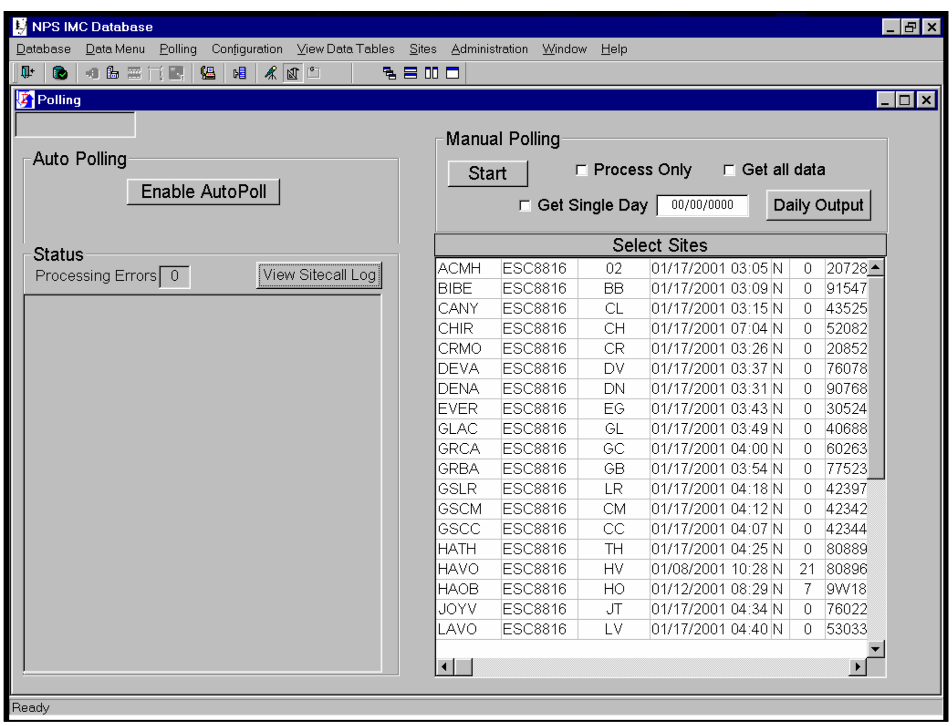

Figure 4-2. The Polling Interface Shows Last Successful Poll.

4.1.1 Starting the Auto Poll Process

Usually, Windows System Agent will launch the AQDBMS application and enable the auto load process. Sometimes the auto load process must be manually started. To run Auto Poll in the Polling window, click the **Enable Auto Poll** command button. The button text changes to read “Disable Auto Poll.”

4.1.1.1 Polling Order

The order in which the sites are polled is determined by the following:

1. Polling time specified in each site’s configuration.

2. Alphabetically by site name.

Sites with identical polling times will be polled alphabetically. To change the polling order of a site, edit the polling configuration as described below.

4.1.1.2 Manual Data Polling

Manual data polling provides functionality not included in the automatic data collection process. Manual data collection is used in the following situations:

- When automatic data collection from a site has failed and the data are needed in the database.

- When recent data are needed for immediate use.

- When archived or edited raw data need to be written to the database without polling the site.

Manual data polling cannot be used at the same time as automatic data collection. It is necessary to disable automatic data collection. To run Manual Poll:

- Select the *sites* to poll by clicking on them (use standard Windows keys for multi-select).

- Select the **Process Only** checkbox if the raw data file already exists (no polling of the site(s) will be performed).

- Select the **Get All Data** checkbox to poll a 21X, 23X, or CR10 datalogger and attempt to retrieve all of the data contained therein. *This may take a long time and may return many months of data*. This option is recommended only in extreme situations. Note: This option only applies to Campbell dataloggers.
  -or
  Select the **Get Single Day** checkbox to poll an ESC datalogger for one specific day.
  -or

Leave both the *Get All Data* and *Get Single Day* checkboxes unchecked. The dates polled will be from the date listed next to each site in the Select Sites list box to the current day. The date listed may also be changed by clicking in the field and entering a new date.

- Click the **Start** button to begin processing the site(s) in the order they appear in the list.

The manual data collection process operates similarly to the automatic data collection process regarding log files, etc.

4.1.1.3 Reviewing the Log and Err Files

The Auto Poll and Manual Poll programs write messages to files tracking the data polling and loading processes. The log files are called *yyyymmdd.log* where *yyyy* is the year, *mm* the month number and *dd* the day number. (For example, the file 20001128.log holds the log entries for November 28, 2000) The error files are called *yyyymmdd.err*. Both files are stored in the N:\project\IMC\esc_sitecall\logs directory and can be viewed by either clicking the **View Sitecall Logs** button in the Polling window or by opening directly in any text editor. Figure 4-3 is a sample log file and Figure 4-4 is a sample ERR file.

4.1.1.4 Daily Output

In addition to polling and loading data, the polling window performs several other functions:

- Update of stackplot files (auto mode)
- Auto printing of datalogger summary files (auto mode)
- Generation of span files (auto and manual modes)

Results of the AQDBMS program run are shown on the AQDBMS polling screen. The data analysts should check the AQDBMS polling status each day by performing the following:

- Launch AQDBMS and open the polling section.
- Check the date next to each site. This indicates date/time of the last successful poll.
- Click the **Daily Output** button to update selected sites.

The database system manager initially installs AQDBMS. Instructions are provided in *Air Quality Data Base Management System (AQDBMS) Database Manager/Programmer's Guide* (ARS, 2001).

```
DATA_COLLECTION: Site No: Figure Error! No text of specified style in
document.-1 SHBM 01-25-200105:38:29 ---------- Begin Site: SHBM ----------
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29 SHBM
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29 540999369834
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29 BM
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29 2
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29 ESC8816
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29 36896
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29
\\ars_net3\vol4\project\IMC\esc_sitecall\SHBM005a.2001r
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29
\\ars_net3\vol4\project\IMC\esc_sitecall\SHBM.dat
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29
\\ars_net3\vol4\project\IMC\esc_sitecall\SHBM.cal
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29
\\ars_net3\vol4\project\imc\esc_sitecall\logs\20010105.LOG
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29
\\ars_net3\sys\ars_soft\programs\campbell\
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29 NONE
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29 Turning modem ON...
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:33 Turning modem ON...
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:37 HANGUP: Opening port #2
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:38 HANGUP: AT&FV1&W
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:45 HANGUP: ATH0
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:54 HANGUP: DTR toggle
DATA_COLLECTION: Site No: SHBM 01-25-200105:39:09 HANGUP: Close port
DATA_COLLECTION: Site No: SHBM 01-25-200105:39:09 Turning modem OFF...
DATA_COLLECTION: Site No: SHBM 01-25-200105:39:13 Offline
DATA_COLLECTION: Site No: SHBM 01-25-200105:39:13 GetDataESC8816() started
DATA_COLLECTION: Site No: SHBM 01-25-200105:39:13 Getting ESC8816 data:
F:\COM_SOFT\ATMAPPS\XTALK32\XTALK30.exe SHBM(NPSAIR BM 01/05/01 5
\\ars_net3\vol4\project\IMC\esc_sitecall\SHBM005a.2001r
\\ars_net3\vol4\project\imc\esc_sitecall\logs\20010105.LOG
\\ars_net3\vol4\project\imc\esc_sitecall\logs\200101
DATA_COLLECTION: Site No: SHBM 01-25-200105:39:13 Executing:
F:\COM_SOFT\ATMAPPS\XTALK32\XTALK30.exe SHBM(NPSAIR BM 01/05/01 5
\\ars_net3\vol4\project\IMC\esc_sitecall\SHBM005a.2001r
\\ars_net3\vol4\project\imc\esc_sitecall\logs\20010105.LOG
```

Figure 4-3. A Sample Data Collection Log.

```
XTALK - shbm 1/25/2001 5:42:33 AM-XTALK data collection failed - shbm
(01/05/01)
FMT8816: SHBM 038 01/25/2001 05:42:37 >> Bad filename and/or path
```

Figure 4-4. A Sample Data Collection Error File.

4.1.2 Daily Preparation for Automatic Execution of the AQDBMS

Software for automatically running the AQDBMS is installed on the data collection workstation. A data analyst prepares the workstation at the end of each day by shutting down and restarting the workstation.

When the data collection workstation is unattended for extended periods such as weekends and holidays, data collection is handled without data analyst intervention. Once the workstation is setup on the afternoon prior to the period, the AQDBMS will automatically run once per night throughout the period at the assigned time.

4.1.3 IMC Daily AQDBMS Summary Report

Each run of the AQDBMS data collection routine generates two diagnostic reports (see Table 4-1). The *Daily Site Information* report is automatically printed at the conclusion of the AQDBMS run and is subsequently examined by the data analyst each working day, to determine the success or failure of the automatic data collection routines. An example of this report is shown in Figure 4-5. This report is intended to summarize the diagnostic information only. Detailed troubleshooting must be performed by the data analyst by manually calling the problem site.

4.1.4 Data Reformat

The data transmitted by the dataloggers are not readily imported into a database. Custom software was written to reformat the data into columns that are easier to import into a database. The AQDBMS performs this task.

Data errors occasionally prove difficult to troubleshoot during the reformat process. A data analyst or applications programmer may need to examine this file in a text editor for additional diagnostic information to find the problem. If the checkpoint fails, the program gives a brief statement of the cause and the recovery status of the data file.

4.1.5 Data Error Checking

The data rarely have errors because all modems are error correcting. Manual error checking is not necessary.

4.2 RETRY OF FAILED DATA COLLECTION SITES

Results of the daily data collection are automatically printed at the completion of the polling process. The data analyst examines the MES file to determine which sites failed to poll correctly. The AQDBMS tracks the last successful poll date for each site. The data analyst carefully examines the automatic collection results and verifies the contents.

To retry failed sites:

- Launch AQDBMS and go to Polling.
- Click the *site* to retry.

- Type in the *date* of data to be collected.
- Click **start**.

Summary of Datalogger Time Accuracy

Site	Logger Julian Date	Logger Date mm/dd/yy	Logger Time hh:mm:ss	IMC Date mm/dd/yy	IMC Time hh:mm:ss	Days Diff. #	Time Diff. hh:mm:ss
ACMH	221	08/08/00	05:33:26	08/08/00	04:35:17	000	-00:01:51
BIBE	221	08/08/00	04:39:50	08/08/00	04:39:52	000	-00:00:02
CANY	221	08/08/00	03:47:05	08/08/00	04:47:11	000	-00:00:06
CHIR	221	08/08/00	03:51:30	08/08/00	04:52:34	000	-00:01:04
CRMO	221	08/08/00	03:53:55	08/08/00	04:58:57	000	-00:05:02
DENA	221	08/08/00	02:04:35	08/08/00	05:05:03	000	-00:00:28
DEVA	221	08/08/00	03:12:53	08/08/00	05:10:41	000	+00:02:12
EVER	221	08/08/00	06:17:08	08/08/00	05:16:54	000	+00:00:14
GLAC	221	08/08/00	04:22:02	08/08/00	05:22:32	000	-00:00:30
GRBA	221	08/08/00	03:26:28	08/08/00	05:27:58	000	-00:01:30
GRCA	221	08/08/00	04:32:31	08/08/00	05:33:15	000	-00:00:44
GSCC	221	08/08/00	06:38:59	08/08/00	05:38:41	000	+00:00:18
GSCD	221	08/08/00	06:43:46	08/08/00	05:43:47	000	-00:00:01
GSCM	221	08/08/00	06:48:52	08/08/00	05:48:50	000	+00:00:02
GSLR	221	08/08/00	06:54:20	08/08/00	05:54:06	000	+00:00:14
HATH	221	08/08/00	01:56:49	08/08/00	05:59:38	000	-00:02:49
HAVO	221	08/08/00	02:05:58	08/08/00	06:05:07	000	+00:00:51
JOYV	221	08/08/00	04:10:36	08/08/00	06:10:41	000	-00:00:05
LAVO	221	08/08/00	04:17:14	08/08/00	06:16:38	000	+00:00:36
MAHM	221	08/08/00	06:23:38	08/08/00	06:23:46	000	-00:00:08
MEVE	221	08/08/00	05:29:12	08/08/00	06:29:15	000	-00:00:03
MORA	221	08/08/00	04:36:20	08/08/00	06:34:56	000	+00:01:24
NOCA	221	08/08/00	04:38:50	08/08/00	06:41:07	000	-00:02:17
OLHR	221	08/08/00	04:46:45	08/08/00	06:47:28	000	-00:00:43
OLYM	221	08/08/00	04:51:39	08/08/00	06:52:08	000	-00:00:29
PINN	221	08/08/00	04:57:51	08/08/00	06:58:34	000	-00:00:43
ROMO	221	08/08/00	07:35:08	08/08/00	08:35:55	000	-00:00:47
SEAS	221	08/08/00	05:04:53	08/08/00	07:04:43	000	+00:00:10
SELK	221	08/08/00	05:08:05	08/08/00	07:08:37	000	-00:00:32
SELP	221	08/08/00	05:51:21	08/08/00	07:51:55	000	-00:00:34
TRVC	221	08/08/00	07:06:36	08/08/00	08:06:33	000	+00:00:03
VIIS							
VOYA	221	08/08/00	08:14:53	08/08/00	08:15:11	000	-00:00:18
YELL	221	08/08/00	07:22:50	08/08/00	08:21:52	000	+00:00:58
YOTD	221	08/08/00	06:30:04	08/08/00	08:30:28	000	-00:00:24

Central Messages Report

Site Timestamp Message

DEVA 08/04/00 16:14:27 FLW FIXED, FILTER WAS NOT FULLY LOCKED INTO IT'S BASE, GOOD THING IT DIDN'T FALL
EVER 08/02/00 12:04:30 CHANGED OFFSET FROM -13 TO -10. DDM-ARS.
LAVO 08/01/00 10:44:41 PERFORMING LAVO STATION CHECK. M.MAGNUSON
SEAS 08/01/00 09:32:50 WEEKLY STATION CHECK AND MULTIPOINT, DMM.
YOTD 08/04/00 11:52:53 REPLACED WETNESS SENSOR-IT WORKS! KATY/NPS

Operator Messages Report

Site Timestamp Message

HATH 07/31/00 10:14:16
HATH 07/31/00 10:17:49 Messages complete

Figure 4-5. Example Daily Site Information File.

4.3 DATA FILES GENERATED BY THE AQDBMS

Data from the daily data files are automatically saved and printed. Figure 4-6 shows the datalogger file. If data load is successful, the AQDBMS moves ASCII files to the *success* directory. TI 3450-5000, *Ambient Air Quality and Meteorological Monitoring Data – Level 0 Validation*, details the steps of loading these data. Moving and copying these files may be done by any file management tool that the data analyst is comfortable with.

```
ESC 8816 Data Collection - lavo
Daily Average          12/27/99 04:35:37     JDay: 361          Logger ID: LV
   Report                 ESC 8816
--------------------------------------------------------------------------------
Name:                      O3         O3CAL         O3R8         VWD          SIG
Channel Num:                1             2            3           4            5
Analog Input:               1             2          N/A           3            3
Units:                    PPB           PPB          PPB         DEG          DEG
Full Scale:                 1 V           1 V        N/A           5 V          5 V
High Output:             490.          980.          N/A        540.         540.
Low Output:              -10.          -20.          N/A          0.           0.
--------------------------------------------------------------------------------
12/26 00:00               32.            2.         34.>C        28.          42.
12/26 01:00               34.            2.         34.>C        23.          50.
12/26 20:00               34.            2.         34.         101.          34.
12/26 21:00              214.<C        207.<C       34.>C        97.          31.
--------------------------------------------------------------------------------
Minimum:                  29.            2.         31.          23.           7.
Maximum:                 214.<C        207.<C       35.>C       283.          82.
Average:                  40.<C         11.<C       33.>C        87.          39.
   Report                 ESC 8816
--------------------------------------------------------------------------------
Name:                     VWS           SWS          PWS         TMP          DTP
Channel Num:                6             7            8           9           10
Analog Input:               4             4          N/A           5            6
Units:                    M/S           M/S          M/S         DGC          DGC
Full Scale:                 5 V           5 V        N/A           1 V          1 V
High Output:             50.0          50.0          N/A        50.0         -5.0
Low Output:               0.0           0.0          N/A       -30.0          5.0
--------------------------------------------------------------------------------
12/26 00:00               0.8           1.1          3.7         5.3          4.1
12/26 01:00               0.8           1.1          3.2         6.5          4.0
12/26 02:00               1.3           1.5          4.5         6.3          4.1
12/26 21:00               1.4           1.7          5.3         2.7          2.2
12/26 22:00               1.6           2.0          5.5         4.5          1.7
12/26 23:00               1.1           1.5          4.9         3.8          2.6
--------------------------------------------------------------------------------
Minimum:                  0.5           1.1          2.2        -1.6         -0.1
Maximum:                  2.4           3.0          7.7        10.2          4.1
Average:                  1.2           1.6          4.2         4.8          1.8
   Report                 ESC 8816
--------------------------------------------------------------------------------
Name:                     SOL           RNF           RH         WET          FLW
Channel Num:               11            12           13          14           15
Analog Input:               7            R1            8           9           10
Units:                    WMS            MM            %         +/-         SLPM
Full Scale:                 5 V         N/A            1 V         1 V          5 V
High Output:            1396.           0.3         100.        100.         5.80
Low Output:                0.           0.0           0.          0.         0.00
--------------------------------------------------------------------------------
12/26 00:00                1.           0.0          30.          0.         3.00
12/26 01:00                1.           0.0          25.          0.         3.00
12/26 22:00                1.           0.0          32.          0.         3.00
12/26 23:00                1.           0.0          34.          5.         3.00
```

Figure 4-6. Example ESC Datalogger Format Data File.

4.4 MANUAL DATA COLLECTION

If the AQDBMS automatic data collection system is unable to correctly retrieve error-free data, the data analyst manually retrieves as much data as possible as soon as possible using one of the following methods:

- Manual retrieval using AQDBMS software:
  - Select the *site*.
  - Select the *date* that is needed.
  - Click **start**.
- Manual retrieval from DataView.
- Data received via e-mail or diskette.
- Third party data report.

Procedures for manual data retrieval using communications software and manual datalogger commands are outlined in the following subsection. Procedures for manual data retrieval from DataView are outlined in Section 4.4.2. TI 3450-5000, *Ambient Air Quality and Meteorological Monitoring Data – Level 0 Validation*, details the steps of manual entry of data from daily data printouts.

4.4.1 Manual Data Retrieval Using AQDBMS Software

All monitoring sites have error-correcting modems hence data files are not edited for problems. To reprocess manually collected data files:

- Launch the AQDBMS.
- Choose a *site* to be reprocessed.
- Type in a *date* of data to be reprocessed.
- Click **process only.**
- Click **start**.

4.4.2 Manual Data Retrieval from DataView

DataView communicates directly with the datalogger retrieving minute data every minute, hourly data every hour, and calibration data every day. These data are stored in a database on the DataView laptop. These data cannot be viewed outside of DataView unless they are exported to a comma-delimited ASCII file (.csv). This can be accomplished in two ways:

- An IMC data analyst can configure DataView to automatically and continuously save minute, hourly, and/or calibration data to an ASCII file. This is normally done only in situations where continuous data availability from the datalogger is not available.

- The DataView user can interactively export specific data to the ASCII files.

Either way, the user must manually copy the .csv files to diskette for retrieval. To retrieve data from the on-site DataView laptop:

- Connect to the site's laptop with pcAnywhere and log on to DataView. If DataView has been configured to automatically generate the .csv files, skip to "Transfer Files" below.

- Manually export the data needed to .csv files. From dropdown boxes along the top of the screen, select **Data Tables** then **Data Export**. The Data Export form will appear.

- Choose the export file destination. The default is *C:\toucans\poll_data*. Change this setting only if creating files that will not be sent to the IMC. If performing export on site, it is recommended that data be exported onto *C:\drive* and transferred to diskette instead of exporting directly to diskette.

- Select the appropriate *data type* (Hourly/Minute/Cals) and a parameter list will appear. If fulfilling an IMC request to recover missing datalogger data, select **Hourly** and **Cals** (the IMC does not need minute data). Click the **Select All** button.

- Select the appropriate *dates*. Click in the **Start Date** box and a calendar will appear. Select the *start* and *end* dates and click the button labeled **Go**. When the message *Export Complete* is displayed, click the **Done** button. Log off from DataView.

- Transfer the files to the IMC using pcAnywhere. The following steps will transfer both the data files and the station log files to *N:\project\IMC\DataView\poll_data*.

  On an IMC computer setup to automatically collect station logs with pcAnywhere:

  - Click the **File Transfer** button at the top of the screen. (The button looks like a page with a lightning bolt).

  - Click the **Auto Transfer** button, then **OK**, then **Yes**.

  - This will transfer the files from the site's laptop to the correct location on the server and then will disconnect from the site. To remain connected, uncheck the **End session when finished** button when the File Transfer Status window appears.

  On any other computer with pcAnywhere:

  - Click on the **File Transfer** button at the top of the screen. (The button looks like a page with a lightning bolt).

  - On your side of the file transfer screen, navigate to *N:\project\IMC\DataView\Poll_data|*.

  - On the DataView laptop side of the file transfer screen, navigate to: *C:\DataView2\poll_data*.

- Select the files to transfer.

- Click the appropriate arrow.

This will transfer the files from the site's laptop to the correct location on our server to be loaded into the database (station logs) and afterwards, disconnect you from the site. If you wish to stay connected, uncheck the **End session when finished** button when the File Transfer Status window appears.

4.5 DAILY REVIEW OF DATA DIRECTORY CONTENTS

Daily review of file sizes and locations is useful for error control and later archiving of data files. Following each daily data collection, the data analyst checks that the number of raw files (ssssjjja.yyyyr) is the same as the number of sites to be called.

4.6 MONTHLY ARCHIVAL OF FINAL RAW DATA FILES

Data collected via telephone modem from monitoring sites using AQDBMS program routines must be archived for possible future reference. The previous sections in this document describe the process to collect and load the data. Each month, the data files are checked for completeness and organization. They are then written to CD and distributed. This process is accomplished in the following steps:

- The data analyst ensures that a complete month of data has been collected and resides in the *\success* directory.

- Select all daily ASCII files for all sites and create an archive.

- Create three (3) copies of the CD and distribute to the network-specific program manager, on-site in the IMC, and to an off-site location other than the IMC.

5.0 REFERENCES

Air Resource Specialists, Inc. (ARS), 2001, Air Quality Data Base Management System (AQDBMS) Database Manager/Programmer's Guide.

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1901 Sharp Point Drive, Suite E
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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**COLLECTION OF DATAVIEW FILES VIA TELEPHONE MODEM**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3350-4005**
DATE	**JANUARY 2001**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Donald E. Mussard	Donald E. Mussard
PROJECT MANAGER	Jessica Ward	Jessica Ward
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
	Reviewed; no changes necessary.	January 2002	G. Mercer
	Reviewed; no changes necessary.	January 2003	G. Mercer
0.1	Changed auto collection time and frequency.	January 2004	G. Mercer
	Reviewed; no changes necessary.	January 2005	G. Mercer
	Reviewed; no changes necessary.	January 2006	G. Mercer
	Reviewed; no changes necessary.	January 2007	G. Mercer
	Reviewed; no changes necessary.	January 2008	G. Mercer
	Reviewed; no changes necessary.	January 2009	G. Mercer
	-- continued --		

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**COLLECTION OF DATAVIEW FILES VIA TELEPHONE MODEM**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3350-4005**
DATE	**JANUARY 2001**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Donald E. Mussard	Donald E. Mussard
PROJECT MANAGER	Jessica Ward	Jessica Ward
PROGRAM MANAGER	David L. Dietrich	
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COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
0.2	Change frequency of file collection.	February 2010	G. Mercer
	Reviewed; no changes necessary.	April 2011	G. Mercer

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1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the steps taken by ARS' Information Management Center (IMC) to collect DataView files (station logs) via telephone modems. The primary purpose of daily collection is to assure quality data capture and minimize data loss by:

- Calling the DataView computer at each station via telephone modem and downloading any new station logs into site-specific daily files.
- Reviewing the daily status report to verify complete information collection or to identify problems.

The station logs contain automatically or manually entered notes that describe results of weekly site visits and maintenance visits to the site.

As referenced from Standard Operating Procedure (SOP) 3350, *Collection of Ambient Air Quality and Meteorological Monitoring Data and Site Documentation*, this TI is a guide for using custom data collection software to assure complete, error-free data collection from network dataloggers via telephone modems.

2.0 RESPONSIBILITIES

2.1 DATA ANALYST

The data analyst shall:

- Set up and maintain the automatic station log collection programs and support information daily.
- Ensure that the workstation used for automatic station log collection is properly configured for daily polling.
- Review the status of the automatic station log collection each Wednesday to verify complete, error-free information collection, assure the integrity of the DataView systems, or to identify problems and initiate corrective actions.
- Perform required daily retries.
- Review collected station log files.
- Provide technical support to the site operator via telephone.
- Ensure proper archive and storage of station log data files.

2.2 FIELD SPECIALIST

The field specialist shall:

- Inform data analysts of any changes in site configurations resulting from maintenance visits.

- Inform data analysts of any equipment or DataView system malfunction, replacements, additions, or inconsistencies.

- Inform data analysts of any DataView system program changes.

- Provide assistance to the IMC for troubleshooting DataView problems.

2.3 SITE OPERATOR

The site operator shall:

- Telephone the IMC or field specialist if DataView problems are noted on-site.

- Provide on-site assistance for troubleshooting DataView problems.

3.0 REQUIRED EQUIPMENT AND MATERIALS

Detailed descriptions of all IMC hardware and software and monitoring station hardware requirements are presented by category in SOP 3340, *Information Management Center (IMC) Concept and Configuration*. The IMC requires the following hardware and software to collect information from DataView via telephone modems:

- DataView on-site system including a laptop computer, modem, and printer.

- IMC hardware:
  - Hardware specifications for IMC servers
  - Hardware specifications for workstations
  - Support hardware

- IMC computer support software:
  - AQDBMS custom software
  - Network operating system and support software
  - DataView station log collection software

4.0 METHODS

This section includes four (4) major subsections:

4.1 Automatic Station Log Collection
4.2 Manual Station Log Collection
4.3 Automatic Import of Station Logs to the AQDBMS
4.4 Monthly Archive of Raw Station Log Files

A flowchart of the station log process is provided in Figure 4-1. Files generated by this process and their distribution are shown in Table 4-1.

4.1 AUTOMATIC STATION LOG COLLECTION

The station logs are collected by several methods. At sites with reliable land-line telephone service, the station logs are automatically acquired by the station log collection software and stored in comma-delimited ASCII files. If the automatic collection fails, the data analyst may also run the software manually. Station logs at sites that do not have reliable telephone service are collected by the site operator onto a 3.5" diskette using a DataView utility and then transmitted to the IMC by e-mail or regular mail/shipping. Logs may also be hand-entered from printed copies of the logs.

4.1.1 Starting the Automatic Station Log Software

The automatic station log collection software is loaded onto a computer with a telephone modem. The software uses a continuous clock/timer function and is configured to begin execution at 2:30 a.m. each Wednesday. This program calls each DataView site and downloads the most recent station log files to the IMC as comma-delimited ASCII files.

4.1.2 Polling Order

The order in which the sites are polled is determined by the time specified in the automatic station log collection software setup, and generally polls according to time zone. The sites are polled in 15-minute intervals with four (4) automatic retries built in to each polling session. To change the polling time of a site, the polling configuration can be directly edited.

4.1.3 Reviewing the Station Log Acquisition Status

The current availability of station logs may be reviewed at any time by running the DataView Status Summary program. A sample of the status summary output is provided as Figure 4-2. This program lists by site, the date of the last station log acquired and the age of the file. Station log files older than 7 days are highlighted. Several columns of information are presented in this table for troubleshooting purposes. The data analyst should review the last three columns of the report daily and take action to recover station logs older than 7 days.

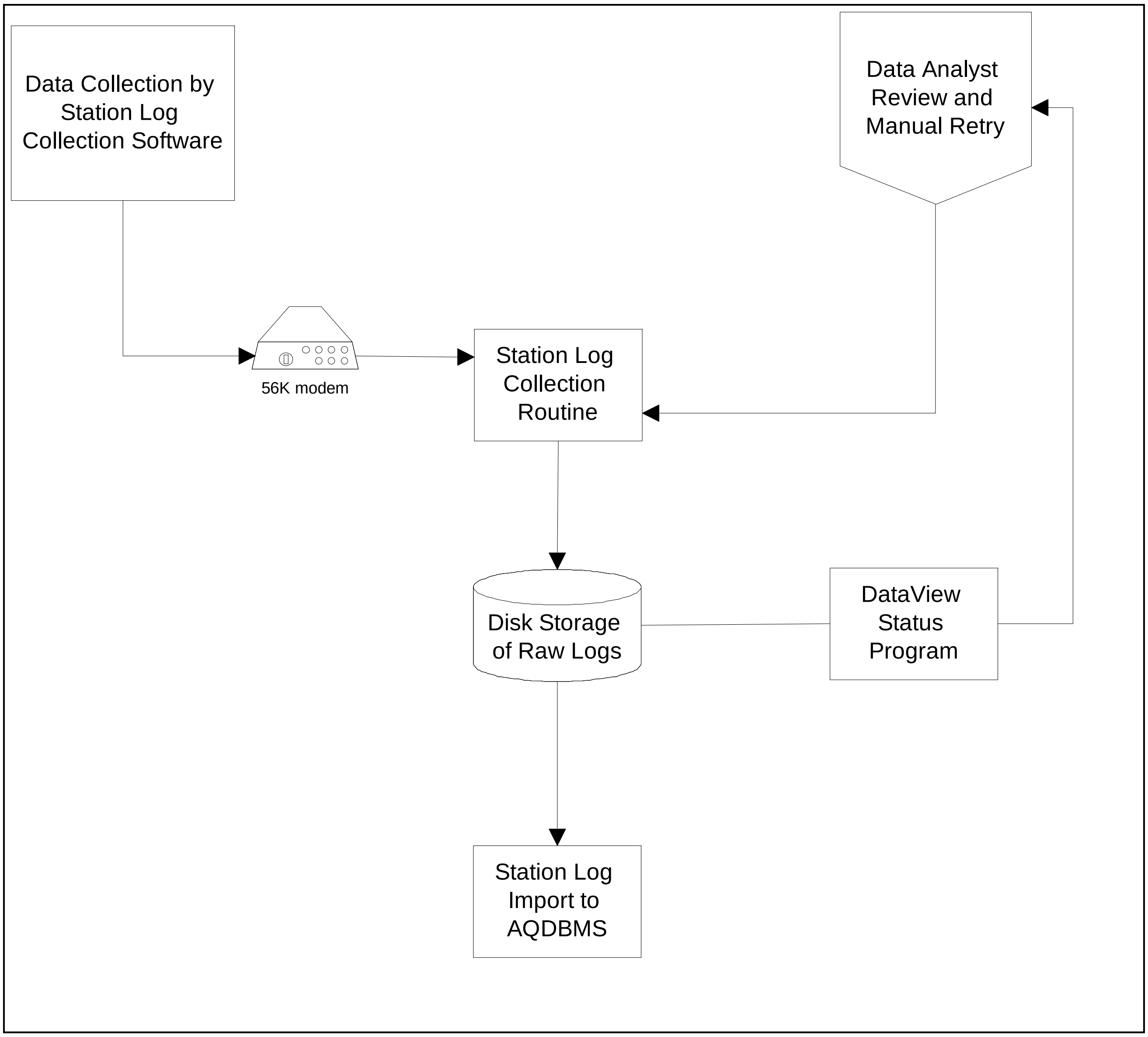


Figure 4-1. AQDBMS Station Log Acquisition and Processing via Telephone Modem Flowchart.

Table 4-1

File Name and Directory Organization of Files Generated by Station Log Collection Routines

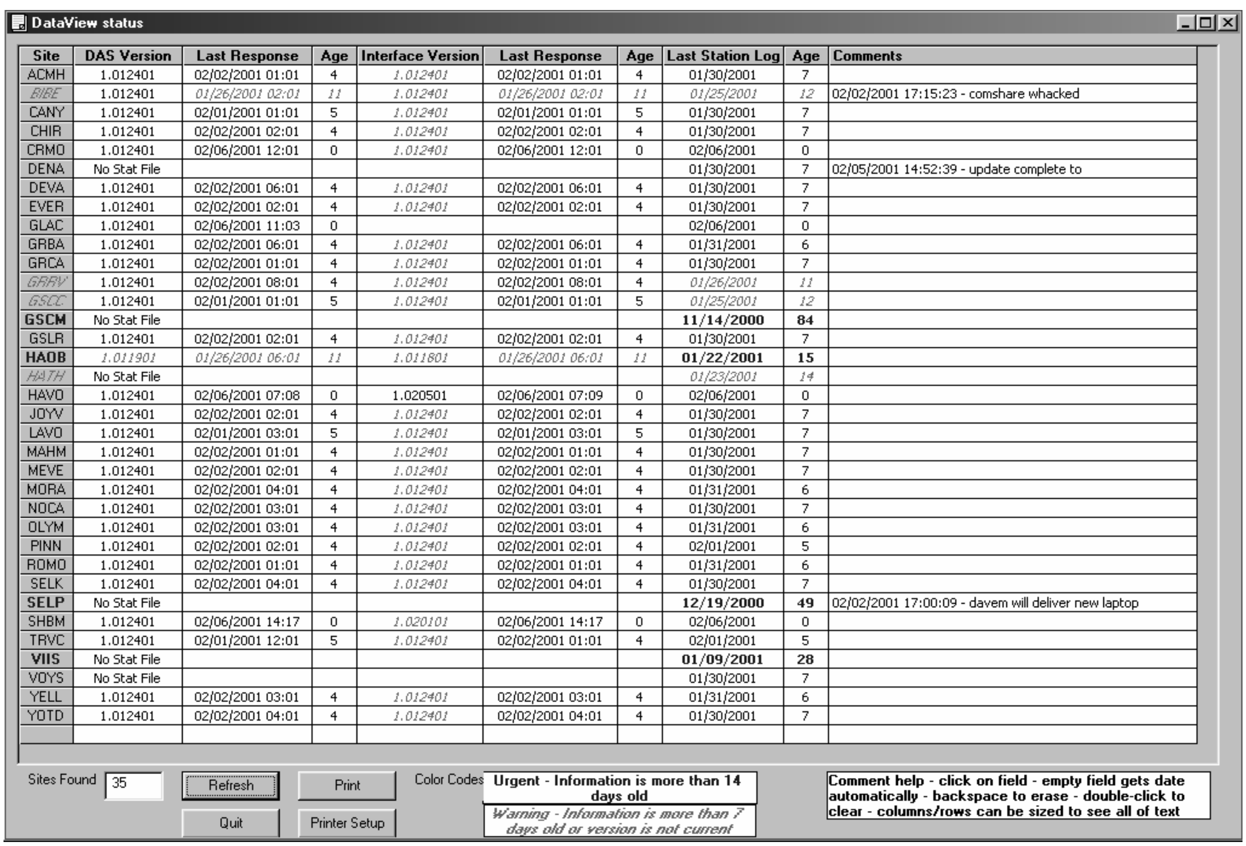
File Type	File Description	Source(s)[1]	File Name(s)[2]	Directory Location[3]	Destination
Station Logs	Comma-delimited ASCII text files	Station log collection software	sitemmddyyyylog .csv	DATAVIEW\POLL_ DATA	Archived and imported to AQDBMS

Notes:
[1] Refers to routines defined in Figure 4-1.

[2] File naming convention: (based on MS-DOS 8.3 file name format)

mm = 2-digit month
dd = 2-digit day
yyyy = 4-digit year
ERR = error report
MES = detailed message report
SUM = summary report
CSV = Excel import format file
site = 4-character site code
RET = retry file
SPN = span file
DAT = stackplot data file
D = hourly data import file
L = calibration data import file

[3] Directory Location: The *AQDBMS* directory is currently located under N:\PROJECT\IMC\.



Site	DAS Version	Last Response	Age	Interface Version	Last Response	Age	Last Station Log	Age	Comments
ACMH	1.012401	02/02/2001 01:01	4	1.012401	02/02/2001 01:01	4	01/30/2001	7	
BIBE	1.012401	01/26/2001 02:01	11	1.012401	01/26/2001 02:01	11	01/25/2001	12	02/02/2001 17:15:23 - comshare whacked
CANY	1.012401	02/01/2001 01:01	5	1.012401	02/01/2001 01:01	5	01/30/2001	7	
CHIR	1.012401	02/02/2001 02:01	4	1.012401	02/02/2001 02:01	4	01/30/2001	7	
CRMO	1.012401	02/06/2001 12:01	0	1.012401	02/06/2001 12:01	0	02/06/2001	0	
DENA	No Stat File						01/30/2001	7	02/05/2001 14:52:39 - update complete to
DEVA	1.012401	02/02/2001 06:01	4	1.012401	02/02/2001 06:01	4	01/30/2001	7	
EVER	1.012401	02/02/2001 02:01	4	1.012401	02/02/2001 02:01	4	01/30/2001	7	
GLAC	1.012401	02/06/2001 11:03	0				02/06/2001	0	
GRBA	1.012401	02/02/2001 06:01	4	1.012401	02/02/2001 06:01	4	01/31/2001	6	
GRCA	1.012401	02/02/2001 01:01	4	1.012401	02/02/2001 01:01	4	01/30/2001	7	
GRRV	1.012401	02/02/2001 08:01	4	1.012401	02/02/2001 08:01	4	01/26/2001	11	
GSCC	1.012401	02/01/2001 01:01	5	1.012401	02/01/2001 01:01	5	01/25/2001	12	
GSCM	No Stat File						**11/14/2000**	**84**	
GSLR	1.012401	02/02/2001 02:01	4	1.012401	02/02/2001 02:01	4	01/30/2001	7	
HAOB	1.011901	01/26/2001 06:01	11	1.011801	01/26/2001 06:01	11	**01/22/2001**	**15**	
HATH	No Stat File						01/23/2001	14	
HAVO	1.012401	02/06/2001 07:08	0	1.020501	02/06/2001 07:09	0	02/06/2001	0	
JOYV	1.012401	02/02/2001 02:01	4	1.012401	02/02/2001 02:01	4	01/30/2001	7	
LAVO	1.012401	02/01/2001 03:01	5	1.012401	02/01/2001 03:01	5	01/30/2001	7	
MAHM	1.012401	02/02/2001 01:01	4	1.012401	02/02/2001 01:01	4	01/30/2001	7	
MEVE	1.012401	02/02/2001 02:01	4	1.012401	02/02/2001 02:01	4	01/30/2001	7	
MORA	1.012401	02/02/2001 04:01	4	1.012401	02/02/2001 04:01	4	01/31/2001	6	
NOCA	1.012401	02/02/2001 03:01	4	1.012401	02/02/2001 03:01	4	01/30/2001	7	
OLYM	1.012401	02/02/2001 03:01	4	1.012401	02/02/2001 03:01	4	01/31/2001	6	
PINN	1.012401	02/02/2001 02:01	4	1.012401	02/02/2001 02:01	4	02/01/2001	5	
ROMO	1.012401	02/02/2001 01:01	4	1.012401	02/02/2001 01:01	4	01/31/2001	6	
SELK	1.012401	02/02/2001 04:01	4	1.012401	02/02/2001 04:01	4	01/30/2001	7	
SELP	No Stat File						**12/19/2000**	**49**	02/02/2001 17:00:09 - davem will deliver new laptop
SHBM	1.012401	02/06/2001 14:17	0	1.020101	02/06/2001 14:17	0	02/06/2001	0	
TRVC	1.012401	02/01/2001 12:01	5	1.012401	02/02/2001 01:01	4	02/01/2001	5	
VIIS	No Stat File						**01/09/2001**	**28**	
VOYS	No Stat File						01/30/2001	7	
YELL	1.012401	02/02/2001 03:01	4	1.012401	02/02/2001 03:01	4	01/31/2001	6	
YOTD	1.012401	02/02/2001 04:01	4	1.012401	02/02/2001 04:01	4	01/30/2001	7	

Figure 4-2. Example DataView Status Report.

4.2 MANUAL STATION LOG COLLECTION

4.2.1 Manually Retrieving Digital Station Logs

If automatic acquisition of the digital station logs fails, the data analyst should attempt to manually retrieve the file by running the station log collection software. After the program begins, the analyst should select the site that has failed and choose the **Run** button. If several manual attempts fail, the problem must be reported to network operations for troubleshooting.

4.2.2 Manually Retrieving Hardcopy Station Logs

If, after all attempts at acquiring the digital station logs fail, including on-site remedies, the data analyst must contact the site operator and request that a copy of the missing pages be printed and/or copied from the DataView computer and mailed to the IMC.

4.3 AUTOMATIC IMPORT OF STATION LOGS TO THE AQDBMS

The station log files are automatically imported into the AQDBMS daily during the automatic data collection process.

4.4 MONTHLY ARCHIVE OF RAW STATION LOG FILES

All collected raw station log files are archived monthly with the other raw data files. Each quarter, the station log files are checked for completeness and organization. They are then written to CD once year year and distributed as described in TI 3350-4000, *Collection of Ambient Air Quality and Meteorological Monitoring Data Via Telephone Modem.* This process is accomplished in the following steps:

- The data analyst ensures that a complete month of station logs have been collected and resides in the *\poll_data* directory.

- Create three (3) copies of the CD and distribute to the client, on-site in the IMC, and to an off-site location other than the IMC.

5.0 REFERENCES

Air Resource Specialists, Inc. (ARS), 2001, Air Quality Data Base Management System (AQDBMS) Database Manager/Programmer's Guide.

Air Resource Specialists, Inc.
1901 Sharp Point Drive, Suite E
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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES

TITLE	**AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA VALIDATION**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3450**
DATE	**MARCH 1999**

AUTHORIZATIONS

Originator	Betsy Davis-Noland	Bet Davis Noland
Project Manager	Jessica Ward	Jessica Ward
Program Manager	Joe Adlhoch	
QA Manager	Gloria S. Mercer	Gloria S. Mercer

REVISION HISTORY

0.0	Initial version.	March 1999	G. Mercer
1.0	Change all procedures for the DataView system	January 2001	G. Mercer
1.1	Add manual review of site documentation.	July 2002	G. Mercer
	Reviewed; no changes necessary.	July 2003	G. Mercer
1.2	Minor text changes incl. adding 3rd level validation proc., new checklist, delete data tech.	February 2004	G. Mercer
1.3	Modify collection/validation flowchart.	May 2004	G. Mercer
1.4	Changed AIRS to AQS; other minor changes.	May 2005	G. Mercer
1.5	Change validation checklist.	February 2006	G. Mercer
2.0	Changed expected zero values.	January 2007	G. Mercer
2.1	Corrected network path for post-final validation.	January 2008	G. Mercer
	Reviewed; no changes necessary.	January 2009	G. Mercer
2.2	Change data collection/validation flowchart.	February 2010	G. Mercer
3.0	Validation coding changes and updated figure.	March 2012	G. Mercer

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1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) outlines the steps of ambient air quality and meteorological data validation, to assure quality data and to ensure that data are validated to meet Environmental Protection Agency (EPA) guidelines for successful submission to the EPA AQS (Air Quality System) database. The steps outlined apply to all ambient air quality and meteorological parameters that are monitored and loaded into the Information Management Center (IMC) database, regardless of whether the data for a specific parameter are uploaded to the EPA AQS database.

The validation process consists of the following major steps:

- Review of raw data visually on a daily basis for data acquisition errors, and for details on instrument performance.
- Process data through Level 0 validation to ensure that all possible data have been collected and are correctly loaded into the permanent table of the database.
- Process data through Preliminary validation to identify values that do not meet acceptance criteria.
- Process data through Final validation that includes input from air quality specialists, field specialists, and site operators to resolve all questionable validation issues.
- Accommodate post-final validation changes when necessary.

Successful validation at each level requires completion of a set of automatic (computer program) and manual checkpoints as shown in the data collection, validation, and reporting flow diagram (Figure 1-1).

This SOP outlines the data validation process. For detailed data validation procedures refer to the following technical instructions (TIs):

- TI 3450-5000 *Ambient Air Quality and Meteorological Monitoring Data – Level 0 Validation*
- TI 3450-5010 *Ambient Air Quality and Meteorological Monitoring Data – Preliminary Validation*
- TI 3450-5020 *Ambient Air Quality and Meteorological Monitoring Data – Final Validation*

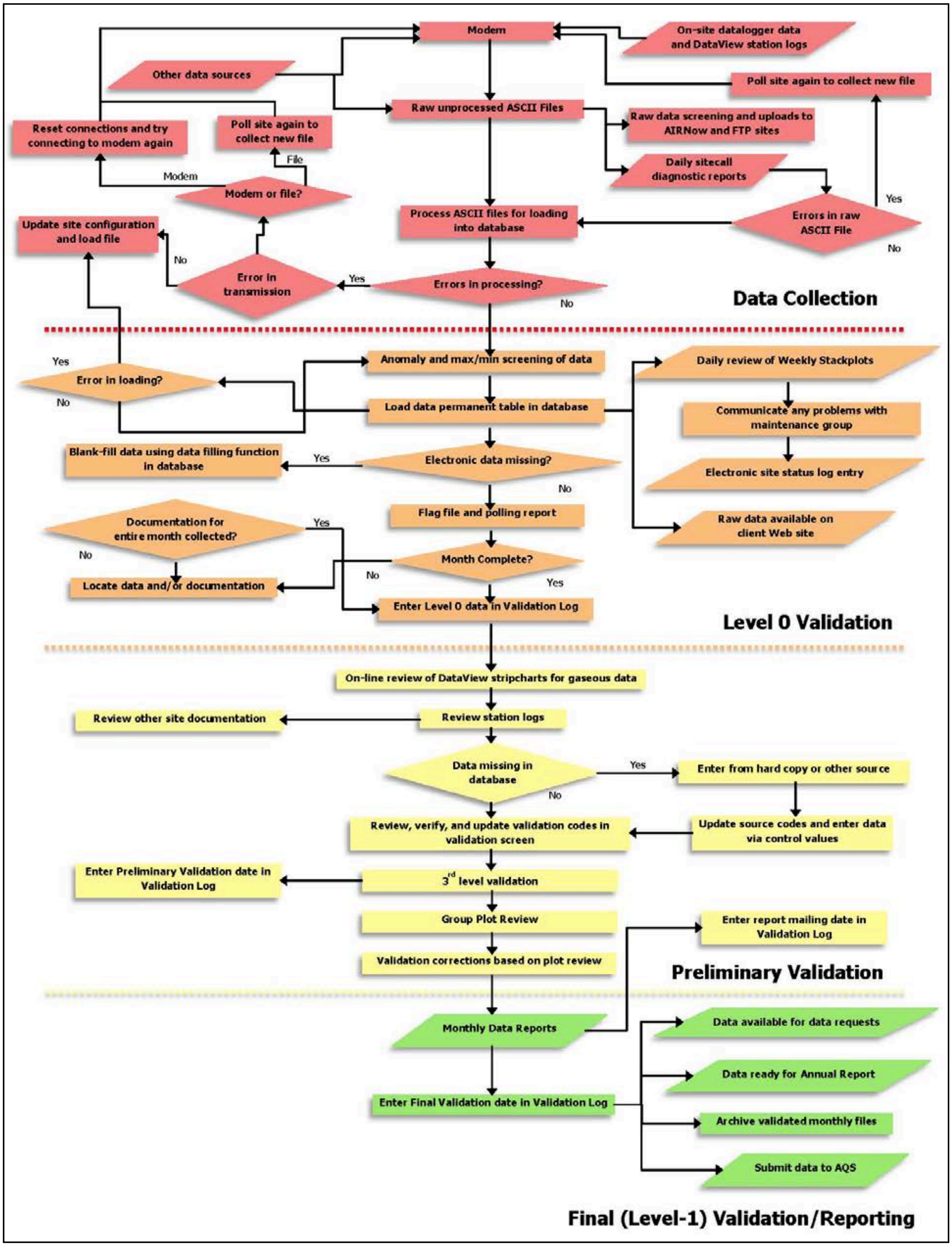

Figure 1-1. General Data Collection, Validation, and Reporting Flow Diagram. (Specific processes may vary by monitoring network).

2.0 RESPONSIBILITIES

Staff positions that have data validation responsibilities are:

- Information Management Section Manager
- Data analyst
- Field specialist
- Site operator
- Technical Assistant
- Sponsoring organization staff

Specific Information Management Center (IMC) staff data collection responsibilities are presented in the TIs that support this SOP (see previous Section 1.0).

3.0 REQUIRED EQUIPMENT AND MATERIALS

All IMC equipment and materials are fully described in SOP 3340, *Information Management Center (IMC) Concept and Configuration for the National Park Service Gaseous Pollutant Monitoring Program*, and SOP 3341, *Air Resource Specialist's, Inc. (ARS) Information Management Center (IMC) Concept and Configuration*. The hardware and software used to perform specific data validation functions are referenced in the TIs that support this SOP (see previous Section 1.0).

4.0 METHODS

This section discusses the levels of data validation and the methods used to complete each level of air quality and meteorological data validation. Throughout the data validation process, the programs within the Air Quality Data Base Management System (AQDBMS) are used extensively. Details on operating the system are found in the TIs that support this SOP (see previous Section 1.0).

This section includes four (4) major subsections:

4.1 Level 0 Validation Procedures
4.2 Preliminary Validation Procedures
4.3 Final Validation Procedures
4.4 Post-Final Validation Procedures

4.1 LEVEL 0 VALIDATION PROCEDURES

Level 0 validation is accomplished by:

- Collecting data via modem or other collection method.
- Initially screening the daily data for anomalies.
- Visually reviewing graphed raw data on stackplots on a weekly basis.
- Verifying the receipt of DataView station logs or manual station logs.

4.1.1 Daily Data Review and Anomaly Screening

Data are collected via modem or other communications and stored in computer files (see SOP 3350, *Collection of Ambient Air Quality and Meteorological Monitoring Data*). Flags applied to the data by the dataloggers are also stored. The data and flags are then loaded into the AQDBMS database and are visually reviewed by the data analyst. Data for one site, all parameters, are displayed on a stackplot displayed on a computer screen one at a time. The data analyst reviews the data and verifies the following:

- All sites and parameters that should be collected were collected.
- The data set for each site is complete.
- The data are reasonable for the site, season, and conditions.

If data for a site have not been properly loaded, the data for the site/day must be deleted, corrected, and loaded again. It may be necessary to compare the data on screen with the raw computer file for verification. If data are missing and unrecoverable, the missing data is "blank-filled" by using the AQDBMS manual data entry screen and program. If raw data values are to be recovered by other than digital means, for example, reduced from a stripchart, the AQDBMS validation screen raw data/source view is used to enter the data.

After data for a site/day is verified, it is screened for anomalies by an AQDBMS program. This program applies anomaly flags (Level 0 validation codes). These flags are added to any datalogger flags that were loaded with the raw data from the datalogger.

Specific values for the screening program are maintained in the AQDBMS Screening Ranges Table for each site/parameter combination. If a site/parameter is not defined, a message is displayed. The Screening Ranges Table must be immediately updated and the data screened again.

After screening, the data analyst notifies the field specialist if any of the following are true:

- Data for any parameter are at a full scale or zero scale values for an uncommonly long time. This indicates an instrument may have been left in zero or span mode inadvertently.

- Daily calibration data (zero and span values from the analyzer) are not within the expected range. Zero values should be within ± 2% of full scale (ozone and carbon monoxide) or ± 3% (oxides of nitrogen and sulfur dioxide) of the instrument and span values within ± 7% (ozone) or ± 10% (all other gases) of the calibrator's corresponding values. In this case, the field specialist must be notified as soon as possible so the analyzer can be calibrated in the field.

- Any unusual and noteworthy anomalies with the data that would call attention to either a needed repair of an instrument or correction of a condition by the site operator (such as datalogger flags, anomaly screening flags, or anomalies resulting from visual data review).

Corrective action is initiated to resolve any noted inconsistencies and the problem and actions are entered in the Site Status Log.

4.1.2 Review of Raw Data Stackplots

A stackplot may include single or multiple user-selected parameters on line or bar graphs plotted against time on the X-axis. Up to 20 parameters may be plotted on up to 10 separate graphs (1 or 2 parameters per graph) in a stack. Temporal data variations are then easy to compare. Stackplots are used throughout the validation process. Raw data are graphed on stackplots on a weekly basis for each site for the following time periods each month:

- Days 1 – 7
- Days 8 – 15
- Days 16 – 23
- Days 24 – end of month

One copy of each plot is generated and is promptly forwarded to all data analysts and the field specialist assigned as technician-of-the-week for examination. Problems not detected up to this point in the validation process are entered into the Site Status Log and a field specialist is notified for resolution of the problem.

4.1.3 Site Documentation

Site operators are required to complete station checklists in DataView or on manual log sheets during every station visit. The DataView station checklists are downloaded and stored in the AQDBMS.

Level 0 validation is complete for a site/month on the date all possible data for the month have been collected and loaded into the AQDBMS database and all site documentation has been received. This date is entered in the AQDBMS Data Validation Log. In the event of DataView failure or for specific instrument types, the operator will complete manual checklists or logsheets and fax a copy of the logsheet to the IMC. All manual logsheets will be reviewed and checked upon arrival at the IMC. Data will be manually entered into the AQDBMS and the logsheets will be stored with the hardcopy stackplots from the site.

4.2 PRELIMINARY VALIDATION PROCEDURES

Data for a site/month must be at Level 0 validation before beginning Preliminary validation. The Monthly Validation Checklist, shown in Figure 4-1, is used as a guide for the Preliminary validation procedure. The checklist identifies the major steps taken during Preliminary validation and provides a record of the date each step was completed and the initials of the analyst completing it. Preliminary data validation is accomplished by the following:

MONTHLY VALIDATION CHECKLIST

Site____________

Month/Year____________

PRELIMINARY (AND LEVEL 0 VERIFICATION)		Date	Initials
1.	Review **previous months'** commented **Stackplots**	______	______
2.	Verify that all **Daily Summaries** are printed.	______	______
3.	Print and review **Station Logs**.	______	______
	Monthly MPC ☐ Monthly RNF ☐ Monthly PM flow check ☐ Weekly station checks ☐ ☐ ☐ ☐ ☐		
4.	Print and review most recent **Site Status Log** and **Calibration Plots**.	______	______
5.	Review **SSRF Forms, Trip Reports** & check **RH Cal Results**.	______	______
6.	Click '**auto validate**' button in database.	______	______
7.	Run **"datalogger flags listing" report** from database, verify all flags were coded.	______	______
8.	Check **O_3 Trace** via PC Anywhere in DataView.	______	______
9.	Apply **additional validation codes** if necessary.	______	______
10.	Record **annotations** on weekly stackplots.	______	______
11.	Run and print "**Stackplots for Validation Review"** – review and change codes as needed.	______	______
12.	Update **Data Validation Log**.	______	______
13.	Monthly **Plot Review**.	______	______

3rd LEVEL			
11.	Review **Site Status Log**, **Field Station Logs**, **Calibration Plots**, and **Daily Summaries** (as needed) to verify annotations on plots.	______	______
12.	Review **Validated Stackplots**, investigate suspect data if necessary.	______	______
13.	Verify preliminary **Validation Codes** in database.	______	______
14.	Update **Data Validation Log**.	______	______

N:\Project\imc\Forms\MoValChkList_newmethod.doc

Figure 4-1. The Monthly Validation Checklist.

- Determining if each data value meets validation acceptance criteria by:

  - Reviewing site documentation.
  - Reviewing the AQDBMS Site Status Log.
  - Recording and reviewing comments on the raw data stackplots.
  - Entering calibration data into the AQDBMS database.
  - Reviewing daily summaries.
  - Reviewing trip reports.
  - Reviewing calibration plots.
  - Entering and reviewing any audit report data received for the site/month into the AQDBMS database.

- Using the Auto Validation tool in the AQDBMS to automatically apply validation codes.
- If necessary, adjusting validation codes or values in the AQDBMS database.
- Updating the AQDBMS Data Validation Log.
- Reviewing validated data stackplots.

4.2.1 <u>Validation Acceptance Criteria</u>

Validation acceptance criteria and the methods for determining if a data value meets the criteria are usually related to one of the following events or limitations:

- Data are out of instrument specifications (instrument-specific, see anomaly screening in TI 3450-5000, *Ambient Air Quality and Meteorological Monitoring Data – Level 0 Validation*).
- Data exceed minimum or maximum expected value (site-specific, see anomaly screening in TI 3450-5000).
- Data exceed minimum or maximum expected rate-of-change (site-specific, see anomaly screening in TI 3450-5000).
- Station temperature is out of specified limits.
- Zero and span check data are within specified limits (instrument- and instrument range-specific, see anomaly screening in TI 3450-5000).
- Data are affected by calibration check.
- Less than 45 minutes of data are available (hourly averaging period).
- Instrument or datalogger was affected by acts of nature.
- Instrument or datalogger was affected by power failure.
- Data capture was affected by a datalogger failure.
- Data were affected by operator maintenance or calibration check.
- Data were affected by site operator error.
- Data were affected by instrument malfunction or failure.
- Data were below lower detectable limit.

To determine if the data meet or do not meet validation acceptance criteria, the data analyst first reviews the site documentation and weekly stackplots for the site/month being validated, uses Auto Validate to apply codes, reviews the codes, and then writes any comments on the plots that affect validation. Comments on plots are based on information from the site documentation, communication with field personnel and site operators, and anomaly and Auto Validation screening results. A commented plot is shown in Figure 4-2. The following guidelines are used when commenting plots:

- Comments are written within the outline of the day of the affected data and in close proximity to the data point affected.
- Comments include the hours affected, the reason(s) for invalidating the data, and the corresponding invalid code. The invalid code gives the reason for invalidating the data.
- Explanations of valid but unusual data are also included.
- Data points flagged by the anomaly-screening program are noted on the plot when appropriate.
- Site visits are identified at the top of the plot above the corresponding date with date, time, and duration of the visit.
- Normal actions that occur during a site visit and do not invalidate data are also identified on the plot (for example, meteorological instrument checks that last less than 15 minutes). This indicates that a required maintenance check was completed and further establishes validity of the data.

Precision check, calibration, and audit data are reviewed and entered if necessary during this step in the Preliminary validation process.

A group plot review is held that includes input from air quality specialists, field specialists, and site operators, to resolve all questionable validation issues. After the plot review, necessary validation code changes are made in the AQDBMS database based on the group plot review discussion.

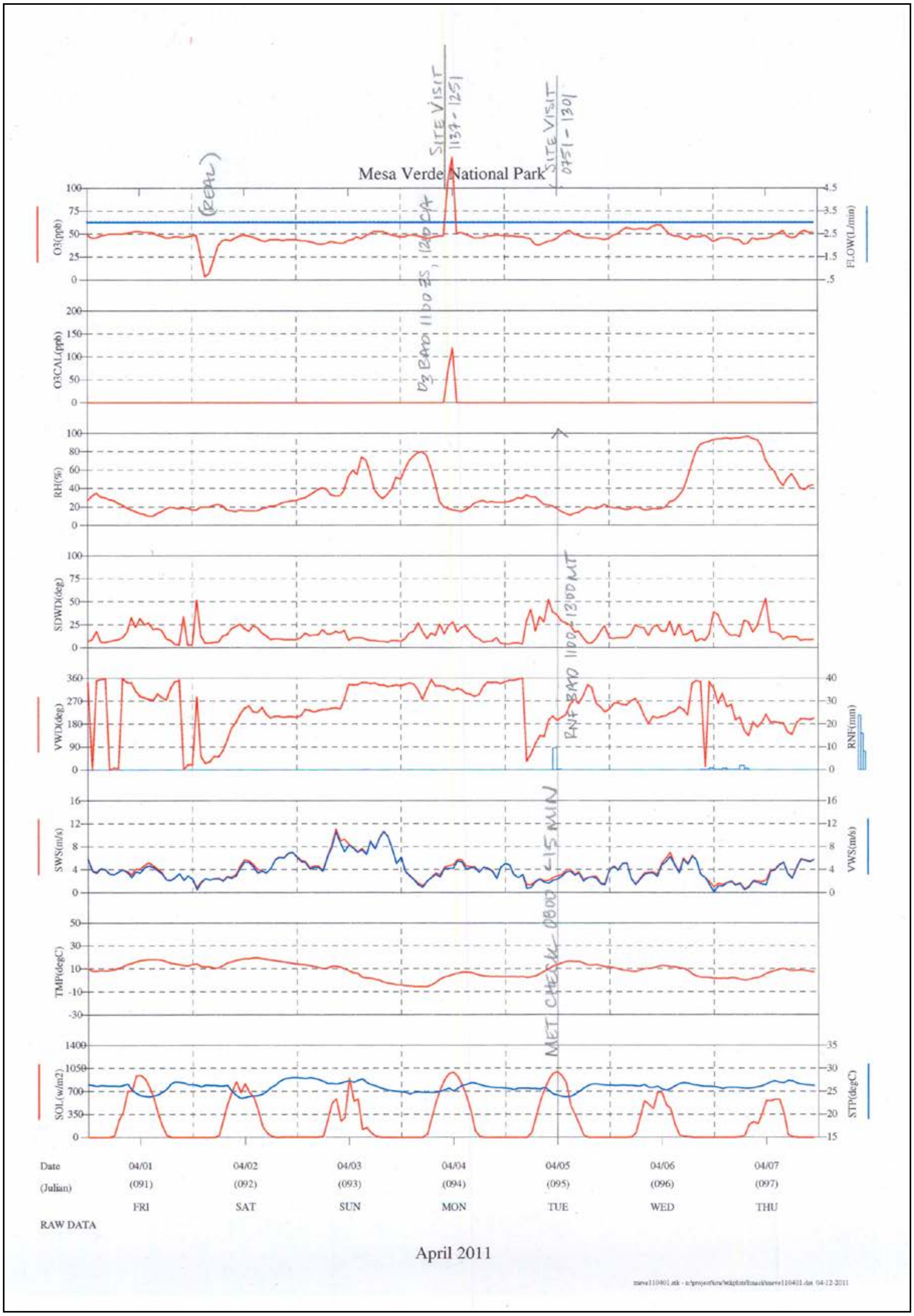

Figure 4-2. Example of a Commented Stackplot.

4.2.2 Entering Validation Codes and Other Values into the AQDBMS Database

During the Preliminary validation process, each data record is assigned a data validation code. These codes identify which records are valid and which are not. To apply these validation codes, the Auto Validation process in the database is initiated. The database then automatically assigns a validation code to each record based on datalogger flags and anomaly screening. The data analyst reviews the codes and makes changes where necessary. Screening flags, datalogger flags, and validation codes are all stored in separate fields within the database so they can always be referred to if necessary. All flags are tracked by date and source.

At times, raw data may need to be adjusted in order to get a correct, validated value. A situation may occur where a data point is valid, but the datalogger was scaled or initialized incorrectly. In cases when the data can be appropriately adjusted, a control value is entered in the control value field that operates on the raw value to provide an adjusted validated value. For example, if the data analyst determines the datalogger was programmed with incorrect units for a parameter, the data is not invalid but it is incorrect. A multiplier placed in the control value field is used to properly convert the data.

Additional tools for verifying complete and accurate entry of validation codes are available within the AQDBMS. The data analyst completes the following checks:

- Reviews the Data Collection Statistics Table for a site/month, to quickly detect if a code was missed for parameters that must be validated identically, and to look for indications of missed power failures or recorder failures.
- Reviews the High Values Tables for individual pollutant parameters, to detect calibration points inadvertently left in as valid.
- Reviews validated data stackplots to further verify that no points were missed.

All of these products can be reviewed either on screen or as printed copy (see SOP 3550, *Ambient Air Quality and Meteorological Monitoring Data Reporting*).

Preliminary data validation is complete after reviewing the validated data graphically..

4.2.3 Third-level Validation Procedures

Third-level validation procedures involve verifying that plots were annotated correctly and cross-checking of all codes applied in the AQDBMS. The AQDBMS Data Validation Log is then updated by entering the date completed and the analyst's initials into the log record for the site/month.

4.3 FINAL VALIDATION PROCEDURES

Data for a site/month must be at Preliminary validation before beginning Final validation. Final validation is accomplished by generating and reviewing raw data plots and comparing them to validated data. During this final review, suspect data are investigated and validation codes are changed where deemed necessary. Once Final validation is complete, monthly reports are generated and e-mailed to specified project personnel. The data are considered final and the

AQDBMS Data Validation Log is updated by entering the date completed and the analyst's initials into the log record for the site/month. The monthly data reports are then filed. At the Final validation level, the data can be uploaded to AQS (see TI 3550-5300, *Submitting Ambient Air Quality and Meteorological Data to the EPA AQS Database*) and can be included in data requests (see TI 3550-5200, *Handling Requests for Ambient Air Quality and Meteorological Monitoring Data*).

4.4 POST-FINAL VALIDATION PROCEDURES

If a validation error is found after the data are labeled as final, the following steps are taken:

- The necessary changes are made in the AQDBMS database.
- Changes made are logged in *N:\\project\IMC\data corrections\revalidated_yyyy.xls.*
- If the affected data have been submitted to the EPA AQS database, they must be resubmitted.
- If the affected data have been submitted to other data depositories (e.g., CASTNet or other project-specific databases or Web sites), they must be resubmitted.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA - LEVEL 0 VALIDATION**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3450-5000**
DATE	**MARCH 1999**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Betsy Davis-Noland	Betsy Davis-Noland
PROJECT MANAGER	Jessica Ward	Jessica Ward
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change all procedures for the DataView system	January 2001	G. Mercer
1.1	Added reference to manual logsheet review	July 2002	G. Mercer
	Reviewed; no changes necessary.	July 2003	G. Mercer
1.2	Replaced stripcharts with daily summaries as alternative data source/ deleted data technician	February 2004	G. Mercer
1.3	Modify collection/validation flowchart.	May 2004	G. Mercer
1.4	Modified to generic model dataloggers.	May 2005	G. Mercer
	Reviewed; no changes necessary.	January 2006	G. Mercer
	Reviewed; no changes necessary.	January 2007	G. Mercer
	-- Continued --		

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PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.5	Clarified automatic/manual anomaly screening.	January 2008	G. Mercer
	Reviewed; no changes necessary.	January 2009	G. Mercer
1.6	Clarified expected range of calibration data.	February 2010	G. Mercer
	Reviewed; no changes necessary.	April 2011	G. Mercer

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1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the steps taken by the Air Resource Specialists', Inc. (ARS) Information Management Center (IMC) for completing Level 0 validation of ambient air quality and meteorological data. These steps apply to all ambient air quality and meteorological parameters that are monitored and loaded into the Air Quality Data Base Management System (AQDBMS). This TI is referenced from SOP 3350, *Collection of Ambient Air Quality and Meteorological Monitoring Data*, and SOP 3450, *Ambient Air Quality and Meteorological Monitoring Data Validation*.

The steps taken to complete Level 0 data validation are:

- Load or enter data into the AQDBMS.
- Review raw data visually on a near daily basis for data collection errors and for details on instrument performance.
- Screen the data for anomalies.
- Collect and log site documentation.

2.0 RESPONSIBILITIES

2.1 INFORMATION MANAGEMENT SECTION MANAGER

The information management section manager shall oversee validation procedures to ensure timely and proper validation.

2.2 DATA ANALYST

The data analyst shall:

- Update information in the Site Configuration Table of the AQDBMS and stackplot configuration files as needed.
- Review stackplots of raw data.
- Verify Data Validation Log updates.
- Update the Data Validation Log in the AQDBMS with the Level 0 validation date.
- Collect digital data and load it into the database.
- Blank-fill missing data as necessary.
- Collect and log field documentation.
- File all hardcopy documentation and maintain hardcopy site files.
- Identify collection or monitoring system problems and initiate corrective actions.

2.3 FIELD SPECIALIST

The field specialist shall review stackplots and troubleshoot inconsistencies observed on the stackplots or identified by IMC staff.

2.4 TECHNICAL ASSISTANT

The technical assistant shall:

- Enter appropriate information into the Site Status Log.
- Print out trip reports and give them to the IMC.
- Print daily digital data files.

3.0 REQUIRED EQUIPMENT AND MATERIALS

All IMC equipment and materials are fully described in SOP 3340, *Information Management Center (IMC) Concept and Configuration for the National Park Service Gaseous Pollutant Monitoring Program*, and SOP 3341, *Air Resource Specialist's, Inc. (ARS) Information Management Center (IMC) Concept and Configuration*. The IMC requires the following hardware and software for Level 0 validation of ambient air quality and meteorological data:

- IMC hardware:
  - Hardware specifications for IMC servers
  - Hardware specifications for workstations
  - IMC computer support hardware:
    - High-quality laser printer
- IMC AQDBMS software:
  - Oracle Database System
  - AQDBMS custom software:
    - Data validation and reporting software
    - Network operating system and support software

4.0 METHODS

This section discusses the methods used to complete Level 0 validation of air quality and meteorological data (see Figure 4-1). This section contains the following eight (8) major subsections:

4.1 The Data Validation Log
4.2 The Site Status Log
4.3 Loading and Entering Data into the AQDBMS Database
4.4 Data Review
4.5 Anomaly Screening
4.6 Review of Raw Data Stackplots
4.7 Site Documentation
4.8 Loading Data From Other Sources

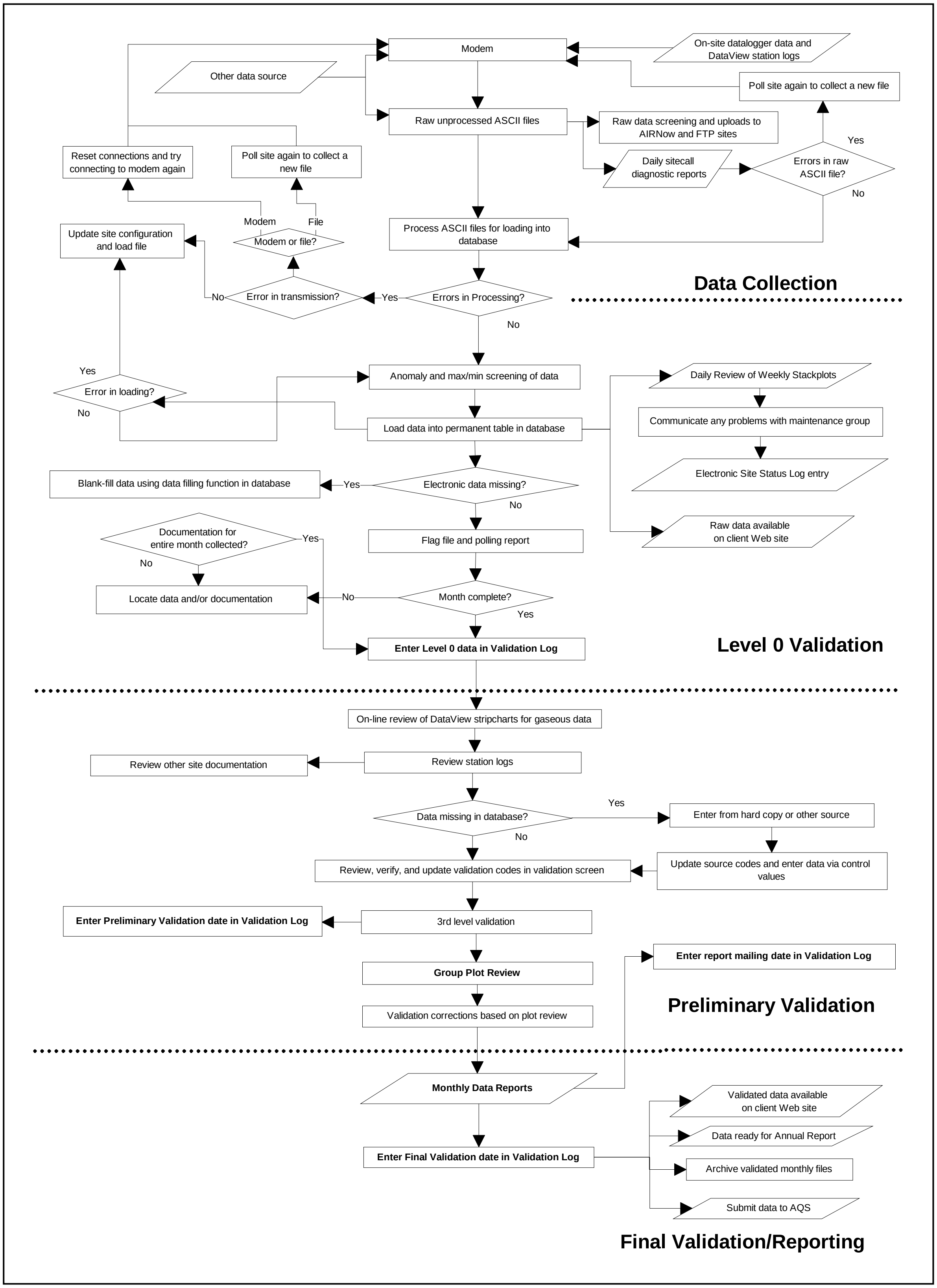


Figure 4-1. General Data Collection, Validation, and Reporting Flow Diagram. (Specific processes may vary by monitoring network).

4.1 THE DATA VALIDATION LOG

The Data Validation Log is used to track the completion of each major step of the validation process. The master record logs the initials of the data analyst completing each validation step and when it occurred. The Detail Table logs the receipt of the various supporting documents received from the field specialist and/or site operator. See Section 4.0, Using the Data Validation Log, in the *Air Quality Data Base Management System (AQDBMS) User's Guide* (ARS, 2001) for detailed instructions.

4.2 THE SITE STATUS LOG

The Site Status Log is a diary of site-related events such as instrument malfunctions and repairs, data adjustments, calibrations, special site visits, weather episodes, etc., that may be relevant to data validation. A basic description of each event is entered as a record in the Master Table. The master record contains the site number and name, a reference number assigned by the program, date started and stopped fields to define the time period involved, and an affected parameters field to indicate which data parameters may be affected by the event. Another field indicates if the event is considered to be a problem resulting in data loss or not. This field is used to quickly create a list of current problems found in the log. The Detail Table holds as many records as needed to record notes about each event. Normally, a master record will have at least one detail record. Entries can be added, modified, or deleted in both the Master Table and the Detail Table. See Section 5.0, Using the Site Status Log in the *Air Quality Data Base Management System (AQDBMS) User's Guide* (ARS, 2001) for detailed instructions.

4.3 LOADING AND ENTERING DATA INTO THE AQDBMS DATABASE

Data are collected daily via modem and stored in computer files as explained in TI 3350-4000, *Collection of Ambient Air Quality and Meteorological Monitoring Data via Modem*. Flags applied to the data by the dataloggers are also stored. The data and flags are then loaded into the AQDBMS. To correctly load data, each site currently being monitored must be properly defined in the AQDBMS Site Configuration Table.

Several methods exist for placing data into the Oracle database. Usually, hourly data are loaded in the Oracle database for all sites for one day at a time using the "ProcessOnly" command. Sometimes, data cannot be acquired electronically and must be hand-entered from daily printouts or stripcharts. As a last resort, data collected by another agency collocated at a site can be entered into the Oracle database. If data cannot be acquired by any means, the missing data are "blank-filled." All of these methods are accomplished through commands found in the AQDBMS application.

4.3.1 Polling Configuration

Figure 4-2 is an example polling configuration. The information in the polling configuration is critical for data collection and must be accurate. Errors in the polling information may cause the data to not be retrieved, be written to the database incorrectly, or not be written at all. Follow these guidelines when adding or modifying polling configurations:

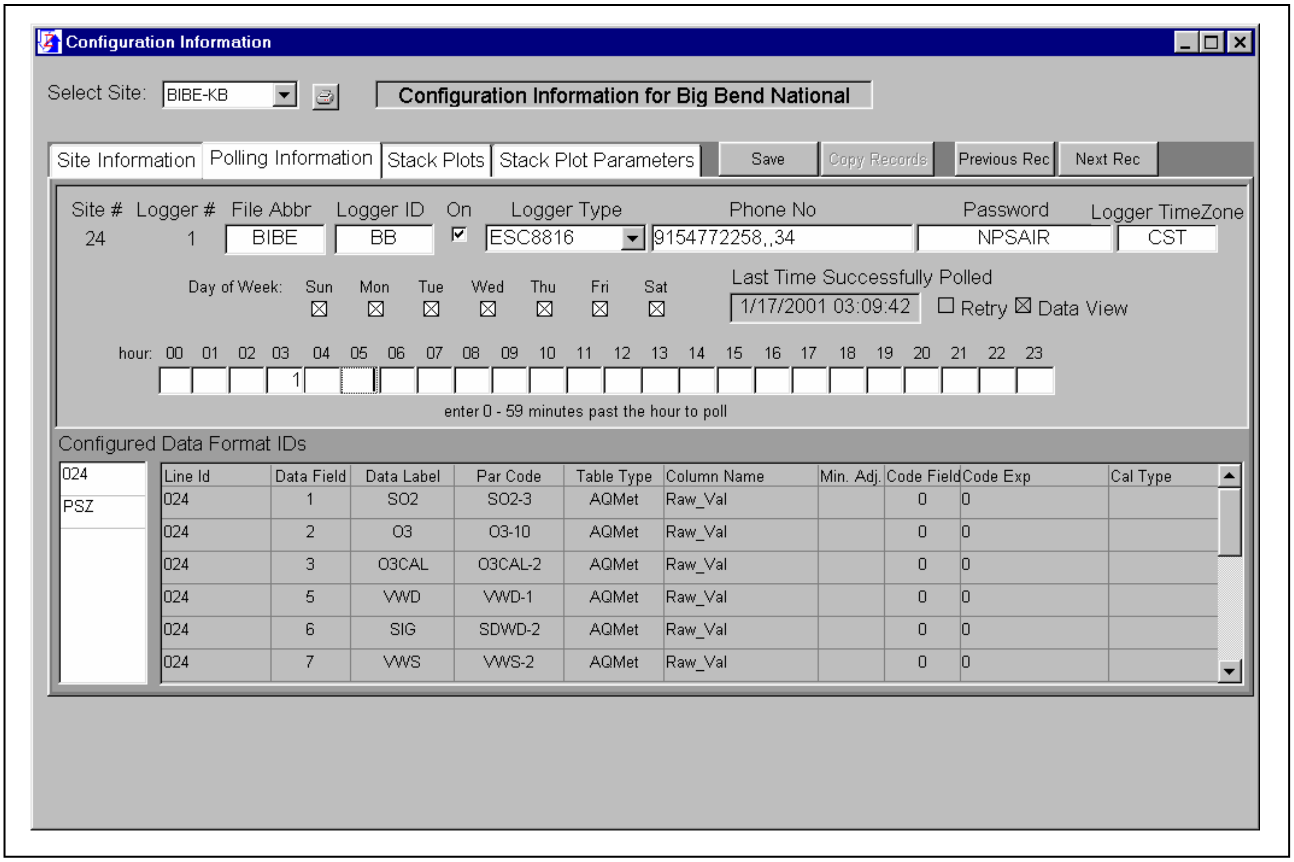


Figure 4-2. Example Polling Configuration.

- Configure new sites in the Site Specifications configuration window before attempting to add a new polling configuration record.
- Sites can have multiple polling configurations for multiple dataloggers.
- The raw data configuration and data parameter configuration must be up-to-date before adding or modifying a site. Attempting to configure the polling information with an undefined raw data format will cause an error.
- If the *On* box is checked, a complete and accurate polling configuration is expected. Fill in all boxes. Check the *DataView* box if DataView is operating at the site. Do not check Retry. Check the *days of the week* to poll (usually all days are checked). The polling minutes are used to define the polling order of the sites within each hour. Using lower polling minutes will cause a site to be polled before other sites with higher polling minutes. Entering any minute value (including zero) into any hourly field will cause the data to be polled for that hour.
- Add or delete linked raw data configurations to a site's polling configuration from the Configured Data Format IDs data window.

4.3.2 Raw Data Formats Configuration

A raw data format configuration defines what type of data are collected by each channel in the datalogger and is used to relate the incoming raw data to information stored in the database. Figure 4-3 is an example of a raw data format for hourly data. Figure 4-4 is an example of a raw data format for ESC calibration sequence.

To access the raw data formats configuration, select **Configuration -> Raw Data Formats** from the Configuration frame. Then select an *abbreviation* from the Select Site drop-down list box or add a new record.

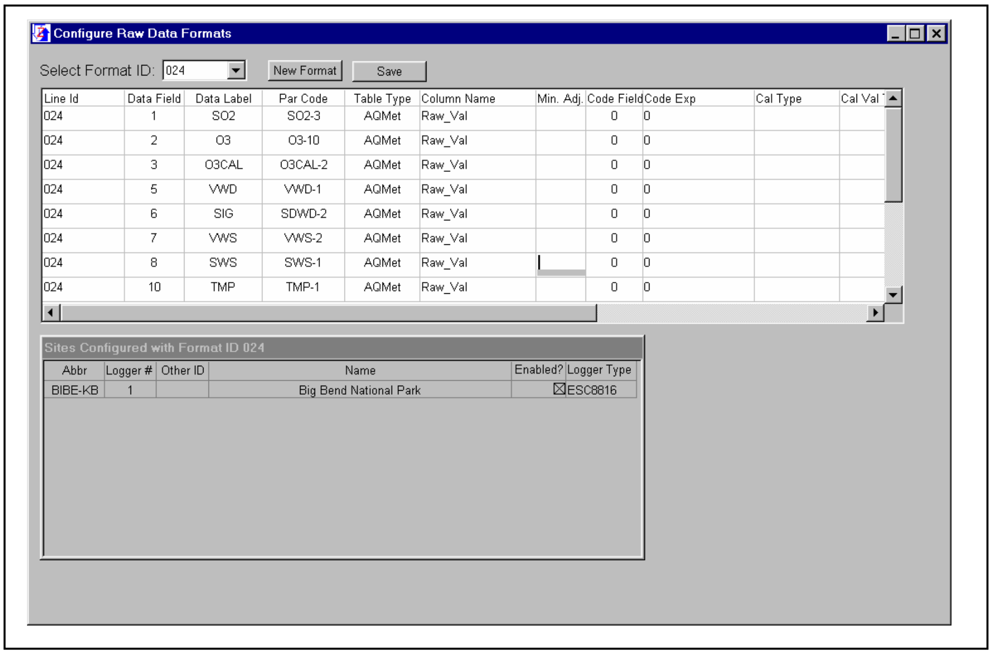


Figure 4-3. Example Raw Data Format for Hourly Data.

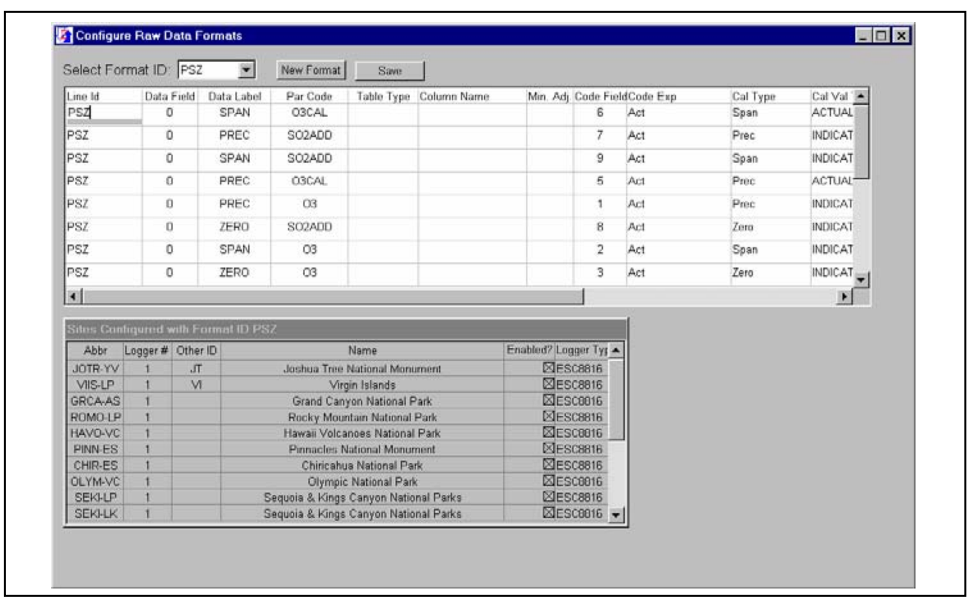


Figure 4-4. Example Raw Data Format for ESC Calibration Sequence.

When configuring raw data formats, follow these guidelines:

- For hourly data collected on dataloggers, the Data Field and Data Label columns must reflect what the datalogger is providing in the raw data. (The Data Field column maps to the channel number).

- The collected data type must already exist in the data parameter configuration. If it does not exist, it will not be available in the Par Code drop-down list box and cannot be used. In this case, a new data parameter is being defined and must be added to the Data Parameters configuration before continuing.

- For calibration data collected on dataloggers:

  - The Data Field column should contain 0.

  - The Data Label column must contain an appropriate label for the calibration data type (SPAN, PREC, or ZERO).

  - The Par Code column must contain the appropriate primary parameter name code rather than a specific parameter code (i.e., "O3" not "O3-10"). The data loading program assigns the correct par code by querying the hourly data.

  - The Code Field, Code Exp, Cal Type, and Cal Val Type columns tell the data loading program where in the reformatted cal file to look for the data.

  - Calibration configurations are not straightforward. Seek the help of the database administrator if a new configuration is required.

- To add a new format ID, click the **New Format** button to show a blank configuration interface.

4.3.3 Using Process Only

The "Process Only" command loads hourly data for a given day for currently monitored sites from ASCII files (such as BIBE0601A.2000R for Big Bend National Park June 2000) into the database. Zero, span, and precision check data are also extracted from ASCII files. The ASCII files must reside in the *\\ARSNW1\vol4\project\IMC\ESC_sitecall* directory. The program also writes to a message file in this directory that can be viewed in any text editor.

To run Process Only:

- Copy the ASCII files to the *\\ARSNW1\vol4\project\IMC\ESC_sitecall* directory.

- From the Polling menu, click **Process Only**.

- Type in the *date* in m/d/yy format (that is 6/1/97 or 06/01/97 for June 1, 1997) and then press **<Enter>** or click **OK**.

- Review the message file when the program finishes.

4.3.4 Correcting Data Loading Errors

The AQDBMS program writes messages to a folder indicating reasons for loading successes or failures of the processes. This folder is located in the *\\ARSNW1\vol4\project\IMC\ESC_sitecall\logs* directory and can be viewed in any text editor. The folder contains error (.err) and message logs (.logs) files. Examples of possible messages and actions are:

Message: Data for BIBE 06/01/97 loaded into database.
Action: None.

Message: Full scale in datalogger column 8 does not match full scale column 8 in site configuration.
Action: Modify the site's site configuration record to match the full scale value of column 8 to the column 8 full scale header in the ASCII file. (Refer to Section 4.3.1, Polling Configuration).

4.3.5 Blank-Filling Data

To blank-fill data:

- Select the *site* to validate.
- Enter the *Start Date/Time* of the data set to work on.
- Enter the *End Date/Time* of the data set to work on.
- Click the **Get ParCodes** button. The program queries the database and returns all the parameter codes found for the selected site and period in the list box.
- Check the **blank fill** box.
- Check the **All** box and click **Get ParCodes** to retrieve a list of all parameter codes. Select the parameter codes to be blank-filled for the selected site and time period.

-or-

Check the pattern date and enter a *date* that contains the parameter codes that need to be blank-filled for the selected period.

-or-

Enter an end date just beyond the period of time to be blank-filled that contains all parameter codes that need to be blank-filled. Click the **Get Par Cod**es button and highlight all parameters listed.

- Select a *code* from the Validation Code drop-down list box.
- Click the **Apply Code** button. Data will be blank-filled with a value of "-999" in the raw value and validated value fields, the selected code in the validation code field, and a "B" in the source code field. NOTE: The program will not overwrite existing data. When the process is complete, the number of blank-filled rows will be indicated in the process box.

To display the data grid:

- Select the *site* to validate.
- Enter the *Start Date/Time* of the data set to work on.
- Enter the *End Date/Time* of the data set to work on.
- Click the **Get ParCodes** button. The program queries the database and returns all the parameter codes found for the selected site and period in the list box.
- Select the *parameter code* to display. NOTE: If more than one parameter code is selected, only data for the first code will be displayed.
- Click the **24x31** button. The data will be displayed in a grid of 24 hours across by days down (optimally one month). For each data point, if any code other than a “V”, “VA”, or “VZ” exists in the validation code field, the code will be displayed in red. Otherwise, the value found in the validated value field is displayed.
- Click the **X** button to close the window and return to the validation window.

4.4 DATA REVIEW

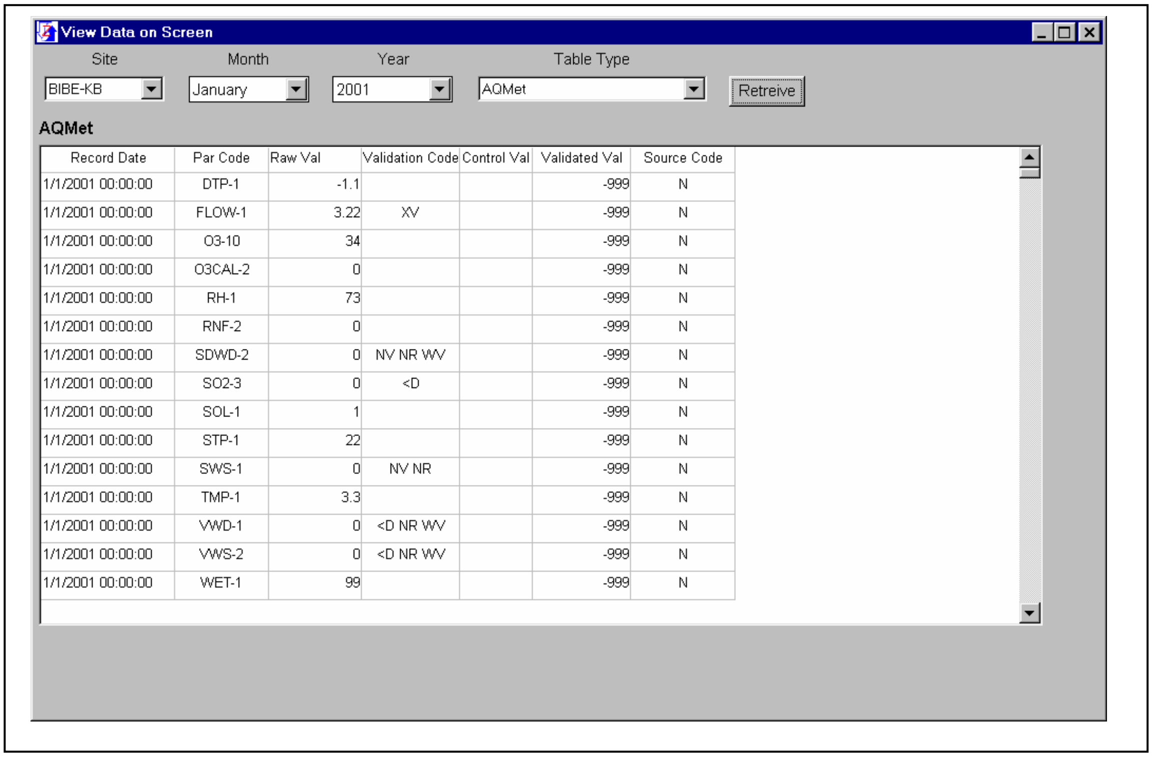
Data are typically collected via modem and stored in ASCII files (see TI 3350-4000, *Collection of Ambient Air Quality and Meteorological Monitoring Data via Modem*). Data flags generated by the dataloggers are also stored. Table 4-1 is a list of datalogger flags. The data and flags are then loaded into the AQDBMS database and visually reviewed by the data analyst. Data for one site, one day, and all parameters, are displayed on the computer screen. The data in this window can also be sorted and filtered but cannot be edited in any way. Figure 4-5 is an example View Tables Monthly Data window. Datalogger data flags are automatically placed in the datalogger flag field. As the data proceed through the data validation process, however, all original datalogger flags are replaced by permanent validation codes.

Table 4-1

ESC 8816 Datalogger Data Flags[1]

Flag	Description
P	Power failure
D	Channel Disabled/Off-line
B	Bad status
C	Calibration
M	Maintenance
+	Maximum exceeded
-	Minimum exceeded
>	Some missing data, but meets requirement for valid average
<	Does not meet requirement for valid average
H	High-high alarm threshold exceeded

[1] These flags are replaced by permanent validation codes later in the validation process.



Record Date	Par Code	Raw Val	Validation Code	Control Val	Validated Val	Source Code
1/1/2001 00:00:00	DTP-1	-1.1			-999	N
1/1/2001 00:00:00	FLOW-1	3.22	XV		-999	N
1/1/2001 00:00:00	O3-10	34			-999	N
1/1/2001 00:00:00	O3CAL-2	0			-999	N
1/1/2001 00:00:00	RH-1	73			-999	N
1/1/2001 00:00:00	RNF-2	0			-999	N
1/1/2001 00:00:00	SDWD-2	0	NV NR WV		-999	N
1/1/2001 00:00:00	SO2-3	0	<D		-999	N
1/1/2001 00:00:00	SOL-1	1			-999	N
1/1/2001 00:00:00	STP-1	22			-999	N
1/1/2001 00:00:00	SWS-1	0	NV NR		-999	N
1/1/2001 00:00:00	TMP-1	3.3			-999	N
1/1/2001 00:00:00	VWD-1	0	<D NR WV		-999	N
1/1/2001 00:00:00	VWS-2	0	<D NR WV		-999	N
1/1/2001 00:00:00	WET-1	99			-999	N

Figure 4-5. Example View Tables Monthly Data Window.

To view the Monthly Data window onscreen:

- Select **View Data Tables** from the Data Collection and Configuration frame.
- Select a *site* from the Site drop-down box.
- Select a *month* and *year* to view from the Month and Year drop-down boxes.
- Select the *table type* (AQMet or AQCal) from the Table Type drop-down box.
- Click the **Retrieve** button.

To sort or filter data in the Monthly Data window:

- Select **View Data Tables** from the Data Collection and Configuration frame.
- Select a *site* from the Site drop-down box.
- Select a *month* and *year* to view from the Month and Year drop-down boxes.
- Select the *table type* (AQMet or AQCal) from the Table Type drop-down box.
- Click the **Retrieve** button.

- Right-click anywhere within the data window.

- Select **Filter** or **Sort** from the pop-up menu. A dialog box is displayed. Follow the dialog box instructions to apply filter or sorting options. Click the **Help** button to access specific help on the dialog boxes.

4.5 ANOMALY SCREENING

After data for a site/day are verified, they are automatically screened for anomalies by an AQDBMS program. This program applies anomaly flags (Level 0 validation codes). These flags are added to any datalogger flags that were loaded with the raw data from the datalogger. The screening program uses values stored in the AQDBMS Screening Ranges Table. Figure 4-6 shows example records from this table. It contains the screening ranges for each current site and parameter code, which allows each screening element to be defined independently from the other. Each record contains the following information fields:

- Minimum expected value

- Maximum expected value

- Minimum rate of change

- Minimum rate of change hours

- Maximum rate of change

- Maximum rate of change hours

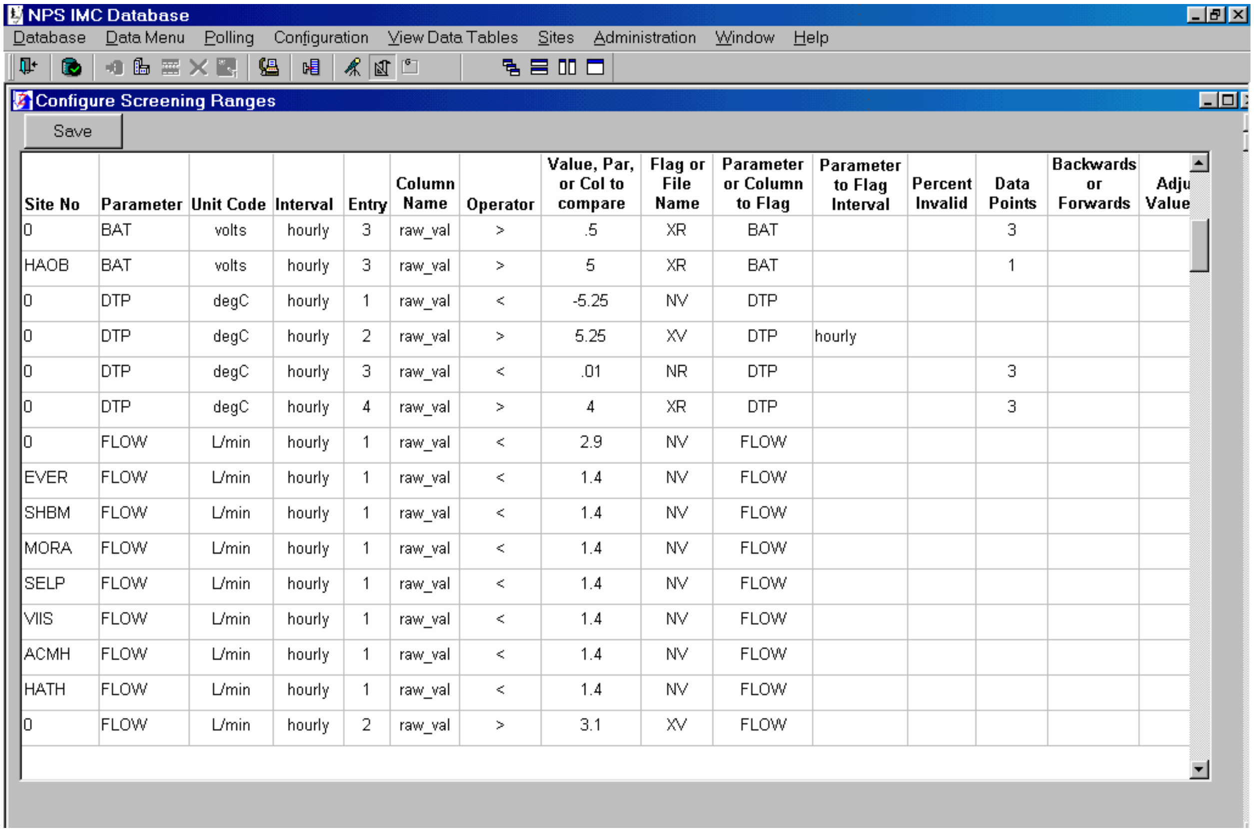
- Zero adjust value (does not apply to all parameters)

- Maximum adjust value (does not apply to all parameters)

To manually screen the data for anomalies, click the **Screen** button. The program looks up acceptable ranges of values in the Screening Ranges Table and flags anomalies. The program also compares the values of certain parameters and applies flags as needed. Table 4-2 is a list of anomaly flags. The program stops and a message is displayed if screening ranges have not been defined for a site/parameter combination. In this case, request that the data analyst make appropriate changes to the Screening Ranges Table, as described in SOP 3650, *Maintenance Responsibilities for the Ambient Air Quality Data Base Management System (AQDBMS)*. After the data analyst makes the changes, run the screening program again.

After screening, the data analyst notifies the field specialist if any of the following are true:

- Data for any parameter are at a full scale or zero scale values for an uncommonly long time. This indicates an instrument may have been left in zero or span mode inadvertently.



Site No	Parameter	Unit Code	Interval	Entry	Column Name	Operator	Value, Par, or Col to compare	Flag or File Name	Parameter or Column to Flag	Parameter to Flag Interval	Percent Invalid	Data Points	Backwards or Forwards	Adju Value
0	BAT	volts	hourly	3	raw_val	>	.5	XR	BAT			3		
HAOB	BAT	volts	hourly	3	raw_val	>	5	XR	BAT			1		
0	DTP	degC	hourly	1	raw_val	<	-5.25	NV	DTP					
0	DTP	degC	hourly	2	raw_val	>	5.25	XV	DTP	hourly				
0	DTP	degC	hourly	3	raw_val	<	.01	NR	DTP			3		
0	DTP	degC	hourly	4	raw_val	>	4	XR	DTP			3		
0	FLOW	L/min	hourly	1	raw_val	<	2.9	NV	FLOW					
EVER	FLOW	L/min	hourly	1	raw_val	<	1.4	NV	FLOW					
SHBM	FLOW	L/min	hourly	1	raw_val	<	1.4	NV	FLOW					
MORA	FLOW	L/min	hourly	1	raw_val	<	1.4	NV	FLOW					
SELP	FLOW	L/min	hourly	1	raw_val	<	1.4	NV	FLOW					
VIIS	FLOW	L/min	hourly	1	raw_val	<	1.4	NV	FLOW					
ACMH	FLOW	L/min	hourly	1	raw_val	<	1.4	NV	FLOW					
HATH	FLOW	L/min	hourly	1	raw_val	<	1.4	NV	FLOW					
0	FLOW	L/min	hourly	2	raw_val	>	3.1	XV	FLOW					

Figure 4-6. Example Records in the Screening Ranges Table.

Table 4-2

Anomaly Screening Flags

Flag	Description
XV	> the maximum value in the Screening Ranges Table.
DT	Dewpoint value is > 2.5°C above the temperature.
NR	Rate-of-change < minimum value in the Screening Ranges Table.
NV	< minimum value in the Screening Ranges Table.
WS	Scalar wind speed > Vector wind speed - generated by the screening program
IM	Set in VWS, VWD, and SDWD when SWS < minimum expected (NV)
XR	Rate-of-change > the maximum value in the Screening Ranges Table.
TH	Data invalid for ozone when station temp is > 30.5°C.
TL	Data invalid for ozone when station temperature < 19.5°C.
VM	Valid but the validated value has been adjusted for the max value by the screening program based on the max_adj, max_adj_to, and max_val fields of the Screening Ranges Table.
VZ	Valid but the validated value has been adjusted for zero by the screening program based on the zero adjustment value in the Screening Ranges Table.

- Daily calibration data (zero and span values from the analyzer) are not within the expected range. Zero values should be within ± 1% of full scale of the instrument and span values within ± 10% of the calibrator's corresponding values. In this case, the field specialist must be notified as soon as possible so the analyzer can be calibrated in the field.

- Other unusual and noteworthy data flags that would call attention to either a needed repair of an instrument or correction of a condition by the site operator.

Once the data have been verified, screened, and all problems reported, the data are moved to the permanent database. Corrective action is initiated to resolve any noted inconsistencies and the problem and actions are entered in the AQDBMS Site Status Log.

4.6 REVIEW OF RAW DATA STACKPLOTS

A stackplot may include single or multiple user-selected parameters on line or bar graphs plotted against time on the X-axis. Up to 18 parameters may be plotted on up to 9 separate graphs (1 or 2 parameters per graph) in a stack. Temporal data variations are then easy to compare. Stackplots are used throughout the validation process. Raw data are graphed on stackplots on a weekly basis for each site for the following time periods each month:

- Days 1 – 7

- Days 8 – 15

- Days 16 – 23

- Days 24 – end of month

One copy of each plot is generated and is promptly forwarded to all data analysts and field specialists for examination. Problems not detected up to this point in the validation process are entered into the Site Status Log and a field specialist is notified for resolution of the problem. Comments regarding the data are handwritten on the plots. This copy is then filed in a temporary file box in order to receive further comments later in the validation process. For instructions on running the stackplot graphics program, see *the Air Quality Data Base Management System (AQDBMS) User's Guide* (ARS, 2001).

4.7 SITE DOCUMENTATION

Site operators are required to complete station checklists in DataView during every station visit. The station checklists are downloaded and stored in the AQDBMS. At times, manual checklists must be completed by the site operators and faxed to the IMC. When this is necessary, the manually collected information is filed with other site documentation in the IMC.

The documentation received is logged in the AQDBMS Data Validation Log. A log record is created for each site/month and documentation items added to the detail log noting the date received any comments. Level 0 validation is complete for a site/month on the date all possible data for the month has been collected and loaded into the AQDBMS database and all site documentation has been received. This date is entered in the AQDBMS Data Validation Log.

4.8 LOADING DATA FROM OTHER SOURCES

As discussed in SOP 3350, *Collection of Ambient Air Quality and Meteorological Monitoring Data*, if data cannot be collected electronically, they are hand-entered from daily summaries received from the site. Typically, if a valid daily summary is available and the time on it is correct and distinguishable, the data are reduced onto a missing data form and then manually entered into the database as raw data. To manually enter data from a daily summary:

- Open the Data Validation data window.
- Click on the **Source Code** field of the raw needing a hand-entered raw value.
- Enter the *source code* that will allow a hand-entered value (**D**).
- Click on the **Raw Val** field and enter the new *value*. Note: Only raw values of –999 should be replaced in this manner. Use the value adjust method for other raw values.

If data are unavailable from all other sources, data collected by another agency collocated at a site can be entered into the Oracle database. This “third-party” data should only be used if similar instruments at similar heights were used to collect it. In this case, the data analyst verifies the suitability of the data, acquires digital data from the third-party, then notifies the database administrator who writes a custom data loading program and loads the data. As the data are loaded, an appropriate source code is assigned to define its source. Since each case is unique, there are no additional standard steps for loading the data.

5.0 REFERENCES

Air Resource Specialists, Inc. (ARS), 2001, Air Quality Data Base Management System (AQDBMS) User’s Guide.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES

TITLE	**AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA - PRELIMINARY VALIDATION**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3450-5010**
DATE	**MARCH 1999**

AUTHORIZATIONS

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REVISION HISTORY

0.0	Initial version.	March 1999	G. Mercer
1.0	Change all procedures for the DataView system	January 2001	G. Mercer
	Reviewed; no changes necessary.	January 2002	G. Mercer
	Reviewed; no changes necessary.	January 2003	G. Mercer
1.1	New checklist, delete data technician, add new data validation data window.	February 2004	G. Mercer
1.2	Modify validation flowchart, add group plot review	May 2004	G. Mercer
1.3	Made generic for sponsoring organization.	May 2005	G. Mercer
1.4	Added parameter validation criteria table.	October 2005	G. Mercer
1.5	Change validation checklist/misc. changes.	February 2006	G. Mercer
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1.6	Clarified entering validation codes [section 1.0]	January 2008	G. Mercer
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1.7	Add zero values acceptance criteria to valid data.	February 2010	G. Mercer
2.0	Update figures, tables, and validation procedures.	March 2012	G. Mercer

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1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the steps taken by Air Resource Specialists', Inc. (ARS) Information Management Center (IMC) to complete Preliminary validation of ambient air quality and meteorological data. These steps apply to all ambient air quality and meteorological parameters that are monitored and loaded into the Air Quality Data Base Management System (AQDBMS). This TI is referenced from SOP 3350, *Collection of Ambient Air Quality and Meteorological Monitoring Data*, and SOP 3450, *Ambient Air Quality and Meteorological Monitoring Data Validation*.

This TI presents the detailed steps used to ensure high quality Preliminary data validation of ambient air quality and meteorological data. Data for a site/month must be at Level 0 validation before beginning Preliminary validation. The Monthly Validation Checklist is used as a guide for the Preliminary validation procedure. The checklist identifies the major steps taken during Preliminary validation and provides a record of the date each step was completed and the initials of the analyst completing it. Preliminary data validation is accomplished by the following:

- Determining if each data value meets validation acceptance criteria by:
    - Reviewing site documentation including daily summaries, field station logs, trend-graphs, and edit logs.
    - Reviewing datalogger and anomaly screening flags.
    - Reviewing the AQDBMS Site Status Log.
    - Recording and reviewing comments on the raw data stackplots.
    - Reviewing precision check and calibration data.
    - Reviewing any recent maintenance trip reports to verify that all instrumentation is operating within specifications.
    - Entering and reviewing any audit report data received for the site/month into the AQDBMS database.
    - Reviewing SSRF forms to check for flow leaks.
- Using the Auto Validation tool in the AQDBMS to automatically apply validation codes.
- Reviewing validation codes and, if necessary, adjusting values in the AQDBMS database.
- Reviewing plots of the validated data compared to the raw data.
- A group plot review that includes input from the sponsoring organization, air quality specialists, and field specialists to resolve all questionable validation issues.
- Making necessary validation code changes in the AQDBMS based on the group plot review discussion.
- Updating the AQDBMS Data Validation Log.
- Reviewing validated data stackplots and other output.

2.0 RESPONSIBILITIES

2.1 INFORMATION MANAGEMENT SECTION MANAGER

The information management section manager shall oversee validation procedures to ensure timely and proper validation.

2.2 SPONSORING ORGANIZATION

Staff from the sponsoring organization, at their discretion, shall participate in the monthly plot review and respond to questions posed during the plot review.

2.3 DATA ANALYST

The data analyst shall:

- Update the Data Validation Log in the AQDBMS with the Preliminary validation date.
- Review validation codes applied by the Auto Validation tool.
- Review and annotate stackplots using field documentation and Auto Validation codes.
- Review plots of the validated data to check for errors.
- Review annotated stackplots with the field specialist.
- Participate in the monthly plot review and respond to questions posed during the plot review.

2.4 FIELD SPECIALIST

The field specialist shall review data issues with the IMC staff before the plot review.

3.0 REQUIRED EQUIPMENT AND MATERIALS

All IMC equipment and materials are fully described in SOP 3340, *Information Management Center (IMC) Concept and Configuration for the National Park Service Gaseous Pollutant Monitoring Program*, and SOP 3341, *Air Resource Specialist's, Inc. (ARS) Information Management Center (IMC) Concept and Configuration*. The IMC requires the following hardware and software for Preliminary validation of ambient air quality and meteorological data:

- IMC hardware:
  - Hardware specifications for IMC servers
  - Hardware specifications for workstations
  - IMC computer support hardware:
    - High-quality laser printer
- IMC AQDBMS software:
  - Oracle Database System
  - AQDBMS custom software:
    - Data validation and reporting software
    - Network operating system and support software

4.0 METHODS

Data for a site/month must be at Level 0 validation before beginning Preliminary validation (see Figure 4-1). The Monthly Validation Checklist, shown in Figure 4-2, is used as a guide for the Preliminary validation procedure. The checklist identifies the major steps taken during Preliminary validation and provides a record of the date each step was completed and the initials of the analyst completing it. This section discusses the methods used to complete Preliminary data validation of air quality and meteorological data. This section contains the following six major subsections:

- 4.1 The Data Validation Log
- 4.2 The Site Status Log
- 4.3 Validation Acceptance Criteria
- 4.4 Applying Validation Codes and Other Values into the AQDBMS Database
- 4.5 Group Plot Review
- 4.6 Reviewing Validated Data Stackplots and Other Output

4.1 THE DATA VALIDATION LOG

The Data Validation Log is used to track the completion of each major step of the validation process. The master record logs the initials of the data analyst completing each validation step and when it occurred. The log entry for a particular site/month must exist before data can be edited in the Data Validation window. The validation log also provides a summary of the decision-making process that went into validating the data. The data analyst provides justification for the validation codes that were applied to the data. See Section 4.0, Using the Data Validation Log, in the *Air Quality Data Base Management System (AQDBMS) User's Guide* (ARS, 2012) for detailed instructions.

4.2 THE SITE STATUS LOG

The Site Status Log is a diary of site-related events such as instrument malfunctions and repairs, data adjustments, calibrations, special site visits, weather episodes, etc., that may be relevant to data validation. A basic description of each event is entered as a record in the Master Table. The master record contains the site number and name, a reference number assigned by the program, date started and stopped fields to define the period of time involved, and an affected parameters field to indicate which data parameters may be affected by the event. Another field indicates if the event is considered to be a problem or not. This field is used to quickly create a list of current problems found in the log. The Detail Table holds as many records as needed to record notes about each event. Normally, a master record will have at least one detail record. Entries can be added, modified, or deleted in both the Master Table and the Detail Table. See Section 5.0, Using the Site Status Log, in the *Air Quality Data Base Management System (AQDBMS) User's Guide* (ARS, 2012) for detailed instructions.

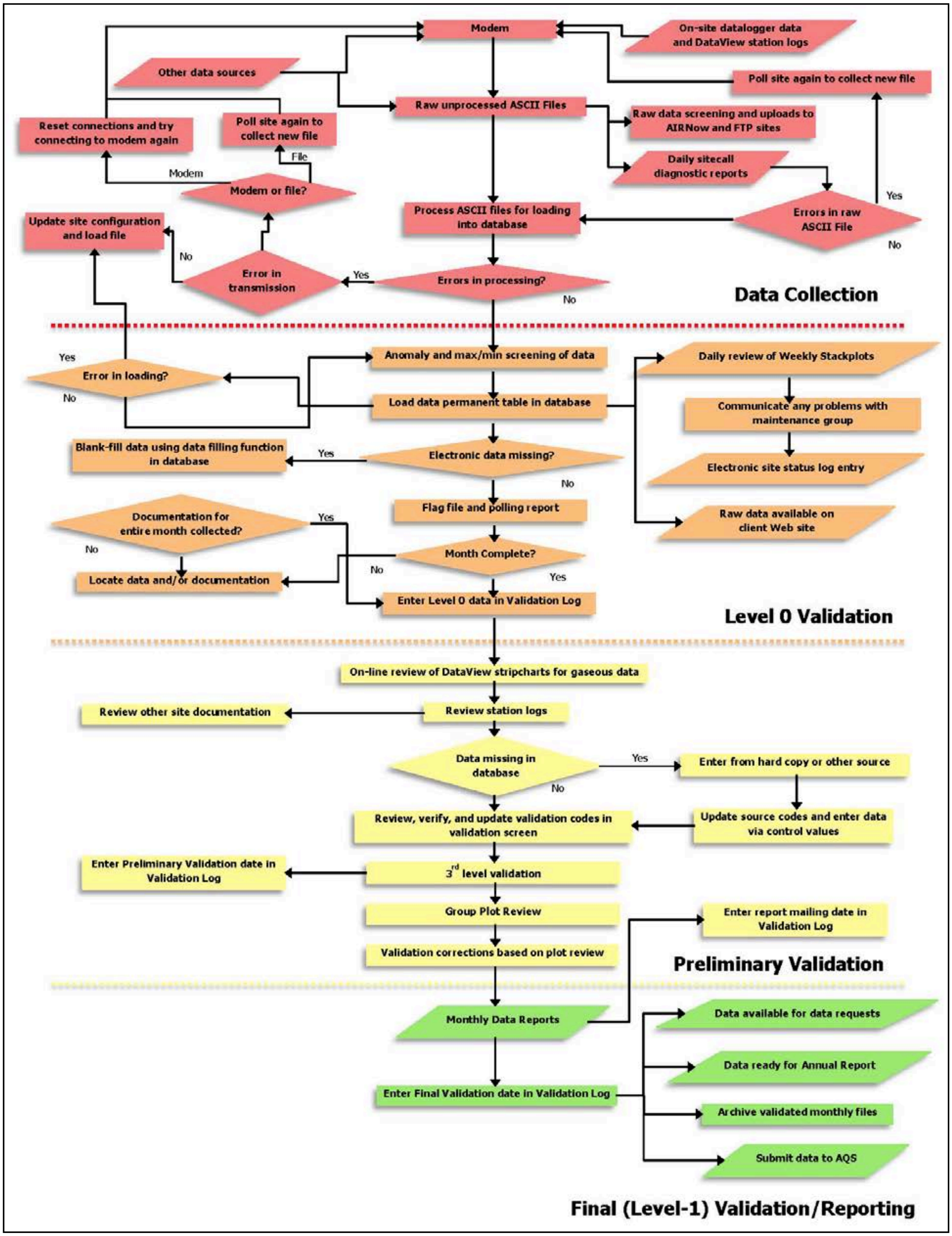


Figure 4-1. General Data Collection, Validation, and Reporting Flow Diagram.
(Specific processes may vary by monitoring network).

MONTHLY VALIDATION CHECKLIST

Site____________

Month/Year____________

PRELIMINARY (AND LEVEL 0 VERIFICATION)		Date	Initials
1.	Review **previous months'** commented **Stackplots**	____	____
2.	Verify that all **Daily Summaries** are printed.	____	____
3.	Print and review **Station Logs**.	____	____
	Monthly MPC ☐ Monthly RNF ☐ Monthly PM flow check ☐ Weekly station checks ☐ ☐ ☐ ☐ ☐		
4.	Print and review most recent **Site Status Log** and **Calibration Plots.**	____	____
5.	Review **SSRF Forms, Trip Reports** & check **RH Cal Results.**	____	____
6.	Click '**auto validate**' button in database.	____	____
7.	Run **"datalogger flags listing" report** from database, verify all flags were coded.	____	____
8.	Check **O_3 Trace** via PC Anywhere in DataView.	____	____
9.	Apply **additional validation codes** if necessary.	____	____
10.	Record **annotations** on weekly stackplots.	____	____
11.	Run and print "**Stackplots for Validation Review"** – review and change codes as needed.	____	____
12.	Update **Data Validation Log.**	____	____
13.	Monthly **Plot Review.**	____	____
3rd LEVEL			
11.	Review **Site Status Log, Field Station Logs, Calibration Plots,** and **Daily Summaries** (as needed) to verify annotations on plots.	____	____
12.	Review **Validated Stackplots**, investigate suspect data if necessary.	____	____
13.	Verify preliminary **Validation Codes** in database.	____	____
14.	Update **Data Validation Log.**	____	____

N:\Project\imc\Forms\MoValChkList_newmethod.doc

Figure 4-2. The Monthly Validation Checklist.

4.3 VALIDATION ACCEPTANCE CRITERIA

Validation acceptance criteria and the methods for determining if a data value meets the criteria are usually related to one of the following events or limitations (specific criteria for each parameter is presented in Table 4-1) :

- Data are out of instrument specifications.
- Data exceed minimum or maximum expected value.
- Data exceed minimum or maximum expected rate-of-change.
- Station temperature is out of specified limits.
- Data are affected by calibration check.
- Zero and span check data are within specified limits.
- Less than 45 minutes of data are available (hourly averaging period).
- Instrument or datalogger was affected by acts of nature.
- Instrument or datalogger was affected by power failure.
- Data capture was affected by a datalogger failure.
- Data were affected by operator maintenance or calibration check.
- Data were affected by site operator error.
- Data were affected by instrument malfunction or failure.
- Data were below lower detectable limit.

For all gas parameters the monthly calibration plot is reviewed. This plot displays the results of the daily automated zero, precision, and span. Zero values should be within ± 2% of full scale (ozone and carbon monoxide) or ± 3% (oxides of nitrogen and sulfur dioxide) of the instrument and span values within ± 7% (ozone) or ± 10% (all other gases) of the calibrator's corresponding values. Data can be zero-adjusted when zeros are outside ± 2% of full scale, but are invalidated when beyond ± 3% of full scale.

To determine if a data value meets validation acceptance criteria, the data analyst reviews the site documentation and weekly stackplots for the site/month being validated, then writes any comments on the plots that affect validation. Comments on plots are based on information from the site documentation, communication with field personnel and site operators, datalogger flags, and anomaly screening flags and reflect the codes in the AQDBMS as applied using the Auto Validation tool. A commented plot is shown in Figure 4-3. The following guidelines are used when commenting plots:

Table 4-1

Validation Acceptance Criteria for the Gaseous and Meteorological Parameters

Parameter	Calibration Method	Criteria	Validation Criteria (Data Reasonableness)
Temperature (Climatronics or RM Young)	Three water baths and certified thermometer (0ºC, 20 to 30ºC, 30 to 50ºC)	Max error	≤ ±0.5°C from actual
Temperature (Rotronics)	Temperature transfer standard	Max error	≤ ±1.5°C
Temperature and Temperature Difference (Climatronics or RM Young)	Three water baths (0ºC, 20 to 30ºC, 30 to 50ºC)	Max error	≤ ±0.5°C
Shelter Temperature	Temperature transfer standard	Max error	±1.5°C
Relative Humidity	RH sensor transfer standard	Max error	≤ ±10.0%
Wind Speed	Selectable speed rpm motor	Max error	≤ ±0.5 m/s for values <5.0 m/s ≤ ±5.0% for values >5.0 m/s
Wind Speed Starting Threshold	Weighted torque disk	Max error	≤ 0.4 g-cm (Climatronics) ≤ 0.5 g-cm (RM Young)
Wind Direction Alignment	Solar Azimuth, Precision compass, USGS map	Max error	≤ ±5° from true degrees
Wind Direction Linearity	45º increment inputs	Max error	≤ ±5°
Wind Direction Starting Threshold	Weighted torque disk	Max error	≤ 8 g-cm (Climatronics) ≤ 11 (RM Young)
Precipitation (Tipping Bucket)	Addition of known water volume	Max error	≤ ±10.0%
Precipitation (Weighting Gauge)	Addition of certified weights, or known water volume	Max error	≤ ±10% or ≤ ±0.10 inches
Wetness Sensor	Mist with distilled water; and apply test resistance (230-240 Ohms)	Response	Confirmed sensor response as necessary to correct readings to full scale of 100 (equivalent to 1.0VDC)
Solar Radiation	Collocated transfer standard	Average error	≤ ±10%
Barometric Pressure	Collocated transfer standard	Max error	≤ ±3.0 mmHg or ±4.0 mb
Gas Max difference	Gas primary or transfer standard (0 and 5 upscale points)	Max error	≤ ±10.0% of actual
Gas Average difference	Gas primary or transfer standard (0 and 5 upscale points)	Average error	≤ ±10.0%
Gas Slope (m)	Gas primary or transfer standard (0 and 5 upscale points)	Actual	0.900 ≤ slope ≤ 1.100
Gas Intercept (b)	Gas primary or transfer standard (0 and 5 upscale points)	Actual	≤ ±5.0 ppb from actual for O_3 and SO_2 ≤ ±5.0 ppm for CO
Gas Correlation (r)	Gas primary or transfer standard (0 and 5 upscale points)	Actual	>0.9900
Data Acquisition System Time	Compare with NIST time	Max error	≤ ±2 minutes
Data Acquisition System Voltage	Known voltage inputs	Max error	≤ ±0.003 VDC
Meteorological Translator Cards	Compare with calibrated voltmeter	Max error	≤ ±0.005 VDC of designated zero value; and ≤ ±0.1% of span

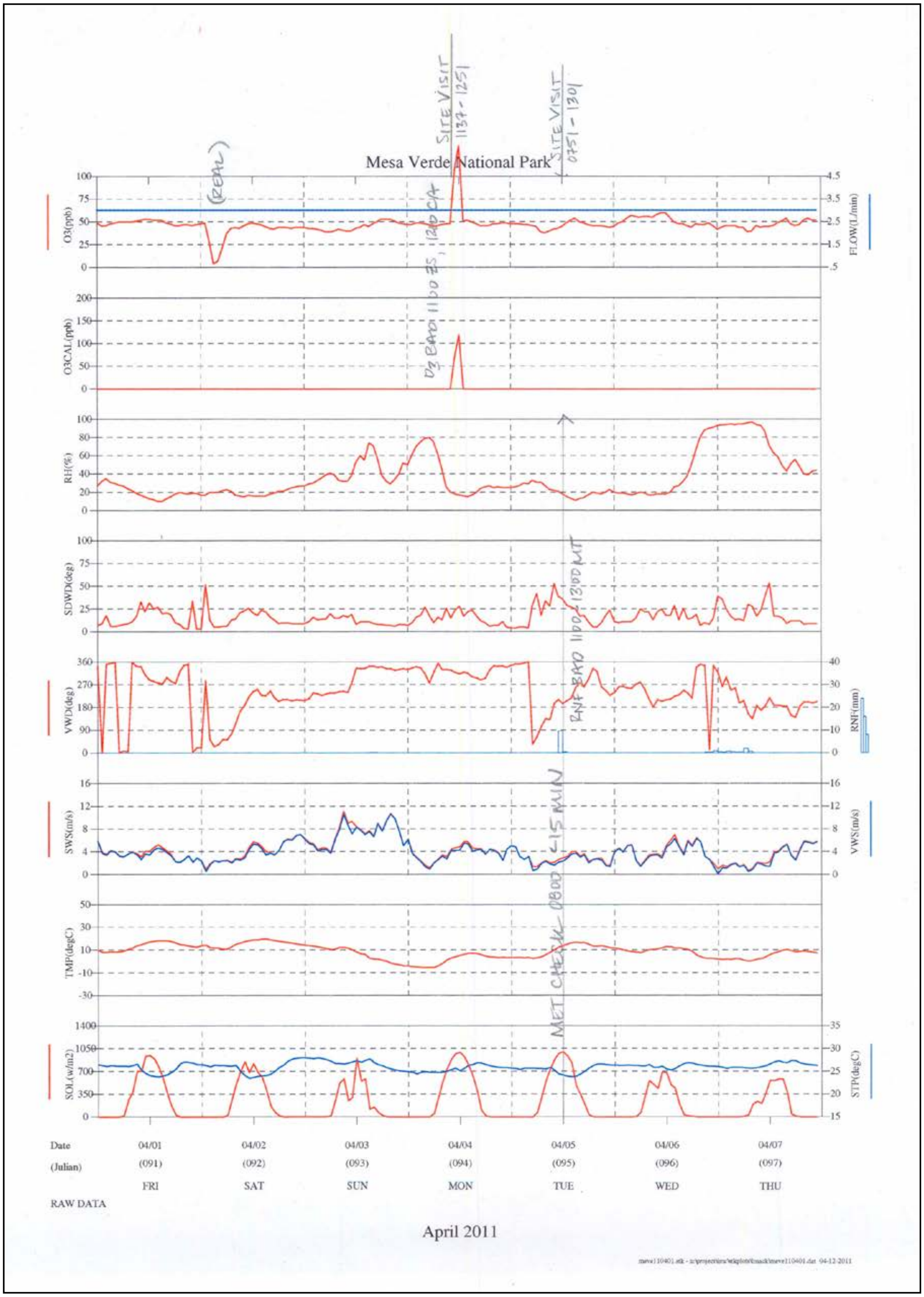


Figure 4-3. Example of a Commented Stackplot.

- Comments are written within the outline of the day of the affected data and in close proximity to the data point affected.
- Comments include the hours affected, the parameters affected, and the corresponding invalid code which provides the reason for invalidating the data.
- Explanations of valid but unusual data are also included.
- Data points invalidated by the Auto Validation tool are noted on the stackplot when appropriate.
- Site visits are identified at the top of the plot above the corresponding date with date, time, and duration of the visit.
- Normal actions that occur during a site visit and do not invalidate data are also identified on the plot (for example, meteorological instrument checks that last less than 15 minutes). This indicates that a required maintenance check was completed and further establishes validity of the data.

Precision check, calibration, and audit data are reviewed during this step in the Preliminary validation process.

After commenting the weekly stackplots for a site/month, the AQDBMS Data Validation Log is updated by entering the date stackplot comments are completed with the analyst's initials into the log record for the site/month. Validation notes are also entered into this log.

4.4 APPLYING VALIDATION CODES AND OTHER VALUES INTO THE AQDBMS DATABASE

During the Preliminary validation process, validation codes are applied in the database. The codes entered are guided by the datalogger and anomaly flags that are already in the database. A validation code is entered for each data point in a field separate from the datalogger and anomaly screening flags. Table 4-2 is a list of datalogger and anomaly screening flags and most common analyst actions taken based on the flags. Table 4-3 is a list of validation codes and conditions.

The Data Validation interface of the AQDBMS is used to apply validation codes to the data via two windows. The initial window provides a way to apply codes to all data points, list missing data, and blank-fill data within a selected set of data. The second window displays a tabular data window of the selected data and provides a way to apply validation codes to *selected* data points within a window. It provides an interface for sorting and applying specific filters to the data and for hand entering data.

To open the Data Validation window, select **Validate** from the AQ and Met Processing frame.

Table 4-2

Analyst's Actions Based on Datalogger and Anomaly Screening Flags

Flag	Type	Description	Action
-	Datalogger	Low alarm	Investigate
#	Datalogger	Insufficient data	Investigate
*	Datalogger	Out of calibration	Investigate
/	Datalogger	Rate-of-change alarm	Investigate
\	Datalogger	Rate-of-change alarm	Investigate
^	Datalogger	High alarm	Investigate
_	Datalogger	Low alarm	Investigate
<	Datalogger	Missing data	Invalidate with PF or RF
B	Datalogger	Bad status	Investigate
C	Datalogger	Calibration	Invalidate with ZS, PC, CA, SC, PA, or MT
D	Datalogger	Channel disabled/off-line	Investigate; can be valid or invalid
P	Datalogger	Power failure	Investigate; may be erroneous or true power failure
Z	Datalogger	Zero/span	Investigate
DT	Screening	Dewpoint more than 2.5°C greater than temperature	Invalidate either TMP or DDT with IM
IM	Screening	Set in VWS, VWD, and SDWD when SWS < min. expected (NV)	Invalidate keeping IM
NR	Screening	Rate-of-change less than minimum value in the Screening Ranges Table	Investigate
NV	Screening	Less than minimum value in the Screening Ranges Table	Investigate
TH	Screening	Ozone data suspect when station temp is > 32°C	Investigate
TL	Screening	Ozone data suspect when station temp is < 18°C	Investigate
VM	Screening	Valid but the validated value has been adjusted for the max value by the screening program based on the max adj, max adj to, and max val fields of the Screening Ranges Table	None
VZ	Screening	Valid but the validated value has been adjusted for zero by the screening program based on the zero adjustment value in the Screening Ranges Table	None
WS	Screening	Vector wind speed greater than Scalar wind speed – generated by the screening program	Invalidate VWS, VWD, SDWD with IM
XR	Screening program	Rate-of-change greater than the maximum value in the Screening Ranges Table	Investigate
XV	Screening program	Greater than the maximum value in the Screening Ranges Table	Investigate

Table 4-3

Validation Codes

Code	Description
BM	Begin monitoring. For a new site or instrument, place in only one hour before valid data.
CA	Multipoint calibration of an AQ instrument, > 15 min/hour.
EM	End monitoring. When a site or instrument is discontinued, place in only one hour after valid data.
IM	Instrument malfunction. Problem was not discovered until after data had been collected, instrument failure or other problem was not identified until the data validation occurred, may or may not be related to a problem listed on the status board.
IN	Acts of nature.
IW	Instrument warm-up. After the instrument was off or a power failure long enough to cause the instrument to go through a warm-up cycle. Some indicators: dpt > temp, noisy signal or drift shown on chart. Usually only used for 1 – 2 hours.
LI	Local interference. Human interference directly or indirectly that was local and not under the control of the operator. Examples: dust, particulates, construction.
MT	Maintenance. Someone on-site actively attempting repairs or doing preventive maintenance (changing chart paper, replacing instrument parts). Can be the site operator or repair person or remote activation or programming of the datalogger.
NA	Monitoring out for the month, before or after an analyzer is placed at a site, no intent of collecting data, unable to calculate value.
OE	Mistake by operator or anybody else at the station that leads to a loss in data. Example.: switches left in incorrect positions after repairs or calibrations, lines not returned to the manifold after an audit, open manifold ports, etc.
OR	Instrument in process of being repaired, often off-site. Incapable of getting good values, more than 1-hour of data, problem identified on site & status log or log book record would normally be present. MT must follow. Often a cal must follow.
OS	Signal is off the top of the chart, data is presumed good.
PA	Calibration on-site by an external agency person. May be several hours. (Gaseous parameters only.)
PC	Precision Check. Normally once per week.
PF	Power failure ≥ 15 minutes/hour, instrument warm-up and data loss at the top of the hour may also be an issue (RF).
RF	Datalogger system fails and chart record is unavailable.
SA	External agency person on-site which leads to data loss (Met parameters only.)
SC	Use when both a precision check and a zero/span check are done within the same hour.
TH	Data invalid for ozone when station temp is > 32° C.
TL	Data invalid for ozone when station temperature < 18° C.
TO	When time is off by more than 5 minutes.
V	Valid Value.
VA	Valid value, but the validated value has been adjusted from the raw value by the data analyst. The control value field must contain the offset.
VM	Valid but the validated value has been adjusted for the max value by the analyst based on the parameter criteria.
VZ	Valid but the validated value has been adjusted for zero.
ZS	Invalid data for the hour if zero/span takes longer than 15 minutes or the hour.

4.4.1 The Initial Data Validation Window

Validation codes may be applied automatically by using the "Auto Validation" button in the Data Validation window, or they may be applied manually by the data analyst when there is a need to override the codes applied by the database. When entering the data validation interface, the initial Data Validation window can be used to list missing data, blank-fill data, auto validate data, display a data grid, or enter the interface to manually apply validation codes. This window is shown in Figure 4-4.

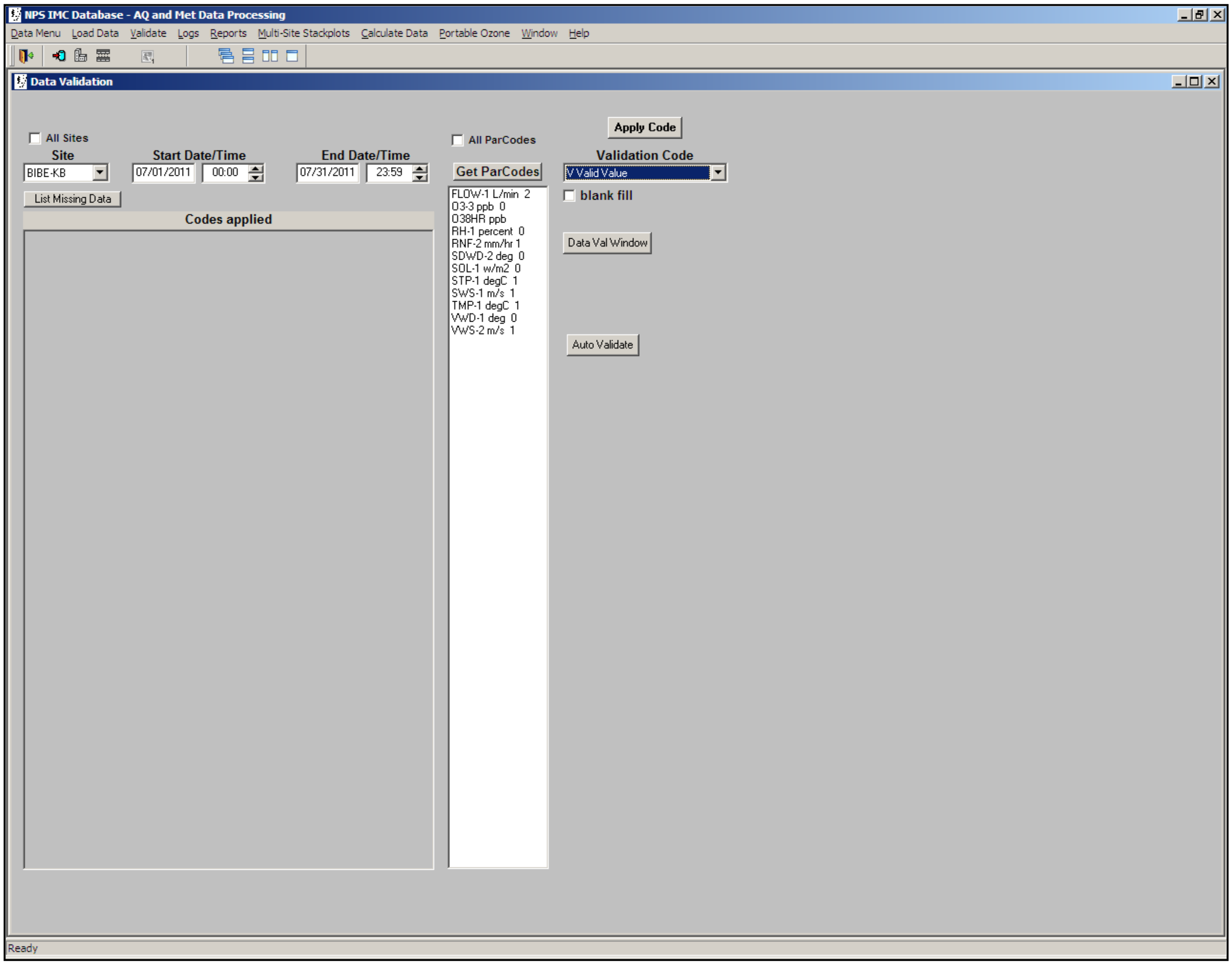


Figure 4-4. The Initial Validation Window.

To apply validation codes manually:

- Select the *site* to validate.
- Enter the *Start Date/Time* of the data set to work on.
- Enter the *End Date/Time* of the data set to work on.
- Click the **Get ParCodes** button. The program queries the database and returns all the parameter codes found for the selected site and period in the list box.

- Select (highlight) one or more *parameter codes* in the list box.
- Select a *validation code* from the Validation Code drop-down box.
- Click the **Apply Code** button. The process window displays a message listing the number of updated records.

  Important Note: When using this method, validation codes are committed to the database table immediately. This method should only be used for power failures or when blank-filling data (see instructions on blank-filling below).

To apply validation codes automatically:

- Select the *site* to validate.
- Enter the *Start Date/Time* of the data set to work on.
- Enter the *End Date/Time* of the data set to work on.
- Click the **Get ParCodes** button. The program queries the database and returns all the parameter codes found for the selected site and period in the list box.
- Select (highlight) one or more *parameter codes* in the list box.
- Select the *Auto Validation* button and the database applies a validation code to each record selected.

To search for missing data:

- Select the *site* to validate.
- Enter the *Start Date/Time* of the data set to work on.
- Enter the *End Date/Time* of the data set to work on.
- Click the **Get ParCodes** button. The program queries the database and returns all the parameter codes found for the selected site and period in the list box.
- Select (highlight) one or more *parameter codes* in the list box.
- Click the **List Missing Data** button. The cursor changes to an hourglass. When the cursor changes back to a pointer, the process has completed. Missing data within the selected data set will be listed in the process box.

To blank-fill data:

- Select the *site* to validate.
- Enter the *Start Date/Time* of the data set to work on.
- Enter the *End Date/Time* of the data set to work on.
- Click the **Get ParCodes** button. The program queries the database and returns all the parameter codes found for the selected site and period in the list box.
- Check the **blank fill** box.

- Check the **All** box and click **Get ParCodes** to retrieve a list of all parameter codes. Select the parameter codes to be blank-filled for the selected site and time period.

-or-

Check the pattern date and enter a *date* that contains the parameter codes that need to be blank-filled for the selected period.

-or-

Enter an end date just beyond the period of time to be blank-filled that contains all parameter codes that need to be blank-filled. Click the **Get Par Cod**es button and highlight all parameters listed.

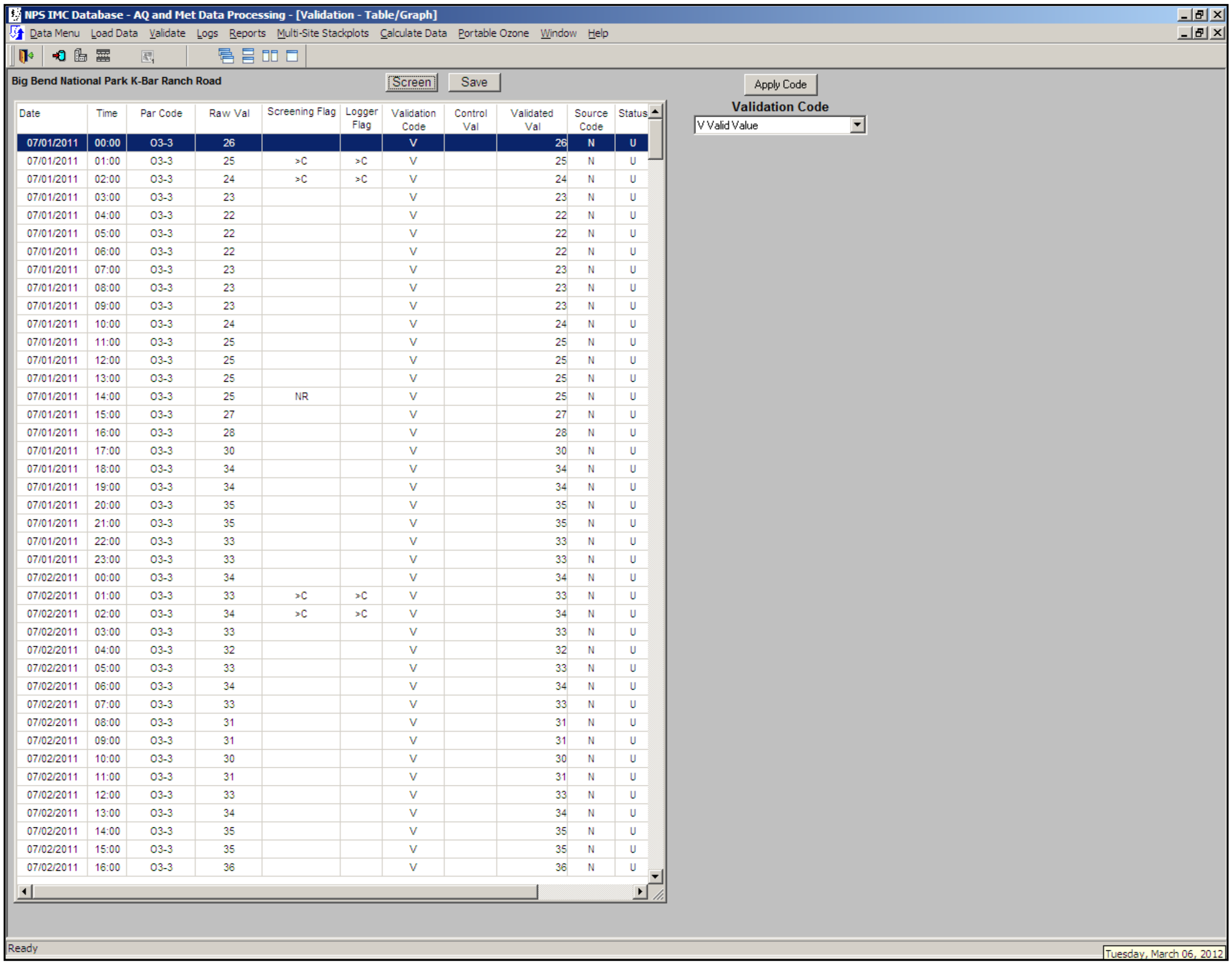
- Select a *code* from the Validation Code drop-down list box.
- Click the **Apply Code** button. Data will be blank-filled with a value of "-999" in the raw value and validated value fields, the selected code in the validation code field, and a "B" in the source code field. NOTE: The program will not overwrite existing data. When the process is complete, the number of blank-filled rows will be indicated in the process box.

To display the data grid:

- Select the *site* to validate.
- Enter the *Start Date/Time* of the data set to work on.
- Enter the *End Date/Time* of the data set to work on.
- Click the **Get ParCodes** button. The program queries the database and returns all the parameter codes found for the selected site and period in the list box.
- Select the *parameter code* to display. NOTE: If more than one parameter code is selected, only data for the first code will be displayed.
- Click the **24x31** button. The data will be displayed in a grid of 24 hours across by days down (optimally one month). For each data point, if any code other than a "V", "VA", "VM", or "VZ" exists in the validation code field, the code will be displayed in red. Otherwise, the value found in the validated value field is displayed.
- Select the **Print** button to print a copy of the data grid.
- Click the **X** button to close the window and return to the validation window.

4.4.2 The Data Validation Data Window

The second window available for data validation provides an interface for applying validation codes to specific, individually selected data points when the data analyst needs to override the codes applied during the Auto Validation process. Data from all columns of the database table are displayed in tabular form as shown in Figure 4-5. The data window data can be sorted and/or filtered. The interface also provides a means for re-screening data and for hand entering data values when necessary.



Date	Time	Par Code	Raw Val	Screening Flag	Logger Flag	Validation Code	Control Val	Validated Val	Source Code	Status
07/01/2011	00:00	O3-3	26			V		26	N	U
07/01/2011	01:00	O3-3	25	>C	>C	V		25	N	U
07/01/2011	02:00	O3-3	24	>C	>C	V		24	N	U
07/01/2011	03:00	O3-3	23			V		23	N	U
07/01/2011	04:00	O3-3	22			V		22	N	U
07/01/2011	05:00	O3-3	22			V		22	N	U
07/01/2011	06:00	O3-3	22			V		22	N	U
07/01/2011	07:00	O3-3	23			V		23	N	U
07/01/2011	08:00	O3-3	23			V		23	N	U
07/01/2011	09:00	O3-3	23			V		23	N	U
07/01/2011	10:00	O3-3	24			V		24	N	U
07/01/2011	11:00	O3-3	25			V		25	N	U
07/01/2011	12:00	O3-3	25			V		25	N	U
07/01/2011	13:00	O3-3	25			V		25	N	U
07/01/2011	14:00	O3-3	25	NR		V		25	N	U
07/01/2011	15:00	O3-3	27			V		27	N	U
07/01/2011	16:00	O3-3	28			V		28	N	U
07/01/2011	17:00	O3-3	30			V		30	N	U
07/01/2011	18:00	O3-3	34			V		34	N	U
07/01/2011	19:00	O3-3	34			V		34	N	U
07/01/2011	20:00	O3-3	35			V		35	N	U
07/01/2011	21:00	O3-3	35			V		35	N	U
07/01/2011	22:00	O3-3	33			V		33	N	U
07/01/2011	23:00	O3-3	33			V		33	N	U
07/02/2011	00:00	O3-3	34			V		34	N	U
07/02/2011	01:00	O3-3	33	>C	>C	V		33	N	U
07/02/2011	02:00	O3-3	34	>C	>C	V		34	N	U
07/02/2011	03:00	O3-3	33			V		33	N	U
07/02/2011	04:00	O3-3	32			V		32	N	U
07/02/2011	05:00	O3-3	33			V		33	N	U
07/02/2011	06:00	O3-3	34			V		34	N	U
07/02/2011	07:00	O3-3	33			V		33	N	U
07/02/2011	08:00	O3-3	31			V		31	N	U
07/02/2011	09:00	O3-3	31			V		31	N	U
07/02/2011	10:00	O3-3	30			V		30	N	U
07/02/2011	11:00	O3-3	31			V		31	N	U
07/02/2011	12:00	O3-3	33			V		33	N	U
07/02/2011	13:00	O3-3	34			V		34	N	U
07/02/2011	14:00	O3-3	35			V		35	N	U
07/02/2011	15:00	O3-3	35			V		35	N	U
07/02/2011	16:00	O3-3	36			V		36	N	U

Figure 4-5. Example Data Validation Data Window.

To open the Data Validation data window:

- In the Initial Data Validation window, select the *site* to validate.
- Enter the *Start Date/Time* of the data set to work on.
- Enter the *End Date/Time* of the data set to work on.
- Click the **Get ParCodes** button. The program queries the database and returns all the parameter codes found for the selected site and period in the list box.
- Select (highlight) one or more *parameter codes* in the list box.
- Click the *data table* picture button. The Data Validation data window is opened and displays the selected set of data in a tabular data window.

To apply validation codes:

- Open the Data Validation data window.
- Highlight the data points to apply the code to.

- Select a *code* from the Validation Code drop-down list box.
- Click the **Apply Code** button.

To sort and filter data:

- Open the Data Validation data window.
- **Right-click** anywhere in the data window.
- Select **Filter** or **Sort** from the pop-up menu. A dialog box is displayed. Follow the dialog box instructions to apply filter or sorting options. Click the **Help** button to access specific help on the dialog boxes.

4.4.3 Entering Control Values

Control values can be entered in the Data Validation data window. Control values are arithmetic expressions that are applied to or replace raw values and result in adjusted validated values. The first character in the control value field must be an arithmetic operator. For example, if you determine that the raw data values for wind speed are 10 m/s less than they truly were enter **+10** in each control value field. This action will add 10 to the raw data values and place the result in the validated data fields. When the control value field is used, the final data validation code must equal “VA” which means valid, but value adjusted.

Acceptable operators for control values:

Operator	Result
+	adds the control value to the raw value
-	subtracts the control value from the raw value
*	multiplies the raw value by the control value
/	divides the raw value by the control value
=	substitutes the control value for the raw value

To enter control values:

- Open the Data Validation data window.
- Select (highlight) the *data points* to apply the VA code to. Note this is a multi-select data window and rows can be selected with shift-click and ctrl-click.
- Select the **VA** code from the Validation Code drop-down list box.
- Enter the *value* to apply in the Control Value box.
- Click the **Apply Code** button.

4.4.4 Replacing Raw Values

On rare occasions, it may be necessary to replace raw data values in the database.

To hand-enter a raw value:

- Open the Data Validation data window.
- Click on the **Source Code** field of the raw needing a hand-entered raw value.
- Enter a *source code* that will allow a hand-entered value (**C**, **P**, **U,** or **D**).
- Click on the **Raw Val** field and enter the new *value*.

4.4.5 Screening Data in the Data Validation Window

Usually, data are screened for anomalies during the data loading process. When necessary, however, screening can also be done in the Data Validation data window. To screen data:

- Open the Data Validation data window.
- Click the **Screen** button. The anomaly screening program will apply the screening flags.

4.4.6 The Data Validation Log

The Data Validation Log is used to track the completion of each major step of the validation process. The master record logs the initials of the IMC staff member completing each validation step and when the step occurred. The Comments Table logs comments regarding data validation. Most of the output programs query the Data Validation Log so the correct level of validation can be applied to the output. To use the Data Validation Log:

- Select **Logs-> Data Validation Log** from the AQ and Met Processing frame.
- Select a *site* from the Site drop-down box. If no records for the selected site exist, a "Site not Found" message is displayed. Click **OK**. Otherwise, the most recent Master Table record and related comments for the selected site are displayed.
- Select a different *month* and/or *year* from the drop-down list boxes to display previous month's records for the site.
- Records can be added as by right-clicking and selecting **Add**.

4.5 GROUP PLOT REVIEW

A plot review is held to review all data collected for a month. Included in the group are program and section managers, data analysts, field specialists, and sponsoring organization personnel affiliated with the project. All plots are reviewed, questions asked, maintenance issues discussed, and questionable validation situations resolved. Any unresolved issues are identified and resolved within a few days after the plot review. Problem resolutions are explained at the following plot review.

4.6 REVIEWING VALIDATED DATA STACKPLOTS AND OTHER OUTPUT

Additional tools for verifying complete and accurate entry of validation codes are available within the AQDBMS. The data analyst completes the following checks:

- Reviews the Data Collection Statistics Table for a site/month, to quickly detect if a code was missed for parameters that must be validated identically and to look for indications of missed power failures or recorder failures.

- Reviews the High Values Tables for individual pollutant parameters to detect calibration points inadvertently left in as valid. This is only done when necessary.

- Reviews validated data stackplots to further verify that no points were missed.

All of these products can be reviewed either on screen or as printed copy. See TI 3550-5000, *Ambient Air Quality and Meteorological Monitoring Data – Weekly and Monthly Reporting*, and TI 3550-5050, *Ambient Air Quality and Meteorological Monitoring Data – Quarterly Reporting*, for detailed instructions.

Preliminary data validation is complete after a plot review is held, validation codes for a site/month are entered and validated data output is reviewed. Annotated stackplots and site documentation are reviewed to verify that all annotations on the plots are complete and accurate. Codes are cross-checked by data analysts during 3rd level validation. The AQDBMS Data Validation Log is then updated by entering the date completed and the analyst's initials into the log record for the site/month.

5.0 REFERENCES

Air Resource Specialists, Inc. (ARS), 2012, Air Quality Data Base Management System (AQDBMS) User's Guide.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES

TITLE	**AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA - FINAL VALIDATION**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3450-5020**
DATE	**MARCH 1999**

AUTHORIZATIONS

Originator	Betsy Davis-Noland	Bet Da Nold
Project Manager	Jessica Ward	Jessica Ward
Program Manager	Joe Adlhoch	
QA Manager	Gloria S. Mercer	Gloria S. Mercer

REVISION HISTORY

0.0	Initial version.	March 1999	G. Mercer
1.0	Change all procedures for the DataView system	January 2001	G. Mercer
	Reviewed; no changes necessary.	January 2002	G. Mercer
	Reviewed; no changes necessary.	January 2003	G. Mercer
1.1	New checklist, delete data technician, delete some post-validation procedures.	February 2004	G. Mercer
1.2	Modify validation flowchart, delete group plot review	May 2004	G. Mercer
1.3	Minor text changes (e.g., changed AIRS to AQS)	May 2005	G. Mercer
1.4	Change validation checklist / misc. changes	February 2006	G. Mercer
2.0	Monthly reports posted on the project Web site.	January 2007	G. Mercer
	Reviewed; no changes necessary.	January 2008	G. Mercer
	Reviewed; no changed necessary.	January 2009	G. Mercer
2.1	Revise data collection/validation flowchart.	February 2010	G. Mercer
3.0	Changed validation procedures and figures.	March 2012	G. Mercer

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LIST OF FIGURES

1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the steps taken by Air Resource Specialists', Inc. (ARS) Information Management Center (IMC) for completing Final validation of ambient air quality and meteorological data. These steps apply to all ambient air quality and meteorological parameters that are monitored and loaded into the Air Quality Data Base Management System (AQDBMS). This TI is referenced from SOP 3350, *Collection of Air Quality and Meteorological Monitoring Data*, and SOP 3450, *Ambient Air Quality and Meteorological Monitoring Data Validation*.

This TI presents the detailed steps used to ensure high quality Final data validation of ambient air quality and meteorological data. Data for a site/month must be at Preliminary validation before beginning Final validation. The Monthly Validation Checklist is used as a guide for the Final validation procedure. The checklist identifies the major steps taken during Final validation. Final data validation is accomplished by generating, reviewing, and distributing monthly data reports. Occasionally, validation errors will be detected after Final validation has been completed and post-final validation steps are taken to record the corrections.

2.0 RESPONSIBILITIES

2.1 INFORMATION MANAGEMENT SECTION MANAGER

The information management section manager shall oversee validation procedures to ensure timely and proper validation.

2.2 DATA ANALYST

The data analyst shall:

- Review validated stackplots.
- Generate the monthly data report.
- Update the Data Validation Log in the AQDBMS with the Final validation date.

2.3 SITE OPERATOR

The site operator shall respond to any questions regarding site documentation or data events, and forward any additional comments or observations to the IMC.

3.0 REQUIRED EQUIPMENT AND MATERIALS

All IMC equipment and materials are fully described in SOP 3340, *Information Management Center (IMC) Concept and Configuration for the National Park Service Gaseous Pollutant Monitoring Program*, and SOP 3341, *Air Resource Specialist's, Inc. (ARS) Information Management Center (IMC) Concept and Configuration*. The IMC requires the following hardware and software for Final validation of ambient air quality and meteorological data:

- IMC hardware:
  - Hardware specifications for IMC servers
  - Hardware specifications for workstations
  - IMC computer support hardware:
    - High-quality laser printer
- IMC AQDBMS software:
  - Oracle Database System
  - AQDBMS custom software:
    - Data validation and reporting software
    - Network operating system and support software

4.0 METHODS

Data for a site/month must be at Preliminary validation before beginning Final validation (see Figure 4-1). The Monthly Validation Checklist, shown in Figure 4-2, is used as a guide for the Final validation procedure. The checklist identifies the major steps taken during Final validation and provides a record of the date each step was completed and the initials of the analyst completing it. This section discusses the methods used to complete Final data validation of air quality and meteorological data, and contains the following four (4) major subsections:

4.1 Review of Validated Data
4.2 Making Validation Code Corrections and Completing Final Validation
4.3 Post-Final Validation Procedures

4.1 REVIEW OF VALIDATED DATA

During the Final validation process, a review of all validated data is completed by the IMC Manager. This is accomplished by reviewing stackplots of the raw data overlayed with the validated data. These plots allow the IMC Manager to see the validated dataset as well as which data points were determined to be invalid. Plots are reviewed to verify that validation is complete and accurate. Any discrepancies found are thoroughly investigated and corrections are made if determined necessary.

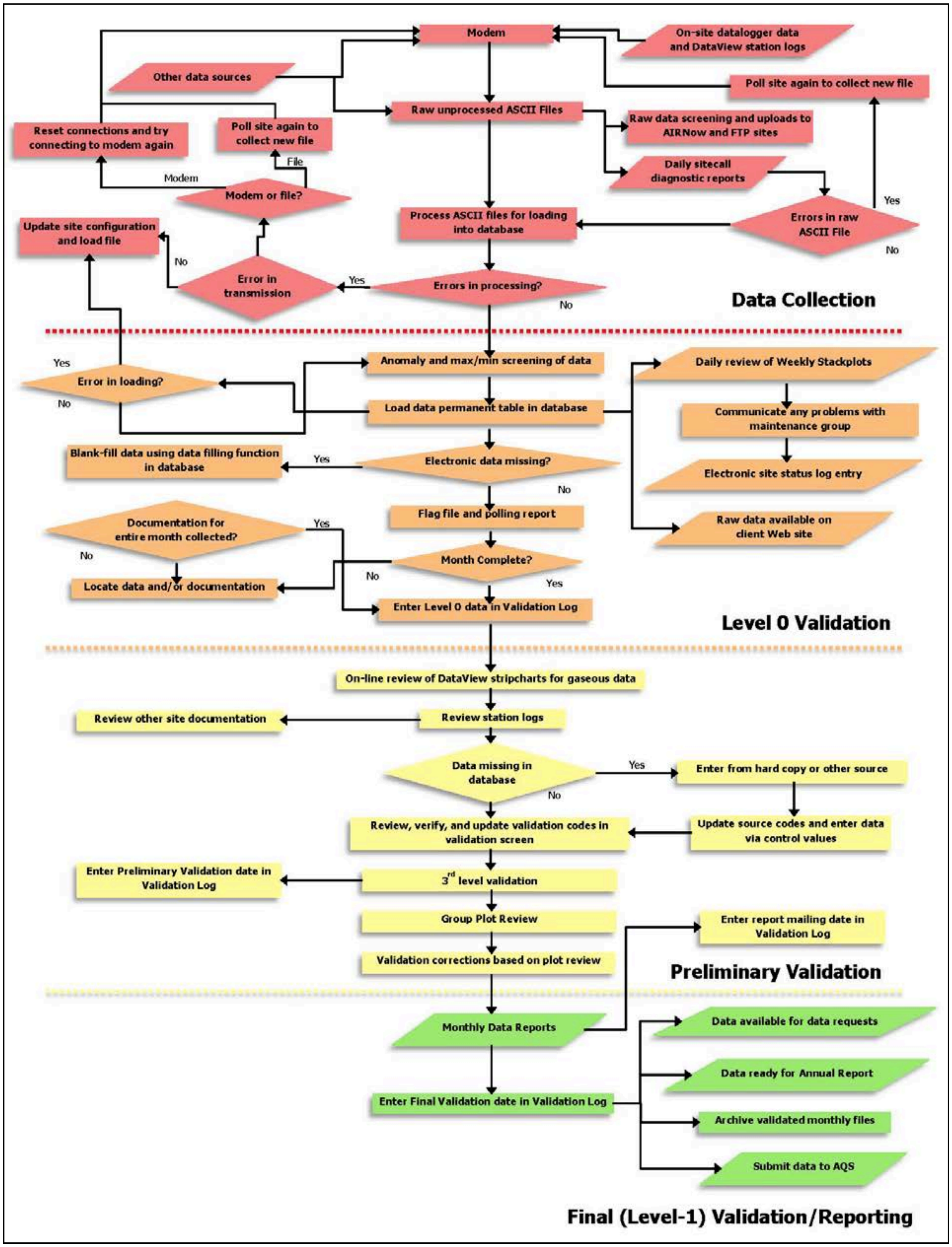


Figure 4-1. General Data Collection, Validation, and Reporting Flow Diagram. (Specific processes may vary by monitoring network).

MONTHLY VALIDATION CHECKLIST

Site____________

Month/Year____________

PRELIMINARY (AND LEVEL 0 VERIFICATION)		Date	Initials
1.	Review **previous months'** commented **Stackplots**	______	______
2.	Verify that all **Daily Summaries** are printed.	______	______
3.	Print and review **Station Logs**.	______	______
	Monthly MPC ☐ Monthly RNF ☐ Monthly PM flow check ☐ Weekly station checks ☐☐☐☐☐		
4.	Print and review most recent **Site Status Log** and **Calibration Plots**.	______	______
5.	Review **SSRF Forms, Trip Reports** & check **RH Cal Results**.	______	______
6.	Click '**auto validate**' button in database.	______	______
7.	Run **"datalogger flags listing" report** from database, verify all flags were coded.	______	______
8.	Check **O_3 Trace** via PC Anywhere in DataView.	______	______
9.	Apply **additional validation codes** if necessary.	______	______
10.	Record **annotations** on weekly stackplots.	______	______
11.	Run and print "**Stackplots for Validation Review"** – review and change codes as needed.	______	______
12.	Update **Data Validation Log**.	______	______
13.	Monthly **Plot Review**.	______	______
3rd LEVEL			
11.	Review **Site Status Log**, **Field Station Logs**, **Calibration Plots**, and **Daily Summaries** (as needed) to verify annotations on plots.	______	______
12.	Review **Validated Stackplots**, investigate suspect data if necessary.	______	______
13.	Verify preliminary **Validation Codes** in database.	______	______
14.	Update **Data Validation Log**.	______	______

N:\Project\imc\Forms\MoValChkList_newmethod.doc

Figure 4-2. Monthly Validation Checklist.

4.2 MAKING VALIDATION CODE CORRECTIONS AND COMPLETING FINAL VALIDATION

After the monthly plot review and after review of the validated stackplots (see TI 3450-5020, *Ambient Air Quality and Meteorological Monitoring Data – Preliminary Validation*) and after problems have been resolved, necessary validation code changes are made in the database. To make validation code changes, the Data Validation data window is used, which displays a tabular data window of selected data. It provides a way to hand-enter and apply validation codes to selected data points within a window.

4.2.1 The Data Validation Data Window

The Data Validation data window provides an interface for applying validation codes to specific, individually selected data points. Data from all columns of the database table are displayed in tabular form as shown in Figure 4-3. The data window data can be sorted and/or filtered. The interface also provides a means for re-screening data and for hand entering data values when necessary.

To open the Data Validation data window:

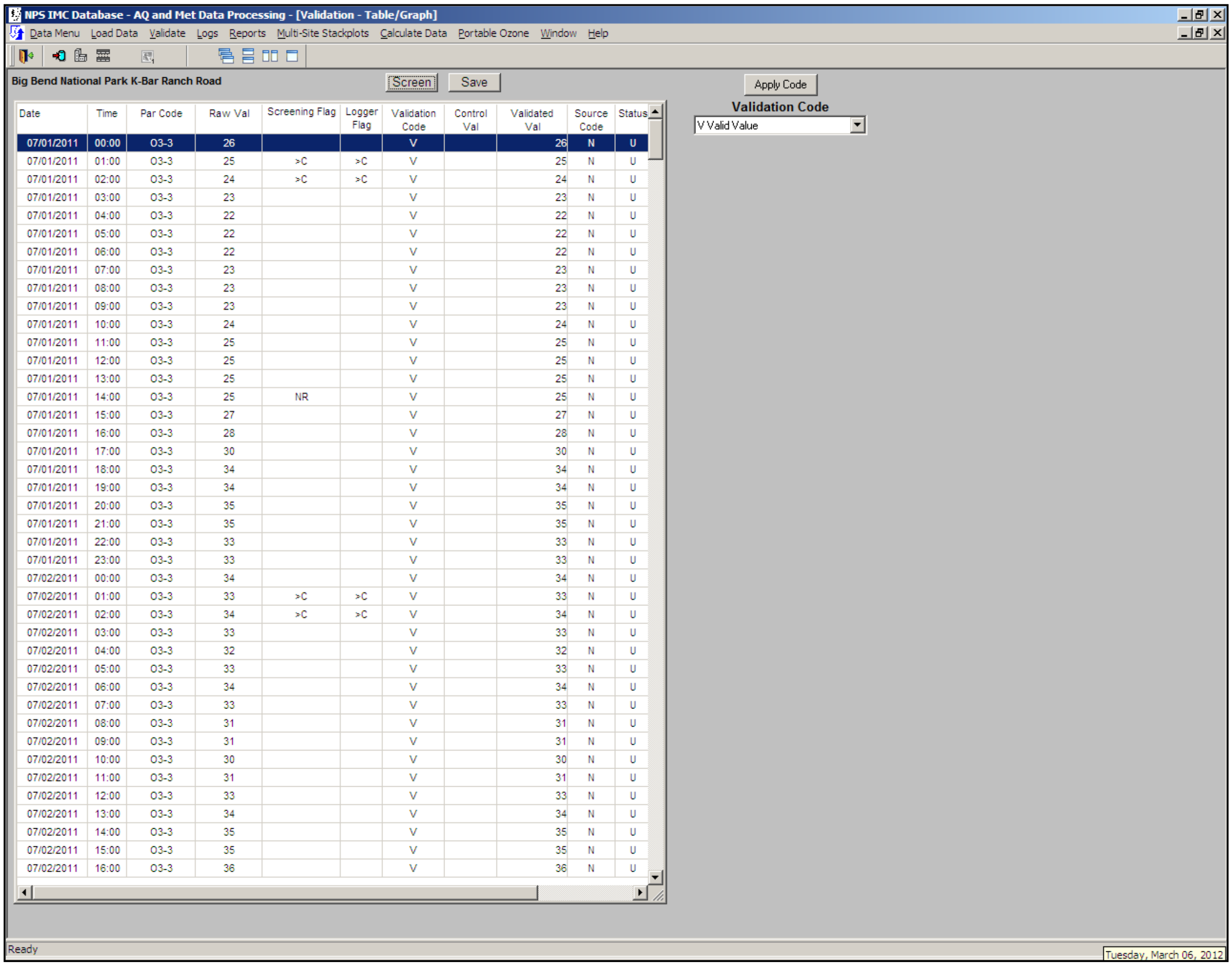
- In the Initial Data Validation window, select the *site* to validate.
- Enter the *Start Date/Time* of the data set to work on.
- Enter the *End Date/Time* of the data set to work on.
- Click the **Get ParCodes** button. The program queries the database and returns all the parameter codes found for the selected site and period in the list box.
- Select (highlight) one or more *parameter codes* in the list box.
- Click the *data table* picture button. The Data Validation data window is opened and displays the selected set of data in a tabular data window.

To apply validation codes:

- Open the Data Validation data window.
- Highlight the data points to apply the code to.
- Select a *code* from the Validation Code drop-down list box.
- Click the **Apply Code** button.

To sort and filter data:

- Open the Data Validation data window.
- **Right-click** anywhere in the data window.
- Select **Filter** or **Sort** from the pop-up menu. A dialog box is displayed. Follow the dialog box instructions to apply filter or sorting options. Click the **Help** button to access specific help on the dialog boxes.



Date	Time	Par Code	Raw Val	Screening Flag	Logger Flag	Validation Code	Control Val	Validated Val	Source Code	Status
07/01/2011	00:00	O3-3	26			V		26	N	U
07/01/2011	01:00	O3-3	25	>C	>C	V		25	N	U
07/01/2011	02:00	O3-3	24	>C	>C	V		24	N	U
07/01/2011	03:00	O3-3	23			V		23	N	U
07/01/2011	04:00	O3-3	22			V		22	N	U
07/01/2011	05:00	O3-3	22			V		22	N	U
07/01/2011	06:00	O3-3	22			V		22	N	U
07/01/2011	07:00	O3-3	23			V		23	N	U
07/01/2011	08:00	O3-3	23			V		23	N	U
07/01/2011	09:00	O3-3	23			V		23	N	U
07/01/2011	10:00	O3-3	24			V		24	N	U
07/01/2011	11:00	O3-3	25			V		25	N	U
07/01/2011	12:00	O3-3	25			V		25	N	U
07/01/2011	13:00	O3-3	25			V		25	N	U
07/01/2011	14:00	O3-3	25	NR		V		25	N	U
07/01/2011	15:00	O3-3	27			V		27	N	U
07/01/2011	16:00	O3-3	28			V		28	N	U
07/01/2011	17:00	O3-3	30			V		30	N	U
07/01/2011	18:00	O3-3	34			V		34	N	U
07/01/2011	19:00	O3-3	34			V		34	N	U
07/01/2011	20:00	O3-3	35			V		35	N	U
07/01/2011	21:00	O3-3	35			V		35	N	U
07/01/2011	22:00	O3-3	33			V		33	N	U
07/01/2011	23:00	O3-3	33			V		33	N	U
07/02/2011	00:00	O3-3	34			V		34	N	U
07/02/2011	01:00	O3-3	33	>C	>C	V		33	N	U
07/02/2011	02:00	O3-3	34	>C	>C	V		34	N	U
07/02/2011	03:00	O3-3	33			V		33	N	U
07/02/2011	04:00	O3-3	32			V		32	N	U
07/02/2011	05:00	O3-3	33			V		33	N	U
07/02/2011	06:00	O3-3	34			V		34	N	U
07/02/2011	07:00	O3-3	33			V		33	N	U
07/02/2011	08:00	O3-3	31			V		31	N	U
07/02/2011	09:00	O3-3	31			V		31	N	U
07/02/2011	10:00	O3-3	30			V		30	N	U
07/02/2011	11:00	O3-3	31			V		31	N	U
07/02/2011	12:00	O3-3	33			V		33	N	U
07/02/2011	13:00	O3-3	34			V		34	N	U
07/02/2011	14:00	O3-3	35			V		35	N	U
07/02/2011	15:00	O3-3	35			V		35	N	U
07/02/2011	16:00	O3-3	36			V		36	N	U

Figure 4-3. Example Data Validation Data Window.

4.2.2 Entering Control Values

Control values can be entered in the Data Validation data window. Control values are arithmetic expressions that are applied to or replace raw values and result in adjusted validated values. The first character in the control value field must be an arithmetic operator. For example, if you determine that the raw data values for wind speed are 10 m/s less than they truly were enter **+10** in each control value field. This action will add 10 to the raw data values and place the result in the validated data fields. When the control value field is used, the final data validation code must equal “VA” which means valid, but value adjusted.

Acceptable operators for control values:

Operator	Result
+	adds the control value to the raw value
-	subtracts the control value from the raw value
*	multiplies the raw value by the control value
/	divides the raw value by the control value
=	substitutes the control value for the raw value

To enter control values:

- Open the Data Validation data window.
- Select (highlight) the *data points* to apply the VA code to. Note this is a multi-select data window and rows can be selected with shift-click and ctrl-click.
- Select the **VA** code from the Validation Code drop-down list box.
- Enter the *value* to apply in the Control Value box.
- Click the **Apply Code** button.

4.2.3 The Data Validation Log

The Data Validation Log is used to track the completion of each major step of the validation process. The master record logs the initials of the IMC staff member completing each validation step and when the step occurred. The Comments Table logs comments regarding data validation. Most of the output programs query the Data Validation Log so the correct level of validation can be applied to the output. To use the Data Validation Log:

- Select **Logs-> Data Validation Log** from the AQ and Met Processing frame.
- Select a *site* from the Site drop-down box. If no records for the selected site exist, a “Site not Found” message is displayed. Click **OK**. Otherwise, the most recent Master Table record and related comments for the selected site are displayed.
- Select a different *month* and/or *year* from the drop-down list boxes to display previous month’s records for the site.
- Records can be added by right-clicking and selecting **Add**.

4.2.4 Completing Final Validation

After making validation code changes, the following steps are taken to complete Final validation:

- The changed data are regenerated into a new stackplot data file to replace the old.
- The validated stackplots are again reviewed; changes are made if necessary and are entered into the database.
- Monthly reports are generated (see TI 3550-5000, *Ambient Air Quality and Meteorological Monitoring Data – Weekly and Monthly Reporting*, and TI 3550-5050, *Ambient Air Quality and Meteorological Monitoring Data – Quarterly Reporting*).
- Reports are e-mailed and posted on the project Web site.
- The Data Validation Log entry for the site/month is updated with the Final validation date and initials of the responsible analyst.
- The Data Validation Log entry for the site/month is updated with the “report mailed” date.

After completing these steps, Final validation is complete and data are ready to be uploaded to AQS, included in data requests, and annual data summary reports.

4.3 POST-FINAL VALIDATION PROCEDURES

If a validation error is found after the data are labeled as final, the following steps are taken:

- The necessary changes are made in the AQDBMS database.
- Changes made are logged in *N:\project\IMC\data corrections\revalidated_yyyy.xls.*
- If the affected data have been submitted to the Environmental Protection Agency's (EPA) Air Quality System (AQS) database, they must be resubmitted.
- If the affected data have been submitted to other data depositories (e.g., CASTNet or other project-specific databases or Web sites), they must be resubmitted.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA REPORTING**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3550**
DATE	**MARCH 1999**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Betsy Davis-Noland	Betsy Davis-Noland
PROJECT MANAGER	Jessica Ward	Jessica Ward
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change all procedures for the DataView system	January 2001	G. Mercer
	Reviewed; no changes necessary.	January 2002	G. Mercer
	Reviewed; no changes necessary.	January 2003	G. Mercer
2.0	Change to weekly progress reports / monthly data reports / data requests / ozone season	May 2004	G. Mercer
3.0	Add quarterly reports, change AIRS to AQS, update annual reporting.	May 2005	G. Mercer
3.1	Add data requests from Web sites.	February 2006	G. Mercer
4.0	Add semiannual contract status reports.	February 2007	G. Mercer
	-- continued --		

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TITLE	**AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA REPORTING**
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ORIGINATOR	Betsy Davis-Noland	Bet Davis-Noland
PROJECT MANAGER	Jessica Ward	Jessica Ward
PROGRAM MANAGER	David L. Dietrich	[illegible]
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
	Reviewed; no changes necessary.	January 2008	G. Mercer
5.0	Change report due dates, ozone ppb limits.	January 2009	G. Mercer
5.1	Revised data collection/validation flowchart.	February 2010	G. Mercer
	Reviewed; no changes necessary.	April 2011	G. Mercer

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LIST OF FIGURES

1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) outlines the steps of producing ambient air quality and meteorological data reports. Reporting includes preparation and distribution of the following report products:

- Weekly progress reports
- Monthly and quarterly data reports
- Semiannual contract status reports
- Annual data reports
- Monthly ozone "hit list" during the summer ozone season

Not all reports will be produced for every project. The project-specific quality assurance project plan (QAPP) will designate the types of reports required for individual projects.

In addition, at the direction of the client, the IMC will also report criteria pollutant, meteorological, and precision and accuracy data to the Environmental Protection Agency's Air Quality System (AQS) database on a monthly basis, and handle individual data requests as they are received. Data reporting is the final step in the network data collection, validation, and reporting process illustrated in Figure 1-1.

Weekly progress reports summarize the technical aspects of the specific monitoring program performed during the reported week. These reports include the technical progress of both network operations and information management tasks, along with project-related milestones and maintenance schedules.

Monthly data reports provide the sponsoring organization, project management, individual station operators, and other project-related personnel, the opportunity to view summaries of air quality and associated meteorological data collected at individual monitoring sites. One summary report is prepared for the entire monitoring network each month. Quarterly data reports generally include project timeline, data collection statistics, plots of hourly average data, and quarterly summary tables and graphics highlighting the range and frequency of data collected during the quarter.

Semiannual contract status reports include summaries of task orders, modifications, and contract funding status for the project. Specific contents of these reports may vary upon direction from the project sponsor.

Annual data summary reports highlight the average range and frequency of data collected by a monitoring site during the year. These summaries provide information on the status and trends of air quality conditions and help determine if a site is exceeding the National Ambient Air Quality Standards (NAAQS) established by the U.S. Environmental Protection Agency (EPA).

The monthly ozone "hit list" is a list (generated for the months of April through October) of site-specific ozone hourly averages $\geq$ 100 and > 124 ppb, and 8-hour averages > 75 ppb. The monthly hit list, based on Level 0 data, is forwarded to the sponsoring organization as a preliminary indication of which sites recorded high ozone values during the month.

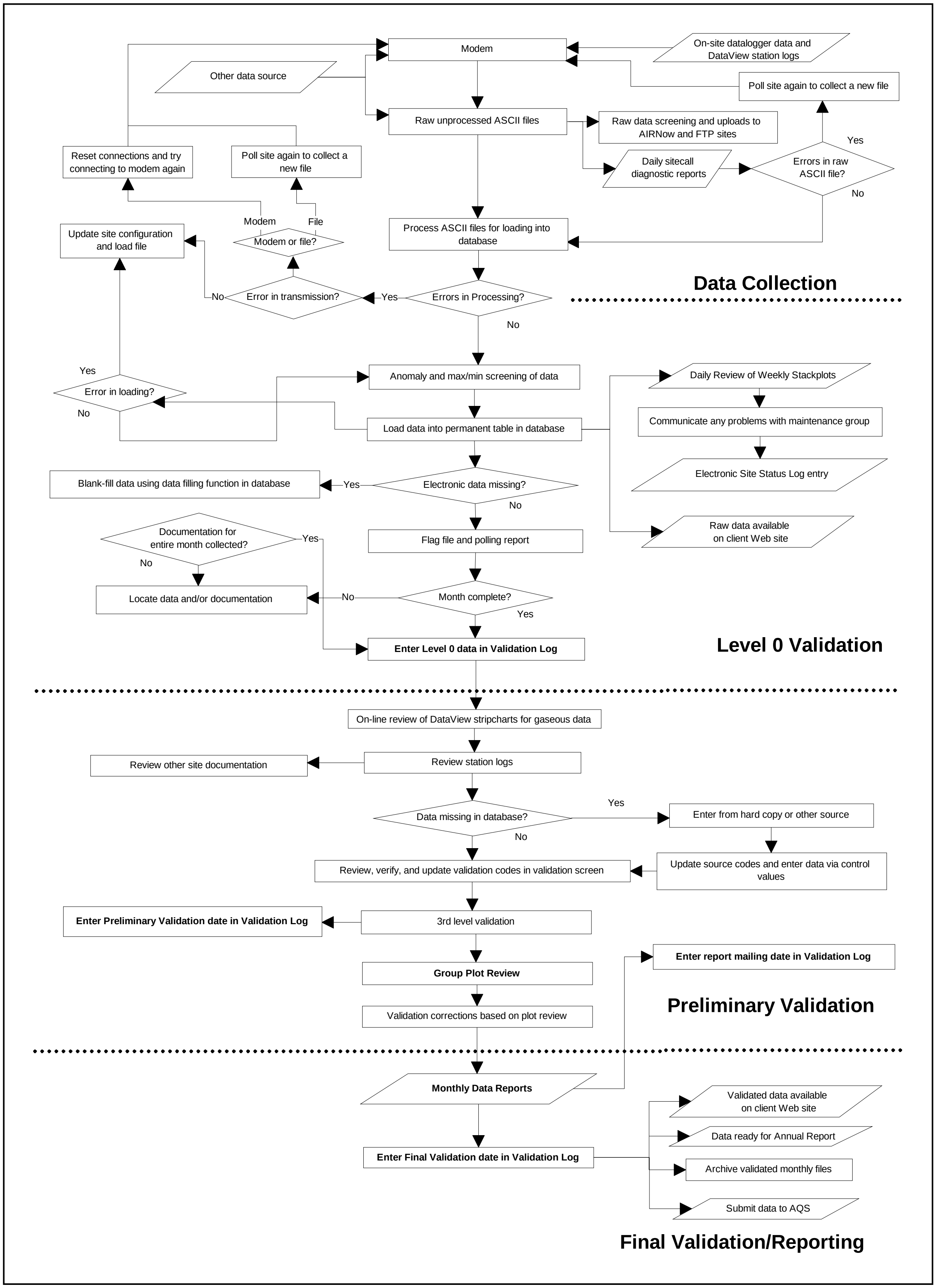

Figure 1-1. General Data Collection, Validation, and Reporting Flow Diagram. (Specific processes may vary by monitoring network).

The EPA AQS database is a repository of air quality-related data from a multitude of federal, state, and city agencies. Data are submitted to the AQS to allow retrieval of the data by other government agencies and researchers from a common source.

Data requests are handled on an individual basis. Requests for non-finalized data are authorized by the sponsoring organization before being filled in the IMC. Although data requests vary, a standard procedure has been developed for handling them.

This standard operating procedure (SOP) outlines the data reporting process. For detailed data reporting instructions, refer to the following technical instructions (TIs):

- TI 3550-5000 *Ambient Air Quality and Meteorological Monitoring Data – Weekly and Monthly Reporting*
- TI 3550-5050 *Ambient Air Quality and Meteorological Monitoring Data – Quarterly Reporting*
- TI 3550-5100 *Ambient Air Quality and Meteorological Monitoring Data – Annual Reporting*
- TI 3550-5200 *Handling Requests for Ambient Air Quality and Meteorological Monitoring Data*
- TI 3550-5300 *Submitting Ambient Air Quality and Meteorological Monitoring Data to the EPA AQS Database*

2.0 RESPONSIBILITIES

Staff positions that have data reporting responsibilities are:

- Program manager
- Information management section manager
- Data analyst
- Technical assistant

Specific Information Management Center (IMC) staff data reporting responsibilities are presented in the TIs that support this SOP (see previous Section 1.0).

3.0 REQUIRED EQUIPMENT AND MATERIALS

All IMC equipment and materials are fully described in SOP 3340, *Information Management Center (IMC) Concept and Configuration for the National Park Service Gaseous Pollutant Monitoring Program*, and SOP 3341, *Air Resource Specialists', Inc. (ARS) Information Management Center (IMC) Concept and Configuration*. The hardware and software used to perform specific data reporting functions are referenced in the TIs that support this SOP (see previous Section 1.0).

4.0 METHODS

The report types selected and report generation is project-specific. Reports will be generated to meet project-specific schedules as outlined in a project QAPP. Distribution will also follow the QAPP guidance. A single report (of each selected type) will be prepared for each defined monitoring program.

The ozone "hit list" is generated from Level 0 data in the AQDBMS database. Data requests are typically filled using finalized data in the AQDBMS database. Final data are generally submitted to the EPA AQS database monthly, but no less than quarterly.

This section includes eight (8) major subsections:

4.1 Weekly Progress Report
4.2 Monthly and Quarterly Data Reports
4.3 Semiannual Contract Status Report
4.4 Annual Data Report
4.5 Ozone Hit List
4.6 Data Requests
4.7 Distribution
4.8 Submitting Data to the EPA AQS Database

These subsections outline the general contents of the identified report types. Actual report contents will vary by project-specific requirements.

4.1 WEEKLY PROGRESS REPORT

Weekly progress reports summarize the progress of program-related tasks during the report week. This report is completed and forwarded to the sponsoring organization by Tuesday following the week of record. Specific content of the progress report varies from week to week, however, each report generally includes the following:

- Network issues
- Site status board entries
- Site visits, reporting, and data requests
- Other significant events
- Contract information

4.2 MONTHLY AND QUARTERLY DATA REPORTS

Monthly data reporting involves generating a data summary containing all sites in the monitoring program where data were collected during the reported period. Monthly data reports are completed and distributed within 35-45 days after the end of the reported month as the culmination of data validation. Each data report contains the following sections and products:

- Summary of gaseous data by site
- Summary of particulate data by site
- Summary of meteorological data by site
- Collection statistics by site for all parameters

The steps taken to produce each monthly data report are:

- Verify completion of preliminary data validation of the reported data.
- Print stackplots of validated data for each site.
- Review stackplots for any data that should be invalidated.
- Print report tables.
- Review reports.
- Make corrections.
- E-mail the reports, post the report on the project Web site (if applicable) and file a hardcopy original.

Instead of a monthly data report, project sponsors may opt for a quarterly data report. The quarterly data report generally involves generating a data summary containing all sites in the monitoring network. The quarterly reports are distributed within 60 days of the end of the quarter. This schedule can vary depending on the monitoring of filter-based measurements that require laboratory analyses. Each quarterly report contains the following sections and products:

- Operational timelines for each site
- Collection statistics for all parameters
- Stackplots of hourly average of all monitored parameters
- Wind roses (for each monitoring height)
- Pollution roses for each monitored air quality parameter
- Summary of gaseous data by site
- Summary of particulate data by site
- Summary of meteorological data by site
- Summary of quality assurance/quality control documentation

The steps taken to produce each quarterly report are:

- Verify completion of all final data validation

- Print graphics (plots and tables)
- Prepare operational timelines
- Prepare and review draft reports
- Copy and distribute reports and file originals
- Create a CD or DVD of all validated data for the quarter to deliver with the report

4.3 SEMIANNUAL CONTRACT STATUS REPORT

Contract status reports summarize contract tasks and modifications, and include a variety of tables such as:

- Listing of task orders and modifications applicable to the program during the period of record.
- Summary of total funding to-date and funding allocations of each task or modification for the contract.
- Funding details by task or modification.
- Status of task orders and modifications (completed or ongoing).
- Miscellaneous funding details of tasks or modifications (if required).

Actual content of contract status reports will vary depending upon the needs of the project sponsor and their specific contract identification system.

4.4 ANNUAL DATA REPORT

Annual data reporting involves generating an annual data summary report for each monitoring network. Annual data summary reports are completed and distributed within 3-7 months following the reported year. Annual data reports contain the following sections and products:

- Introduction:
  - A description of the monitoring program and its objectives
  - Parameters measured
- Network Description:
  - A description of the monitoring network including a site map
  - A detailed table containing individual monitoring site specifications
- Data Summaries:
  - Gaseous data summaries
  - Particulate data summaries
  - Meteorological data summaries

- Data Quality Assurance:
  - Summary table of data collection statistics by site
  - Summary table of overall data collection statistics by network
  - Summary table of gaseous analyzer precision and accuracy
  - Summary table of overall network gaseous analyzer precision and accuracy

The steps taken to produce each annual summary report are:

- Verify completion of final data validation of the reported data.
- Retrieve and load non-network data into the AQDBMS database.
- Create stackplot data files.
- Review stackplots for any anomalies in the data.
- Investigate data anomalies to determine if the data are valid.
- Print report tables.
- Create report maps.
- Print the cover page, text pages, and map pages.
- Review report.
- Make corrections.
- Copy and distribute the report, and file the original.

4.5 OZONE HIT LIST

The monthly ozone "hit list" is a list of site-specific ozone hourly averages ≥100 ppb and > 124 ppb, and 8-hour averages > 75 ppb. The ozone hit list is generated from Level 0 data at the end of every month during the ozone season, April through October. Since the data have not yet been validated, the data analysts review the list and exclude values recorded during obvious non-ozone events such as daily zero/span calibrations.

4.6 DATA REQUESTS

Data requests are received from various sources. Final data are publicly available at *http://ard-request.air-resource.com*, and requests may also be fulfilled through the IMC. All raw data requests are reviewed with the sponsoring organization and data or products will only be provided if approved by the sponsoring organization. For these requests, the data analyst:

- Forwards the request information to the sponsoring organization for authorization.
- Prepares the data files and/or hardcopy output required to fill the request.
- Prepares accompanying support documentation and/or correspondence.

- Delivers the request.
- Reports a list of fulfilled data requests in the next progress report.

4.7 DISTRIBUTION

4.7.1 Distribution of Data Reports

Data reports will be distributed to the persons/organizations designated and according to schedule presented in the project-specific QAPP.

4.7.2 Distribution of Data Requests

Each data request will be distributed to the person making the request. In certain situations, a copy of the digital data delivered is archived permanently.

4.8 SUBMITTING DATA TO THE EPA AQS DATABASE

The steps required to submit data to the EPA AQS database are:

- Create the AQS transaction files for hourly average criteria pollutant and meteorological data.
- Create the AQS transaction files for precision data from criteria pollutant analyzer precision checks (typically one per week).
- Create the AQS transaction files for accuracy data on criteria pollutant analyzers (typically one every 3 months to one year).
- Transfer the files to AQS using CDX (Central Data Exchange).
- Load data into the AQS database, successfully run the AQS statistical analysis programs, and post the data to the AQS database.

These steps are detailed in TI 3550-5300, *Submitting Ambient Air Quality and Meteorological Monitoring Data to the EPA AQS Database.*

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA – WEEKLY AND MONTHLY REPORTING**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3550-5000**
DATE	**MARCH 1999**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Laura A. Wilson	Laura A. Wilson
PROJECT MANAGER	Jessica Ward	Jessica Ward
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change all procedures for the DataView system	January 2001	G. Mercer
	Reviewed; no changes necessary.	January 2002	G. Mercer
	Reviewed; no changes necessary.	January 2003	G. Mercer
2.0	Change monthly to weekly progress reports/ revise monthly data reports / revise ozone hit list.	May 2004	G. Mercer
2.1	Changed monthly report process / revised hit list	May 2005	G. Mercer
2.2	Revised graphics.	February 2006	G. Mercer
	Reviewed; no changes necessary.	January 2007	G. Mercer
	-- continued --		

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA – WEEKLY AND MONTHLY REPORTING**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3550-5000**
DATE	**MARCH 1999**

AUTHORIZATIONS

TITLE	NAME	SIGNATURE
ORIGINATOR	Laura A. Wilson	Laura A. Wilson
PROJECT MANAGER	Jessica Ward	Jessica Ward
PROGRAM MANAGER	David L. Dietrich	[illegible]
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
COTR		

REVISION HISTORY

REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
3.0	Change ozone hit list / monthly report preparation.	January 2008	G. Mercer
4.0	Update with new ozone standard of 75 ppb.	January 2009	G. Mercer
4.1	Make client-generic/ added particulates.	February 2010	G. Mercer
	Reviewed; no changes necessary.	April 2011	G. Mercer

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LIST OF FIGURES

LIST OF FIGURES (CONTINUED)

1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the steps of producing ambient air quality and meteorological weekly progress reports and monthly data reports, and is referenced from SOP 3550, *Ambient Air Quality and Meteorological Monitoring Data Reporting*. Reporting of ambient air quality and meteorological monitoring by the ARS Information Management Center (IMC) includes preparation and distribution of the following report products:

- Weekly progress reports
- Monthly data reports
- Monthly ozone “hit list” (prepared during the ozone season, April through October)

Weekly progress reports summarize the technical aspects of a monitoring program performed during the reported week. These reports include the technical progress of both network operations and information management tasks, along with project-related milestones and maintenance schedules.

Monthly data reports provide air quality management staff, individual station operators, and other project-related personnel, ambient ozone (O_3) and/or sulfur dioxide (SO_2) data and associated meteorological data collected at individual monitoring sites. One report is prepared for the entire network each month.

The monthly ozone “hit list” is a list of ozone 8-hour averages > 75 ppb, indicating the locations and frequency of high ozone values .This list is forwarded to the client.

2.0 RESPONSIBILITIES

2.1 INFORMATION MANAGEMENT SECTION MANAGER

The information management section manager shall oversee all reporting procedures and provide direction when required.

2.2 DATA ANALYST

The data analyst shall:

- Verify that preliminary and final data validation has been successfully completed for each month.
- Prepare monthly data reports and forward the reports to the client and site operators.
- Prepare and forward the monthly ozone “hit list” to the client.
- Submit data to the Environmental Protection Agency’s (EPA) Air Quality System (AQS) database.
- Summarize IMC-related progress and forward items to the technical assistant for inclusion in the weekly progress report.

2.3 TECHNICAL ASSISTANT

The technical assistant shall:

- Assemble and organize the information for the weekly progress report.
- Word process the weekly progress report.
- Copy and deliver the weekly progress report.

3.0 REQUIRED EQUIPMENT AND MATERIALS

Detailed descriptions of all IMC hardware and software, and monitoring station hardware requirements are presented by category in SOP 3340, *Information Management Center (IMC) Concept and Configuration*. The IMC requires the following hardware and software for Level 0 validation of ambient air quality and meteorological data:

- IMC hardware:
  - Hardware specifications for IMC servers
  - Hardware specifications for workstations
  - IMC computer support hardware:
    - High-quality laser printer
- IMC AQDBMS software:
  - Oracle Database System
  - AQDBMS custom software:
    - Data validation and reporting software
    - Network operating system and support software

4.0 METHODS

One weekly progress report for the network is generated each week and one monthly data report for the network is generated each month. The ozone "hit list" is generated monthly from raw data in the Air Quality Data Base Management System (AQDBMS) during the summer ozone season.

This section contains the following three (3) major subsections:

4.1 Weekly Progress Report
4.2 Monthly Data Report
4.3 Monthly Ozone Hit List

4.1 WEEKLY PROGRESS REPORT

Weekly progress reports summarize the progress of program-related tasks during the reported week. This report is completed and distributed by the Tuesday following the week of record. Specific content of the progress report varies from week to week, however, each report generally includes the following:

- Network issues discussed during project meetings with client personnel
- Site issues/operational problems resolved and unresolved
- Site visits performed and scheduled
- Reporting status and data requests
- Contract administration items

Using the previous week's report as a template, the technical assistant reviews each page of the report and makes updates with information from the Site Status Log, trip reports, and other information forwarded by the IMC staff and field specialists.

4.2 MONTHLY DATA REPORT

Monthly data reporting includes generating one data report for an entire monitoring network, or for individual stations within a network, as advised by the client. Monthly reports are completed and distributed within 35 days following the reported month as the culmination of data validation (see Figure 4-1).

The main steps taken to report monthly data are:

- Determine the specific contents needed for the report.
- Update the report text.
- Determine which sites to include in the report tables.
- Generate and compile the report tables.
- Review the report.
- If necessary, make corrections and regenerate affected contents.
- Distribute the reports.

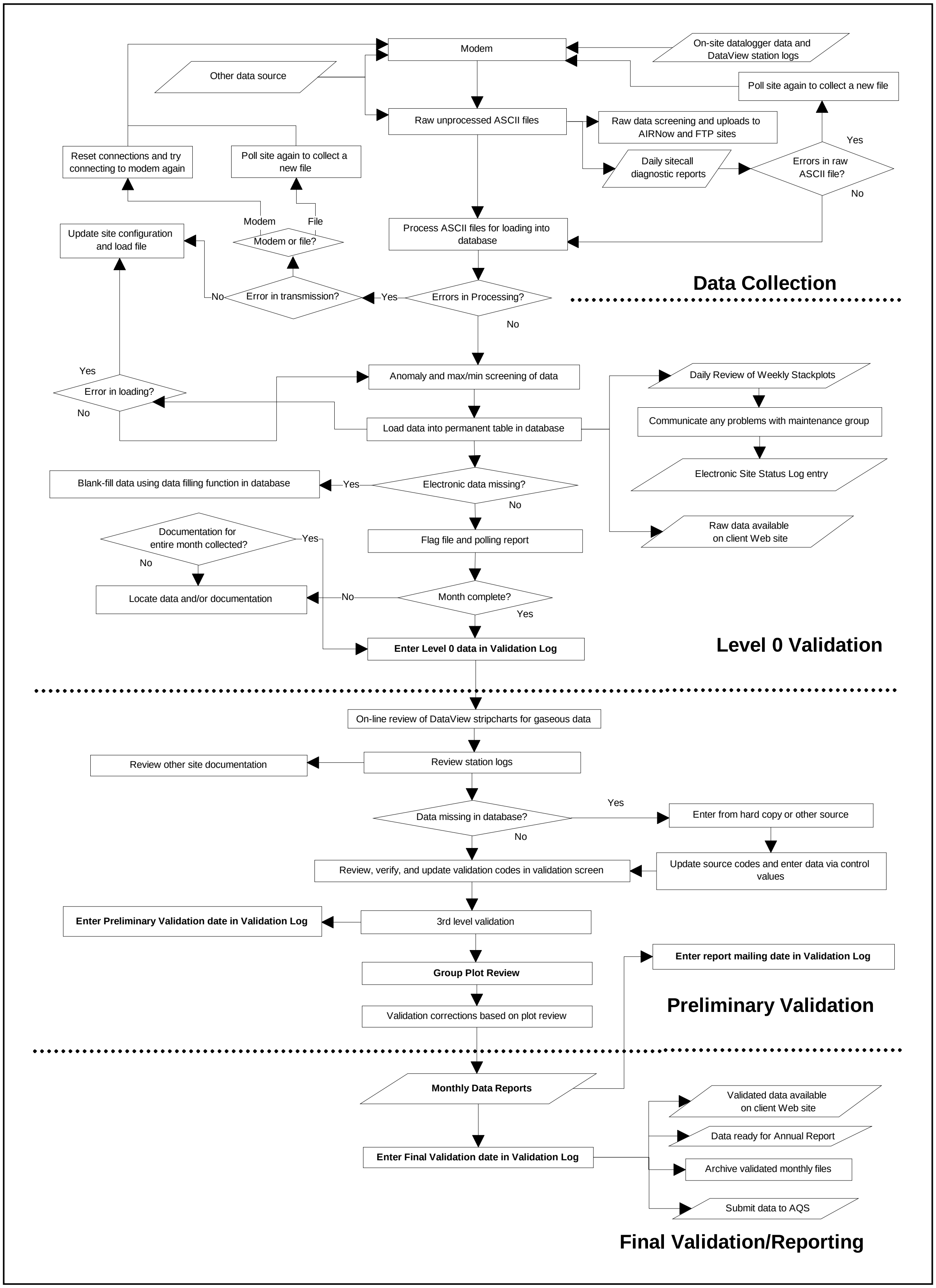

Figure 4-1. General Data Collection, Validation, and Reporting Flow Diagram. (Specific processes may vary by monitoring network).

4.2.1 Monthly Data Report Contents

Before generating report contents, the data analyst determines which sites are to be reported and the output that needs to be included in the report. Data reports contain the following products:

- Data Collection Statistics by site for all parameters
- Summary of ozone data by site
- Summary of sulfur dioxide data by site
- Summary of $PM_{2.5}$ data by site
- Summary of PM_{10} data by site
- Summary of selected meteorological data by site

Figures 4-2 through 4-5 present example report products.

Data Collections Statistics by Site
05/01/2005 - 05/31/2005
National Park Service Gaseous Pollutant Monitoring Program

National Park Unit	Site Name	Parameter Code											
		O3 % valid[1]	SO2 % valid[1]	SO2Add % valid[1]	VWD % valid[1]	SWS % valid[1]	TMP % valid[1]	RH % valid[1]	RNF % valid[1]	WET % valid[1]	DTP % valid[1]	SOL % valid[1]	FLOW % valid[1]
Pinnacles	East Entrance Station	95.2	—	—	99.6	99.6	99.6	100.0	99.3	99.3	99.6	99.6	100.0
Rocky Mountain	Longs Peak Ranger Station	89.5	—	—	100.0	100.0	100.0	100.0	99.2	99.3	100.0	100.0	99.9
Sequoia and Kings Canyon	Ash Mountain	89.4	—	—	100.0	100.0	100.0	46.5	99.5	99.3	99.9	99.7	100.0
Sequoia and Kings Canyon	Lower Kaweah	94.4	—	—	99.9	99.9	99.9	100.0	99.2	—	—	99.9	—
Shenandoah	Big Meadows	95.4	95.4	—	100.0	100.0	100.0	100.0	99.5	99.6	100.0	100.0	100.0
Theodore Roosevelt	Visitor Center	—	—	—	100.0	100.0	100.0	100.0	99.3	99.5	100.0	74.2	100.0
Voyageurs	Sullivan Bay	95.2	—	—	100.0	100.0	100.0	100.0	99.1	99.6	100.0	100.0	100.0
Wind Cave	Visitor Center	—	—	—	100.0	100.0	76.7	82.0	99.6	76.5	76.7	98.4	100.0
Yellowstone	Old Faithful	—	—	—	100.0	100.0	100.0	100.0	—	—	—	—	—
Yellowstone	Water Tank	95.0	—	—	99.6	99.6	99.6	99.6	53.4	99.5	99.6	99.6	100.0
Yosemite	Merced River	94.2	—	—	100.0	100.0	100.0	100.0	99.4	—	—	100.0	—
Yosemite	Turtleback Dome	95.3	—	—	100.0	100.0	100.0	100.0	99.2	99.1	100.0	100.0	100.0
Zion	Dalton's Wash	95.3	—	—	100.0	100.0	100.0	100.0	99.2	—	—	100.0	—
Average Network Data Collection		94.6	95.5	95.5	98.8	99.4	99.2	98.3	96.0	98.4	98.8	98.8	99.0

Key:
O3 = Ozone Analyzer
SO2 = Sulfur Dioxide Analyzer
SO2Add = Sulfur Dioxide Analyzer
VWD = Vector Wind Direction
SWS = Scalar Wind Speed
TMP = Ambient Temperature
RH = Relative Humidity
RNF = Precipitation
WET = Wetness Sensor
DTP = Delta Temperature
SOL = Solar Radition
FLOW = Filter Pack Flow Rate

Performance Goals:

Monthly Criteria:
100% of sites, >= 60% valid data capture
90% of sites, >= 75% valid data capture
80% of sites, >= 85% valid data capture

Quarterly Criteria:
100% of sites, >= 85% valid data capture
90% of sites, >= 90% valid data capture
80% of sites, >= 95% valid data capture

1. Percent valid can be less than 100% due to calibrations, routine maintenance, power failures, audits or other circumstances where the instrument was not available to collect data. For example, automatic zeros and spans are performed daily on most ambient gas analyzers; therefore, no ambient gas data can be collected during this time. As a result, the maximum percent valid for ambient gas data typically cannot be greater than 95.8. Percent valid can also be less than 100% due to influencing factors such as instrument error, operator error, timing problems, flow issues, and other factors that affect instrument operation.

Color shading key:
- Acceptable: indicates data recovery of 85% - 100%
- Marginal: indicates data recovery of 75% - 84.9%
- Low: indicates data recovery of 60% - 74.9%
- Unacceptable: indicates data recovery of 0% - 59.9%

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Figure 4-2. Example Data Collection Statistics by Site for All Parameters.

Summary of Ozone Data by Site
05/01/2005 - 05/31/2005
National Park Service Gaseous Pollutant Monitoring Program

National Park Unit	Site Name	4 Highest Daily Maximum 8-Hour Average Concentrations[1] (ppb) 1st Highest	2nd Highest	3rd Highest	4th Highest	# Days with 8-Hour Average O3 Values >=85 ppb[3]	Highest Daily Maximum 1-Hour Average Concentrations [2] (ppb) 1st Highest	# Days with 1-Hour Average O3 Values >=125 ppb
Rocky Mountain	Longs Peak Ranger Station	73	66	65	62	0	82	0
Sequoia and Kings Canyon	Ash Mountain	90	89	80	78	2	98	0
Sequoia and Kings Canyon	Lower Kaweah	85	83	77	74	1	94	0
Shenandoah	Big Meadows	81	77	76	71	0	84	0
Voyageurs	Sullivan Bay	66	65	63	61	0	70	0
Yellowstone	Water Tank	58	56	55	55	0	61	0
Yosemite	Merced River	49	44	43	41	0	57	0
Yosemite	Turtleback Dome	71	66	62	61	0	84	0
Zion	Dalton's Wash	73	71	68	66	0	77	0

1. The primary and secondary National Ambient Air Quality Standard for ozone is 0.08 ppm over an 8-hour period. (Attainment of the primary standard is reached if the annual fourth highest daily maximum 8-hour ozone concentration, averaged over three years, does not exceed 0.08 ppm, 84 ppb, or 157 μg/m³.) (40 CFR 50.10 with reference to Appendix D and I.)

2. The primary and secondary National Ambient Air Quality Standard for ozone is 0.12 ppm over a 1-hour period not to be exceeded more than once per year. (A value greater than 0.12 ppm, 124 ppb, or 235 μg/m³.) (40 CFR 50.9 with reference to Appendix D and H.)

3. An exceedance of the National Ambient Air Quality Standard for ozone occurs when an 8-hour average ozone conentration exceeds 0.08 ppm, 84 ppb, or 157μg/m³. (40 CFR 50.10 with reference to Appendix D and I.)

Figure 4-3. Example Summary of Ozone Data by Site.

Summary of Sulfur Dioxide Data by Site
05/01/2005 - 05/31/2005
National Park Service Gaseous Pollutant Monitoring Program

National Park Unit	Site Name	Highest Hourly Average Concentration (ppb)	Highest Daily Maximum 3-Hour Average Concentrations[1] (ppb) 1st Highest	# Days with 3-Hour Average SO2 Values >=550	Highest Daily Maximum 24-Hour Average Concentrations [2] (ppb) 1st Highest	# Days with 24-Hour Average SO2 Values >=145 ppb
Hawaii Volcanoes	Observatory - Additional	2372	1340.0	1	308.4	1
Hawaii Volcanoes	Visitor Center - Additional	1007	769.0	1	198.5	1
Shenandoah	Big Meadows	11	8.4	0	5.0	0

1. The secondary National Ambient Air Quality Standard for sulfur dioxide is 0.5 ppm over a 3-hour period not to be exceeded more than once per year. (A value greater than 0.5 ppm, 549 ppb, or 1300 μg/m³ exceeds the standard.) (40 CFR 50.5.)

2. The primary National Ambient Air Quality Standard for sulfur dioxide is 0.14 ppm over a 24-hour period not to be exceeded more than once per year. (A value greater than 0.14 ppm, 144 ppb, or 365 μg/m³ exceeds the standard.) (40 CFR 50.4.)

Figure 4-4. Example Summary of Sulfur Dioxide Data by Site.

Summary of Selected Meteorological Data by Site
05/01/2005 - 05/31/2005
National Park Service Gaseous Pollutant Monitoring Program

National Park Unit	Site Name	Wind Speed (Scalar) (m/s)	Ambient Temperature (degrees C)			Relative Humidity (%)			Precipitation (mm)
		Average	Average	Maximum	Minimum	Average	Maximum	Minimum	Accumulated during period
Mount Rainier	Tahoma Woods	0.9	11.9	31.7	3.7	84	100	15	158.4
North Cascades	Marblemount Ranger Station	1.6	13.8	33.3	5.9	73	100	12	104.2
Olympic	Portable Ozone	0.9	12.6	22.6	1.8	55	99	21	2.6
Padre Island	Portable Ozone	6.3	24.2	28.2	16.5	82	95	60	57.1
Petrified Forest	Horse Barn	4.3	17.8	32.4	3.1	30	80	7	0.3
Pinnacles	East Entrance Station	2.3	16.3	32.5	4.2	63	96	18	10.1
Rocky Mountain	Longs Peak Ranger Station	2.4	6.2	21.8	-11.2	56	99	11	61.6
Sequoia and Kings Canyon	Ash Mountain	2.5	17.9	30.7	4.8	57	94	32	95.2
Sequoia and Kings Canyon	Lower Kaweah	1.6	9.5	21.2	-3.1	81	100	25	131.3
Shenandoah	Big Meadows	2.5	10.0	21.8	-0.8	69	100	27	70.0
Theodore Roosevelt	Visitor Center	5.2	10.3	26.0	-4.9	64	100	20	130.2
Voyageurs	Sullivan Bay	2.8	10.3	27.1	-3.9	68	99	12	154.0
Wind Cave	Visitor Center	3.9	12.2	28.5	-5.3	56	98	16	41.0
Yellowstone	Old Faithful	2.0	5.5	17.6	-9.6	67	95	10	—
Yellowstone	Water Tank	1.5	3.9	16.0	-9.2	73	99	15	33.1
Yosemite	Merced River	0.3	11.0	24.4	1.7	75	97	32	73.4
Yosemite	Turtleback Dome	4.0	11.1	23.1	-0.4	66	99	24	147.6
Zion	Dalton's Wash	3.2	19.3	34.2	3.8	35	90	8	12.8

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Figure 4-5. Example Summary of Selected Meteorological Data by Site.

4.2.2 Generating a Monthly Data Report

The steps taken to generate each monthly data report are:

- Verify completion of preliminary data validation of the reported data.
- Print validated stackplots.
- Review stackplots for any data that should be invalidated.
- Update report text.
- Print report tables.
- Review reports.
- Make corrections.
- E-mail reports and post to project Web site; file a hardcopy original.

The following subsections explain how each step is accomplished.

4.2.2.1 Verifying Preliminary Validation Status

Before a monthly data report can be generated, Preliminary data validation must be complete. The validation status of each site is tracked in the AQDBMS Data Validation Log (see Figure 4-6).

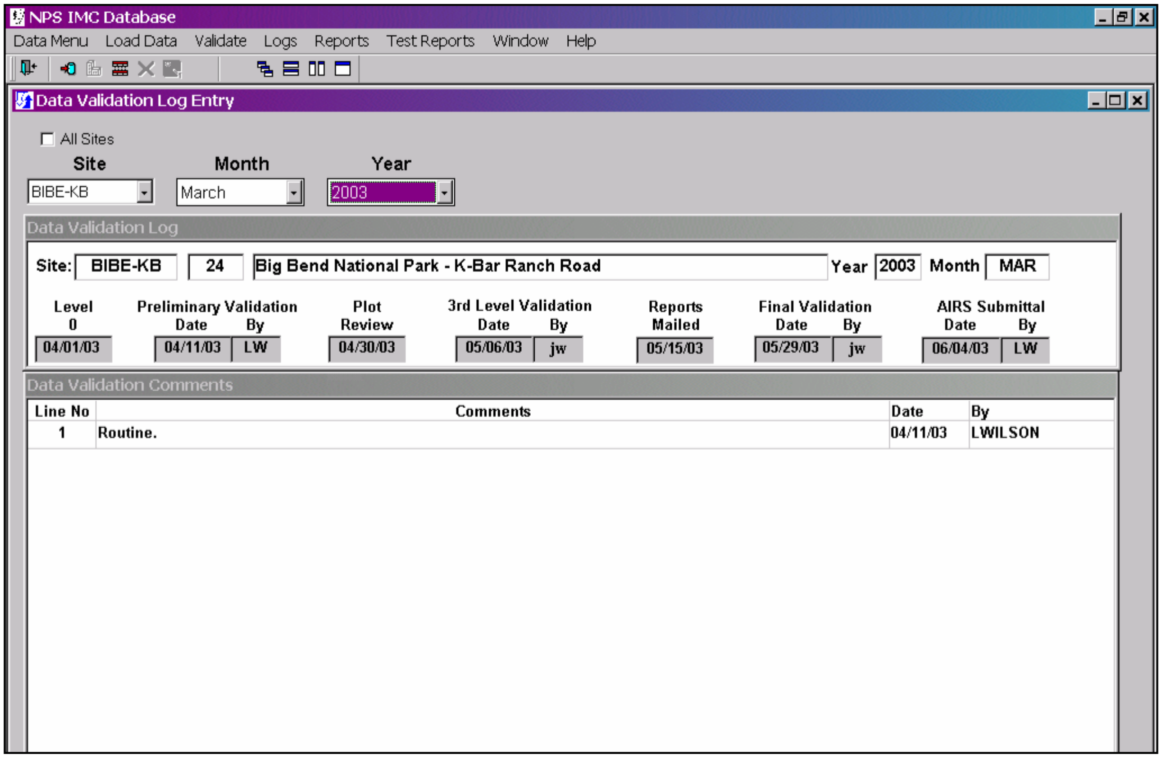

Figure 4-6. The Data Validation Log.

The Data Validation Log is used to track the completion of each major step of the validation process. The master record logs the initials of the IMC staff member completing each validation step and when the step occurred. The Comments Table logs comments regarding data validation. Most of the output programs query the Data Validation Log so the correct level of validation can be applied to the output .To use the Data Validation Log:

- Select **Logs-> Data Validation Log** from the AQ and Met Processing frame.

- Select a *site* from the Site drop-down box. If no records for the selected site exist, a “Site not Found” message is displayed. Click **OK**. Otherwise, the most recent Master Table record and related comments for the selected site are displayed.

- Select a different *month* and/or *year* from the drop-down list boxes to display previous month’s records for the site.

- Records can be added as usual.

4.2.2.2 Generating Report Tables

The Reports interface of the AQDBMS provides a single interface for producing various types of output products. The initial display of the reports interface is shown in Figure 4-7. A tab control is used to help the user select the specific input required for the selected product. The content of each tab updates dynamically to reflect the specific options available for the selected product. The interface allows the user to “Run” a job immediately or “Submit” jobs to a queue to later be run as a batch of jobs.

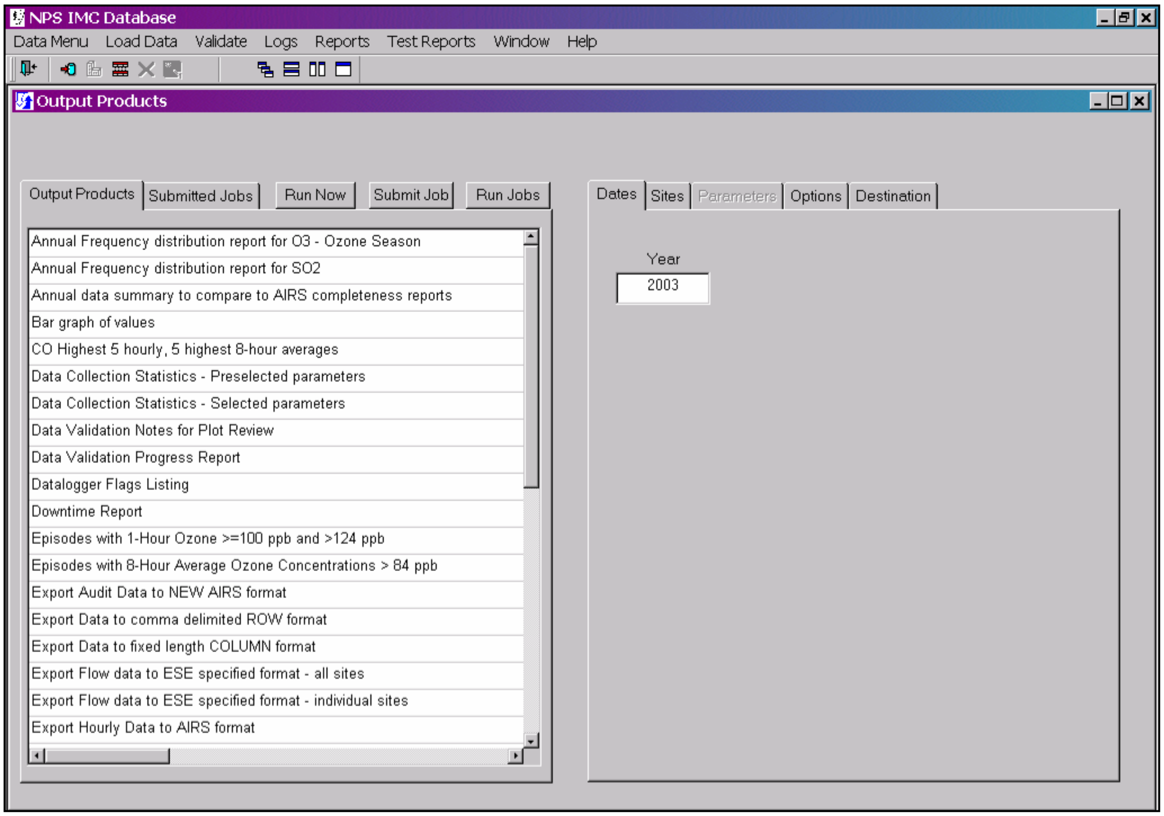

Figure 4-7. The Reports Interface.

To use the Reports interface:

- Select **Reports** from the AQ and Met Processing frame.
- Select a *product* to generate from the list displayed on the Output Products tab.
- Click on each *enabled tab* of the tab control (right side of screen) to input the required information and select *options* specific to the selected product.
- Click **Run Now** to run the job immediately or click **Submit Job** to add the job to the Submitted Jobs list.
- Click **Run Jobs** to begin running the jobs in the Submitted Jobs list.

The tab control on the right side of the Reports interface has five tab screens. Access to each screen is updated when the user selects a product in the Output Products list. If the tab is disabled, its content does not relate to the selected product. The tab screens are discussed below:

<u>The Dates tab</u> displays one or more fields for the user to input the desired time period of data to be included in the output product. Usually, there are Start Date and End Date fields that require dates in mm/dd/yyyy format. Other products may need only a year to be entered. Figure 4-8 shows the Dates tab screen.

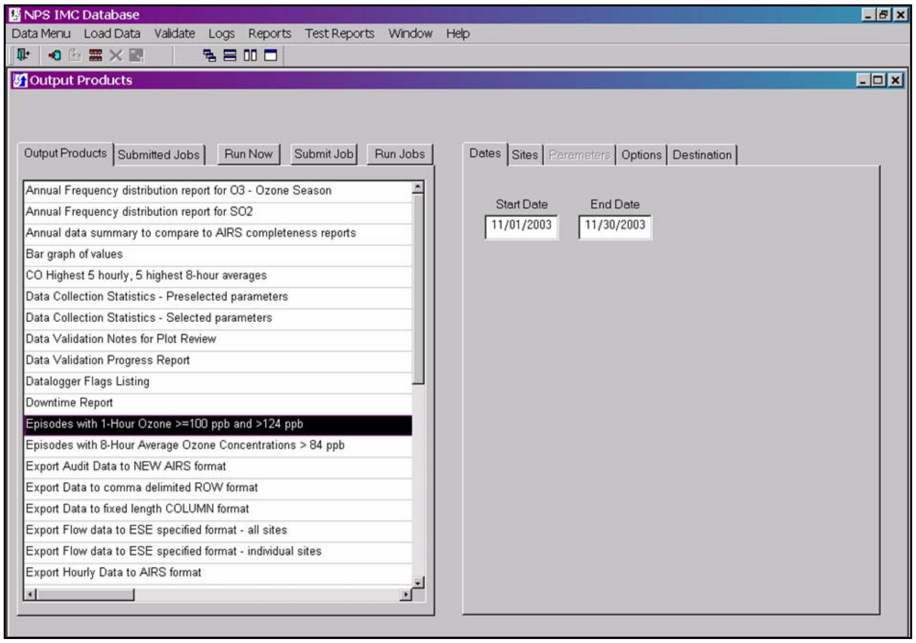

Figure 4-8. The Dates Tab.

<u>The Sites tab</u> displays a tree view of site groups as configured. Groups and/or individual sites can be selected to be included in the output job. Figure 4-9 shows the Sites tab screen.

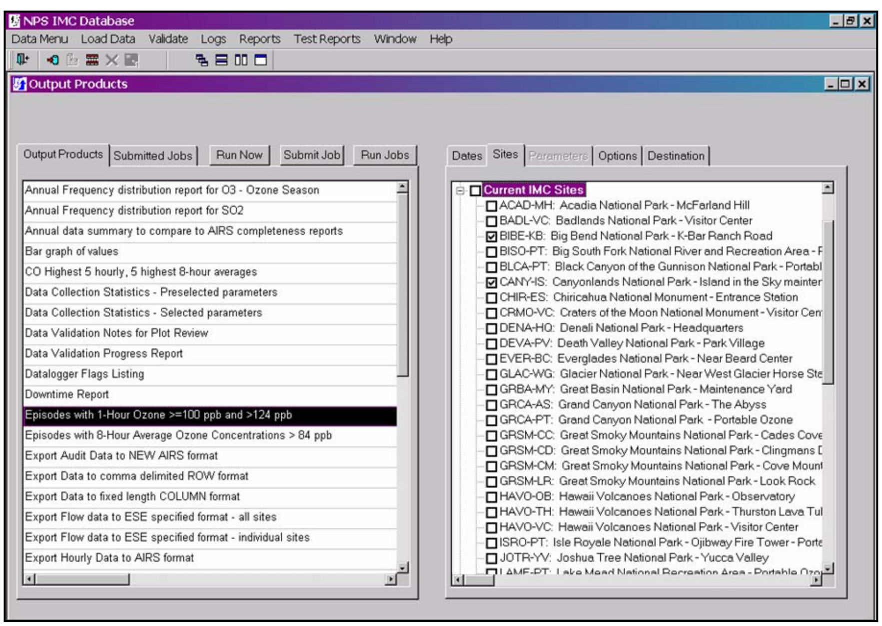

Figure 4-9. The Sites Tab.

<u>The Parameters tab</u> displays a list of all parameters as shown in Figure 4-10. The user can also choose the output units for each selected parameter and the output generator will convert the values as necessary. To choose output units:

- Click in the **Output Units** column of the selected parameter.
- From the drop-down list, select an available *Unit Code*.

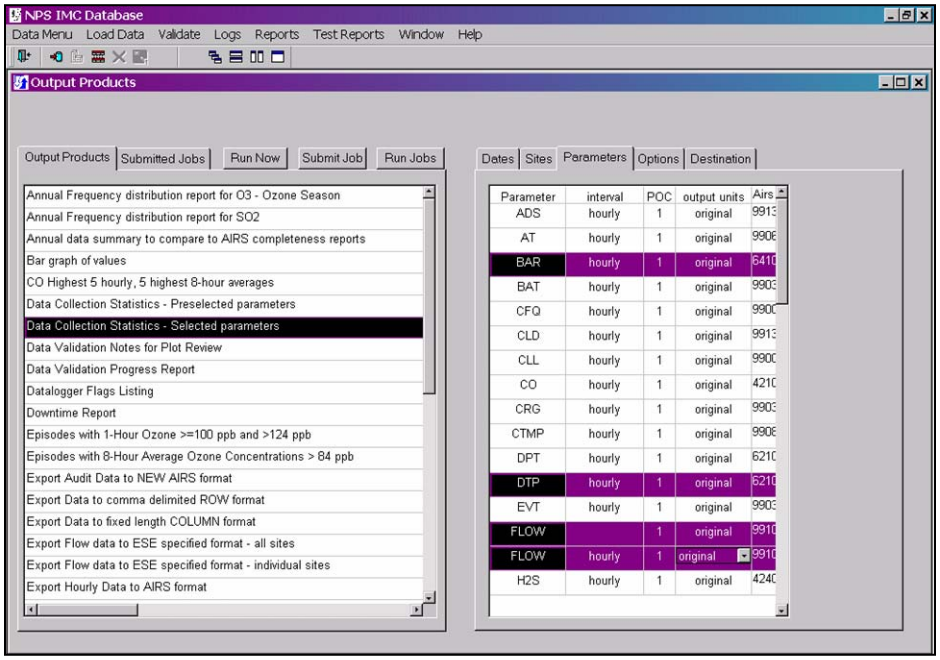

Figure 4-10. The Parameters Tab.

<u>The Options tab</u> displays additional options for the selected product. An example of the Options tab when the "Data Collection Statistics – Selected Parameters" product is selected is shown in Figure 4-11. Two sections are found on the page; Standard Options and Special Options. The Standard section includes the following:

- Radio buttons for selecting a Validation Level option. Select **Raw**, **Preliminary**, or **Final** to force the level to the selected option.
- A page number option to input a report page number.
- A checkbox to place all of the currently selected sites on one page or continuous output instead of separate pages or files for each site.

The Special Options section includes special options for the selected report. Examples of special options are:

- A Raw Data checkbox. Checking this box instructs the program to use raw data and not validated data in the product.

- Number of Values to list. Instructs the program to include the number of values entered on the product. For example, to list the top 10 Highest Hourly Averages.

- Other options exist, depending upon the report type.

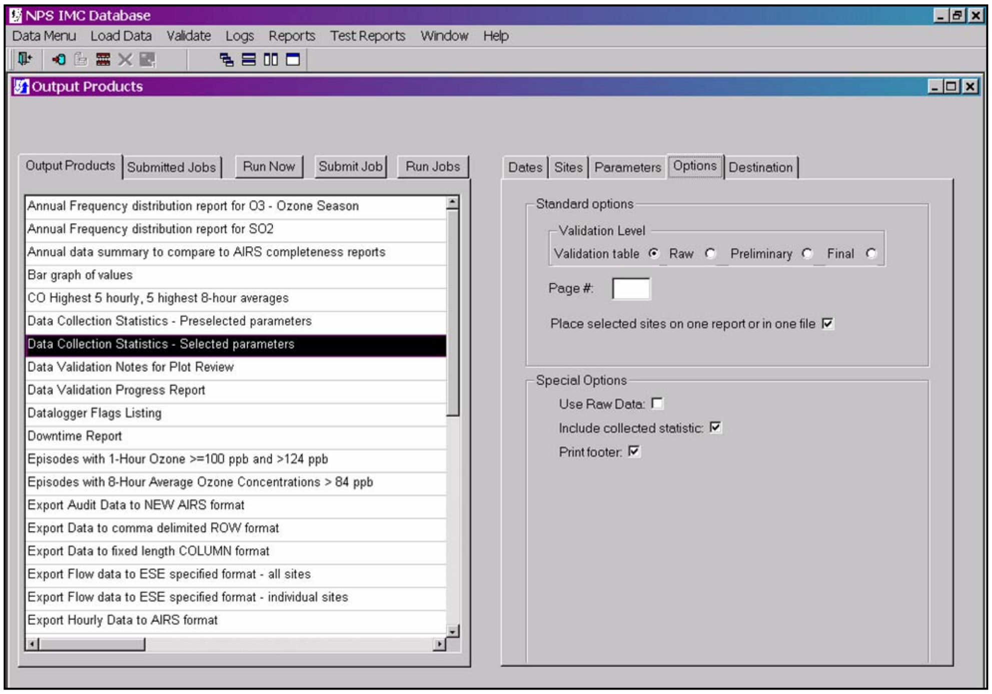

Figure 4-11. The Options Tab.

The Destinations tab displays options on the type of output to produce as shown in Figure 4-12. This tab updates dynamically depending on the product selected. Only the possible options for the selected product are enabled. More than one option can be selected. Destination options are:

- Output to screen. This option causes the output generator to pause after each product has been created and display the product on the screen before going onto the next. Click the **Print** button to send the output product to the printer. Click the **Continue** button to close the on-screen display.

- Output to printer. This option sends the output directly to the currently selected printer.

- Output to PDF file. This option uses the Adobe Portable Document File (PDF) Writer to create PDF files of the output. When the checkbox is selected, an input field displays prompting the user to enter a destination folder for the generated PDF files.

- Output to text file. This option writes the output to ASCII text files. When the checkbox is selected, an input field displays prompting the user to enter a destination folder for the text files.

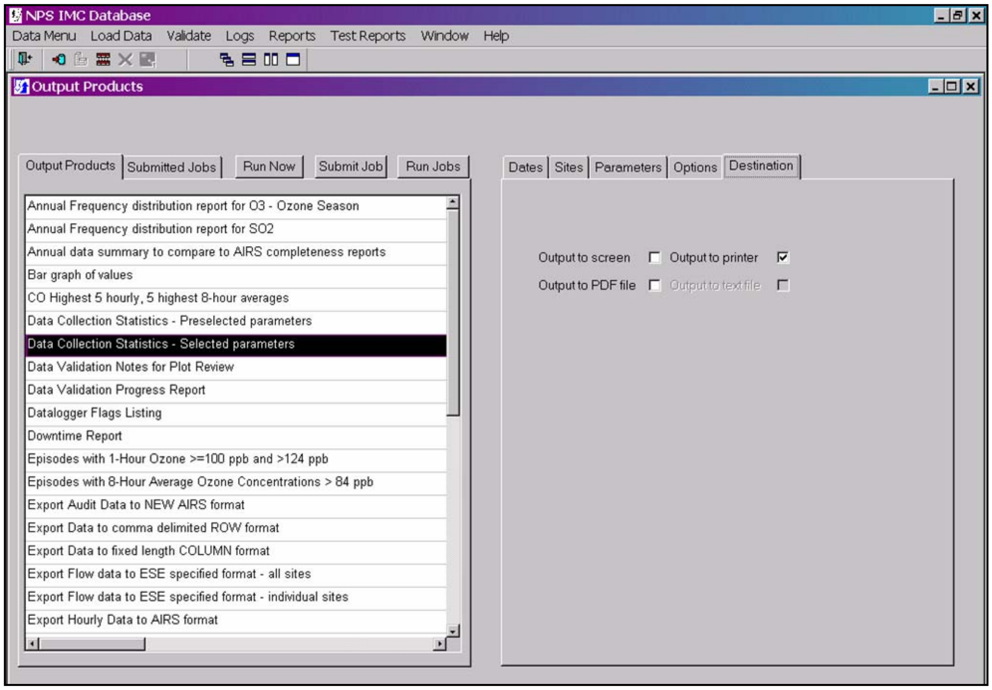

Figure 4-12. The Destinations Tab.

4.2.3 <u>Distributing Reports</u>

A hardcopy of each monthly data report is filed permanently in the IMC. Each report is e-mailed to:

- The site operators.
- The client project manager.
- Client air quality coordinators.
- A client administrative contact.

4.3 MONTHLY OZONE HIT LIST

4.3.1 Generating the Monthly Ozone Hit List

The monthly ozone "hit list" is a list of site-specific ozone 8-hour averages > 75 ppb. The list is generated from raw data at the end of every month during the ozone season (April through October). An example hit list is shown in Figure 4-13. Since the data have not yet been validated, a data analyst reviews the list and excludes values recorded during obvious non-ozone events such as daily zero/span calibrations.

To generate the ozone hit list, launch the IMC application:

- From the Reports menu, select **Episodes with 1-Hour Ozone Concentrations ≥ 100 ppb and > 124 ppb.**

  - Under the Dates tab, enter the *month* that just passed.
  - Under the Sites tab, select **Current IMC Sites**.
  - Under the Options tab, leave the defaults at *Validation Table* and *Place groups/sites on one report*.
  - Under the Output tab, select **Printer**.

- Review the report and check that all values in exceedence are real values and not calibrations, instrument warm-ups, or other problem. This is determined by viewing stackplots and looking at O3 and O3CAL values together in the validation area of the database. If there is an invalid exceedence, invalidate the hour(s) in the database temporarily with a "TI" (Temporarily Invalid) code.

- Run the report again and select **Printer and PDF file** (the files are placed in ARSNW1\ project\IMC\hitlist*year*). Double-check that all invalid values have been removed.

- Repeat the above three (3) steps with the report **Episodes with 8-Hour Average Ozone Concentrations > 75 ppb**.

- Run the report **Summer High Ozone List**. Direct the output to the printer (or screen, then select **Print**).

- Enter the values from the Summer High Ozone List report into the Word file at ARSNW1\project\IMC\Hitlist*year*\Hit List Chart *month*.doc. Update any changes to previous months that may have occurred since the last revision. Also update the revised date and validation levels for each month.

- E-mail files to the client and IMC personnel. See Section 4.3.2, *Distributing the Monthly Ozone Hit List* for details on the specific files distributed.

2008 Ozone Standard Exceedances

	April	May	June	July	Aug.	Sept.	Oct.	2008 Season		
*Validation Level **	2	2	2	2	2	2	2	Total Count	Max 8-hr O3 (ppb)	4th highest max. 8-hr O3 (ppb)
National Park	Count	Count	Count	Count	Count	Count	Count			
Acadia – Cadillac Mountain	0	0	0	2	0	0	0	2	90	74
Assateague Island – Maintenance Area	0	0	2	1	0	0	0	3	83	74
Cape Cod – State Monitor	0	0	1	2	0	0	0	3	106	75
Chamizal – State Monitor	0	0	1	0	1	1	0	3	84	73
Cowpens – State Monitor	1	0	2	1	1	0	0	6	85	79
Cumberland Gap – Hensley Settlement	0	0	1	0	0	0	0	1	76	70
Death Valley – Park Village	0	0	4	1	0	0	0	5	94	77
Denali – Headquarters	1	0	0	0	0	0	0	1	76	68
Great Basin – Maintenance Yard	1	0	0	0	0	0	0	1	76	71
Great Smoky Mountains – Cades Cove	0	1	0	0	0	0	0	1	78	71
Great Smoky Mountains – Clingmans Dome	1	1	3	4	0	0	0	9	86	80
Great Smoky Mountains – Cove Mountain	1	0	1	4	1	0	0	7	83	79
Great Smoky Mountains – Look Rock	1	4	1	4	4	0	0	14	87	82
Great Smoky Mountains – Purchase Knob	1	0	0	4	0	0	0	5	89	80
Joshua Tree – Black Rock	6	6	22	17	14	5	0	70	110	105
Joshua Tree – Cottonwood Canyon	1	3	10	3	0	0	0	17	88	84
Joshua Tree – Pinto Wells	3	5	3	2	0	0	0	13	85	82
Lassen Volcanic – Manzanita Lake Fire Stn.	0	0	6	2	0	0	0	8	104	83
Mammoth Cave – Houchin Meadow	0	0	0	0	0	0	0	0	73	70
Mojave – Kelso Mountains	2	5	11	12	3	2	0	35	100	86
Pinnacles – SW of East Entrance Stn.	0	0	4	5	0	3	0	12	94	86
Rocky Mountain – Long's Peak	0	2	0	2	0	0	0	4	81	76
Rocky Mountain – Trail Ridge	0	0	0	1	0	0	0	1	76	67
Saguaro – Pima County	0	0	1	0	0	0	0	1	80	74
Sequoia and Kings Canyon – Ash Mountain	0	11	19	19	4	17	4	74	121	112
Sequoia and Kings Canyon – Lower Kaweah	0	3	18	25	21	6	0	73	113	101
Shenandoah – Big Meadows	2	1	2	0	0	0	0	5	81	78
Yosemite – Mobile	0	0	4	8	3	3	0	18	102	83
Yosemite – School Yard	0	0	0	3	0	0	0	3	105	75
Yosemite – Turtleback Dome	1	1	12	10	6	5	0	35	102	94
Zion National Park – Dalton's Wash	1	0	0	0	0	0	0	1	76	72

*Validation level 0 indicates raw data. Validation level 1 indicates preliminary data. Validation level 2 indicates final, validated data.
Counts of days with 8-hr average ozone greater than 75 ppb may change after the data is fully validated.
The ozone season runs from April to October for the detailed current ozone conditions. During the winter, more limited numbers of locations and web products are available.

Good
Moderate
Unhealthy for Sensitive Groups
Unhealthy
Very Unhealthy

†The current NAAQS is 0.075 parts per million (ppm), daily maximum 8-hour average. The ozone standard is exceeded at an ambient air quality monitoring site when the 3-year average of the annual fourth-highest daily maximum 8-hour average ozone concentration is greater than 0.075 ppm, which occurs when the 3-year average equals or exceeds 0.076 ppm (76 parts per billion or ppb).

Figure 4-13. Example Ozone Hit List.

- Continue updates at the beginning of each month until all data are final through October.

- When data are finalized through October, run an inclusive report of both the 1-hour and 8-hour reports for April through October, and a final hit list chart. Name the report files as *yyyy Final 1-hr.pdf* and *yyyy Final 8-hr.pdf*, and the name the hit list chart *Final Hit List Chart yyyy.doc* and *Final Hit List Chart yyyy.html* (with yyyy being the year being reported). Distribute the files by e-mail (see Section 4.3.2), and add final reports to the Hitlist Notebook.

4.3.2 Distributing the Monthly Ozone Hit List

The hit list is completed at the beginning of each month following the ozone months of April through October, and forwarded to the client by the 5th of the month. The monthly ozone hit list is distributed by e-mail to the client and cc'd to:

- The IMC section manager.
- The field maintenance group section manager.
- Each member of the IMC staff.

Three files are e-mailed:

- Summer High Ozone List.doc
- Episodes with 1-Hour Ozone Concentrations ≥ 100 ppb and > 124 ppb for current month
- Episodes with 8-Hour Average Ozone Concentrations > 75 ppb for current month

5.0 REFERENCES

Air Resource Specialists, Inc. (ARS), 2001, Air Quality Data Base Management System (AQDBMS) User's Guide.

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA – ANNUAL REPORTING**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3550-5100**
DATE	**MARCH 1999**

AUTHORIZATIONS		
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PROJECT MANAGER	Jessica Ward	Jessica Ward
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change all procedures for the DataView system	January 2001	G. Mercer
	Reviewed; no changes necessary.	January 2002	G. Mercer
	Reviewed; no changes necessary.	January 2003	G. Mercer
2.0	Change in report products and distribution.	January 2005	G. Mercer
2.1	Delete plotting procedures.	January 2006	G. Mercer
3.0	Changes to report contents.	January 2007	G. Mercer
3.1	Change QA to a separate, supplemental report.	January 2008	G. Mercer
4.0	Changed report products and distribution.	January 2009	G. Mercer
	-- continued --		

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
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TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3550-5100**
DATE	**MARCH 1999**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
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COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
	Reviewed; no changes necessary.	February 2010	G. Mercer
	Reviewed; no changes necessary.	April 2011	G. Mercer

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF FIGURES (continued)

1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the steps of producing ambient air quality and meteorological annual data reports, and is referenced from SOP 3550, *Ambient Air Quality and Meteorological Monitoring Data Reporting*. Annual data summary reports highlight the average range and frequency of data collected at monitoring sites during the year. These summaries provide information on the status and trends of air quality conditions and help determine if a site is exceeding the National Ambient Air Quality Standards (NAAQS) established by the U.S. Environmental Protection Agency (EPA). Reports may be network-specific and include all sites where monitoring occurred during the reported year, or they might be for an individual station only. By request, data from specific non-network sites are included in annual reports.

Reports are distributed within the timeframe set by the sponsoring organization and are reported only after final data validation and a year-end annual data review has occurred. Refer to SOP 3450, *Ambient Air Quality and Meteorological Monitoring Data Validation*, for a full explanation of validation procedures and levels.

2.0 RESPONSIBILITIES

2.1 INFORMATION MANAGEMENT CENTER SECTION MANAGER

The Information Management Center section manager shall:

- Oversee all reporting preparation and provide direction as necessary.
- Review draft and final data reports for completeness and accuracy.
- Verify that completed reports are properly distributed.

2.2 DATA ANALYST

The data analyst shall:

- Verify that data validation has been successfully completed for the reporting period.
- Compile data statistics and prepare plots and graphics.
- Create the annual data report.
- Prepare a CD or DVD of the annual validated data for delivery with the annual data report.

2.3 TECHNICAL ASSISTANT

The technical assistant shall:

- Assemble and organize the information for the data report.
- Prepare annual data reports and forward to the project manager for review.
- Distribute the reports and associated data to the sponsoring agency and other project personnel as directed.

3.0 REQUIRED EQUIPMENT AND MATERIALS

Detailed descriptions of all IMC hardware and software, and monitoring station hardware requirements are presented by category in SOP 3340, *Information Management Center (IMC) Concept and Configuration*. The IMC requires the following hardware and software for Final validation of ambient air quality and meteorological data:

- IMC hardware:
  - Hardware specifications for IMC servers
  - Hardware specifications for workstations
  - IMC computer support hardware:
    - High-quality laser printer
- IMC AQDBMS software:
  - Oracle Database System
  - AQDBMS custom software:
    - Data validation and reporting software
    - Network operating system and support software

4.0 METHODS

One annual data report for each site or network is generated for each year of operation. The annual reports generally follow calendar years, but may differ for specific projects. This section contains the following three (3) major subsections:

4.1 Annual Data Report Contents
4.2 Generating Annual Data Reports
4.3 Distributing Annual Data Reports

4.1 ANNUAL DATA REPORT CONTENTS

Before generating report contents, the sponsoring organization determines the sites to be reported and the output that needs to be included in the report. Annual reporting of ambient air quality and meteorological monitoring includes a discussion of the background of the monitoring program and its objectives, and a discussion of the locations and parameters measured.

Air Resource Specialists', Inc. (ARS) Information Management Center (IMC) prepares and distributes some or all of the following report products:

- Operational timelines for each site
- Collection statistics for all parameters (see Figure 4-1)
- Stackplots of hourly averages of all monitored parameters (see Figure 4-2)
- Wind roses (for each monitoring height) (see Figure 4-3)

- Pollution roses for each monitored air quality parameter
- Summary of gaseous data by site
- Pollutant violation summaries (see Figure 4-4)
- Resource injury indices
- Maps displaying pollutant levels at sites within a network (see Figure 4-5)
- Bar charts displaying pollutant concentrations
- Summary of particulate data by site
- Summary of meteorological data by site (see Figure 4-6)
- Summary of quality assurance/quality control documentation

Figures 4-1 through 4-6 present example report products.

Data Collection Statistics
Campbell County Wyoming

Final Validation
07/01/2006 - 09/30/2006

Parameter	Interval	Par Code	Data Recovery No. Possible	No. Collected	% Collected	Valid Data No. Valid	% Valid
Nitric Oxide	hourly	NO	2208	2021	91.5	2021	91.5
Nitrogen Dioxide	hourly	NO2	2208	2021	91.5	2021	91.5
Oxides of Nitrogen	hourly	NOX	2208	2021	91.5	2021	91.5
Ozone	hourly	O3	2208	2020	91.5	2020	91.5
Relative Humidity - external	hourly	RH	2208	2135	96.7	2135	96.7
Standard Deviation for Wind Direction	hourly	SDWD	2208	2136	96.7	2136	96.7
Station Temperature	hourly	STP	2208	2137	96.8	2137	96.8
Scalar Wind Speed	hourly	SWS	2208	2136	96.7	1820	82.4
Ambient Temperature (aspirated)	hourly	TMP	2208	2135	96.7	2135	96.7
Vector Wind Direction	hourly	VWD	2208	2136	96.7	2136	96.7

Notes: The percent valid is calculated against the number possible.
Automatic zeros and spans are performed daily on most ambient gas analyzers, therefore, no ambient data can be collected during this time. As a result, the maximum percent valid for ambient gas data typically can not be greater than 95.8.

Performance Goals:

Quarterly Criteria:	Monthly Criteria:
100% of sites, >= 85% valid data capture	100% of sites, >= 60% valid data capture
90% of sites, >= 90% valid data capture	90% of sites, >= 75% valid data capture
80% of sites, >= 95% valid data capture	80% of sites, >= 85% valid data capture

Final Validation 11/16/2006

Figure 4-1. Example Collection Statistics Summary.

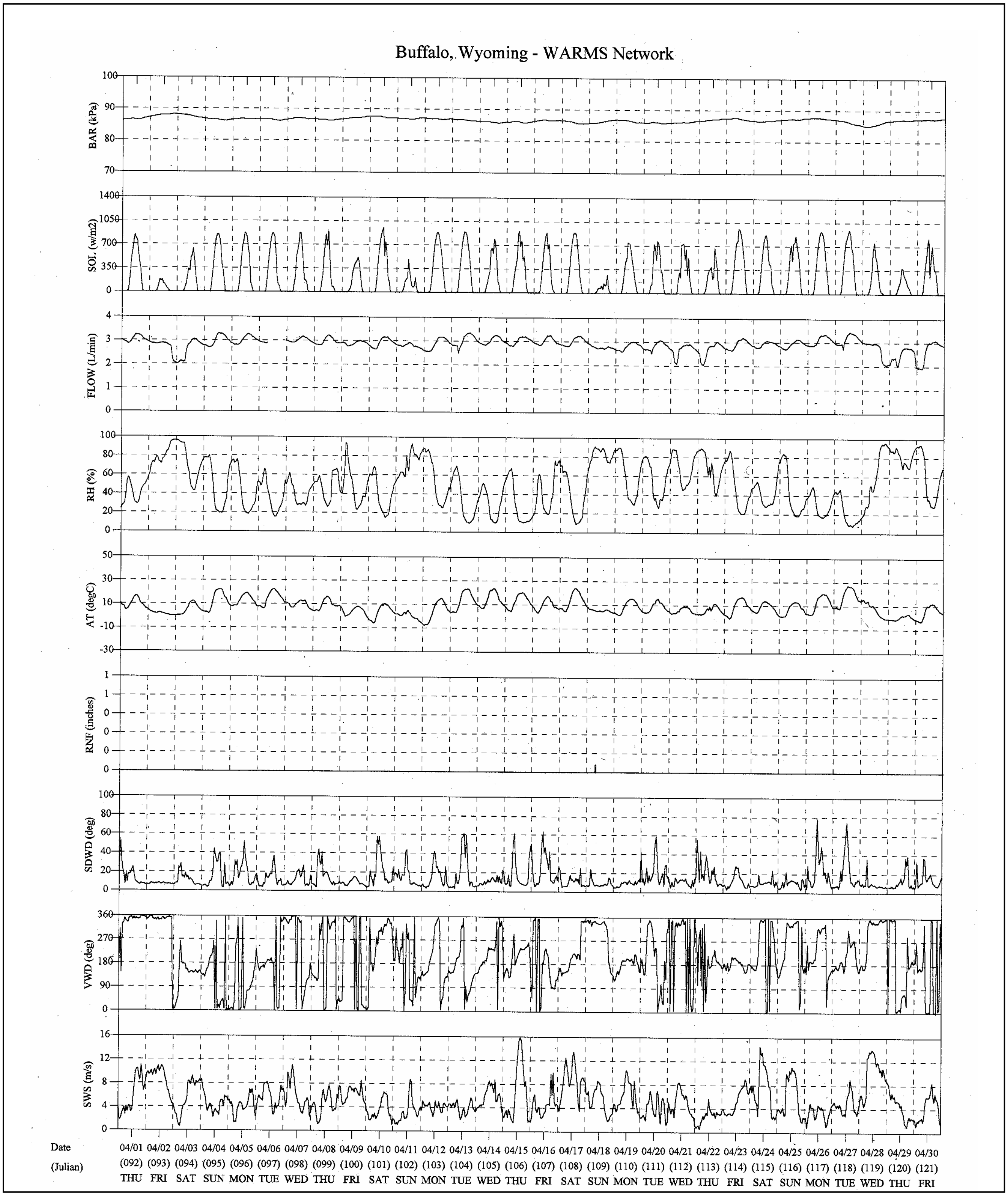

Figure 4-2. Example Stackplot of Monitored Parameters.

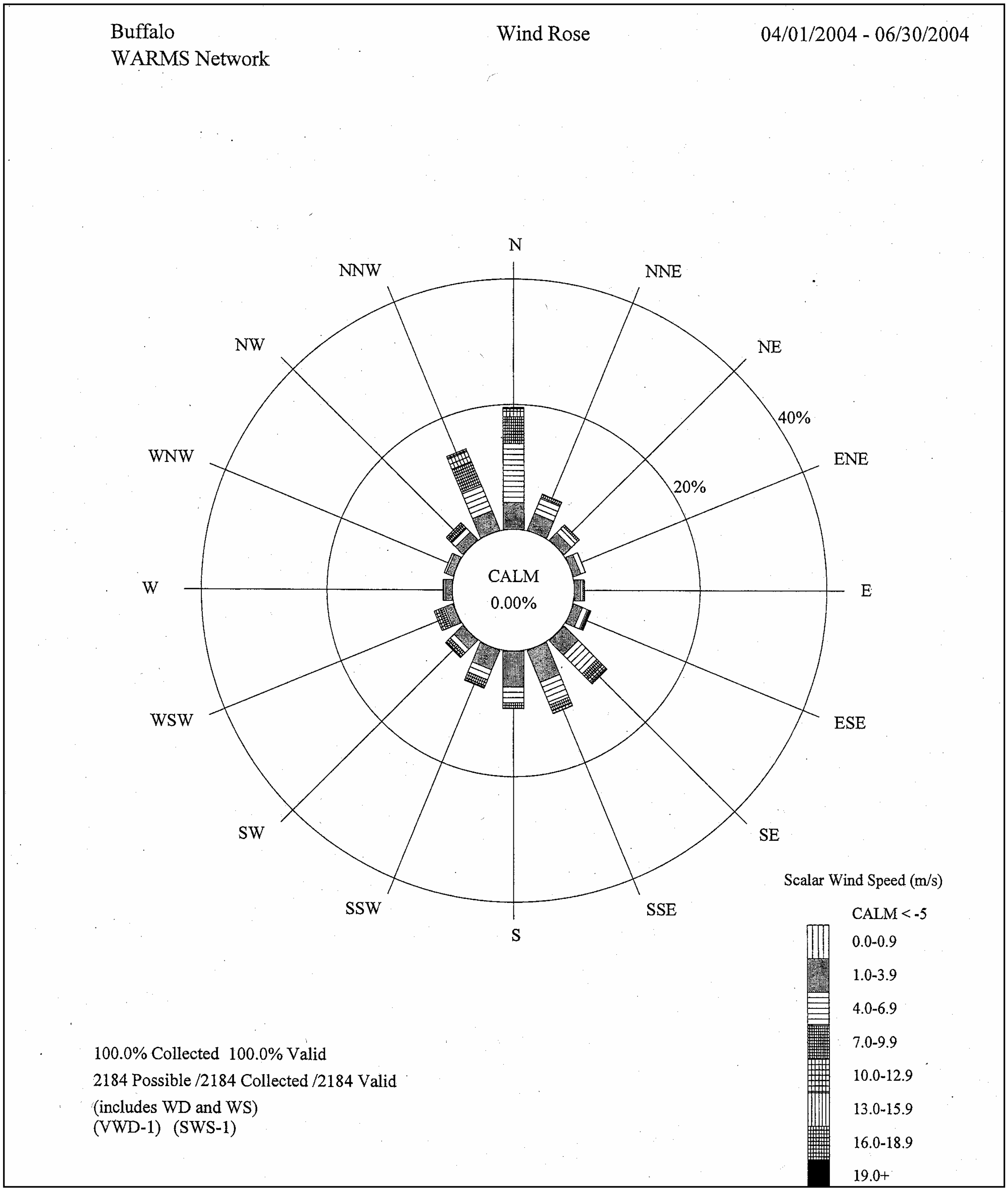

Figure 4-3. Example Wind Rose Summary.

Table 2. 2007 Summary of 8-hour average ozone concentrations (ppb).

National Park Unit	Site Name	Valid Number of Days	1st Highest	2nd Highest	3rd Highest	4th Highest[a]	5th Highest	# Days with 8-Hour Average O_3 Values ≥85 ppb[a]
Sites operated by the National Park Service								
Badlands	Visitor Center	363	68	65	65	64	64	0
Big Bend	K-Bar Ranch Road	355	72	72	71	68	67	0
Canyonlands	Island in the Sky	339	74	74	73	72	71	0
Chiricahua	Entrance Station	352	73	70	68	67	67	0
Craters of the Moon	Visitor Center	220	71	68	67	67	65	0
Death Valley	Park Village	351	94	91	91	85	85	6
Denali	Headquarters	348	55	55	53	53	53	0
Glacier	West Glacier Horse Stables	339	59	54	54	54	54	0
Grand Canyon	The Abyss	352	72	70	70	69	69	0
Great Basin	Maintenance Yard	348	82	80	78	75	75	0
Great Smoky Mountains	Clingmans Dome	174	92	90	88	87	87	9
Great Smoky Mountains	Cove Mountain	360	89	89	88	88	86	5
Great Smoky Mountains	Look Rock	363	96	95	92	88	87	11
Joshua Tree	Black Rock	341	106	105	104	104	103	40
Joshua Tree	Cottonwood Canyon	281	82	78	76	76	75	0
Lassen Volcanic	Manzanita Lake Fire Station	362	78	77	76	76	73	0
Mammoth Cave	Houchin Meadow	359	84	84	83	82	82	0
Mesa Verde	Resource Management Area	356	72	71	71	70	69	0
Mount Rainier	Tahoma Woods	342	65	62	61	58	54	0
North Cascades	Marblemount Ranger Stn	354	57	51	50	48	48	0
Petrified Forest	South Entrance	278	74	71	69	69	68	0
Pinnacles	SW of East Entrance Station	361	83	77	76	75	74	0
Rocky Mountain	Long's Peak	335	79	79	78	78	77	0
Sequoia and Kings Canyon	Ash Mountain	238	102	102	102	99	98	44
Sequoia and Kings Canyon	Lower Kaweah	360	94	93	92	91	91	25
Shenandoah	Big Meadows	339	75	75	74	73	73	0
Voyageurs	Sullivan Bay	327	75	68	67	63	63	0
Yellowstone	Water Tank	347	69	67	66	65	64	0
Yosemite	Turtleback Dome	334	97	92	92	88	88	8
Zion	Dalton's Wash	305	77	77	71	71	70	0

[a] The primary and secondary National Ambient Air Quality Standard for ozone is 0.08 ppm over an 8-hour period. (An exceedance of the standard occurs when an 8-hour average ozone concentration is greater than or equal to 85 ppb. A violation of the standard occurs when the 3-year average of the fourth highest daily maximum 8-hour average ozone concentration equals or exceeds 85 ppb.) Exceedances of the standard are highlighted here in orange or red.

Note: The color coding break points follow the color categories used on the EPA's AIRNow Web Site (*http://www.airnow.gov*). Dashed lines represent no data available at that site.

Operating agency key: plain text = site operated by the National Park Service; *italics* = site operated by a state agency; underline = site operated by the National Park Service, but consisting of non-EPA certified portable instrumentation

Color shading key: 4th highest 8-hour average: (yellow) = 85 - 105 ppb ozone concentration; (orange) > 105 ppb ozone concentration. # days with 8-hour average ≥85 ppb: (yellow) = 4 - 10 days; (orange) > 10 days

Note: On March 12, 2008, the EPA revised the ozone standard from 0.08 ppm to 75 ppb. 8-hour average ozone concentrations > 75 ppb will exceed the new ozone standard.

Figure 4-4. Example Pollutant Violation Summary.

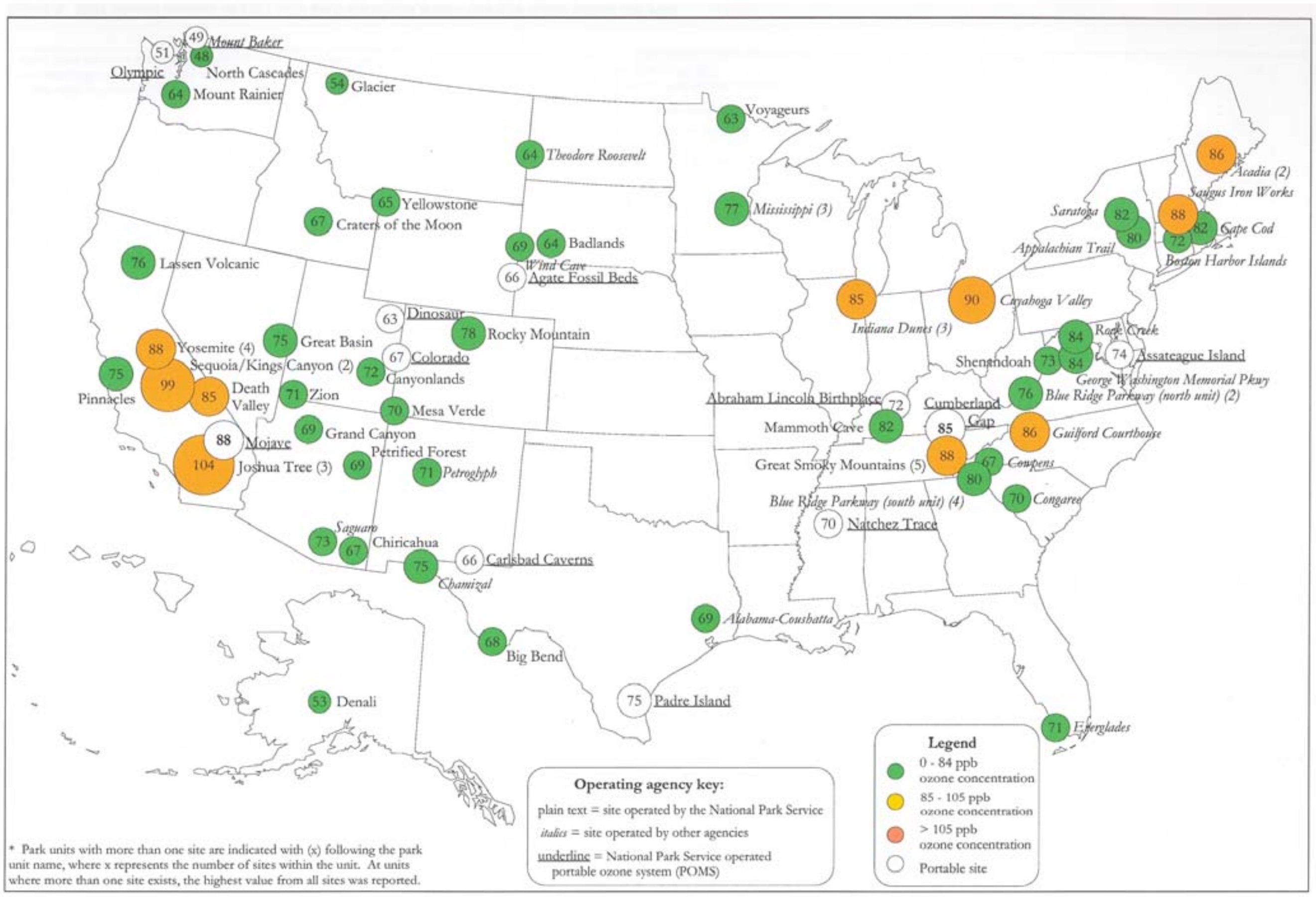

Figure 4-5. Example Map of Pollutant Levels at Network Sites.

Summary of Selected Meteorological Data

Rocky Mountain Steel Mill - Pueblo

Final Validation

09/01/2006 - 11/30/2006

Parameter	Value	Units	Number	Std Dev
SCALAR WIND SPEED				
Average	2.4	m/s	2166	1.5
Maximum	9.5	m/s		
Percent calm = 1.94				
AMBIENT TEMPERATURE				
Average	10.9	degC	2166	8.0
Maximum	28.8	degC		
Minimum	-15.6	degC		
RELATIVE HUMIDITY				
Average	55	percent	2171	23
Maximum	99	percent		
Minimum	7	percent		
PRECIPITATION (Rainfall or Snow melt)				
Average non-zero rate	1.4	mm/hr	51	1.9
Maximum non-zero rate	9.5	mm/hr		
Minimum non-zero rate	.3	mm/hr		
Accumulated during period	71.8	mm		
SOLAR RADIATION				
Average Daily Total	11,963,165	joules/m2day	69	4,412,544
Maximum Daily Total	18,817,200	joules/m2day		
Minimum Daily Total	716,400	joules/m2day		

Note: Calms are included in the average scalar wind speed and are defined as winds less than 0.5 m/s (1.0 mph).

Solar radiation terms are based on the calculation of the total amount of solar energy incident on a unit area during each day. The maximum and minimum daily totals are selected from the list of daily totals. The totals for all days are then added and divided by the number of days to yield the average daily total. Only days with 24 valid values are included in these statistics.

NA indicates instrument not available.

Final Validation 01/05/2007

Figure 4-6. Example Meteorological Data Summary.

4.2 GENERATING ANNUAL DATA REPORTS

The main steps taken to produce each annual data summary report are:

- Verify completion of final data validation of the reported data.
- Determine the specific contents needed for the report.
- Generate and compile the contents of the report.
- Review the report.
- Make corrections and regenerate affected contents.
- Distribute the reports.

The following subsections explain how each step is accomplished.

4.2.1 Verifying Preliminary Validation Status

Before an annual data report can be generated, Final data validation must be complete. The validation status of each site is tracked in the AQDBMS Data Validation Log (see Figure 4-7).

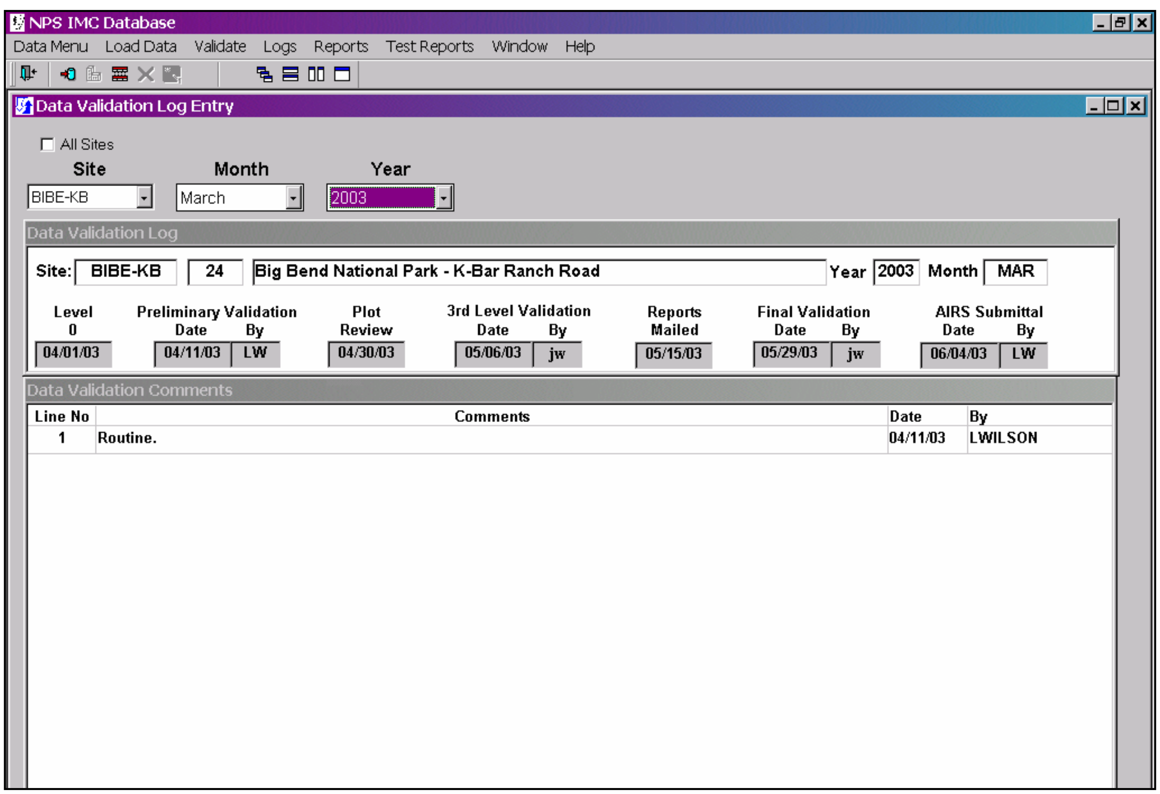

Figure 4-7. The Data Validation Log.

The Data Validation Log is used to track the completion of each major step of the validation process. The master record logs the initials of the IMC staff member completing each validation step and when the step occurred. The Comments Table logs comments regarding data validation. Most of the output programs query the Data Validation Log so the correct level of validation can be applied to the output. To use the Data Validation Log:

- Select **Logs-> Data Validation Log** from the AQ and Met Processing frame.
- Select a *site* from the Site drop-down box. If no records for the selected site exist, a "Site not Found" message is displayed. Click **OK**. Otherwise, the most recent Master Table record and related comments for the selected site are displayed.
- Select a different *month* and/or *year* from the drop-down list boxes to display previous month's records for the site.
- Records can be added as usual.

4.2.2 Generating Report Tables and Data Files

The Reports interface of the AQDBMS provides a single interface for producing various types of output products. The initial display of the reports interface is shown in Figure 4-8. A tab control is used to help the user input the specific input required for the selected product. The content of each tab page updates dynamically to reflect the specific options available for the selected product. The interface allows the user to "Run" a job immediately or "Submit" jobs to a queue to later be run as a batch of jobs.

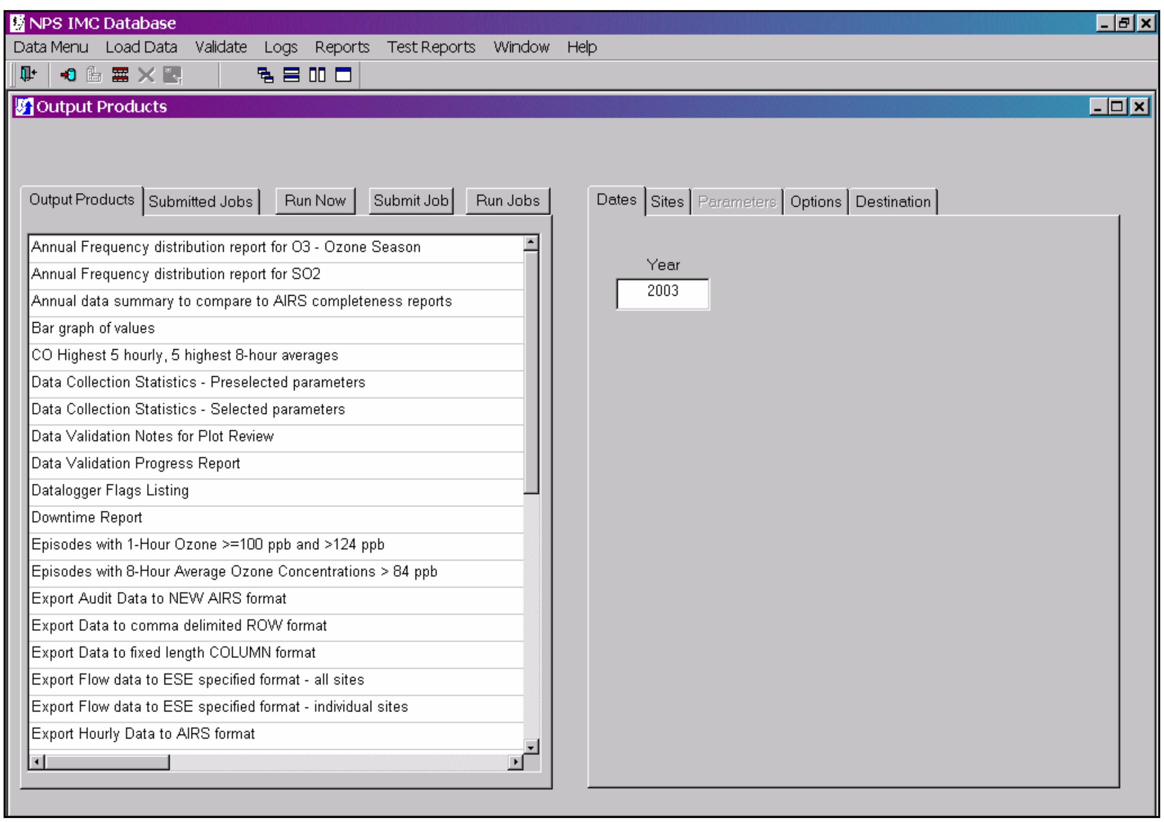

Figure 4-8. The Reports Interface.

To use the Reports interface:

- Select **Reports** from the AQ and Met Processing frame.

- Select a *product* to generate from the list displayed on the Output Products tab.

- Click on each *enabled tab* of the tab control (right side of screen) to input the required information and select *options* specific to the selected product.

- Click **Run Now** to run the job immediately or click **Submit Job** to add the job to the Submitted Jobs list.

- Click **Run Jobs** to begin running the jobs in the Submitted Jobs list.

The tab control on the right side of the Reports interface has five tab screens. Access to each screen is updated when the user selects a product in the Output Products list. If the tab is disabled, its content does not relate to the selected product. The tab screens are discussed below:

The Dates tab displays one or more fields for the user to input the desired time period of data to be included in the output product. Usually, there are Start Date and End Date fields that require dates in mm/dd/yyyy format. Other products may need only a year to be entered. Figure 4-9 shows the Dates tab screen.

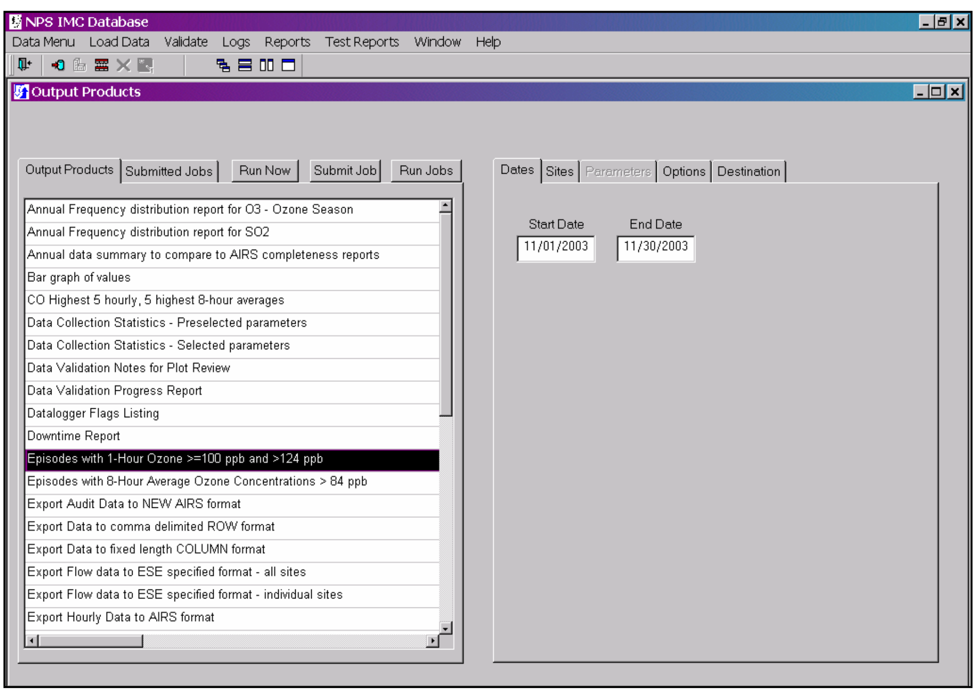

Figure 4-9. The Dates Tab.

The Sites tab displays a tree view of site groups as configured. Groups and/or individual sites can be selected to be included in the output job. Figure 4-10 shows the Sites tab screen. When generating annual report products for network summary reports, it is helpful to create an annual report sites group that includes all sites to be included in the annual report. To create a new sites group, select *Site Groups* from the Sites tab in the data collection and configuration portion of the AQDBMS. Right-click to add a new group, and copy and paste the desired sites from existing site groups into the new group.

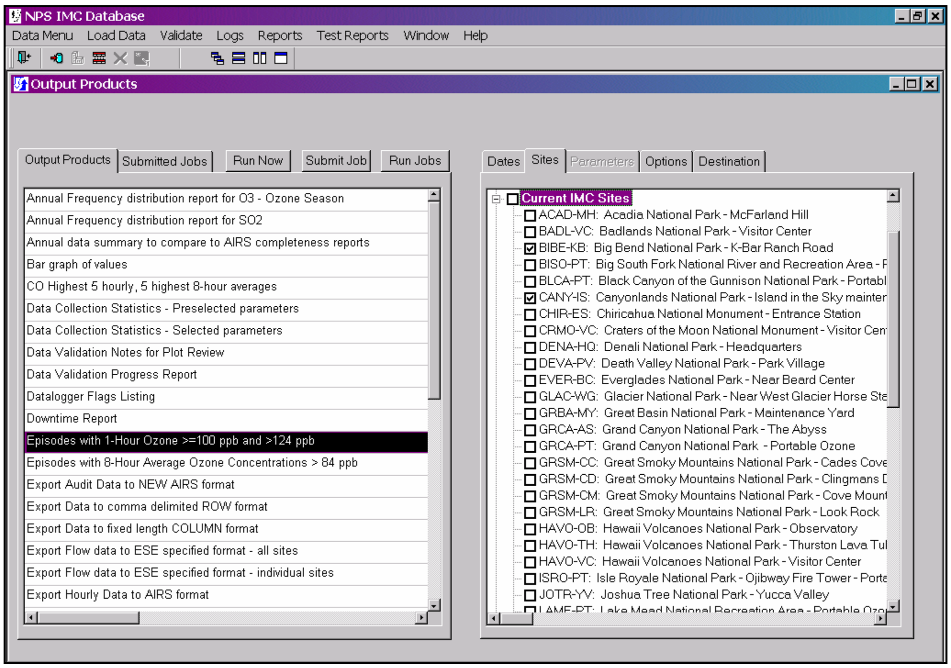

Figure 4-10. The Sites Tab.

The Parameters tab displays a list of all parameters as shown in Figure 4-11. The user can also choose the output units for each selected parameter and the output generator will convert the values as necessary. To choose output units:

- Click in the **Output Units** column of the selected parameter.
- From the drop-down list, select an available *Unit Code*.

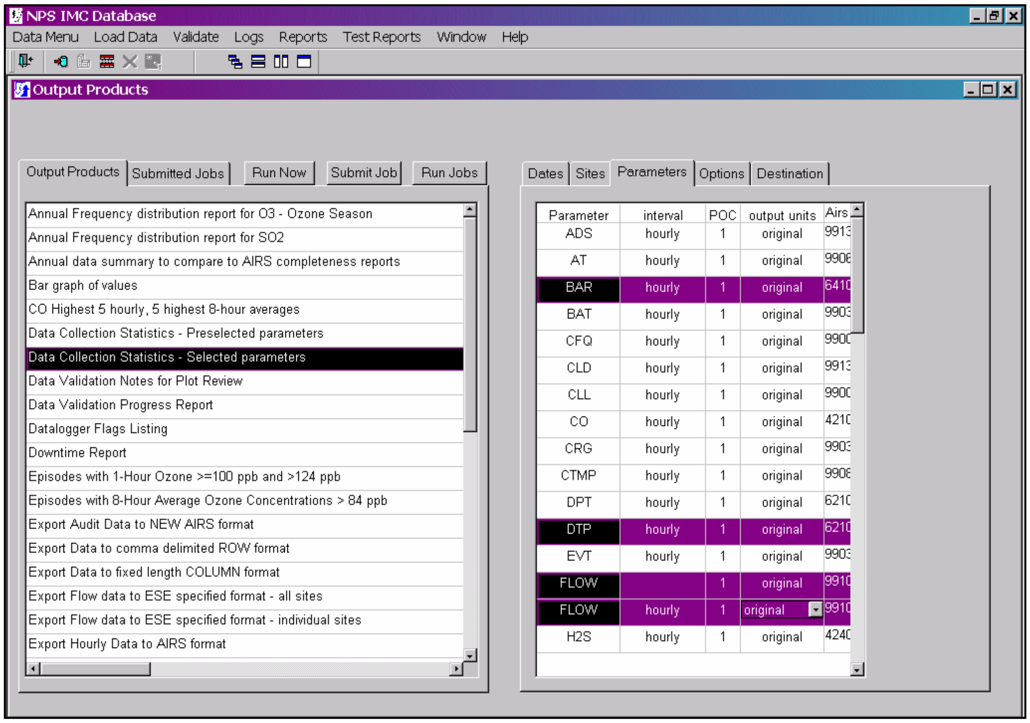

Figure 4-11. The Parameters Tab.

<u>The Options tab</u> displays additional options for the selected product. An example of the Options tab when the "Data Collection Statistics – Selected Parameters" product is selected is shown in Figure 4-12. Two sections are found on the page; Standard Options and Special Options. The Standard section includes the following:

- Radio buttons for selecting a Validation Level option. Select **Raw**, **Preliminary**, or **Final** to force the level to the selected option.

- A page number option to input a report page number.

- A checkbox to place all of the currently selected sites on one page or continuous output instead of separate pages or files for each site.

The Special Options section includes special options for the selected report. Examples of special options are:

- A Raw Data checkbox. Checking this box instructs the program to use raw data and not validated data in the product.

- Number of Values to list. This option instructs the program to include the number of values entered on the product. For example, to list the top 10 Highest Hourly Averages.

- Other options exist, depending upon the report type.

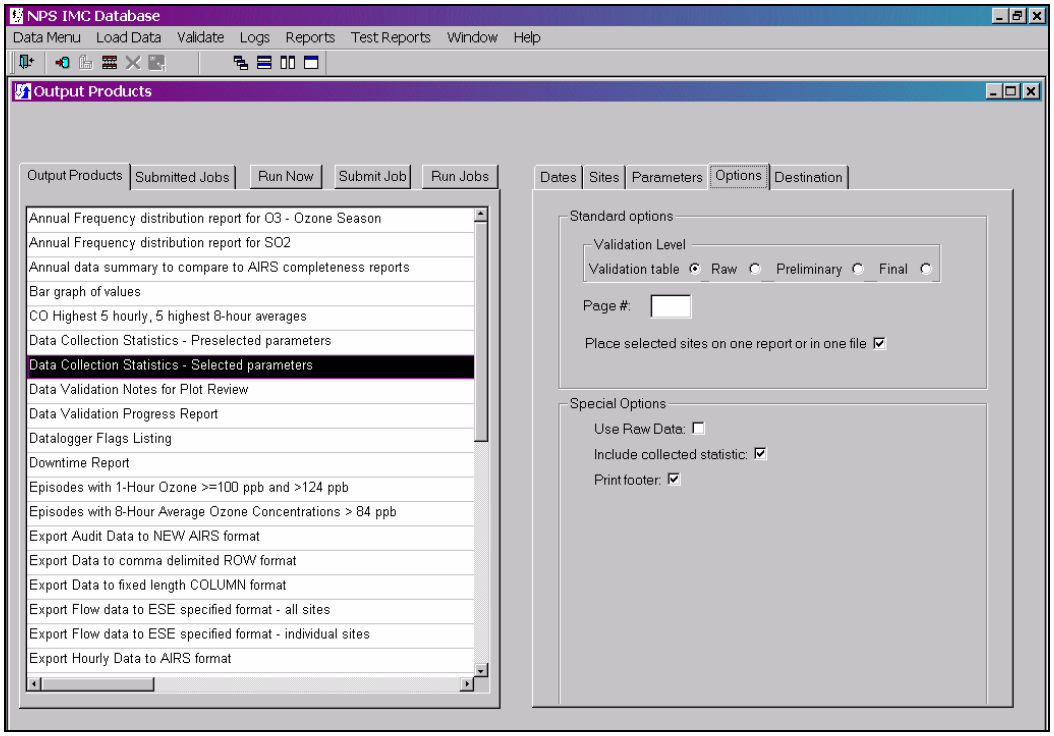

Figure 4-12. The Options Tab.

<u>The Destinations tab</u> displays options on the type of output to produce as shown in Figure 4-13. This tab updates dynamically depending on the product selected. Only the possible options for the selected product are enabled. More than one option can be selected. Destination options are:

- Output to screen. This option causes the output generator to pause after each product has been created and display the product on the screen before going onto the next. Click the **Print** button to send the output product to the printer. Click the **Continue** button to close the on-screen display.

- Output to printer. This option sends the output directly to the currently selected printer.

- Output to PDF file. This option uses the Adobe Portable Document File (PDF) Writer to create PDF files of the output. When the checkbox is selected, an input field displays prompting the user to enter a destination folder for the generated PDF files.

- Output to text file. This option writes the output to ASCII text files. When the checkbox is selected, an input field displays prompting the user to enter a destination folder for the text files.

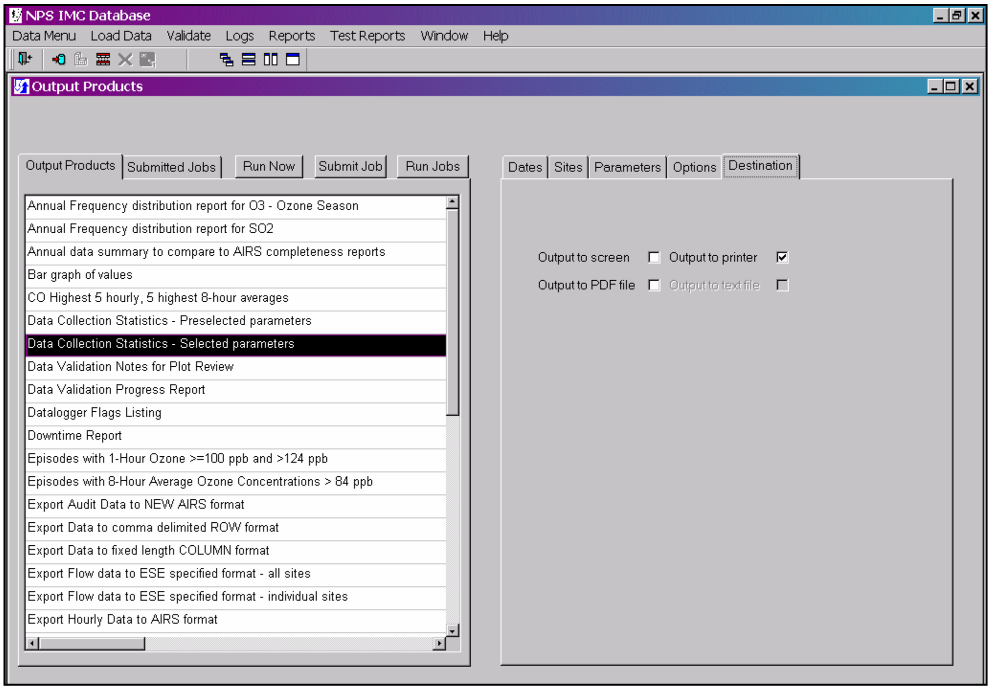

Figure 4-13. The Destinations Tab.

4.2.3 <u>Generating Report Maps</u>

Maps are generated by importing the latitude and longitude coordinates of each site from the AQDBMS Site Configuration Table into MapViewer mapping software. The site locations are plotted on a map of the United States along with their corresponding values that are being summarized on the map.

4.3 NON-NETWORK DATA

Sponsoring organizations may provide a list of non-network sites for inclusion in annual data summary reports. Data for these sites are collected, validated, and submitted to the EPA AQS database by other agencies. Data are retrieved from AQS and loaded into the AQDBMS to be included in the production of the annual data summary reports.

4.3.1 <u>Retrieving and Downloading Data From AQS</u>

The AQDBMS includes a program for loading data from Type 1 (one-hour average data) AQS records. Before the data can be imported, however, they must be retrieved and downloaded from the AQS. Refer to TI 3550-5300, *Submitting and Retrieving Ambient Air Quality and Meteorological Monitoring Data to the EPA AQS Database*.

4.3.2 Importing AQS Data into the AQDBMS

For all data from an AQS file to be successfully imported, site and parameter information must be defined in the AQDBMS database for the AQS codes encountered during the import. If the program finds undefined codes, an error message is written to a log file, and the undefined AQS record is written to a redo file. The data analyst then creates the necessary new records in the database tables and runs the program again until all data are imported without error. For instructions on adding site and parameter information to the AQDBMS see SOP 3650, *IMC Staff's Maintenance Responsibilities for the Ambient Air Quality Data Base Management System (AQDBMS).* Refer to Section 5.4, Importing Data From AQS Transaction Files, in the *Air Quality Data Base Management System (AQDBMS) User's Guide* (ARS, 2001) for instructions on importing a downloaded AQS file into the AQDBMS database.

4.4 REVIEWING REPORTS

Annual data summary reports are reviewed by at least three IMC staff or project-related personnel. If errors are found, corrections are made and the affected report contents are regenerated.

4.5 DISTRIBUTION

The reports are compiled, assembled, and copied for distribution. Copies are distributed as designated by sponsoring organization personnel. Copies may be hard copy or electronic on CD. A copy is also maintained by the project manager.

A digital copy of all validated data (and also raw data if requested) will be delivered to the sponsoring agency in conjunction with the quarterly data reports. The data will be provided on CD unless another media is requested by the sponsoring agency.

5.0 REFERENCES

Air Resource Specialists, Inc. (ARS), 2001, Air Quality Data Base Management System (AQDBMS) User's Guide.

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Fort Collins, CO 80525
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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**HANDLING REQUESTS FOR AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3550-5200**
DATE	**MARCH 1999**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Laura A. Wilson	Laura A Wilson
PROJECT MANAGER	Jessica Ward	Jessica Ward
PROGRAM MANAGER	David L. Dietrich	[illegible]
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change all procedures for the DataView system	January 2001	G. Mercer
	Reviewed; no changes necessary.	January 2002	G. Mercer
	Reviewed; no changes necessary.	January 2003	G. Mercer
2.0	Add section about data requests made through the data retrieval Web site/delete request form	March 2004	G. Mercer
2.1	Minimize non-standard request discussions.	March 2005	G. Mercer
2.2	Add creating graphics from AQDBMS	January 2006	G. Mercer
2.3	Change IP address for Project Web site / delete rose plots from annual report	January 2007	G. Mercer
	-- Continued --		

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TITLE	NAME	SIGNATURE
ORIGINATOR	Laura A. Wilson	Laura A. Wilson
PROJECT MANAGER	Jessica Ward	Jessica Ward
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
2.4	Delete references to diskettes.	January 2008	G. Mercer
	Reviewed; no changes necessary.	January 2009	G. Mercer
2.5	Make client-generic / add to graphics programs.	February 2010	G. Mercer
	Reviewed; no changes necessary.	April 2011	G. Mercer

TABLE OF CONTENTS

LIST OF FIGURES

1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the procedures and methods used by the ARS Information Management Center (IMC), in handling data requests for ambient air quality and meteorological data. Ambient air quality and meteorological data are requested by various persons to meet various objectives. An example of a data request is:

> "Provide monthly data files containing scalar wind speed, vector wind direction, relative humidity, and temperature for Mammoth Cave National Park, from January 1991 through August 1992. Place the files on the ARS ftp site for download."

The IMC has developed steps for handling data requests to ensure that high quality data are readily available to fill these requests. Data requests may also specify a graphics format. This TI is referenced from SOP 3550, *Ambient Air Quality and Meteorological Monitoring Data Reporting*.

2.0 RESPONSIBILITIES

2.1 INFORMATION MANAGEMENT SECTION MANAGER

The information management section manager shall oversee all reporting procedures and provide direction when required.

2.2 DATA ANALYST

The data analyst shall:

- Handle all data requests.
- Communicate with the client regarding data requests.

2.3 DATABASE ADMINISTRATOR/PROGRAMMER

The database administrator/programmer shall create custom data summaries, data listings, or graphics, for data requests requiring non-standard output.

2.4 TECHNICAL ASSISTANT

The technical assistant shall compile all data requests for inclusion in Weekly Project Status Reports.

3.0 REQUIRED EQUIPMENT AND MATERIALS

Detailed descriptions of all IMC hardware and software, and monitoring station hardware requirements are presented by category in SOP 3340, *Information Management Center (IMC) Concept and Configuration*. The IMC requires the following hardware and software for Level 0 validation of ambient air quality and meteorological data:

- IMC hardware:

  - Hardware specifications for IMC servers
  - Hardware specifications for workstations
  - IMC computer support hardware:
    - High-quality laser printer

- IMC AQDBMS software:

  - Oracle Database System
  - AQDBMS custom software:
    - Data validation and reporting software
    - Network operating system and support software

4.0 METHODS

Data requests are received by the client or IMC and forwarded to the data analyst to fill. This section contains the following five (5) major subsections, which detail the steps taken to complete data requests:

4.1 The Data Retrieval Web site
4.2 Authorization of Data Requests
4.3 Generating Data Files for Data Requests
4.4 Other Types of Data Requests
4.5 Delivering Data Requests

4.1 THE DATA RETRIEVAL WEB SITE

Most requesters are directed to the data retrieval Web site, where they can retrieve the data they need themselves. Approximately 95% of all data requesters use this “standard” method, by logging onto *http://ard-request.air-resource.com.* Non-standard methods, including download via FTP site, transmit via e-mail, or delivery via CD-ROM, are seldom used. The database contains all data under final validation.

4.2 AUTHORIZATION OF DATA REQUESTS

Data requests that can be handled through the standard output interface require only that the client be advised. Some data requests, for example those made via the NPS ARD, have an implied authorization. The client must authorize each non-standard data request before processing the request. Otherwise, details of the data request are forwarded to the client by telephone, e-mail, or fax. Authorization is returned to the IMC also by telephone, e-mail, or fax.

Some data requests can be unusually complex or require large volumes of data or non-standard output. In these cases, the IMC section manager must estimate the amount of time and materials needed to fill the request and communicate this information to the client. Doing so will allow the client to judge if filling the request is an appropriate use of the data analysts’ time or if the scope of the request needs to be negotiated with the requester.

4.3 GENERATING DATA FILES FOR DATA REQUESTS

Data requests that are not processed through the Data Retrieval Web site are made by the data analyst via the air quality database management system (AQDBMS). The Reports interface of the AQDBMS provides a single interface for producing various types of output products. The initial display of the reports interface is shown in Figure 4-1. A tab control has been used to help the user input the specific information required for the selected product. The content of each tab page updates dynamically to reflect the specific options available for the selected product. The interface allows the user to "Run" a job immediately or "Submit" jobs to a queue to later be run as a batch of jobs.

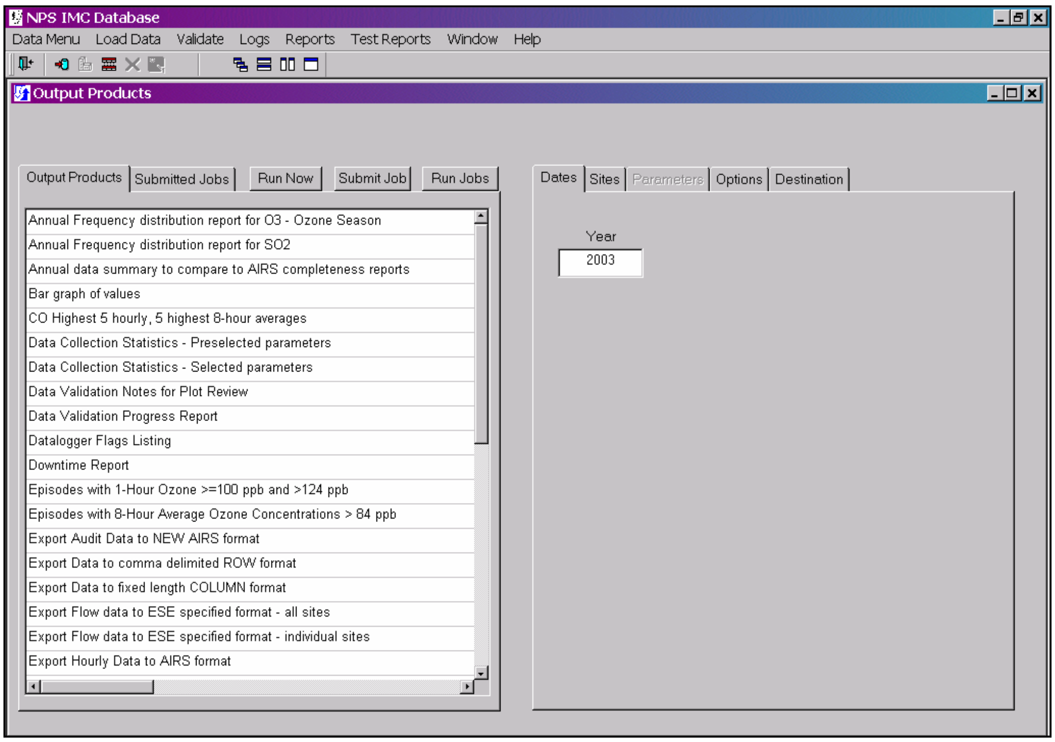

Figure 4-1. The Reports Interface.

To use the Reports interface:

- Select **Reports** from the AQ and Met Processing frame.
- Select a *product* to generate from the list displayed on the Output Products tab.
- Click on each *enabled tab* of the tab control (right side of screen) to input the required information and select *options* specific to the selected product.
- Click **Run Now** to run the job immediately or click **Submit Job** to add the job to the Submitted Jobs list.
- Click **Run Jobs** to begin running the jobs in the Submitted Jobs list.

The tab control on the right side of the Reports interface has five tab screens. Access to each screen is updated when the user selects a product in the Output Products list. If the tab is disabled, its content does not relate to the selected product. The tab screens are discussed below:

The Dates tab displays one or more fields for the user to input the desired time period of data to be included in the output product. Usually, there are Start Date and End Date fields that require dates in mm/dd/yyyy format. Other products may need only a year to be entered. Figure 4-2 shows the Dates tab screen.

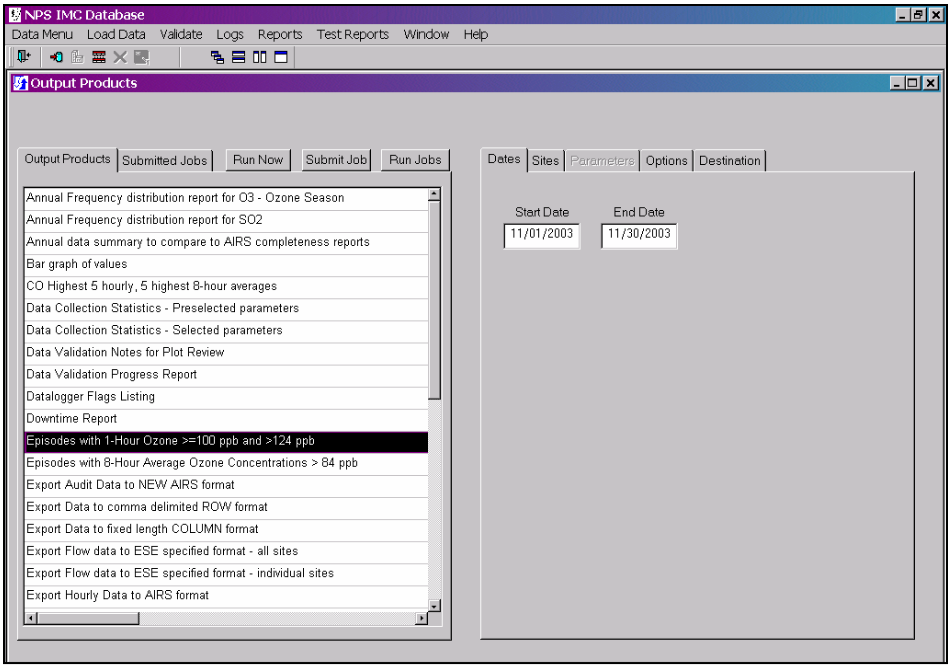

Figure 4-2. The Dates Tab.

The Sites tab displays a tree view of site groups as configured. Groups and/or individual sites can be selected to be included in the output job. Figure 4-3 shows the Sites tab screen.

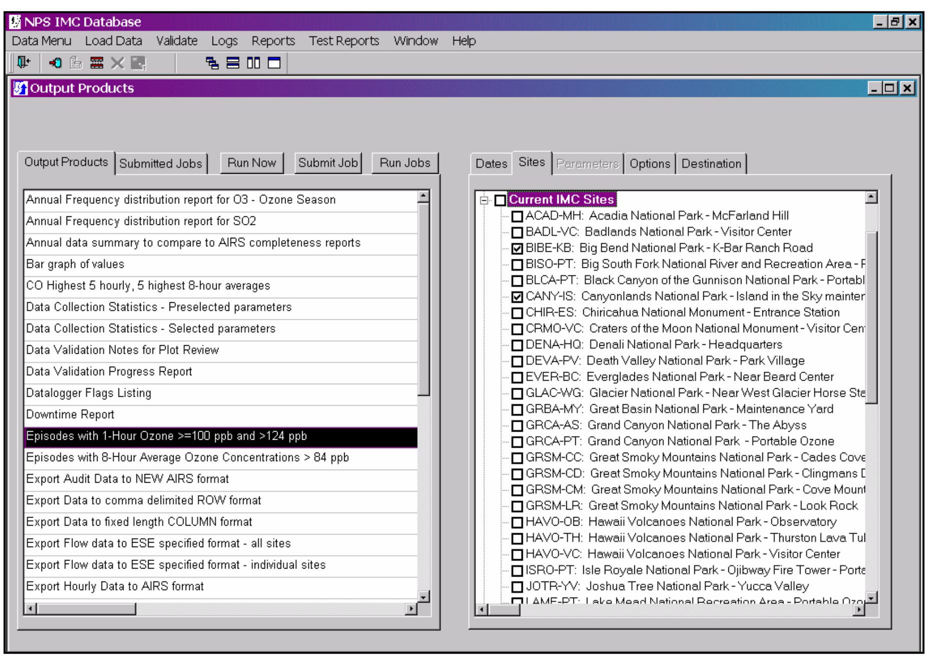

Figure 4-3. The Sites Tab.

The Parameters tab displays a list of all parameters as shown in Figure 4-4. The user can also choose the output units for each selected parameter and the output generator will convert the values as necessary. To choose output units:

- Click in the **Output Units** column of the selected parameter.
- From the drop-down list, select an available *Unit Code*.

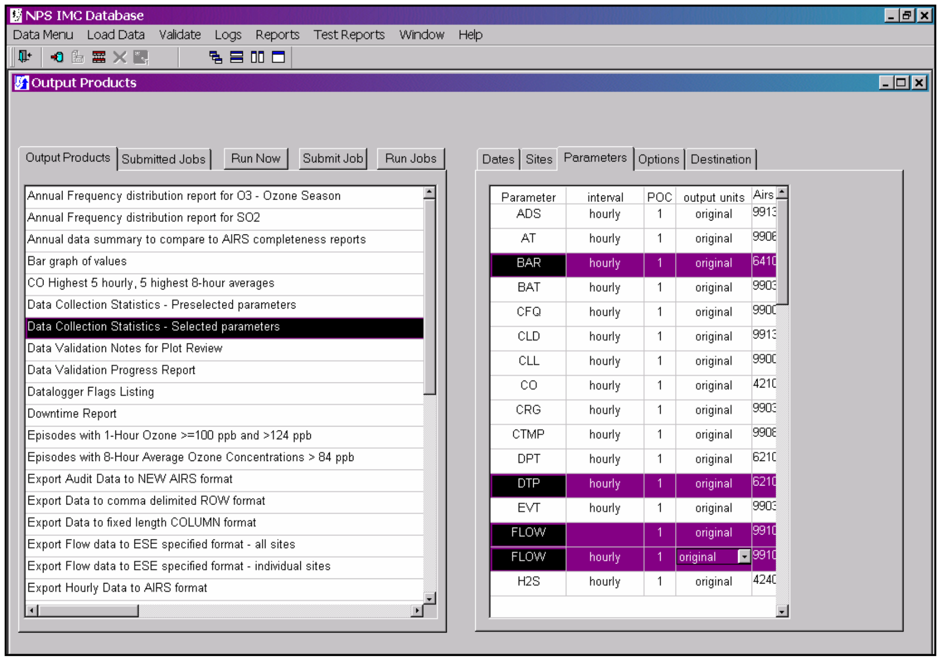

Figure 4-4. The Parameters Tab.

The Options tab displays additional options for the selected product. An example of the Options tab when the "Data Collection Statistics – Selected Parameters" product is selected is shown in Figure 4-5. Two sections are found on the page; Standard Options and Special Options. The Standard section includes the following:

- Radio buttons for selecting a Validation Level option. Select **Raw**, **Preliminary**, or **Final** to force the level to the selected option.
- A page number option to input a report page number.
- A checkbox to place all of the currently selected sites on one page or continuous output instead of separate pages or files for each site.

The Special Options section includes special options for the selected report. Examples of special options are:

- A Raw Data checkbox. Checking this box instructs the program to use raw data and not validated data in the product.

- Number of Values to list. This option instructs the program to include the number of values entered on the product. For example, to list the top 10 Highest Hourly Averages.

- Other options exist, depending upon the report type.

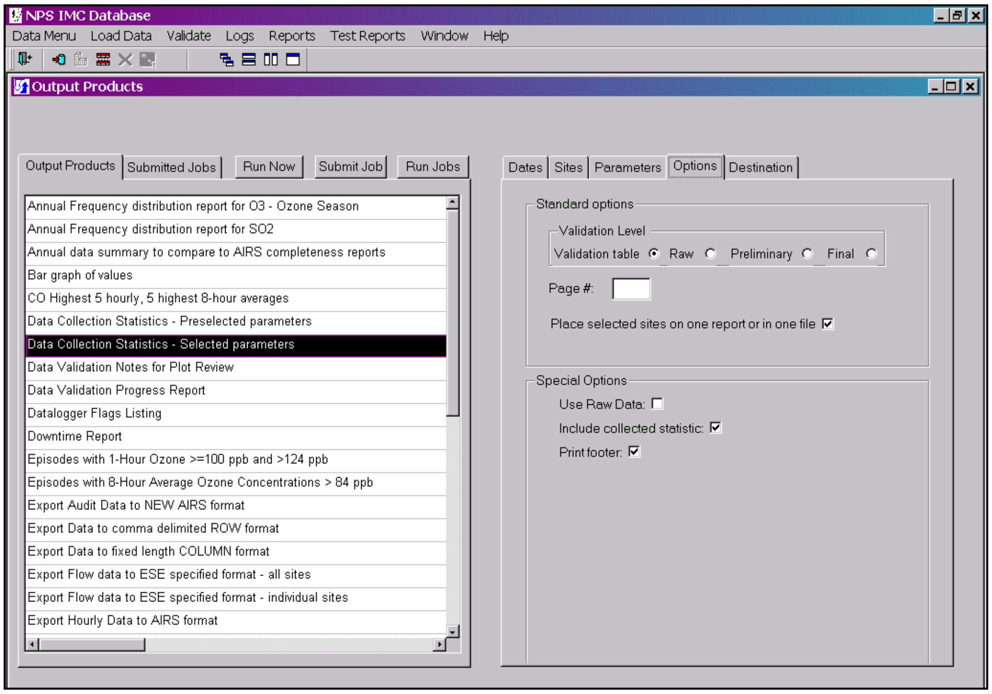

Figure 4-5. The Options Tab.

The Destinations tab displays options on the type of output to produce as shown in Figure 4-6. This tab updates dynamically depending on the product selected. Only the possible options for the selected product are enabled. More than one option can be selected. Destination options are:

- Output to screen. This option causes the output generator to pause after each product has been created and display the product on the screen before going onto the next. Click the **Print** button to send the output product to the printer. Click the **Continue** button to close the on-screen display.

- Output to printer. This option sends the output directly to the currently selected printer.

- Output to PDF file. This option uses the Adobe Portable Document File (PDF) Writer to create PDF files of the output. When the checkbox is selected, an input field displays prompting the user to enter a destination folder for the generated PDF files.

- Output to text file. This option writes the output to ASCII text files. When the checkbox is selected, an input field displays prompting the user to enter a destination folder for the text files.

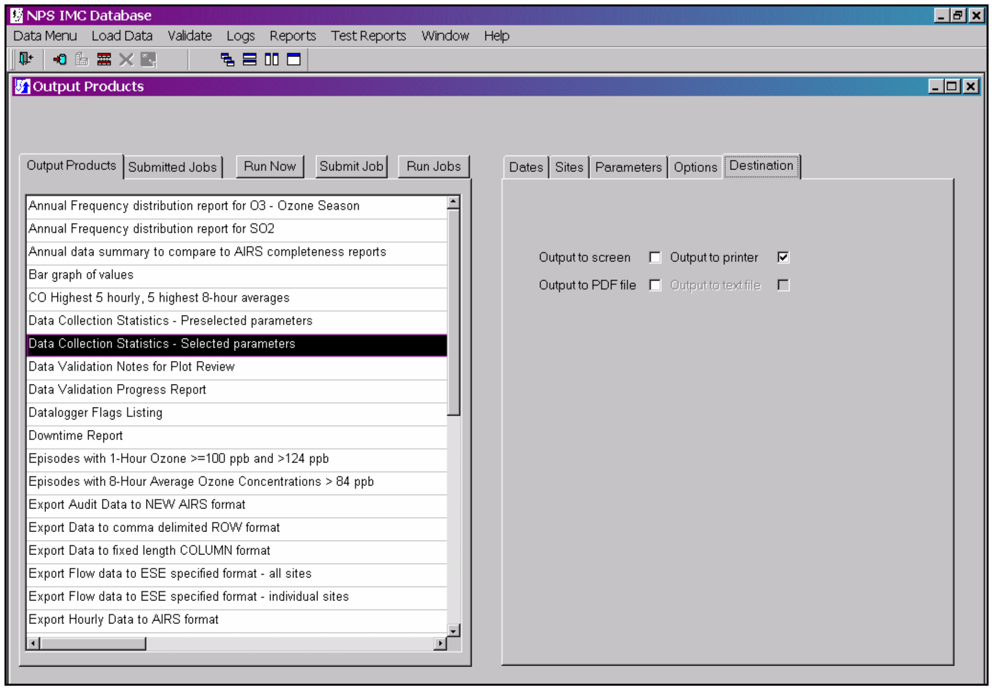

Figure 4-6. The Destinations Tab.

4.4 OTHER TYPES OF DATA REQUESTS

Some data requests may include requests for standard monthly or annual report tables or plots. Standard output can be generated by the AQDBMS application at any time. Refer to TI 3550-5000, *Ambient Air Quality and Meteorological Monitoring Data – Weekly and Monthly Reporting*, TI 3550-5100, *Ambient Air Quality and Meteorological Monitoring Data - Annual Reporting* or the *Air Quality Data Base Management System (AQDBMS) User's Guide* (ARS, 2001) for instructions on generating standard output.

Data requests may also include requests for custom data summaries or lists meeting certain criteria or graphics. In these cases, the data analysts work with the database administrator/programmer to generate the necessary output. Additional information in creating graphics is provided in the following subsections.

4.4.1 AQDBMS Graphics Products

Four programs are available to create graphical representations of AQDBMS data directly from the database. The graphics products are also available from the data request Web site. The AQDBMS graphics programs provide the following common features:

- Execution directly from the AQDBMS or the Windows desktop
- Single-site plot vs. submit file option to create multiple-site plots
- Printer destination and setup selection
- Start and end date selection

- Monthly, quarterly, and annual plots (except One-Year and Three-Year Summary plots)
- Plot title customization
- Plotting scale adjustment
- Force Final Validation footnote for historical data
- Automatic printing option
- Windows metafile output

4.4.1.1 Description of AQDBMS Products

A Rose Plot summarizes the relationship between wind speed or a user-selected pollutant parameter in a standard wind rose. Before creating these plots, verify that the submit file is current and contains all sites to be plotted. See Section 4.3.4.3 on creating plots for multiple sites from the AQDBMS graphics programs, for information on creating a submit file and how to create plots for multiple sites.

A Three-Year Summary Plot summarizes user-selected pollutant parameters in a bar chart that compares the second highest 1-hour average on a monthly basis.

A Diurnal Plot summarizes user-selected pollutant parameters in a line graph that bins the values by time of day.

A Summay by Month Plot summarizes user-selected pollutant parameters in a bar chart that compares highest hourly averages, highest 8-hour averages, and monthly averaages by month.

These graphics products query data directly from the AQDBMS. The user interface for these programs have many similar features that are described in the next section. Options unique to each of these products are described in subsections following this.

4.4.1.2 Creating Plots From the AQDBMS Graphics Programs

The AQDBMS graphics programs may be run directly from a Windows desktop icon. To create a plot:

- Double-click the *icon* for the desired graphics product on the Windows desktop.
- Select a *site* from the Select Site drop-down list box.
- Enter the *start and end dates* for the period to be plotted in the Start and End boxes.
- Click the **Get Parameter List** button. The program retrieves a parameter code list for the selected site/period.
- Select the *parameter* to be plotted from the Available Parameter List drop-down list box.
- Select applicable *options*. Each type of plot has one or more options that can be changed.
- To print the plot automatically, click the **AutoPrint** checkbox.
- Click the **Draw Plot** button. The program retrieves and plots the data.

- If needed, modify the default graph scaling values, then click the **Redraw** button.
- Click the **Print** button to print the plot.

4.4.1.3 Creating Plots for Multiple Sites From the AQDBMS Graphics Programs

Plots can be created for multiple sites/parameters for the same time period. To create multiple plots in a single run, a submit file containing a list of the site/parameters to be plotted is created in advance. The sites/parameters included in a submit file will be plotted with common options. Sites with parameters that do not use common options – such as a scaling change – must be run in a single site mode. Create separate submit files for each of the graphics products.

To create a submit file:

- Open a new file in a text file editor such as Windows Notepad (do not use a word processor such as Microsoft Word).

- On the first line of this file:

  – Type a four-character *site abbreviation* followed by a comma **<,>**.
  – Type a *parameter abbreviation* followed by a hyphen **<->** and a comma **<,>**.
  – Type a **Y** followed by a comma **<,>.**
  – Type three more *commas*, then press **<Enter>.** For example, type **BIBE,O3-4,Y,,,,** to plot ozone data for Big Bend National Park.

- Repeat the above step for each combination of site/parameter that you want to include in the batch of plots.

- Select **Save As** from the File menu. Save the file in the folder and with the filename of your choice.

To create plots for multiple sites:

- Double-click the *icon* for the desired graphics product on the Windows desktop.

- Set up the printer:

  - From the File menu, choose **Select Printer**.
  - Select the desired Printer *destination*.
  - Set the paper *orientation* for the current graphic product (all are *portrait* except the One-Year Summary plot, which is *landscape*).

- Enter the *start and end dates* for the period to be plotted in the Start and End boxes.

- Select applicable *option*s. Each type of plot has one or more options that can be changed.

- To not automatically print the plots, click the **AutoPrint** checkbox to deselect the auto printing feature.

- From the File menu, select **Run a Submit File**.

- Select the *submit file* you previously created and saved from the File-open dialogue box and click **OK**.

4.5 DELIVERING DATA REQUESTS

Hardcopy data requests are mailed or faxed to the recipient. Digital data requests are delivered in one of the following ways depending on the volume of data and/or how the recipients want to receive the data:

- Downloaded by the recipient from the ARS FTP site.
- Transmitted via an e-mail attachment.
- Written to CD-ROM and mailed.

If the data files are to be downloaded from the ARS FTP site:

- The files are uploaded to the site.
- An-e-mail message is sent, which includes instructions for downloading the files.
- The message is sent.
- The files are removed from the FTP site after it is confirmed that the recipient has successfully retrieved them.

If the data files are transmitted via an e-mail attachment:

- The data file(s) are attached to the e-mail message and the message is sent.

If data files are written to CD-ROM:

- The data analyst copies the files to the appropriate media and labels each piece as to its contents.

- The data analyst prepares a cover letter and the package is sent first class mail unless directed otherwise by the ARD.

After the request is completed and delivered, the technical assistant prepares a list of all requests filled during the week and includes them in the Weekly Progress Status Report delivered to the contracting officer's technical representative (COTR).

5.0 REFERENCES

Air Resource Specialists, Inc. (ARS), 2001, Air Quality Data Base Management System (AQDBMS) User's Guide.

Air Resource Specialists, Inc.
1901 Sharp Point Drive, Suite E
Fort Collins, CO 80525
Phone: 970-484-7941
Fax: 970-484-3423

QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES

TITLE	**SUBMITTING AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA TO THE EPA AQS DATABASE**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3550-5300**
DATE	**MARCH 1999**

AUTHORIZATIONS

TITLE	NAME	SIGNATURE
ORIGINATOR	Laura A. Wilson	Laura A. Wilson
PROJECT MANAGER	Jessica Ward	Jessica Ward
PROGRAM MANAGER	David L. Dietrich	[illegible]
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
NPS COTR		

REVISION HISTORY

REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change all procedures for the DataView system	January 2001	G. Mercer
	Reviewed; no changes necessary.	January 2002	G. Mercer
	Reviewed; no changes necessary.	January 2003	G. Mercer
2.0	Major changes in submittal procedures.	March 2004	G. Mercer
2.1	Minor changes, change AIRS to AQS.	March 2005	G. Mercer
	Reviewed; no changes necessary.	January 2006	G. Mercer
	Reviewed; no changes necessary.	January 2007	G. Mercer
	Reviewed; no changes necessary.	January 2008	G. Mercer
	-- continued --		

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**SUBMITTING AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA TO THE EPA AQS DATABASE**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3550-5300**
DATE	**MARCH 1999**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Laura A. Wilson	Laura A. Wilson
PROJECT MANAGER	Jessica Ward	Jessica Ward
PROGRAM MANAGER	David L. Dietrich	[illegible]
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
NPS COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
2.2	Changed AQS reference.	January 2009	G. Mercer
	Reviewed; no changes necessary.	February 2010	G. Mercer
	Reviewed; no changes necessary.	April 2011	G. Mercer

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LIST OF FIGURES

1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the procedures and methods used by the National Park Service (NPS) Air Resources Division's (ARD) Information Management Center (IMC), for submitting data to the Environmental Protection Agency's (EPA) Air Quality System (AQS) database. These data include hourly average ambient air quality and meteorological data, precision data from criteria pollutant analyzer precision checks, and accuracy data from twice-annual maintenance visits and external audits of criteria pollutant analyzers.

All data and associated AQS codes required for creating AQS transactions are stored in the Air Quality Data Base Management System (AQDBMS). Computer programs within the AQDBMS create the AQS transaction files; data are submitted on a monthly basis for hourly data, and on a quarterly basis for precision and accuracy data, after all data for the quarter are at the Final validation level. This TI is referenced from SOP 3550, *Ambient Air Quality and Meteorological Monitoring Data Reporting*.

2.0 RESPONSIBILITIES

2.1 INFORMATION MANAGEMENT SECTION MANAGER

The information management section manager shall oversee all reporting procedures and provide direction when required.

2.2 DATA ANALYST

The data analyst shall:

- Maintain the required AQS codes for all sites and parameters within the monitoring network within the AQDBMS and in AQS.
- Be adequately trained in operating the EPA AQS interface and be familiar with the set of EPA-issued AQS documentation.
- Be responsible for generating and submitting hourly ambient and meteorological data and precision and accuracy data to the EPA AQS on at least a quarterly basis.

3.0 REQUIRED EQUIPMENT AND MATERIALS

3.1 SYSTEM HARDWARE AND SOFTWARE REQUIREMENTS

Detailed descriptions of all IMC hardware and software, and monitoring station hardware requirements are presented by category in SOP 3340*, Information Management Center (IMC) Concept and Configuration*. The IMC requires the following hardware and software for validation of ambient air quality and meteorological data:

- IMC hardware:

  - Hardware specifications for IMC servers
  - Hardware specifications for workstations
  - IMC computer support hardware:
    - High-quality laser printer

- IMC AQDBMS software:

  - Oracle Database System
  - AQDBMS custom software:
    - Data validation and reporting software
    - Network operating system and support software

3.2 COMMUNICATIONS REQUIREMENTS

Submitting data to AQS requires connecting directly to AQS by accessing the Internet using DSL, cable, T1, or other high-speed connection.

3.3 EPA AQS TRAINING AND DOCUMENTATION

The EPA provides regularly scheduled training sessions on the EPA AQS. The data analyst will attend training sessions as needed to keep skills and knowledge current. In addition, the IMC holds a complete set of EPA issued documentation on AQS. The data analyst is familiar with and will use this documentation as a supplement to this TI and when working within AQS.

4.0 METHODS

All hourly average ambient air quality and meteorological data at the Final validation level are submitted to AQS on a monthly basis. Precision data from criteria pollutant analyzer precision checks and accuracy data from twice-annual maintenance visits and external audits of criteria pollutant analyzers are submitted on a quarterly basis.

This section contains the following three (3) major subsections, which detail the steps taken to complete data submittal to AQS:

4.1 Generating AQS Files From the AQDBMS
4.2 Transferring an AQS File to AQS via CDX
4.3 Loading, Statistical Analysis, and Posting of Data to AQS

The steps required to submit data to the EPA AQS database are:

- Create and verify the accuracy of AQS transaction files for hourly average ambient air quality and meteorological data.

- Create and verify the accuracy of AQS transaction files for precision data from criteria pollutant analyzer precision checks (typically one per week per site/analyzer).

- Create and verify the accuracy of AQS transaction files for accuracy data from audit reports on criteria pollutant analyzers (typically one every 6-12 months per site/analyzer).

- Transfer the files to AQS using CDX (Central Data Exchange).

- Load data into the AQS database, successfully run the AQS statistical analysis programs, and post data to the AQS database.

Refer to the *Air Quality System User Guide* (EPA, 2006) for detailed information about submitting data to AQS.

4.1 GENERATING AQS FILES FROM THE AQDBMS

4.1.1 Hourly Average Files

Hourly average ambient air quality and meteorological data must be formatted as AQS Type RD transactions to be submitted to AQS. A program in the AQDBMS generates Type RD transaction files.

To generate transaction Type RD AQS files:

- From the AQDBMS, select **AQ and Met Processing**.

- Select **Reports**.

- Select **Export Hourly Data to NEW AQS Format**.

- Select the *sites*, *parameters* (defaults to select all parameters with AQS codes), and *dates* of the data set to use.

- Click the **Run** button.

Unless renamed under "options" before running, a file called AQS.DAT is written to the *\\arsnw1\vol4\project\imc\aqs* directory. A message displays if the file already exists. Answer **Yes** to append to the existing file or **No** to overwrite the existing file.

Notes:

- The program looks up each selected site in the Site Configuration Table. This is where the AQS site code (state, county, and site number) is stored. If this information is not filled in, a message is displayed and that site will not be written to the AQS data file. If the information is wrong, problems will occur in AQS.

- If a site does not exist for the entire period that was selected, only the period where a record exists in the database will be written to the file (i.e., nothing will be written for the times when there are no records). If a record does exist, however, even if it's coded NA, it will be written to the file. Likewise, if a parameter is chosen and a site does not have that monitor, then that parameter will be skipped.

- Each parameter's associated AQS code, method code, and POC code is defined in the Parameter Codes Table, under *table maintenance*.

4.1.2 Precision Data AQS Files

The weekly precision checks conducted on criteria pollutant analyzers within the network are submitted to AQS as precision or Type RP transactions. A program in the AQDBMS generates Type RP transaction files.

To generate transaction Type RP AQS files:

- From the AQDBMS, select **AQ and Met Processing**.
- Select **Reports**.
- Select **Export Precision Data to New AQS Format**.
- Select the *sites*, *parameters*, and *dates* of the data set to use.
- Click the **Run** button.

A file called PARS.DAT is written to the *\\arsnw1\vol4\project\imc\aqs* directory. A message displays if the file already exists. Answer **Yes** to append to the existing file or **No** to overwrite the existing file.

4.1.3 Accuracy Data AQS Files

Data from twice-annual or external audits conducted on criteria pollutant analyzers within the network are submitted to AQS as accuracy or Type RA transactions. A program in the AQDBMS generates Type RA transaction files.

To generate transaction Type RA AQS files:

- From the AQDBMS, select **AQ and Met Processing**.
- Select **Reports**.
- Select **Export Audit Data to New AQS Format**.
- Select the *sites*, *parameters*, and *dates* of the data set to use.
- Click the **Run** button.

Unless renamed under “options” before running, a file called AUDIT.DAT is written to the *\\arsnw1\vol4\project\imc\aqs* directory. A message displays if the file already exists. Answer **Yes** to append to the existing file or **No** to overwrite the existing file.

4.2 TRANSFERRING AN AQS FILE TO AQS VIA CDX

Once the AQS data file is generated and deemed accurate by the data analyst, it is ready to be sent to the AQS database. Files are transferred using the program *CDX*. To transfer files:

- Login to your CDX account on any high-speed Internet connection, using your current ID and password, at *https://cdx.epa.gov/SSL/cdx/login.asp*.

- Click on the file transfer profile **AQS: Air Quality System – File Transfer**, to access the AQS Web Submittal Form.

- Click on the box titled **Select** from the right side of the screen. This will bring up a browsing window where you select and open the files created in Section 4.1. These files will then appear in the list of files box.

- Highlight the file(s) to transfer, and click the **Send** box at the bottom of the screen.

The system will send an e-mail informing when the files are in the system and are ready to load into AQS.

4.3 LOADING, STATISTICAL ANALYSIS, AND POSTING OF DATA TO AQS

4.3.1 Loading Records into AQS

- Login to your AQS account on any high-speed Internet connection. From the bottom of the page at *http://www.epa.gov/ttn/airs/airsaqs/aqsweb/aqswebhome.htm*, click **Proceed to AQS**.

- Click on **I agree to these terms and want to enter the AQS application**.

- Enter your current *ID* and *password*, and *aqsprod* for database.

- Click on **Session**, highlight the appropriate *screening group*, press **OK**, and then go to the Batch menu.

- Under the Batch Load tab, highlight the appropriate *file* from the CDX list, and click **Load File** (see Figure 4-1). When the file has loaded, you will receive an e-mail with the file's status from AQS (see Figure 4-2).

  NOTE: At this point, raw data records loading without errors are in "preproduction", while raw data records containing an error are in "staging tables" of AQS. Precision and/or accuracy data are automatically posted at this stage. You do not need to run statistics on, nor post precision and/or accuracy data).

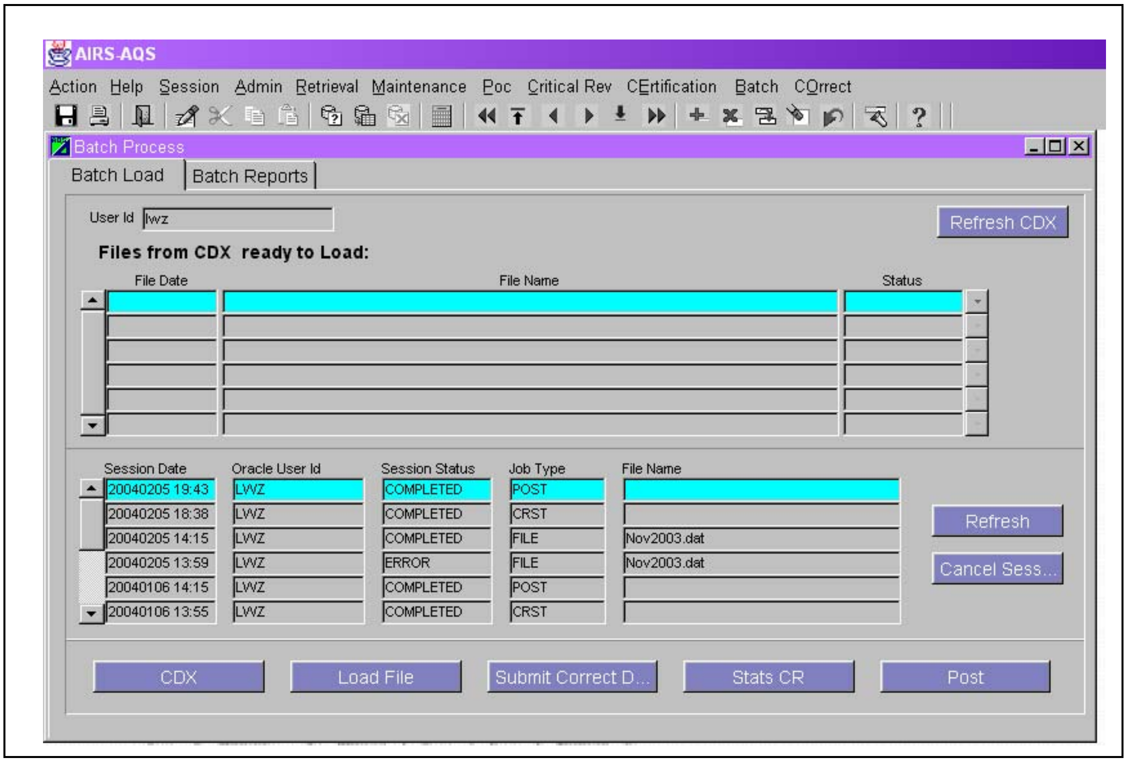

Figure 4-1. Batch Load Tab AQS Screen.

From: Laura Wilson <lwz@canyon.rtpnc.epa.gov>
To: <aqsemaillog@EPA.gov>, <lwilson@air-resource.com>
Date: Tuesday, January 06, 2004 11:51AM
Subject: AQS Batch Job Log for LOAD

AQS Batch Job (aqs_exec build 323).
Oracle SID: aqsprod
Screening Group: 44
User: LWZ
Session Date/Time: 2004JAN061315
Email: lwilson@air-resource.com,aqsemaillog@EPA.gov
Job Type: LOAD
#

SQL*Loader: Release 8.1.7.4.0 - Production on Tue Jan 6 13:16:15 2004

(c) Copyright 2000 Oracle Corporation. All rights reserved.

aqsload FILE /tmp/aqsprod_LWZ_2004JAN061315_reval1218u.dat lwz 44 2004JAN061315
AQS Load system started (Build 345).
Date of run is 2004JAN061319
Session Date = 2004JAN061315
AQS Load finished with NO errors.
917.89 CPU seconds used by Oracle in this session.
Job completed successfully.
2062.90 elapsed seconds, 1184.34 CPU seconds
917.89 CPU seconds used by this Oracle session

Figure 4-2. Example E-mail Confirming File Load.

If the file loaded without errors, more files may be loaded using the same procedure, or continue to Statistical Analysis.

If the file did not load, or if it loaded with errors, the e-mail will contain a listing of the errors, and the issues must be researched and addressed before continuing. Records with errors can be retrieved and corrected manually in AQS from the main menu under *Correct → Raw*. To make a global change, such as changing all input codes from I to U, query Staging Table records using the wildcard *%* in any field, and AQS should return all data with errors. If you continue without correcting errors, records with errors will not be posted, but will remain in Staging Tables. If left at this point, there will be holes in the data, percentage data completeness will be in error, and records left in Staging Tables will remain to confuse the user during future loads. With proper authority, if data cannot be corrected, or should for any reason not be uploaded, all data remaining in Staging Tables can be deleted at once by clicking **Correct → Delete by screening group**. AQS will return the question, "You are about to delete all correct data for screening group NATIONAL PARK SERVICE. Do you want to continue? Yes/No.

When corrections are complete, reload the corrected data from Staging Tables by clicking on the **Submit Correct D[ata]** button from the Batch screen. If there are still errors, continue to make corrections as above. When data load completely without errors, continue to Statistical Analysis.

4.3.2 <u>Statistical Analysis in AQS</u>

Under the Batch Load tab, check that the current session is highlighted, and click **Stats CR**. AQS will forward an e-mail when the report is complete (see Figure 4-3).

From: Laura Wilson <lwz@canyon.rtpnc.epa.gov>
To: <aqsemaillog@EPA.gov>, <lwilson@air-resource.com>
Date: Tuesday, January 06, 2004 12:13PM
Subject: AQS Batch Job Log for STATCR

```
# AQS Batch Job (aqs_exec build 323).
#          Oracle SID: aqsprod
#     Screening Group: 44
#                User: LWZ
#   Session Date/Time: 2004JAN061355
#               Email: lwilson@air-resource.com,aqsemaillog@EPA.gov
#            Job Type: STATCR
#
Critical review  started at 20040106 13:55.
Critical review completed at 20040106 14:07.
Statistical evaluation started at 20040106 14:07.
Statistical evaluation completed at 20040106 14:12.
# Job completed successfully.
# 1014.92 elapsed seconds, 442.96 CPU seconds
# 442.68 CPU seconds used by this Oracle session
```

Figure 4-3. Example E-mail Confirming Complete Report.

Flagged data can be reviewed under the Batch Reports tab by clicking on **Scan Report** and/or **Stat Evaluation** (see Figure 4-4). Figure 4-4 shows the Batch Reports tab. *Stats CR* can also be run against past loads, by highlighting the desired session in the list and pressing **Stats CR**.

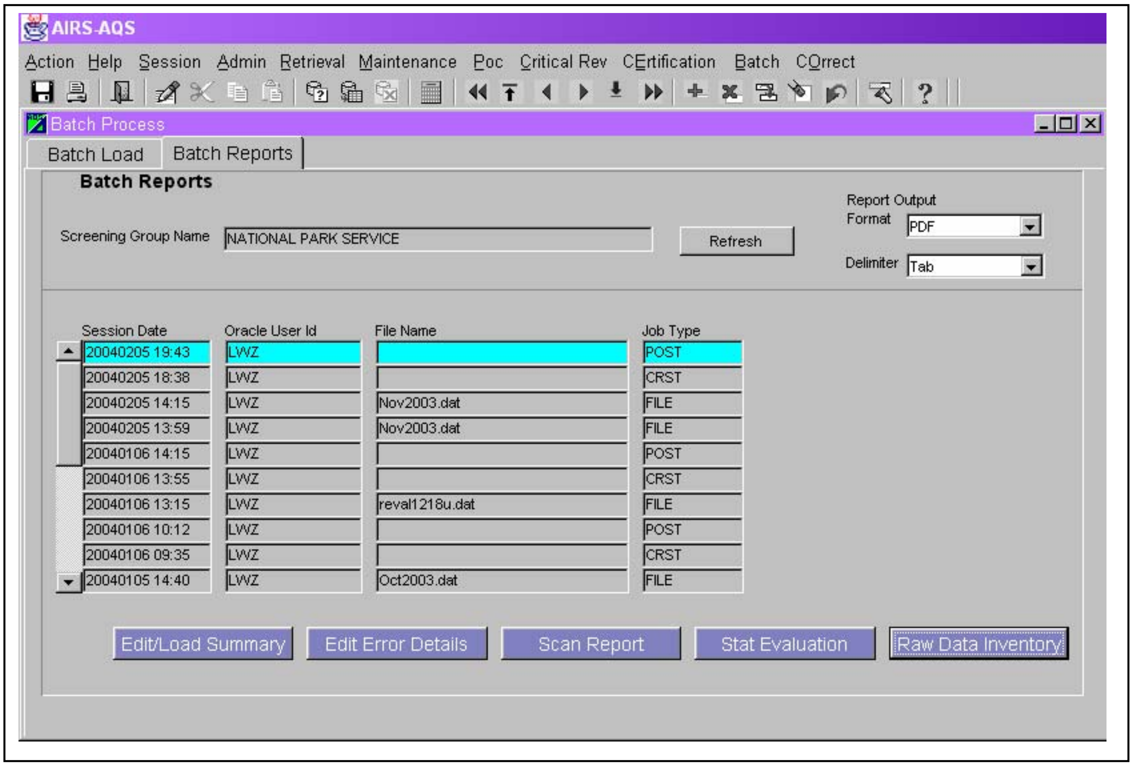

Figure 4-4. Batch Reports Tab AQS Screen.

4.3.3 Posting Data to AQS

Under the Batch Load tab, check that the current session is highlighted, and click **Post**. AQS will forward an e-mail when the post is complete (see Figure 4-5).

When complete, go to the Batch Reports tab, and click on **Raw Data Inventory**. This will provide you with a report of all posted data – keep this report for future reference. This report only works for raw data (not precision or accuracy data).

5.0 REFERENCES

Environmental Protection Agency (EPA), 2006, Air Quality System User Guide, January.

From: Laura Wilson <lwz@canyon.rtpnc.epa.gov>
To: <aqsemaillog@EPA.gov>, <lwilson@air-resource.com>
Date: Tuesday, January 06, 2004 12:55PM
Subject: AQS Batch Job Log for POST

```
# AQS Batch Job (aqs_exec build 323).
#          Oracle SID: aqsprod
#     Screening Group: 44
#                User: LWZ
#   Session Date/Time: 2004JAN061415
#               Email: lwilson@air-resource.com,aqsemaillog@EPA.gov
#            Job Type: POST
#
Post started at 20040106 14:16.
Post completed at 20040106 14:54.
# Job completed successfully.
# 2281.09 elapsed seconds, 1391.00 CPU seconds
# 1390.78 CPU seconds used by this Oracle session
```

Figure 4-5. Example E-mail Confirming Complete Post.

Air Resource Specialists, Inc.
1901 Sharp Point Drive, Suite E
Fort Collins, CO 80525
Phone: 970-484-7941
Fax: 970-484-3423

QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**IMC STAFF'S MAINTENANCE RESPONSIBILITIES FOR THE AMBIENT AIR QUALITY DATA BASE MANAGEMENT SYSTEM (AQDBMS)**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3650**
DATE	**MARCH 1999**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Betsy Davis-Noland	Bet DaNold
PROJECT MANAGER	Jessica Ward	Jessica Ward
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
NPS COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change all procedures for the DataView system.	January 2001	G. Mercer
	Reviewed; no changes necessary.	January 2002	G. Mercer
	Reviewed; no changes necessary.	January 2003	G. Mercer
	Reviewed; no changes necessary.	January 2004	G. Mercer
2.0	Changed New Site/Relocation Form.	May 2004	G. Mercer
2.1	Changed AIRS to AQS.	May 2005	G. Mercer
	Reviewed; no changes necessary.	January 2006	G. Mercer
	Reviewed; no changes necessary.	January 2007	G. Mercer
	-- Continued --		

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QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	**IMC STAFF'S MAINTENANCE RESPONSIBILITIES FOR THE AMBIENT AIR QUALITY DATA BASE MANAGEMENT SYSTEM (AQDBMS)**
TYPE	**STANDARD OPERATING PROCEDURE**
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DATE	**MARCH 1999**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Betsy Davis-Noland	Bet Da Nolal
PROJECT MANAGER	Jessica Ward	Jessica Ward
PROGRAM MANAGER	David L. Dietrich	[illegible]
QA MANAGER	Gloria S. Mercer	Gloria S. Mercer
NPS COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
	Reviewed; no changes necessary.	January 2008	G. Mercer
	Reviewed; no changes necessary.	January 2009	G. Mercer
2.2	Make client-generic / delete AIRS references	February 2010	G. Mercer
	Reviewed; no changes necessary.	April 2011	G. Mercer

TABLE OF CONTENTS

LIST OF FIGURES

1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) describes the steps taken by ARS' Information Management Center (IMC) for maintaining network configuration and related information in the Air Quality Data Base Management System (AQDBMS). The data are stored in Oracle database tables and other digital files and must be accurate and thorough in order to operate all aspects of the AQDBMS including data collection, loading data into the database, data validation, data reporting, and submitting data to AQS. This SOP describes the IMC staff's responsibilities for maintaining the AQDBMS. This SOP is to be used as a guide through the onscreen AQDBMS displays. The user is expected to view the AQDBMS screens while using this SOP. All available screen displays are not presented in this SOP as hardcopy printouts.

2.0 RESPONSIBILITIES

2.1 IMC STAFF

IMC staff shall accurately maintain network configuration and related information in the AQDBMS.

2.2 FIELD SPECIALIST

The field specialist shall:

- Notify the IMC of additions and modifications to the air quality network.
- Provide accurate site instrumentation, support systems, and the datalogger configuration information to the IMC.

3.0 REQUIRED EQUIPMENT AND MATERIALS

All IMC equipment and materials are fully described in SOP 3340/3341, *Information Management Center (IMC) Concept and Configuration.*

4.0 METHODS

This section includes seven (7) major subsections:

4.1 Adding New Site Information
4.2 Modifying Site Information
4.3 Adding a New Parameter and/or Parameter Code
4.4 Adding a Conversion Formula
4.5 Adding a New Measurement Unit
4.6 Adding a New AQS Method Code
4.7 Creating or Modifying Files for Stackplots

4.1 ADDING NEW SITE INFORMATION

The specific tasks required for adding new site information include:

- Collecting the site configuration information from the field specialist.
- Creating AQS site and monitor records.
- Adding the site and its current datalogger configuration to the Site Configuration Table in the Oracle database.
- Adding screening ranges information for each monitoring parameter at the new site to the Screening Ranges Table.
- Creating a stackplot configuration (.stk) file.

After the ARD notifies the IMC of plans for a new site, a New Site/Site Relocation Form (Figure 4-1) is forwarded to the field specialist. This form includes information that will be required to configure the site in the AQS database as well as the AQDBMS. Information on the form includes location information, modem, datalogger, and parameter information. This form must be completed and returned to the IMC before the IMC can begin collecting data from the site. When the IMC receives the completed form, the information from it is used to complete the tasks detailed in the following subsections.

4.1.1 Creating AQS Site and Monitor Records

Before data can be successfully submitted to AQS, related site and monitor records must exist within AQS. When a new site is configured, or an existing site adds or deletes a parameter, these records must be created. See Technical Instruction 3550-5300, *Submitting Ambient Air Quality and Meteorological Monitoring Data to the EPA AQS Database* for instructions.

4.1.2 Adding a Site to the Site Configuration Table

To correctly load data, each site currently being monitored must be properly defined in the AQDBMS Site Configuration Table. The information in the polling configuration is critical for data collection and must be accurate. Errors in the polling information may cause the data to not be retrieved, be written to the database incorrectly, or not be written at all. Follow these guidelines when adding or modifying polling configurations:

- Configure new sites in the Site Specifications configuration window before attempting to add a new polling configuration record.
- Sites can have multiple polling configurations for multiple dataloggers.
- The raw data configuration and data parameter configuration must be up-to-date before adding or modifying a site. Attempting to configure the polling information with an undefined raw data format will cause an error.

Information Management Center (IMC)
New Site / Site Relocation Form

Today's Date: ________________ Change Effective Date: ________________ Initials: ______________ Site Name: _______________________

Landmark Location Description: ____ Six-Letter Abbr.: _________ Polling Abbr.: _________

Password: ___________________ Database Site Number: __________ No. of Parameters: __________

Site Telephone Number: _____________________ Land Line or Cell: ________________

DataView: (Y/N) Datalogger type: ________________ Datalogger ID: _____________ Modem Type: ______________ Baud Rate: ____________

AIRS Codes: State:_______ County: __________ Agency: ____________ Site Number: ________ EPA Region: _________

Location: (Nearest City or County, etc.): _______________________ State: _______ Time Zone: __________ NPS Region: _______________

Line ID(s): ____________ _______________ ________________ Calibration Sequence(s): ____

Latitude: Deg_______ Min______ Sec_______ Longitude: Deg______ Min______ Sec______ Elevation (m): ___________

New Configuration: **PLEASE ADVISE IMC PRIOR TO EFFECTIVE DATE OF AS MUCH OF THIS INFORMATION AS POSSIBLE**

Channel Number																						
Channel Name																						
Channel Units																						
Full Scale Value																						
High Output																						
Low Output																						
Resolution (decimal places)																						
Load Channel (Y/N)																						

Comments: ____

____

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Figure 4-1. Example New Site Configuration Form.

Information Management Center (IMC)
New Site / Site Relocation Form

SITE:

____

LOCATION SETTING:

______________ Urban (1)

______________ Suburban (2)

______________ Rural (3)

LAND USE:

_____________ Forest (5)

_____________ Desert (6)

_____________ Other (Specify)

ROAD TYPE:

_____________ Arterial (1)

_____________ Expressway (2)

_____________ Freeway (3)

_____________ Major Street or Highway (4)

_____________ Through Street or Highway (5)

_____________ Local Street or Highway (6)

ESTIMATED DAILY TRAFFIC FLOW:

_______________ cars/day

NEAREST STREET NAME:

____

ESTIMATE OF ACCURACY IN DETERMINING LAT/LONG:

___________ Min

___________ Sec

METHOD OF DETERMINING LAT/LONG:

___________ Navigation Quality GPS (NAV-GPS)

___________ Geodetic Quality GPS (SUR-GPS)

___________ 7.5' x 7.5' (Scale 1:20,000) Map (20000A)

___________ 7.5' x 7.5' (Scale 1:20,000 Map (20000B)

___________ 7.5' x 7.5' (Scale 1:24,000) Map (24000A)

___________ 7.5' x 15' (Scale 1:24,000) Map (24000B)

___________ Other map (Specify Scale: 1:______________)

___________ Other Method (Specify: __________________)

Figure 4-1 (continued) Example New Site Configuration Form.

Information Management Center (IMC)
New Site / Site Relocation Form

Site Evaluation in Conformance with EPA Requirements: Site Name: ______________________ Observed by: ______________

Make and Model #: Carbon Monoxide Monitor: ____________________ Nitrogen Dioxide Monitor: ____________________

CRITERIA	REQUIREMENTS*	CRITERIA MET? Yes	No
CARBON MONOXIDE			
Horizontal and Vertical Probe Placement (Par. 4.1)	3 ± 1 ½ m for microscale		
	3-15 m for middle and neighborhood scale		
Spacing from Obstructions (Par. 4.2)	≥270° or 180° if on side of building		
Spacing from Roads (Par. 4.3)	2-10 m from edge of nearest traffic lane for microscale; ≥10 m from intersection, preferably at midblock		
	See Table 1 for middle and neighborhood scale		
Spacing from Trees (Par 4.4)	Should be ≥10 m from dripline of trees, if tree is ≥5m above sampler and is between the probe and the road.	N/A	
Comments:			

NITROGEN DIOXIDE			
Vertical Probe Placement (Par. 6.1)	3-15 m above ground		
Spacing from Supporting Structure (Par. 6.1)	Greater than 1 m		
Obstacle Distance (Par. 6.2)	≥Twice the height the obstacle protrudes above probe		
Unrestricted Airflow (Par. 6.2)	Must be 270° or 180° if on side of building		
Spacing between Station and Roadway (Par. 6.3)	See Table 2		
Spacing from Trees (Par. 6.4)	Should be ≥20 m from dripline of trees	N/A	
	Must be ≥10 m from dripline, if trees are an obstruction **		
Probe Material (Par. 9)	Teflon or pyrex glass		
Residence Time (Par. 9)	Less than 20 seconds		
Comments:			

* Citations from 40 CFR 58, Appendix E.
** A tree is considered an obstruction if it protrudes above the height of the probe by 5 meters or more.

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Figure 4-1 (Continued). Example New Site Configuration Form.

Information Management Center (IMC)
New Site / Site Relocation Form

Site Evaluation in Conformance with EPA Requirements: Site Name: ______________________ Observed by: ______________

Make and Model #: Ozone Monitor:__________________________ Sulfur Dioxide Monitor:______________________

CRITERIA	REQUIREMENTS*	CRITERIA MET?	
		Yes	No
OZONE			
Vertical Probe Placement (Par. 5.1)	3-15 m above ground		
Spacing from Supporting Structure (Par. 5.1)	Greater than 1 m		
Obstacle Distance (Par. 5.2)	≥twice the height the obstacle protrudes above probe		
Unrestricted Airflow (Par. 5.2)	Must include predominant wind. 180° if on side of building. Otherwise 270°.		
Spacing between Station and Roadway (Par. 5.3)	See Table 3		
Spacing from Trees (Par. 5.4)	Should be ≥20 m from dripline	N/A	
	Must be ≥10 m if blocking daytime wind from urban core		
Probe Material (Par. 9)	Teflon or pyrex glass		
Residence time (Par. 9)	Less than 20 seconds		
Comments:			

SULFUR DIOXIDE			
Horizontal and Vertical Probe Placement (Par. 3.1)	3-15 m above ground		
	> 1 m from supporting structure		
	Away from dirty, dusty areas		
	If on side of building, should be on side of prevailing winter wind	N/A	
Spacing from Obstructions (Par. 3.2)	≥1 m from walls, parapets, penthouses, etc.		
	If neighborhood scale, probe must be at a distance ≥twice the height the obstacle protrudes above probe		
	≥270°arc of unrestricted airflow around vertical probes, and wind during peak season must be included in arc		
	180° if on side of building		
	No furnace or incineration flues or other minor sources of SO_2 should be nearby	N/A	
Spacing from Trees (Par. 3.3)	Should be ≥20 m from dripline of trees	N/A	
	≥10 m when trees act as an obstruction		
Comments:			

* Citations from 40 CFR 58, Appendix E.

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Figure 4-1 (Continued). Example New Site Configuration Form.

Table 1

Minimum Separation Distance Between Roadways and Probes or Monitoring Paths for Monitoring Neighborhood Scale Carbon Monoxide

Roadway average daily traffic, vehicles per day	Minimum separation distance[1] for probes or 90% of a monitoring path (meters)
≤10,000	10
15,000	25
20,000	45
30,000	80
40,000	115
50,000	135
≤60,000	150

[1] Distance from the edge of the nearest traffic lane. The distance for intermediate traffic counts should be interpolated from the table values based on the actual traffic count.

Table 2

Separation Distance Between Pb Stations and Roadways (Edge of Nearest Traffic Lane)

Roadway average daily traffiic, vehicles per day	Separation distance between roadways and stations, in meters		
	Microscale	Middle Scale	Neighborhood urban regional scale
≤10,000	5-15	[1]> 15-50	[1]>50
20,000	5-15	> 15-75	>75
≥40,000	5-15	> 15-100	>100

[1] Distances should be interpolated based on traffic flow.

Table 3

Minimum Separation Distance BetweenRoadways and Probes or Monitoring Paths for Monitoring Neighborhood and Urban Scale Ozone and Nitrogen Dioxide

Roadway average daily traffic, vehicles per day	Minimum separation distance[1] in meters
≤10,000	10
15,000	20
20,000	30
40,000	50
70,000	100
110,000	250

[1] Distance from the edge of the nearest traffic lane. The distance for intermediate traffic counts should be interpolated from the table values based on the actual traffic count.

Figure 4-1 (Continued). Example New Site Configuration Form.

- If the *On* box is checked, a complete and accurate polling configuration is expected. Fill in all boxes. Check the *DataView* box if DataView is operating at the site. Do not check Retry. Check the *days of the week* to poll (usually all days are checked). The polling minutes are used to define the polling order of the sites within each hour. Using lower polling minutes will cause a site to be polled before other sites with higher polling minutes. Entering any minute value (including zero) into any hourly field will cause the data to be polled for that hour.

- Add or delete linked raw data configurations to a site's polling configuration from the Configured Data Format IDs data window.

A raw data format configuration defines what type of data are collected by each channel in the datalogger and is used to relate the incoming raw data to information stored in the database. To access the raw data formats configuration, select **Configuration -> Raw Data Formats** from the Configuration frame. Then select an *abbreviation* from the Select Site drop-down list box or add a new record. When configuring raw data formats, follow these guidelines:

- For hourly data collected on ESC dataloggers, the Data Field and Data Label columns must reflect what the datalogger is providing in the raw data. (The Data Field column maps to the channel number).

- The collected data type must already exist in the data parameter configuration. If it does not exist, it will not be available in the Par Code drop-down list box and cannot be used. In this case, a new data parameter is being defined and must be added to the Data Parameters configuration before continuing.

- For calibration data collected on ESC dataloggers:

  - The Data Field column should contain 0.

  - The Data Label column must contain an appropriate label for the calibration data type (SPAN, PREC, or ZERO).

  - The Par Code column must contain the appropriate primary parameter name code rather than a specific parameter code (i.e., "O3" not "O3-10"). The data loading program assigns the correct par code by querying the hourly data.

  - The Code Field, Code Exp, Cal Type, and Cal Val Type columns tell the data loading program where in the reformatted cal file to look for the data.

  - Calibration configurations are not straightforward. Seek the help of the database administrator if a new configuration is required.

- To add a new format ID, click the **New Format** button to show a blank configuration interface.

- Enter information into the site configuration record.

4.1.3 Adding Screening Ranges Records

The anomaly screening configuration is used to flag raw data that fall outside of expected values so the data will be quickly inspected to rule out instrument problems and to aid the data analyst during the validation process. Currently, there is no “wizard” type interface for this configuration and, due to its complexity, only the database administrator should modify this configuration.

4.1.4 Creating or Modifying Stackplot Configuration Files

The stackplot configuration consists of configuring each plot (titles, temporary plot file, etc.) and each graph on each plot (plotting parameters, line types, etc.). A plot represents a physical page and a graph represents a trace of data for a parameter drawn on the page. A site can have one or more plots associated with it and each plot can have one or more graphs on it.

Each plot configuration requires information specific to the plot page as shown in Figure 4-2. When configuring a plot, follow these guidelines:

- The contents of the *Stkplot File* field must be unique because it is used to create temporary ASCII files that are accessed by the Stkwin program for generating stackplots.

- The *Min. Increment* must contain the shortest interval of time that will be plotted (usually 1 or 24 hours) on this plot page).

- Check the **Include in Daily Review** box for the plot to be generated as part of the polling process. When this box is checked, also enter the number of Days back to plot. Check the **Today** box to plot through the current date; leave it unchecked to plot through the day before the current date.

Each graph on the plot has many parameters specifying how data will look on the graph and how the graph will look on the plot. Though some plotting parameters are not configurable and most of them have default settings, it is necessary to configure each graph at least once. Figure 4-3 shows an example stackplot parameter configuration. When configuring stackplot parameters, follow these guidelines:

- The *Par Code*, *Table*, and *Column Name* fields must be configured properly in order for the program to find the correct data. If necessary, refer back to the polling configuration to see the specific parameter codes assigned to a site’s data.

- One or two parameters can be plotted on the same graph. Use the *Yes* and *No* radio buttons to toggle this option.

- Configuring stackplot parameters takes practice and often requires several modifications before the plot looks right.

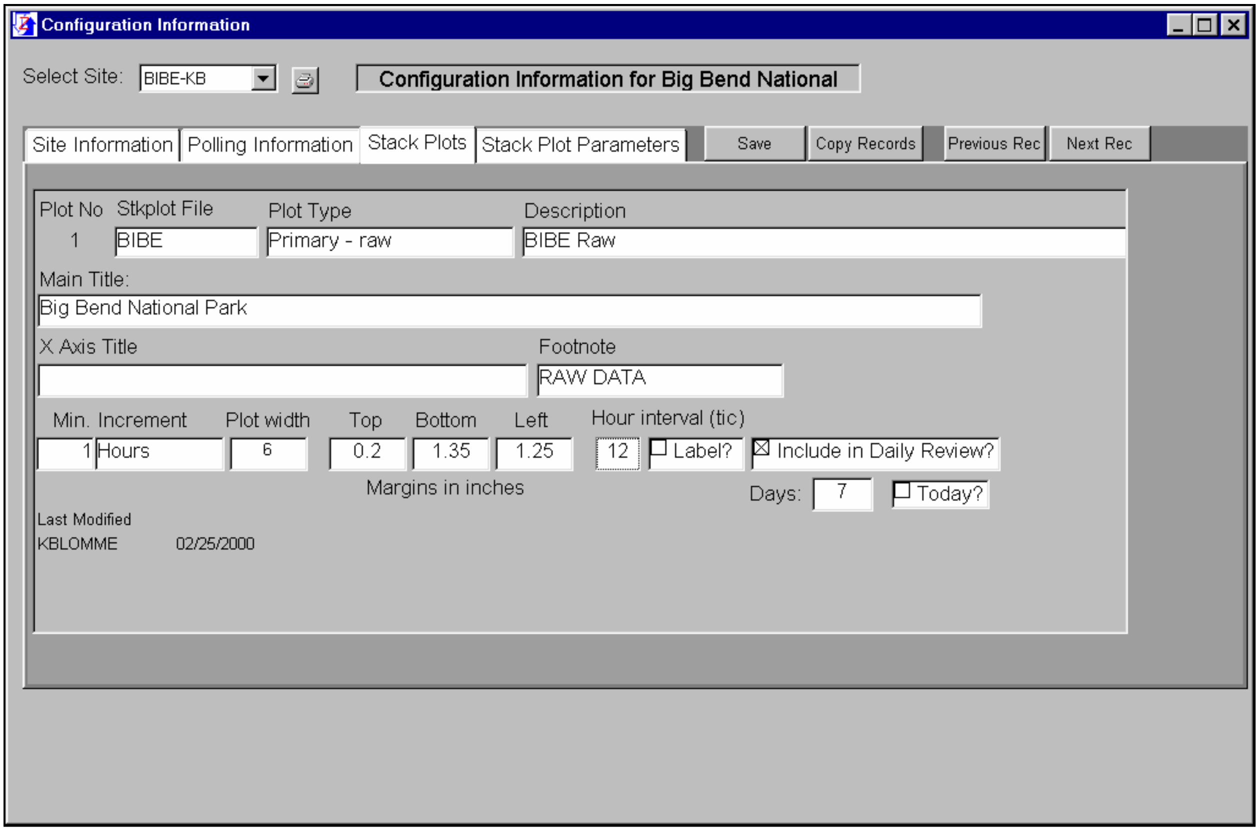

Figure 4-2. Stackplot Page Configuration.

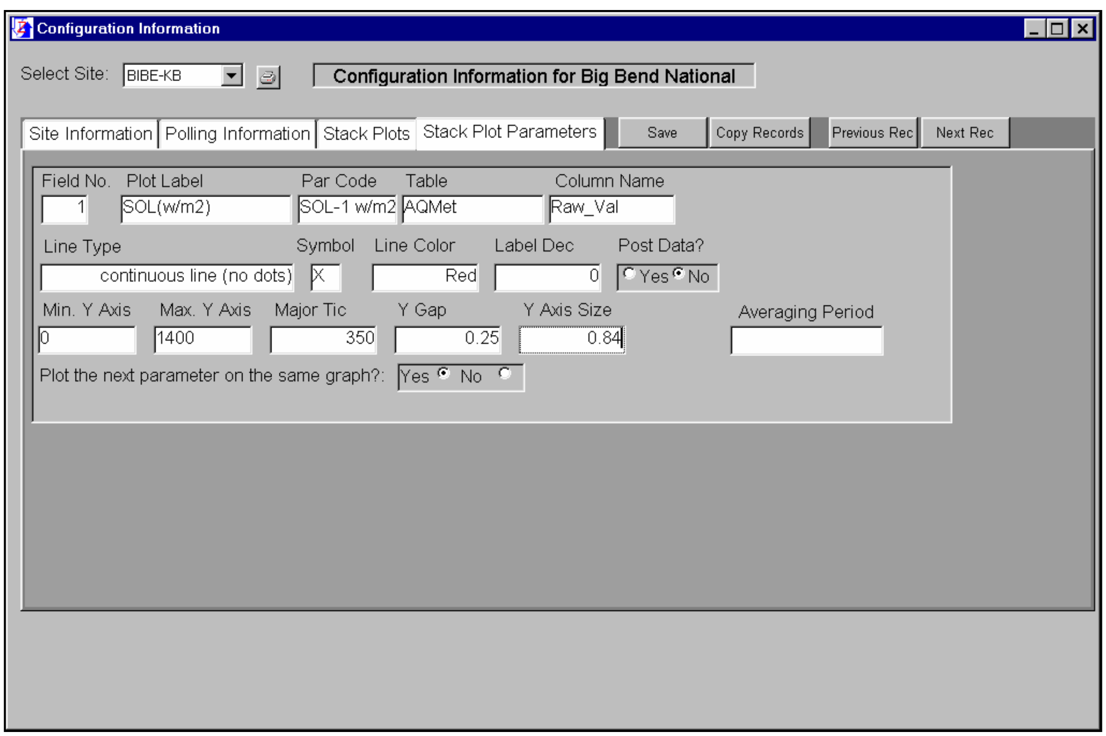

Figure 4-3. Stackplot Parameter Configuration.

4.2 MODIFYING SITE INFORMATION

Changes in site configuration require modifications to the site information. Several examples of configuration changes and the actions required are:

Change	Actions
A new site begins monitoring	• Add the site name to .SBM files.
A site begins monitoring an additional parameter.	• Add the datalogger column information to the site's record in the Site Configuration Table. • Add the parameter to the site's standard stackplot configuration file if the parameter should be plotted. • Submit the new monitoring information to AQS.
A site discontinues all monitoring.	• Uncheck the **Include in Auto Poll** box in the site'' record in the Site Configuration Table. • Submit the termination dates to AQS. • Delete the site name from the .SBM files.
A site discontinues monitoring of one or more parameters.	• Modify the site's record in the Site Configuration Table to reflect the new datalogger configuration. • Submit changes to AQS. • Modify the site's stackplot file to remove the discontinued parameters if they had been plotted.
A site begins monitoring a parameter with a different measurement unit or model of analyzer.	• Change the parameter code for the appropriate datalogger column in the site's record in the Site Configuration Table.

For detailed instructions for each of these actions, or any other network changes that require site information modifications in the AQDBMS, refer to TI 3550-5300, *Submitting Ambient Air Quality and Meteorological Monitoring Data to the EPA AQS Database*.

4.3 ADDING A NEW PARAMETER AND/OR PARAMETER CODE

Two tables exist in the database that define the collected parameters in the air quality network. The *Parameter Table* holds the records for each basic parameter monitored, such as ozone (O_3) or sulfur dioxide (SO_2). Each record in this table has a unique entry in the parameter field and a unique set of AQS codes. The *Parameter Codes Table* holds records that further define each parameter, such as the units of measurement and the AQS method code for the type of analyzer used. If a gaseous pollutant or meteorological parameter is added to the network, one that has never been collected at any site in the network, the parameter must be added to the Parameter Table. If an already existing parameter changes with regard to any of its defining elements (units of measurement, method code, or parameter occurrence code) a new parameter code must be added. For instructions for adding new parameters and parameter codes, see the adding a new parameter and/or parameter code section in the *Air Quality Data Base Management System (AQDBMS) User's Guide* (ARS, 2008).

4.4 ADDING A CONVERSION FORMULA

Most network parameters are collected in standard units; however, throughout the history of the air quality network, parameters have been collected in varying units of measurement, often varying from one period to another at a specific site. The AQDBMS stores all data in the originally collected units, therefore the reporting programs have been developed to handle these variations. During execution, the reporting program queries a table in the AQDBMS that holds the conversion formulas and converts values as needed in order to correctly generate output. If a new parameter type is defined or if an existing parameter is going to be collected in different units that exist in the Parameter Table, the table must be modified to handle the unit conversion requirements.

The following examples are provided to illustrate when additional conversion formulas are necessary:

> Event: The ozone analyzers at all sites have been collecting data in parts per million (ppm). Glacier National Park begins collecting ozone data in parts per billion (ppb).
>
> Action: Add two records to the Conversion Formula Table; one for converting ozone in ppm to ppb and one to convert ozone in ppb to ppm.
>
> Event: Chiricahua National Monument begins collecting ozone data in parts per billion (ppb).
>
> Action: None, because the required conversion formula records already exist.

For instructions on adding conversion formulas, see the adding a conversion formula section of the *Air Quality Data Base Management System (AQDBMS) User's Guide* (ARS, 2008).

4.5 ADDING A NEW MEASUREMENT UNIT

Each data value in the AQDBMS database is tagged with a parameter code. The parameter definition includes the measurement unit. Therefore, RNF-1 is defined as rainfall (precipitation) in *mm* and RNF-2 is defined as rainfall in *in*. Another table, the Units Table, is used to define what *mm* and *in* are, millimeters and inches. This table also stores the equivalent AQS code for each unit. Since AQS uses thousands of different units, only those required by the AQDBMS have been defined in the Units Table and new units must be added.

If a site begins collecting data using a unit that has not been previously used at any site for any parameter, a record defining the unit must first be added to the Units Table before the unit can be used to define a parameter code. For example, if Big Bend National Park began collecting rainfall in buckets instead of millimeters or inches, the IMC data analyst would find the AQS unit code for buckets in the AQS documentation and then add a new record to its Units Table defining buckets. After adding the new unit, a new parameter code would be added. To add a new unit, see the adding new units section of the *Air Quality Data Base Management System (AQDBMS) User's Guide* (ARS, 2008).

4.6 ADDING A NEW AQS METHOD CODE

AQS uses a method code in its database to define the type of instrumentation used to collect data. For instruments that collect pollutant parameters, the method codes differ not only with the type of analyzer but also with the specific analyzer make and model. The AQDBMS must know what method code to associate with each data value when creating records to submit to AQS. Again, the parameter code is used to accomplish this. For example, the parameter code O3-5 is defined as ozone collected in ppm with method code 83. The unit ppm is defined in the Units Table and, similarly, method code 83 is defined in the Methods Codes Table. Since AQS uses thousands of different method codes, only those required by the AQDBMS have been defined in its Method Codes Table and any new method codes must be added. To add a new method code, see the adding a new parameter or parameter section in the *Air Quality Data Base Management System (AQDBMS) User's Guide* (ARS, 2008).

4.7 CREATING OR MODIFYING FILES FOR STACKPLOTS

Setting up a stackplot is complex due to the large number of possible data combinations and options. Therefore, a set of standard setup files (.STK file*)* have been created for plots that are created on a regular basis with only a change in the time period to be plotted. These files are maintained in *\\ARSNW1\vol4\project\imc\stkplots\dailyreviewl*. File names are *ssss*STD.STK, where *ssss* is the 4-letter site abbreviation. Refer to the *Stackplot User's Guide* (ARS, 2007) for layout information.

5.0 REFERENCES

Air Resource Specialists, Inc. (ARS), 2007, Stackplot User's Guide.

Air Resource Specialists, Inc. (ARS), 2008, Air Quality Data Base Management System (AQDBMS) User's Guide.

The Air Quality Database Management System (AQDBMS)

Database Administrator and Programmer's Reference

Prepared by Air Resource Specialists, Inc.
March 1999
Revised January 2001

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1.0 Introduction

This document discusses the designs, definitions, specifications, and current maintenance schedule for the Air Quality Data Base Management System (AQDBMS) developed by Air Resource Specialists, Inc. (ARS) for the National Park Service (NPS) Air Resources Division's (ARD) Information Management Center (IMC). When combined with the documentation provided by the commercial software vendors involved, this document will help the experienced Oracle database administrator and/or database programmer to understand and maintain the operational Oracle database and interface applications. Specific categories that will be addressed include:

- Overall system description
- Database design
- Client installation instructions
- Database startup and shutdown instructions
- Oracle database maintenance schedule and instructions

Note: System hardware and software requirements are specified in SOP 3340, *Information Management Center (IMC) Concept And Configuration.*

2.0 AQDBMS Overview

The AQDBMS IMC Oracle database (IMC database) is specifically designed to hold air quality network data and related site information data, validation data, diagnostic data, and parameter data that accommodate the many temporal, spatial, and functional variations found within an air quality network. The database resides on a network server computer. The AQDBMS also includes a custom database user interface developed by Air Resource Specialists, Inc. (ARS) with Powersoft PowerBuilder Enterprise for Windows and Microsoft Visual Basic. Both are graphical application development environments that provide the tools needed to build easy to use, powerful database applications for Windows operating systems. The interface consists of menus and windows (or screens that users interact with) and makes extensive use of standard point and click window controls and functions, such as:

- Command buttons, check boxes, and radio buttons.
- Drop-down lists to facilitate data entry and ensure data integrity.
- Dialog boxes that prompt the user for information or display error messages.
- Tab controls for organizing processes and user input.
- The ability to open more than one window (screen) at a time for "multi-tasking."

The custom interface supplies the following functions:

- Primary gaseous pollutant and meteorological data loading and storage
- Precision checks and audit data loading and storage

- Site and parameter configurations maintenance
- Data validation
- Data reporting
- Data retrieval and export including creation and loading of EPA AIRS transaction files
- Logging of site problems, instrument maintenance, etc.

The *Air Quality Data Base Management System (AQDBMS) User's Guide* (ARS, 1999, 2001) provides detailed instructions on using the interface to accomplish these tasks.

3.0 Database Description

The IMC database has been designed using the entity-relationship model and Codd's rules of normalization. In summary, this means the database is a collection of tables containing columns and rows and the data in each table are related to data in one or more other tables. In addition:

- Each entry in a table occurs only once, (i.e., each row is unique).
- Each column is named.
- All values of a given column are of the same type.
- Column order is immaterial.
- Row order is immaterial.

Because common columns relate tables in a relational database, the rules that govern the relationship of the columns must be maintained. Referential integrity rules enforced by foreign key constraints guarantee that these relationships are preserved. This means that no user may at any time or through any data access path enter undefined or incomplete information, nor can a user delete a row for which related rows exist. In addition, Oracle database triggers are used to enforce the rules of allowable combinations of values that may be entered into the main data table (primary_data). A database trigger is a stored database procedure automatically invoked by the Relational Data Base Management System (RDBMS) during insert, update, or delete operations on the table for which it has been defined.

A list of IMC database tables and associated tablespaces is shown in Table 3-1. Foreign key constraints are presented in Table 3-2. An Appendix to this document contains a description of each table, including column names, data types, indexes, and triggers.

Table 3-1

Tables in the IMC Database

Name	Owner	Tablespace
AIRS_METHODS	DPC	CODES
AMBIENT_AQ_STANDARDS	DPC	CODES
AQMET_SPECS	DPC	SITE_CONFIGURATION
AQ_CAL	DPC	CAL_DATA
AUDIT_DATA	DPC	CAL_DATA
COLUMNS	DPC	POLLING
CONVERSIONS	DPC	DATA_VALIDATION
DATA_FORMS	DPC	DATA_VALIDATION
DATA_VALIDATION_LOG	DPC	DATA_VALIDATION
DATA_VALIDATION_COMMENTS	DPC	DATA_VALIDATION
DATA_VALIDATION_LOG_DETAIL2	DPC	DATA_VALIDATION
DATA_WINDOW	DPC	USER_DATA
INTERVAL_CODES	DPC	CODES
MESSAGES	DPC	SITE_CONFIGURATION
OUTPUT_GROUPINGS	DPC	SITE_CONFIGURATION
OUTPUT_GROUPS	DPC	SITE_CONFIGURATION
OUTPUT_PRODUCTS	DPC	SITE_CONFIGURATION
OUTPUT_PRODUCTS_OPTIONS	DPC	SITE_CONFIGURATION
PARAMETER_CODES	DPC	CODES
PARAMETERS	DPC	CODES
PARS_INFO	DPC	CODES
POLLING	DPC	SITE_CONFIGURATION
POLLING_DETAIL	DPC	SITE_CONFIGURATION
POLLING_LINE_ID	DPC	SITE_CONFIGURATION
PRIMARY_DATA	DPC	DPC_DATA
SCREENING_TABLE1	DPC	SITE_CONFIGURATION
SITES	DPC	SITE_CONFIGURATION
SITE_GROUPINGS	DPC	SITE_CONFIGURATION
SITE_GROUPINGS	DPC	SITE_CONFIGURATION
SITE_GROUPS	DPC	SITE_CONFIGURATION
SITE_LOGS	DPC	DATA_VALIDATION
SITE_STATUS_LOG	DPC	SITE_STATUS_LOG
SITE_STATUS_LOG_DETAIL	DPC	SITE_STATUS_LOG
SITE_STATUS_LOG_DETAIL	DPC	SITE_STATUS_LOG
SOURCE_CODES	DPC	CODES
SOURCE_CODES	DPC	CODES
STKPLOT_MASTER	DPC	SITE_CONFIGURATION
STKPLOT_MASTER	DPC	SITE_CONFIGURATION
STKPLOT_DETAIL	DPC	SITE_CONFIGURATION
STKPLOT_DETAIL	DPC	SITE_CONFIGURATION
TIME_ZONES	DPC	SITE_CONFIGURATION
UNIT_CODES	DPC	CODES
VALIDATION_CODES	DPC	CODES
VALIDATION_CODES	DPC	CODES

Table 3-2

Foreign Key Constraints on IMC Tables

Foreign Key Name	Child Table		Parent Table	
	Table Name	Column Names	Table Name	Column Names
FK_AQ_CAL	AQ_CAL	SITE_NO	SITES	SITE_NO
FK_AQMET_SPECS	AQMET_SPECS	SITE_NO	SITES	SITE_NO
FK_AUDIT_PAR	AUDIT_DATA	PAR_CODE	PARAMETER_CODES	PAR_CODE
FK_AUDIT_SITE	AUDIT_DATA	SITE_NO	SITES	SITE_NO
FK_CONVERSIONS_PARAMETER	CONVERSIONS	PARAMETER	PARAMETERS	PARAMETER
FK_CONVERSIONS_FROMUNITCODE	CONVERSIONS	FROM_UNIT_CODE	UNIT_CODES	UNIT_CODE
FK_CONVERSIONS_TOUNITCODE	CONVERSIONS	TO_UNIT_CODE	UNIT_CODES	UNIT_CODE
FK_DAILY_OUTPUT	DAILY_OUTPUT	SITE_NO	SITES	SITE_CONFIGURATION
FK_DATA_VALIDATION_LOG	DATA_VALIDATION_COMMENTS	SITE_NO YEAR MONTH	DATA_VALIDATION_LOG	SITE_NO YEAR MONTH
FK_DATA_VALIDATION_LOG	DATA_VALIDATION_DETAIL2	SITE_NO YEAR MONTH	DATA_VALIDATION_LOG	SITE_NO YEAR MONTH
FK_DATAVALIDATIONLOG_SITENO	DATA_VALIDATION_LOG	SITE_NO	SITES	SITE_NO
FK_OUTPUT_GROUP_NO	OUTPUT_GROUPINGS	GROUP_NO	OUTPUT_GROUPS	GROUP_NO
FK_OUTPUT_PROD_NO	OUTPUT_GROUPINGS	PROD_NO	OUTPUT_PRODUCTS	PROD_NO
FK_OUTPUT_OPTIONS	OUTPUT_PRODUCT_OPTIONS	PROD_NO	OUTPUT_PRODUCTS	PROD_NO
FK_PARAMETERS	PARAMETER_CODES	PARAMETER	PARAMETERS	PARAMETER
K_UNIT_CODE	PARAMETER_CODES	RAW_UNIT_CODE	UNIT_CODES	UNIT_CODE
FK_PARS_INFO_PAR	PARS_INFO	PARAMETER	PARAMETERS	PARAMETER
FK_PARS_INFO_UNIT	PARS_INFO	UNIT_CODE	UNIT_CODES	UNIT_CODE
FK_POLLING	POLLING	SITE_NO	SITES	SITE_NO
FK_TIMEZONE	POLLING	LOGGER_TIMEZONE	TIMEZONES	TIMEZONE_ABBR
FK_POLLING_DETAIL_SITE	PARS_DETAIL	SITE_NO LOGGER_NO	POLLING	SITE_NO LOGGER_NO
FK_POLLING_DETAIL_LINE	POLLING_DETAIL	LINE_ID	POLLING_LINE_ID	LINE_ID
FK_POLLING_LINE_COL	POLLING_LINE_ID	COLUMN_NAME	COLUMNS	COLUMN_NAME
FK_POLLING_LINE_TAB	POLLING_LINE_ID	TABLE_NAME	TABLES	TABLE_NAME
FK_PARCODE	PRIMARY_DATA	PAR_CODE	PARAMETER_CODES	PAR_CODE
FK_SITENO	PRIMARY_DATA	SITE_NO	SITES	SITE_NO
FK_SOURCE	PRIMARY_DATA	SOURCE_CODE	SOURCE_CODES	SOURCE_CODE
FK_SITE_GROUPINGS	SITE_GROUPINGS	GROUP_NO	SITE_GROUPS	GROUP_NO
FK_SITE_LOGS	SITE_LOGS	SITE_NO	SITES	SITE_NO
FK_SITESTATUSLOG_SITENO	SITE_STATUS_LOG	SITE_NO	SITES	SITE_NO
FK_SITE_STATUS_LOG	SITE_STATUS_LOG_DETAIL	SITE_NO REF_NO	SITE_STATUS_LOG	SITE_NO REF_NO
FK_STKPLOT_DETAIL	STKPLOT_DETAIL	SITE_NO PLOT_NO	STKPLOT_MASTER	SITE_NO PLOT_NO
FK_STKPLOT_MASTER	STKPLOT_MASTER	SITE_NO	SITES	SITE_NO

4.0 The Oracle RDBMS

Oracle provides the ability to store and access data in a manner consistent with the relational model. Because of this, Oracle is referred to as a relational database management system (RDBMS). The Oracle RDBMS is available for a number of specific platforms. Currently, the AQDBMS uses the Oracle 8i 8.1 Server for Netware with the TCP/IP Protocol Adapter to provide database access from Windows client workstations to the database residing on a Netware server. This section provides information and instructions for managing the database in this environment.

> **Note:** System hardware and software requirements are specified in SOP 3340, *Information Management Center (IMC) Concept And Configuration.*

4.1 Oracle Database Files

The Oracle RDBMS uses files to store its data. In addition, files are used to store configuration and initialization parameters. A set of system tables, called the Oracle data dictionary, tracks all of the database files; where they reside on the file server, their time stamps, and other information. To ensure integrity of the database, the database will not successfully open on startup if the physical files have been moved or if the files have inconsistent timestamps. Table 4-1 lists the paths and names of the physical files, tablespace names, and/or purposes.

4.2 Loading and Unloading the Oracle Server Netware Loadable Modules

The Oracle Netware Loadable Modules (NLMs) must be loaded into memory on the Netware Server in order for the database to be accessed. As the NLMs are loaded, settings in the CONFIG.ORA are used. Figure 4-1 shows the contents of the current CONFIG.ORA file. See Oracle 8i 8.1.6 Server Getting Started for NetWare (Oracle Corporation, 2000). Table 4-2 is list of the current Novell Netware NLMs and Oracle NLMs required by the Oracle server. Once the NLMs are loaded, the database can be started.

➢ To Load the Oracle 8i Server:

1. Verify that the required Novell Netware NLMs have been loaded (see Table 4-2).
2. At the Netware Server console, type **ORALOAD**. This is the name of the Oracle Netware Configuration File (NCF) that loads all of the *required* Oracle NLMs. After loading the NLMs, the database administrator must startup the database. See Section 5.2 IMC Database Startup and Shutdown for instructions.

➢ To Unload the Oracle 8i Server:

1. At the Netware Server console, type **ORAUNLD**. This is the name of the Oracle Netware Configuration File (NCF) that unloads all of the Oracle NLMs.

Table 4-1

IMC Database Data Files

Netware File Name	Tablespace Name or purpose	File type	Size
Sys\database\caldata1.dbf	CAL_DATA	Binary	35mb
Sys\database\codes1.dbf	CODES	Binary	30mb
Sys\database\dval1.dbf	DATA_VALIDATION	Binary	68mb
Sys\database\datatmp1.dbf	DATATEMP	Binary	20mb
Sys\database\data1.dbf	DPC_DATA	Binary	2.3gb
Sys\database\site1.dbf Vol2\database\site2.dbf	SITE_CONFIGURATION	Binary	25mb 10mb
Sys\database\stat1.dbf	SITE_STATUS_LOG	Binary	30mb
Sys\oranw803\database\dbs1imc.ora Sys\database\sys2.dbf	SYSTEM (System tables)	Binary	9mb 100mb
	IMC database control file	Binary	141kb
	Database log files	Binary	201kb 201kb
Sys\database\rbig1.dbf	RBS_BIG (Large rollback segments)	Binary	140mb
Sys\database\rollback.dbf	ROLLBACK_SEGS (Rollback segments)	Binary	30mb
Sys\database\temp1.dbf	TEMP (temporary segments)	Binary	100mb
Sys\database\user1.dbf Vol2\database\userdat2.ora	USER_DATA	Binary	15mb 5mb
Vol2\database\prndx1.dbf	PR_NDX (primary_data table index)	Binary	2.8gb
Vol2\database\tmpirg.dbf Vol5\database\tmplg2.dbf	TEMP_LARGE (Large temp segments)	Binary	50mb 4gb
Vol2\database\calndx1.dbf	CAL_NDX (cal_data table index)	Binary	15mb
Vol2\database\ndx_01.dbf	DPC_NDX (other table indexes)	Binary	70mb
Vol5\orahome1\nlm\config.ora	Oracle Server Initialization file	Text	1kb
Vol5\orahome1\database\pwdimc.ora	Oracle IMC Password file	Binary- encrypted	2kb
Initimc.ora	Oracle IMC Instance initialization file	Text	5kb
wgctl2.ora	IMC database backup control file	Binary	141kb
Vol5\orahome1\network\admn\listener.ora	Oracle server listener configuration	Text	1kb
Vol5\orahome1\network\admin\tnsnames.ora	Oracle service names configuration	Text	2kb

```
OS_NAME=netware
ORACLE_HOME=VOL5:\OraHome1
NETWORK=VOL5:\OraHome1\NETWORK
ORA_NLS33=VOL5:\OraHome1\OCOMMON\NLS\ADMIN\DATA
NLSRTL33=VOL5:\OraHome1\OCOMMON\NLS\ADMIN\DATA
ORACORE=VOL5:\OraHome1\RDBMS
NLS_LANG=AMERICAN_AMERICA.WE8ISO8859P1
PROD_HOME=VOL5:\OraHome1\oracle.swd.oui
ORD=VOL5:\OraHome1\ord
RDBMS=VOL5:\OraHome1\RDBMS
PLSQL=VOL5:\OraHome1\PLSQL
MD=VOL5:\OraHome1\MD
NW_ENABLE_SID_SUPPORT=TRUE
# Setting NW_FSTYPE to DFS is not supported on
# Volumes with Block Suballocation ON
NW_FSTYPE=CLIB
CTX=VOL5:\OraHome1\CTX
SQLPLUS=VOL5:\OraHome1\SQLPLUS
PRECOMP=VOL5:\OraHome1\PRECOMP
SQLPATH=VOL5:\OraHome1\SQLPATH
API=VOL5:\OraHome1\RDBMS
LOCAL=ARS_IMC-orcl-beq.world
UTILITY_MSG+VOL5:\OraHome1\RDBMS
```

Figure 4-1. The Config.ora file.

Table 4-2

Netware Requirements

Operating System	Netware 5 or 5.1
Novell NLMs	• CLIB • MATHLIB • STREAMS CLIB will automatically load additional NLMs

Important Note: Do not unload the Oracle NLMs without first shutting down the database. See Section 5.2, IMC Database Startup and Shutdown.

4.3 IMC Database Backup and Recovery

Several operating system files contain the objects and initialization parameters for the IMC database as shown in Table 4-1. These files should be backed up on a regular basis. Oracle Corporation guarantees only those backups performed when the database is shutdown (referred to as "cold" backups) or databases running in "archive" mode. This database was installed to run in "no archive" mode. This means that any updates to the database since the last backup could be lost if the file server goes down with a critical disk error.

➢ To Backup the IMC Database:

1 Shutdown the database prior to the start of the network backup procedure (see Section 5.2, IMC Database Startup and Shutdown).
2 Make sure all the database files in Table 4-1 are included in the list of files to be backed up during the network backup procedure.

➢ To Recover the Oracle Database:

1 Restore the database files from the backup media used during the last successful backup to the paths listed in Table 4-1.
2 Startup the database.

4.4 Database Security and Netware Rights

To run the AQDBMS client application and graphics programs, users must have Netware file scan and read rights to the directories containing the executable application code as specified in Sections 7.0 and 8.0. In addition, several processes in the AQDMBS application read or write files external to the database, so users must be given Netware scan, read, and modify rights to these directories. The specific directories and files are referenced in the *Air Qualitiy Data Base Management System (AQDBMS) User's Guide* (ARS, 1999, 2001).

5.0 IMC Database Administration Tasks

The Database Administrator (DBA) is responsible for providing a database that is robust, dependable, secure, extensible, and designed to meet the objectives of the applications it supports. A complete discussion of managing all of the database’s internal architecture to meet these objectives is beyond the scope of this document. The following subsections, however, include an overview of the utilities used to manage the IMC database and discussion, and instructions for several ongoing and scheduled DBA tasks.

5.1 Oracle DBA Utilities

Version 8i of the Oracle Client Software includes a package of Database Administration Utilities collectively called The Oracle Enterprise Manager (OEM). The OEM is installed on the DBA's workstation and provides graphical interfaces for performing many tasks. A sub-set of utilities collectively referred to as DBA Management Tools contain the components of OEM used for managing the IMC database. These components are:

- The Instance Manager for monitoring database connections and for database startup and shutdown. See the next section for instructions on using this utility to startup and shutdown the database.
- The Schema Manager for easy execution of data definition language (DDL) commands.
- The Security Manager for managing database users and roles and their properties.
- The Storage Manager for monitoring and modifying data files.
- The SQL Worksheet for issuing Structured Query Language (SQL) commands in either command line or script form.

See OEM online help for information on using these utilities.

5.2 IMC Database Startup and Shutdown

Several utilities may be used to startup and shutdown the IMC database. One is Instance Manager, a graphical interface and component of the Enterprise Manager installed on a client workstation. The other is Server Manager, a non-graphical DOS program. Both server and client versions of Server Manager are available.

➢ To Startup the IMC Database Using Instance Manager from a Workstation:

1 Launch the Instance Manager (typically from the Oracle Toolbar or find it in the Windows program list).
2 In the "User name" field of the login window, type **SYS.**
3 In the "Password" field of the login window, type the database *password*.
4 In the "Service" field of the login window, type **IMC.**
5 Select **sysdba** from the connection type drop-down.
6 Click on the database icon under the correct instance in the Instance Manager window.
7 From the "Object" menu, select **Startup**.
8 Enter the IMC Database initialization file path and name: **\\ARS_IMC\VOL5\ORHOME1\DATABASE\INITIMC.ORA.**
9 Click the **Startup** button.

➢ To Shutdown the IMC Database Using Instance Manager from a Workstation:

1 Launch the Instance Manager (typically from the Oracle Toolbar or find it in the Windows program list).
2 In the "User name" field of the login window, type **SYS.**

3 In the "Password" field of the login window, type the database *password*.
4 In the "Service" field of the login window, type **IMC.**
5 Select **sysdba** from the connection type drop-down.
6 Click on the database icon under the correct instance in the Instance Manager window.
7 From the "Object" menu, select **Shutdown**.
8 Click the *radio* button for the type of shutdown to perform, **Normal, Immediate**, or **Abort**. In most cases, **Normal** or **Immediate** are appropriate options. Use **Abort** only in times of critical server errors.
9 Click the **Shutdown** button.

➢ To Startup the IMC Database Using Server Manager from the Server Console:

1 At the server console, type **svrmgr31** and press **ENTER**. The Server Manager utility is launched.
2 Type **set instance imc**. Server Manager responds with "Instance set."
3 Type **connect sys/******@imc as sysdba** and press **ENTER (******* indicates the database password.) Server Manager responds with "Connected."
4 Type **startup pfile=vol5:\orahome1\database\initimc.ora** and press **ENTER.** Server Manager responds with database startup information.
5 Type **disconnect** and press **ENTER**. Server Manager responds with "Disconnected."
6 Type **exit** and press **ENTER**.

➢ To Shutdown the IMC Database Using Server Manager from the Server Console:

1 At the server console, type **svrmgr31** and press **ENTER**. The Server Manager utility is launched.
2 Type **set instance imc.** The Server Manager responds with "Instance set."
3 Type **connect sys/******@imc as sysdba** and press **ENTER** (***** indicates the database password.) Server Manager responds with "Connected."
4 Type **shutdown normal** (or **immediate** or **abort**) and press **ENTER**. Server Manager responds with "Database closed."
Note: In most cases, n**ormal** or **immediate** are appropriate options. Use a**bort** only in times of critical server errors.
5 Type **disconnect** and press **ENTER**.
6 Type **exit** and press **ENTER**.

5.3 Monitoring IMC Database Data File Usage

The IMC database data files (tablespaces) have been sized based on estimates of the amount of data to be stored. Since these are only estimates, the data file space usage should be checked on a monthly basis and data files extended or new data files added as required. The Storage Manager component of the OEM is used to monitor, add, and extend data files. See the OEM online documentation for instructions.

5.4 Using the Oracle Analyze Command

The Oracle analyze command is used to collect statistics on a database object. The statistics are stored in the data dictionary and used by the Oracle optimizer to choose the execution plan for SQL statements. Since thousands of rows are added to the primary_data table on a daily basis, the analyze command should be run on the primary_data table and its primary index at least once every three months.

Note: Users will not be able to access the primary_data table during this process.

➢ **To run the analyze command on the primary_data table:**

1 Launch the SQL Worksheet utility (typically from the Oracle Toolbar or find it in the Windows program list).
2 In the "User name" field of the login window, type **SYSTEM.**
3 In the "Password" field of the login window, type the *password* for user system.
4 In the "Service" field of the login window, type **IMC.**
5 In the "SQL Worksheet" area, type **analyze dpc.primary_data estimate statistics percent 15.** Click the **execute** button.
6 When the process has finished, type **analyze dpc.pk_primary_data estimate statistics percent 15.** Click the **execute** button.

6.0 Oracle Workstation Client Software Installation

Each Windows workstation client that will access the IMC database must have the Oracle client software installed. The current version is Oracle 8.1.6.

➢ **To install the Oracle Client Software:**

1 Insert the Oracle 8..1.6 Client CD and either allow it to auto run or run "setup.exe."
2 Follow the prompts, the Oracle home should be set to a directory on the local drive.
3 Select **Custom Installation** then click **NEXT**.
4 From the "Available Components" list, select **Net8 Client 8.1.6** and **Oracle ODBC Driver 8.1.6,** then click **NEXT.**
5 Click **INSTALL**.
6 From the "Protocols List" select **TCP/IP Protocol Adapter** then click **NEXT**.
7 Hold down the **CTRL** key and click to select **Oracle8 ODBC Driver 8.03.03**.
8 If the install program attempts to run the configuratin assistant, cancel out of it.
9 Follow the prompts to finish and exit the install program.
10 After the install is complete, copy the files SQL.ORA and TNSNAMES.ORA from \\ars_net3\sys\ars_soft\programs\sqlnet to the \network\admin directory under the Oracle Home directory on the local drive.
11 Test the connection. From the MS-DOS prompt type **TNSPING IMC** from the bin directory under the Oracle Home directory on the local drive.

7.0 The PowerBuilder Application Files and Deployment

The AQDBMS PowerBuilder Application was originally written in Powerbuilder Version 4 and has been migrated to Versions 5, 6, and to the current Version 7. The PowerBuilder interface supplies the following functions:

- Primary gaseous pollutant and meteorological data loading and storage
- Precision checks and audit data loading and storage
- Site and parameter configurations maintenance
- Data validation
- Output of non-graphic data reports
- Data retrieval and export including creation of EPA AIRS transaction files
- Logging of site problems, instrument maintenance, etc.

The PowerBuilder application source code is contained in PowerBuilder libraries in the directory \\ARS_AQDB\VOL4\POWERBUILDER\AQDB\VERSION 2. The library files have a PBL file extension. The PowerBuilder application object is named ARSMON and is contained in ARSMONAPP.PBL. The main executable file is ARSMON.EXE and the compiled library files have a PBD file extension. The application has been compiled using a project object also called ARSMON and is compiled using the native executable format (non-machine code). The compiled code is stored in the directory \\ARS_NET3\ARS_SOFT\PROGRAMS\AQDB\VERSION2. Users must have file scan and read rights to this directory to run the AQDBMS application. They must also have the correct version of the PowerBuilder deployment files installed in the windows\system directory on their workstation. Table 7-1 is a list of the required PowerBuilder deployment files for this application.

Table 7-1

Required PowerBuilder Deployment Files

PBVM70.DLL
PBDWE70.DLL
LIBJCC.DLL
PBTRA70.DLL

8.0 The Microsoft Visual Basic Graphics Programs and Deployment

Graphics programs are written in Microsoft Visual Basic Version 5, Service Pack 3. Table 8-1 lists the programs and the paths to the source code and to the executable code. Users must have file scan and read rights to the executable code directories.

Table 8-1

Visual Basic Source and Executable Files

Name/Description	Path and File
Stkwin: generate stack plots	Source:\\ars_net3\sys\ars_soft\source\vb\stkwin32.5 Executable: \\ars_net\sys\ars_soft\programs\stkwin.exe
Roseplot: generate rose plots	Source: \\ars_net3\sys\ars_soft\source\vb\dpc_ro32.5 Executable: \\ars_net\sys\ars_soft\programs\aqrose.exe
3YrSummary: generate 3-year summary plots	Source: \\ars_net3\sys\ars_soft\source\vb\dpc_su32.5 Executable: \\ars_net\sys\ars_soft\programs\aqsumm.exe
Barplot: generate bar charts	Source: \\ars_net3\sys\ars_soft\source\vb\dpc_ba32.5 Executable: \\ars_net\sys\ars_soft\programs\aqbar.exe
To generate diurnal plots	Source: \\ars_net3\sys\ars_soft\source\vb\dpc_di32.5 Executable: \\ars_net\sys\ars_soft\programs\aqdiur.exe

Visual Basic deployment software must be installed on the user workstation as described below.

➢ To Install Visual Basic Graphics Programs:

1. Run "setup.exe" from the \\ars_net3\sys\ars_soft\install\aq 3yrSummary Install (vb32.5sp3)\144\Disk1 directory.
2. Accept all default values from the setup program. This will install and register all Windows 95 runtime files on the workstation that are necessary for the IMC graphics programs.
3. When the setup program is complete, open Windows Explorer and delete the folder named "c:\program files\dpc sum plot." All of the executable programs are run directly from the network by the IMC AQDBMS application so it is not necessary to retain this local folder.
4. Delete the "AQ 3Year Summary Plot" folder from the Windows 95 Start\Programs folder.

The graphics programs that retrieve data directly from the IMC database use the Oracle 8 ODBC client driver. Configuration instructions follow.

➢ To Configure the Oracle ODBC Driver:

1. Install the Oracle 8 ODBC driver as explained in Section 6.0, Oracle Workstation Client Software Installation.
2. From the Windows 95 control panel, double-click the **32-bit ODBC** icon.
3. In the "Data Sources" dialog box, click the **Add** button.
4. Select **Oracle 8 ODBC** from the list of Installed ODBC Drivers, then click **OK.**
5. Type **IMC** in the Data Source field of the "Oracle ODBC Setup dialog" box.

6 Type a description, such as **IMC 8**, in the Description field of the "Oracle ODBC Setup dialog" box.
7 Type **IMC** in the SQL*Net Connect String field of the "Oracle ODBC Setup dialog" box.
8 Click the **Close** button in the "Data Sources dialog" box.

9.0 References

Air Resource Specialists, Inc. (ARS), 1999, 2001 Air Quality Data Base Management System (AQDBMS) User's Guide

Oracle Corporation, 2000, Oracle 8i Server Getting Started for NetWar, Release 8.1.6.

Appendix A
Database Table Descriptions

Index

AIRS_METHODS: A look-up table to describe the method codes used in the PARAMETER_CODES table.

Column List

Name	Type	P	M
METHOD_CODE	NUMBER(3)	Yes	Yes
DESCRIPTION	VARCHAR2(250)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_METHOD_CODES	Yes	No	No	No	No	METHOD_CODE	ASC

AMBIENT_AQ_STANDARDS: A table to define the air quality standards as defined in AIRS. Used in generating AIRS-type reports.

Column List

Name	Type	P	M
STATE	CHAR(2)	Yes	Yes
PAR	VARCHAR2(25)	Yes	Yes
UNIT_CODE	VARCHAR2(20)	No	Yes
MAX_VALUE	NUMBER	No	No
SEA_STARTMO	NUMBER(2)	No	No
SEA_ENDMO	NUMBER(2)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_AQ_STANDARDS	Yes	No	No	No	No	STATE PAR	ASC ASC

AQMET_SPECS: Air quality and meteorological site specifications. It has a one-to-one relationship with the SITES table, but has been used to allow for flexibility if other types of data are introduced into the database.

Column List

Name	Type	P	M
SITE_NO	NUMBER(3)	Yes	Yes
AQMET_ABBR	VARCHAR(15)	No	Yes
AIRS_STATE_CODE	NUMBER(2)	No	No
AIRS_COUNTY_CODE	NUMBER(3)	No	No
AIRS_SITE_CODE	NUMBER(4)	No	No
AIRS_AGENCY_CODE	NUMBER(3)	No	No
LONG_DEG	NUMBER(3)	No	No
LONG_MIN	NUMBER(2)	No	No
LONG_DEC	NUMBER(2)	No	No
LAT_DEG	NUMBER(3)	No	No
LAT_MIN	NUMBER(2)	No	No
LAT_SEC	NUMBER(2)	No	No
ELEVATION	NUMBER(4)	No	No
FLOW_ABBR	VARCHAR(6)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_AQMET	Yes	No	No	No	No	SITE_NO	ASC
UK_AQMET_ABBR	No	No	No	Yes	No	AQMET_ABBR	ASC

AQ_CAL: Actual and indicated values for zero, precision, and span readings for raw criteria pollutants used for diagnostic and validation purposes. Zero and precision data are also submitted to AIRS.

Column List

Name	Type	P	M
SITE_NO	NUMBER(3)	Yes	Yes
RECORD_DATE	DATE	Yes	Yes
PAR_CODE	VARCHAR2(25)	Yes	Yes
CAL_TYPE	NUMBER(15,3)	Yes	Yes
VAL_TYPE	VARCHAR2(10)	Yes	Yes
CAL_VAL	NUMBER(15,7)	No	Yes
FLAGS	VARCHAR2(10)	No	No
CAL_TYPE	NUMBER(15,3)	Yes	Yes
CAL_TYPE	NUMBER(15,3)	Yes	Yes
VAL_TYPE	VARCHAR2(10)	Yes	Yes
VAL_TYPE	VARCHAR2(10)	Yes	Yes
CAL_VAL	NUMBER(15,7)	No	Yes
CAL_VAL	NUMBER(15,7)	No	Yes
FLAGS	VARCHAR2(10)	No	No
FLAGS	VARCHAR2(10)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_AQ_CAL	Yes	No	No	Yes	No	SITE_NO	ASC
						RECORD_DATE	ASC
						PAR_CODE	ASC
						CAL_TYPE	ASC
						VAL_TYPE	ASC

AUDIT_DATA: Ambient audit (or accuracy) data collected and logged on-site and hand-entered via the data entry screen. Includes multipoint calibrations.

Column List

Name	Type	P	M
SITE_NO	NUMBER(3)	Yes	Yes
RECORD_DATE	DATE	Yes	Yes
PAR_CODE	VARCHAR2(25)	Yes	Yes
AUDIT_SOURCE	VARCHAR2(50)	No	No
AIRS_AUDIT_TYPE	NUMBER(1)	No	No
STANDARD_SOURCE	CHAR(1)	No	No
ACTUAL_ZERO	NUMBER(15,3)	No	No
INDICATED_ZERO	NUMBER(15,3)	No	No
ACTUAL_LEVEL1	NUMBER(15,3)	No	No
INDICATED_LEVEL1	NUMBER(15,3)	No	No
ACTUAL_LEVEL2	NUMBER(15,3)	No	No
INDICATED_LEVEL2	NUMBER(15,3)	No	No
ACTUAL_LEVEL3	NUMBER(15,3)	No	No
INDICATED_LEVEL3	NUMBER(15,3)	No	No
ACTUAL_LEVEL4	NUMBER(15,3)	No	No
INDICATED_LEVEL4	NUMBER(15,3)	No	No
ACTUAL_LEVEL5	NUMBER(15,3)	No	No
INDICATED_LEVEL5	NUMBER(15,3)	No	No
TO_AIRS	CHAR(1)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_AUDIT_DATA	Yes	No	No	Yes	No	SITE_NO RECORD_DATE PAR_CODE	ASC ASC ASC

COLUMNS: Table column names to provide drop-down data entry and data integrity for polling configuration.

Column List

Name	Type	P	M
COLUMN_NAME	VARCHAR2(25)	Yes	Yes
COLUMN_NAME DESCRIPTION	VARCHAR2(25) VARCHAR2(50)	Yes No	Yes No
DESCRIPTION	VARCHAR2(50)	No	No
COLUMN_NAME	VARCHAR2(25)	Yes	Yes
COLUMN_NAME DESCRIPTION	VARCHAR2(25) VARCHAR2(50)	Yes No	Yes No
DESCRIPTION	VARCHAR2(50)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_COLUMNS	Yes	No	No	Yes	No	COLUMN_NAME	ASC
PK_COLUMNS	Yes	No	No	Yes	No	COLUMN_NAME	ASC

CONVERSIONS: The AQDBMS reporting programs must sometimes convert data values in order to correctly report the data. The programs access the formulas in this table as needed.

Column List

Name	Type	P	M
PARAMETER	VARCHAR2(25)	Yes	Yes
FROM_UNIT_CODE	VARCHAR2(20)	Yes	Yes
TO_UNIT_CODE	VARCHAR2(20)	Yes	Yes
FORMULA	VARCHAR2(100)	No	No
ACCURACY	NUMBER(2)	No	No
MULTIPLIER	NUMBER(15,8)	No	No
OFFSET	NUMBER(10,5)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_CONVERSIONS	Yes	No	No	Yes	No	PARAMETER FROM_UNIT_CODE TO_UNIT_CODE	ASC ASC ASC

DATA_FORMS: A look-up table of data form names used during data entry of site log information.

Column List

Name	Type	P	M
FORM_NAME	VARCHAR2(40)	Yes	Yes

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_DATAFORMS	Yes	No	No	Yes	No	FORM_NAME	ASC

DATA_VALIDATION_LOG: Used to track the completion of each major step of the validation process and the initials of the IMC staff member completing the step.

Column List

Name	Type	P	M
SITE_NO	NUMBER(3)	Yes	Yes
YEAR	NUMBER(4)	Yes	Yes
MONTH	NUMBER(2)	Yes	Yes
LEVEL_0	DATE	No	No
PRELIM_VAL_DATE	DATE	No	No
PRELIM_VAL_BY	VARCHAR2(25)	No	No
FINAL_VAL_DATE	DATE	No	No
FINAL_VAL_BY	VARCHAR2(25)	No	No
PLOT_COM_DATE	DATE	No	No
PLOT_COM_BY	VARCHAR2(25)	No	No
PLOT_REVIEW_DATE	DATE	No	No
REPORTS_MAILED_DATE	DATE	No	No
AIRS_SUBMIT_DATE	DATE	No	No
AIRS_SUBMIT_BY	VARCHAR2(25)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_DATAVALIDATIONLOG	Yes	No	No	Yes	No	SITE_NO YEAR MONTH	ASC ASC ASC

DATA_VALIDATION_COMMENTS: Provides the opportunity for the data analysts to comment on the validation process for each site/month.

Column List

Name	Type	P	M
SITE_NO	NUMBER(3)	Yes	Yes
YEAR	NUMBER(4)	Yes	Yes
MONTH	NUMBER(2)	Yes	Yes
LINE_NO	NUMBER(2)	Yes	Yes
COMMENTS	VARCHAR2(2500)	No	No
COMMENTS	VARCHAR2(2500)	No	No
COMMENTS	VARCHAR2(2500)	No	No
COMMENTS_DATE	DATE	No	No
COMMENTS_DATE	DATE	No	No
COMMENTS_DATE	DATE	No	No
COMMENTS_DATE	DATE	No	No
COMMENTS_BY	VARCHAR2(25)	No	No
COMMENTS_BY	VARCHAR2(25)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_DATAVALIDATION_COMMENTS	Yes	No	No	Yes	No	SITE_NO YEAR MONTH LINE_NO	ASC ASC ASC ASC

DATA_VALIDATION_LOG_DETAIL2 (Detail): This table logs the receipt of the various supporting documents received from the site operators for each row in the master table. **NOTE:** Rows are no longer being inserted on this table as the process of logging site documentation has changed.

Column List

Name	Type	P	M
SITE_NO	NUMBER(3)	Yes	Yes
YEAR	NUMBER(4)	Yes	Yes
MONTH	NUMBER(2)	Yes	Yes
LINE_NO	NUMBER(2)	Yes	Yes
DATE_RECD	DATE	No	No
FORM_NAME	VARCHAR2(40)	No	No
START_DATE	DATE	No	No
END_DATE	DATE	No	No
YES_NO	CHAR(1)	No	No
COMMENTS	VARCHAR2(2000)	No	No
POST_CARD_DATE	DATE	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_DATAVALIDATIONLOGDETAIL2	Yes	No	No	Yes	No	SITE_NO YEAR MONTH LINE_NO	ASC ASC ASC ASC

DATA_WINDOW: This table is used to simplify the programming and formatting of certain output products by providing temporary holding places for data from other tables. It has no permanent rows.

Column List

Name	Type	P	M
REC_NO	NUMBER(3)	Yes	Yes
COL_1_DEC	NUMBER(15,3)	No	No
COL_2_DEC	NUMBER(15,3)	No	No
COL_3_DEC	NUMBER(15,3)	No	No
COL_4_DEC	NUMBER(15,3)	No	No
COL_5_DEC	NUMBER(15,3)	No	No
COL_1_STR	VARCHAR2(100)	No	No
COL_2_STR	VARCHAR2(100)	No	No
COL_3_STR	VARCHAR2(100)	No	No
COL_4_STR	VARCHAR2(100)	No	No
COL_5_STR	VARCHAR2(100)	No	No
GROUP_COL	CHAR(1)	No	No
COL_1_INT	NUMBER(4)	No	No
COL_2_INT	NUMBER(4)	No	No
COL_3_INT	NUMBER(4)	No	No
COL_4_INT	NUMBER(4)	No	No
COL_5_INT	NUMBER(4)	No	No
COL_6_DEC	NUMBER(15,3)	No	No
COL_7_DEC	NUMBER(15,3)	No	No
COL_8_DEC	NUMBER(15,3)	No	No
COL_9_DEC	NUMBER(15,3)	No	No
COL_10_DEC	NUMBER(15,3)	No	No
COL_11_DEC	NUMBER(15,3)	No	No
COL_12_DEC	NUMBER(15,3)	No	No
COL_13_DEC	NUMBER(15,3)	No	No
COL_6_STR	VARCHAR2(100)	No	No
COL_7_STR	VARCHAR2(100)	No	No
COL_8_STR	VARCHAR2(100)	No	No
COL_9_STR	VARCHAR2(100)	No	No
COL_9_STR	VARCHAR2(100)	No	No
COL_10_STR	VARCHAR2(100)	No	No
COL_10_STR	VARCHAR2(100)	No	No
COL_11_STR	VARCHAR2(100)	No	No
COL_11_STR	VARCHAR2(100)	No	No
COL_12_STR	VARCHAR2(100)	No	No
COL_12_STR	VARCHAR2(100)	No	No
COL_1_DATE	DATE	No	No
COL_1_DATE	DATE	No	No
COL_2_DATE	DATE	No	No
COL_2_DATE	DATE	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_DATAWINDOW	Yes	No	No	Yes	No	REC_NO	ASC
PK_DATAWINDOW	Yes	No	No	Yes	No	REC_NO	ASC

INTERVAL_CODES: Interval code information to allow for flexibility if data with other than hourly average intervals are introduced to the database.

Column List

Name	Type	P	M
INTERVAL_CODE	VARCHAR2(25)	Yes	Yes
INTERVAL	VARCHAR(15)	No	No
QUANTITY	NUMBER(7)	No	No
TIME_UNIT	VARCHAR2(15)	No	No
AVG_TYPE	VARCHAR2(15)	No	No
DESC	VARCHAR2(50)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_INTERVAL_CODES	Yes	No	No	Yes	No	INTERVAL_CODE	ASC

MESSAGES: Messages accessed by the Powerbuilder application.

Column List

Name	Type	P	M
MSGID	VARCHAR2(40)	Yes	Yes
MSGTEXT	VARCHAR(255)	No	No
MSGICON	VARCHAR2(12)	No	No
MSGBUTTON	VARCHAR2(17)	No	No
MSGDEFAULTBUTTON	NUMBER(6)	No	No
MSGSEVERITY	NUMBER(6)	No	No
MSGPRINT	VARCHAR2(1)	No	No
MSGUSERINPUT	VARCHAR2(1)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_MSGID	Yes	No	No	Yes	No	MSGID	ASC

OUTPUT_GROUPINGS: Links output products and groups.

Column List

Name	Type	P	M
GROUP_NO	NUMBER(3)	Yes	Yes
PROD_NO	NUMBER(3)	Yes	Yes

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_OUTPUT_GROUPINGS	Yes	No	No	Yes	No	SITE_NO PROD_NO	ASC

OUTPUT_GROUPS: Groups of output products based on data types.

Column List

Name	Type	P	M
GROUP_NO	NUMBER(3)	Yes	Yes
GROUP_NAME	VARCHAR2(50)	No	No
GROUP_TYPE	VARCHAR2(25)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_OUTPUT_GROUPS	Yes	No	No	Yes	No	GROUP_NO	ASC

OUTPUT_PRODUCTS: List of output products, associated function names and common options. Used by the reporting module of the interface.

Column List

Name	Type	P	M
PROD_NO	NUMBER(3)	Yes	Yes
FUNC_NAME	VARCHAR2(50)	No	No
PROD_NAME	VARCHAR2(250)	No	No
SITES	NUMBER(1)	No	No
DATES	NUMBER(1)	No	No
PARS	NUMBER(1)	No	No
PRINT	NUMBER(1)	No	No
SCREEN	NUMBER(1)	No	No
BREATK	NUMBER(1)	No	No
PDF	NUMBER(1)	No	No
PAGE_NO	NUMBER(1)	No	No
FILEOUT	NUMBER(1)	No	No
USER_LEVEL	NUMBER(1)	No	No
PAR_BREAK	NUMBER(1)	No	No
LAUNCH_PROG	NUMBER(1)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_OUTPUT_PRODUCTS	Yes	No	No	Yes	No	PROD_NO	ASC
PK_OUTPUT_PRODUCTS	Yes	No	No	Yes	No	PROD_NO	ASC

OUTPUT_PRODUCT_OPTIONS: List of output products and variable options. Used by the reporting module of the interface.

Column List

Name	Type	P	M
PROD_NO	NUMBER(3)	Yes	Yes
OPTION_NO	NUMBER(2)	Yes	Yes
OPTION_NAME	VARCHAR2(250)	No	No
DATATYPE	VARCHAR2(25)	No	No
DEFAULT_VAL	VARCHAR2(25)	No	No
ITEM_LIST	VARCHAR2(250)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_OUTPUT_OPTIONS	Yes	No	No	Yes	No	PROD_NO OPTION_NO	ASC

PARAMETER_CODES: This table contains the definition of each parameter code referenced in other tables (such as Primary_Data). Specifically defined parameter codes, such as "O3-1" and "O3-2," reflect critical variations in the derivation of the data, such as instrument type or model and the associated AIRS method code and parameter occurrence code (POC), units used, and decimal precision of the raw values collected. Each parameter code is derived from a base code that must exist in the Parameter Table (such as "O3").

Column List

Name	Type	P	M
PAR_CODE	VARCHAR2(25)	Yes	Yes
RAW_UNIT_CODE	VARCHAR2(20)	No	No
PARAMETER	VARCHAR2(25)	No	No
RAW_WIDTH	NUMBER(3)	No	No
RAW_PREC	NUMBER(3)	No	No
METHOD_CODE	NUMBER(3)	No	No
MORE_INFO	VARCHAR2(150)	No	No
POC	NUMBER(1)	No	No
PRC	NUMBER(1)	No	No
PAR_ABBR	VARCHAR2(25)	No	No
INTERVAL	VARCHAR2(25)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_PARAMETERCODES	Yes	No	No	Yes	No	PAR_CODE	ASC

PARAMETERS: This table defines each parameter in general terms to allow grouping of the parameter codes, definition of standard output units and decimal precision, and AIRS monitor codes. Additional fields (plot order, stats_report, etc.) are used during generation of various output products.

Column List

Name	Type	P	M
PARAMETER	VARCHAR2(25)	Yes	Yes
AIRS_CODE	NUMBER(5)	No	No
AIRS_METHOD	NUMBER(3)	No	No
DESCRIPTION	VARCHAR2(50)	No	No
PARS_CODE	NUMBER(5)	No	No
DATA_TYPE	VARCHAR2(15)	No	No
REPORT_UNIT_CODE	VARCHAR2(20)	No	No
REPORT_WIDTH	NUMBER(3)	No	No
REPORT_PRECISION	NUMBER(3)	No	No
REPORT_ORDER	NUMBER(3)	No	No
PLOT_ORDER	NUMBER(3)	No	No
STATS_REPORT	CHAR(1)	No	No
STACK_PLOT	CHAR(1)	No	No
PAR_TYPE	VARCHAR2(25)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_PARAMETERS	Yes	No	No	Yes	No	PARAMETER	ASC

PARS_INFO: Defines parameter/unit_code specific information which is used primarily during generation of varoius output products.

Column List

Name	Type	P	M
PARAMETER	VARCHAR2(25)	Yes	Yes
UNIT_CODE	VARCHAR2(20)	Yes	Yes
PRECISION_FROM	NUMBER(7,3)	No	No
PRECISION_TO	NUMBER(7,3)	No	No
LEVEL1_FROM	NUMBER(7,3)	No	No
LEVEL1_TO	NUMBER(7,3)	No	No
LEVEL2_FROM	NUMBER(7,3)	No	No
LEVEL2_TO	NUMBER(7,3)	No	No
LEVEL3_FROM	NUMBER(7,3)	No	No
LEVEL3_TO	NUMBER(7,3)	No	No
LEVEL4_FROM	NUMBER(7,3)	No	No
LEVEL4_TO	NUMBER(7,3)	No	No
PLOT_MAX	NUMBER(7,3)	No	No
PLOT_STOP	NUMBER(7,3)	No	No
PLOT_NAAQS	NUMBER(7,3)	No	No
PLOT_FMT	NUMBER(7,3)	No	No
ROSE_STEP	NUMBER(7,3)	No	No
ROSE_STEP	NUMBER(7,3)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_PARAMETERS	Yes	No	No	Yes	No	PARAMETER	ASC
PK_PARAMETERS	Yes	No	No	Yes	No	PARAMETER	ASC

POLLING: Contains information on each current datalogger and is used by the polling program to determine the auto polling schedule.

Column List

Name	Type	P	M
SITE_NO	NUMBER(3)	Yes	Yes
LOGGER_NO	NUMBER(2)	Yes	Yes
POLLING_ABBR	VARCHAR2(4)	No	Yes
ON_OR_OFF	CHAR(30)	No	Yes
LOGGER_TYPE	VARCHAR2(15)	No	Yes
PHONE_NO	VARCHAR2(50)	No	No
PASSWORD	VARCHAR2(20)	No	No
SUCCESS_TIME	DATE	No	No
HOUR_00	NUMBER(2)	No	No
HOUR_01	NUMBER(2)	No	No
HOUR_02	NUMBER(2)	No	No
HOUR_03	NUMBER(2)	No	No
HOUR_04	NUMBER(2)	No	No
HOUR_05	NUMBER(2)	No	No
HOUR_06	NUMBER(2)	No	No
HOUR_07	NUMBER(2)	No	No
HOUR_08	NUMBER(2)	No	No
HOUR_09	NUMBER(2)	No	No
HOUR_10	NUMBER(2)	No	No
HOUR_11	NUMBER(2)	No	No
HOUR_12	NUMBER(2)	No	No
HOUR_13	NUMBER(2)	No	No
HOUR_14	NUMBER(2)	No	No
HOUR_15	NUMBER(2)	No	No
HOUR_16	NUMBER(2)	No	No
HOUR_17	NUMBER(2)	No	No
HOUR_18	NUMBER(2)	No	No
HOUR_19	NUMBER(2)	No	No
HOUR_20	NUMBER(2)	No	No
HOUR_21	NUMBER(2)	No	No
HOUR_22	NUMBER(2)	No	No
HOUR_23	NUMBER(2)	No	No
SUN	CHAR(1)	No	No
MON	CHAR(1)	No	No
TUE	CHAR(1)	No	No
WED	CHAR(1)	No	No
THU	CHAR(1)	No	No
FRI	CHAR(1)	No	No
SAT	CHAR(1)	No	No
RETRY	CHAR(1)	No	No
RETRY_COUNT	NUMBER(2)	No	No
ADJ_MIN	NUMBER(2)	No	No
LOGGER_ID	VARCHAR2(10)	No	No
PATH_NAME	VARCHAR2(100)	No	No
DATA_VIEW	CHAR(1)	No	No
LOGGER_TIMEZONE	VARCHAR2(10)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_POLLING	Yes	No	No	Yes	No	SITE_NO LOGGER_NO	ASC ASC

Index Code	P	F	A	U	C	Column Code	Sort
UK_POLLING_ABBR	No	No	No	Yes	No	POLLING_ABBR	ASC

POLLING_DETAIL: Links the rows in the POLLING table to the LINE_ID and is used during the data loading process.

Column List

Name	Type	P	M
SITE_NO	NUMBER(3)	Yes	Yes
LOGGER_NO	NUMBER(2)	Yes	Yes
LINE_ID	VARCHAR2(15)	Yes	Yes

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_POLLING_DETAIL	Yes	No	No	Yes	No	SITE_NO LOGGER_NO LINE_ID	ASC ASC ASC

POLLING_LINE_ID: Datalogger configurations used during the polling and loading processes.

Column List

Name	Type	P	M
LINE_ID	VARCHAR2(15)	Yes	Yes
LOGGER_FIELD	NUMBER(3)	Yes	Yes
CODE_FIELD	NUMBER(2)	Yes	No
CODE_EXP	VARCHAR2(25)	Yes	No
LOGGER_LABEL	VARCHAR2(8)	No	No
PAR_CODE	TABLE_TYPE	No	No
TABLE_TYPE	VARCHAR2(30)	No	No
COLUMN_NAME	VARCHAR2(15)	No	No
DESCRIPTION	VARCHAR2(50)	No	No
CAL_TYP	VARCHAR2(10)	No	No
MINUTES_ADJUSTED	NUMBER(2)	No	No
CAL_VAL_TYPE	VARCHAR2(10)	No	No
CAL_VAL_EXP	VARCHAR2(25)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_POLLING_LINE_ID	Yes	No	No	Yes	No	LINE_ID LOGGER_FIELD CODE_FIELD CODE_EXP	ASC ASC ASC ASC

PRIMARY_DATA: Each row represents a single measurement. This structure allows for flexibility without carrying null values or repeating information. Raw values are not modified once they have been appended (except on rare occasions and then under controlled conditions). The validation code column is used during the validation process to store datalgoger codes, to flag anomalies and to store the preliminary or final data validation code. The validated value column is initialized to –999 and is updated during the validation process. Each row also contains a placeholder for a control value that may be used during the valiation process.

Column List

Name	Type	P	M
SITE_NO	NUMBER(3)	Yes	Yes
RECORD_DATE	DATE	Yes	Yes
PAR_CODE	VARCHAR2(25)	Yes	Yes
VALIDATION_CODE	VARCHAR2(12)	No	No
CONTROL_VAL	VARCHAR2(35)	No	No
VALIDATED_VAL	NUMBER(15,3)	No	No
RAW_VAL	NUMBER(15,3)	No	Yes
SOURCE_CODE	CHAR(1)	No	Yes

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_PRIMARY_DATA	Yes	No	No	Yes	No	SITE_NO RECORD_DATE PAR_CODE	ASC ASC ASC

Trigger List

Name: Validate_Data

```
Body:
BEGIN
 /* If the first character of the validation code is not V then the validated value must be -999*/
 IF SUBSTR(:NEW.VALIDATION_CODE,1,1) <> 'V' AND :NEW.VALIDATED_VAL <> -999 THEN
  RAISE_APPLICATION_ERROR(-20001,'-20001 Check '||to_char(:old.record_date,'MM/DD/YY HH24')||' ||:old.par_code);
 END IF;
 /*If the validated_val=-999 then the first char of validation code can not be V */
 IF SUBSTR(:NEW.VALIDATION_CODE,1,1) = 'V' AND :NEW.VALIDATED_VAL = -999 THEN
  RAISE_APPLICATION_ERROR(-20002,'-20002 Check '||to_char(:old.record_date,'MM/DD/YY HH24')||' '||:old.par_code);
 END IF;
        /* If the validation code is V then the validated value must equal the raw value*/
 IF :NEW.VALIDATION_CODE = 'V' AND :NEW.VALIDATED_VAL <> :NEW.RAW_VAL THEN
  RAISE_APPLICATION_ERROR(-20003,'-20003 Check '||to_char(:old.record_date,'MM/DD/YY HH24')||' '||:old.par_code);
 END IF;
 /*If the validation code is VA then ctrl_val must contain a value. */
        IF :NEW.VALIDATION_CODE = 'VA' AND :NEW.CONTROL_VAL IS NULL THEN
  RAISE_APPLICATION_ERROR(-20004,'-20004 Check '||to_char(:old.record_date,'MM/DD/YY HH24')||' '||:old.par_code);
 END IF;
 /*If the validation code is VA and raw_value <> 0 then the validated_val must not equal the raw value.*/
        IF :NEW.VALIDATION_CODE = 'VA' AND :NEW.RAW_VAL<>0 AND :NEW.VALIDATED_VAL=:NEW.RAW_VAL
THEN
  RAISE_APPLICATION_ERROR(-20005,'-20005 Check '||to_char(:old.record_date,'MM/DD/YY HH24')||' '||:old.par_code);
 END IF;
END;
```

SCREENING_TABLE1: Contains information used by the anomaly screening process. The SITE_NO field may contain the value of 0 which indicates the default set of screening criteria.

Column List

Name	Type	P	M
SITE_NO	NUMBER(3)	Yes	Yes
PARAMETER	VARCHAR2(25)	Yes	Yes
INTERVAL	VARCHAR2(25)	Yes	Yes
LINE_NO	NUMBER(2)	Yes	Yes
COLUMN_NAME	VARCHAR2(25)	No	No
VAL_OPERATOR	VARCHAR2(10)	No	No
PAR_COL_OR_VAL	VARCHAR2(25)	No	No
FLAG_OR_FILE	VARCHAR2(25)	No	No
FLAG_PAR_OR_COL	VARCHAR2(25)	No	No
DATA_POINTS	NUMBER(4)	No	No
BACK_OR_FORE	VARCHAR2(8)	No	No
ADJ_TO	NUMBER(7,4)	No	No
ADJ_PAR_OR_COL	VARCHAR2(25)	No	No
FLAG_PAR_INTERVAL	VARCHAR2(25)	No	No
PERCENT_VALID	NUMBER(2)	No	No
UNIT_CODE	VARCHAR2(20)	No	No
DESCRIPTION	VARCHAR2(500)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_SCREENING_TABLE1	Yes	No	No	Yes	No	SITE_NO	ASC
						PARAMETER	ASC
						INTERVAL	ASC
						LINE_NO	ASC

SITES: This table contains one row for each monitoring site (current and historical).

Column List

Name	Type	P	M
SITE_NO	NUMBER(3)	Yes	Yes
ABBR	VARCHAR2(10)	No	No
NAME	VARCHAR2(255)	No	No
NAME2	VARCHAR2(255)	No	No
PRINT_NAME2	CHAR(1)	No	Yes

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_SITES	Yes	No	No	Yes	No	SITE_NO	ASC

SITE_GROUPINGS: Links site groups and sites or other groups together for reporting purposes. Each row must contain a value in either SITE_MEM_NO or GROUP_MEM_NO but not both.

Column List

Name	Type	P	M
GROUP_NO	NUMBER(3)	Yes	Yes
SITE_MEM_NO	NUMBER(3)	Yes	No
GROUP_MEO_NO	NUMBER(3)	Yes	No
DATABASE	VARCHAR2(15)	No	No
NAME	VARCHAR2(150)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_SITE_GROUPINGS	Yes	No	No	Yes	No	GROUP_NO SITE_MEM_NO GROUP_MEM_NO	ASC ASC ASC

SITE_GROUPS: Defines groups for reporting purposes.

Column List

Name	Type	P	M
GROUP_NO	NUMBER(3)	Yes	Yes
DESCRIPTION	VARCHAR2(250)	No	No
GROUP_ABBR	VARCHAR2(25)	No	No
GROUP_TYPE	VARCHAR2(25)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_GROUPS	Yes	No	No	Yes	No	GROUP_NO	ASC
PK_GROUPS	Yes	No	No	Yes	No	GROUP_NO	ASC

SITE_LOGS: Contains site (station) logs of operator maintenance information collected by the DataView application.

Column List

Name	Type	P	M
SITE_NO	NUMBER(3)	Yes	Yes
RECORD_DATE	DATE	Yes	Yes
LINE_NO	NUMBER(2)	Yes	Yes
OPERATION	VARCHAR2(100)	No	No
LOGGED_BY	VARCHAR2(25)	No	No
MESSAGE	VARCHAR2(2500)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_SITE_LOGS	Yes	No	No	Yes	No	SITE_NO RECORD_DATE LINE_NO	ASC ASC ASC

SITE_STATUS_LOG (Master): This table is a diary of site operations with the purpose of aiding the field specialists with tracking and resolving problems and the data validation staff with data validation procedures. Date and time columns define when the problem occurred and other events such as site visits, audits, precision checks, etc. The affected parameters column is a variable length column which allows entry of multiple parameters which are effected by the event described.

Column List

Name	Type	P	M
SITE_NO	NUMBER(3)	Yes	Yes
REF_NO	NUMBER	Yes	Yes
PROBLEM_FLAG	CHAR(1)	No	No
START_DATE	DATE	No	No
STOP_DATE	DATE	No	No
ARS_VISIT	DATE	No	No
OP_VISIT	DATE	No	No
AUDIT_DATE	DATE	No	No
PREC_CK	DATE	No	No
MULTIPNT_CAL	DATE	No	No
AFFECTED_PARS	VARCHAR2(250)	No	No
ABBR_DESC	VARCHAR2(250)	No	No
ABBR_DESC	VARCHAR2(250)	No	No
DATA_LOST	CHAR(1)	No	No
DATA_LOST	CHAR(1)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_SITESTATUSLOG	Yes	No	No	Yes	No	SITE_NO REF_NO	ASC ASC
PK_SITESTATUSLOG	Yes	No	No	Yes	No	SITE_NO REF_NO	ASC ASC

SITE_STATUS_LOG_DETAIL (Detail): This table contains detail information describing events related to a row in the master table.

Column List

Name	Type	P	M
SITE_NO	NUMBER(3)	Yes	Yes
REF_NO	NUMBER	Yes	Yes
LINE_NO	NUMBER(4)	Yes	Yes
NOTE	VARCHAR2(2000)	No	No
DATE_ENTERED	DATE	No	No
ENTERED_BY	VARCHAR2(25)	No	No
DATE_REPORTED	DATE	No	No
REPORTED_BY	VARCHAR2(25)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_SITESTATUSLOGDETAIL	Yes	No	No	Yes	No	SITE_NO REF_NO LINE_NO	ASC ASC ASC

SOURCE_CODES: A look up table for the primary data table source_code column that defines the codes and is used to programmatically determine if the code opens up the raw_val column for a manually entered replacement value.

Column List

Name	Type	P	M
SOURCE_CODE	CHAR(1)	Yes	Yes
DESCRIPTION	VARCHAR2(250)	No	No
REPLACE_RAW	CHAR(1)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_SOURCECODES	Yes	No	No	Yes	No	SOURCE_CODE	ASC

STKPLOT_MASTER: Contains information for the stackplot program (one row per plot).

Column List

Name	Type	P	M
SITE_NO	NUMBER(3)	Yes	Yes
PLOT_NO	NUMBER(3)	Yes	Yes
DESCRIPTION	VARCHAR2(500)	No	No
STKPLOT_FILE	VARCHAR2(8)	No	Yes
MAIN_TITLE	VARCHAR2(200)	No	No
X_TITLE	VARCHAR2(50)	No	No
SETUP_BY	VARCHAR2(25)	No	No
SETUP_DATE	DATE	No	No
STK_X_PLOT_SIZE	NUMBER(15,4)	No	No
INC_MIN	NUMBER(4)	No	No
TIME_UNITS	VARCHAR2(15)	No	No
B_MARGIN	NUMBER(3,2)	No	No
T_MARGIN	NUMBER(3,2)	No	No
L_MARGIN	NUMBER(3,2)	No	No
FOOTNOTE	VARCHAR2(25)	No	No
HOUR_INTERVAL	NUMBER(2)	No	No
HOUR_LABELS	CHAR(1)	No	No
PLOT_TYPE	VARCHAR2(25)	No	No
DAILY_REVIEW	CHAR(1)	No	No
DAYS_BACK	NUMBER(3)	No	No
FROM_TODAY	CHAR(1)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_STKPLOT_MASTER	Yes	No	No	Yes	No	SITE_NO	ASC
						PLOT_NO	ASC
UK_STKPLOT_FILE	No	No	No	Yes	No	STKPLOT_FILE	ASC

STKPLOT_DETAIL: Contains detail information for the stackplot program (one row per plot/parameter).

Column List

Name	Type	P	M
SITE_NO	NUMBER(3)	Yes	Yes
PLOT_NO	NUMBER(3)	Yes	Yes
INPUT_FIELD	NUMBER(3)	Yes	Yes
PAR_CODE	VARCHAR2(25)	No	Yes
TABLE_TYPE	VARCHAR2(50)	No	No
CAL_TYPE	VARCHAR2(10)	No	No
COLUMN_NAME	VARCHAR2(25)	No	No
NEXT_GRAPH	CHAR(1)	No	No
LINE_TYPE	NUMBER(3)	No	No
FIELD_NAME	VARCHAR2(30)	No	No
YMIN	VARCHAR2(10)	No	No
YMAX	VARCHAR2(10)	No	No
MAJOR_TIC	NUMBER(15,4)	No	No
LABEL_DEC	NUMBER(3)	No	No
LINE_COLOR	NUMBER(3)	No	No
SYMBOL	CHAR(1)	No	No
Y_GAP	NUMBER(7,4)	No	No
Y_AXIS_SIZE	NUMBER(7,4)	No	No
AVG_PERIOD	VARCHAR2(25)	No	No
IPOST	NUMBER(1)	No	No
POST_ALIGN	CHAR(1)	No	No
POST_CHH	NUMBER(4,2)	No	No
POST_FORM	VARCHAR2(10)	No	No
CAL_VAL_TYPE	VARCHAR2(10)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_STKPLOT_DETAIL	Yes	No	No	Yes	No	SITE_NO PLOT_NO INPUT_FIELD	ASC ASC ASC

TIME_ZONES: This is a look-up table for the daily datalogger report that compares datalogger times to current time.

Column List

Name	Type	P	M
TIMEZONE_ABBR	VARCHAR2(10)	Yes	Yes
HOURS_DIFF	NUMBER(2)	No	No
TIMEZONE_DESC	VARCHAR2(5)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_TIMEZONE	Yes	No	No	Yes	No	TIMEZONE_ABBR	ASC

UNIT_CODES: This is a look-up table for the unit_code columns of the parameter, parameter_codes and conversions tables. It defines the codes and provides the equivalent AIRS codes during generation of AIRS transaction files.

Column List

Name	Type	P	M
UNIT_CODE	VARCHAR2(20)	Yes	Yes
UNIT_DESCRIPTION	VARCHAR2(250)	No	No
AIRS_UNIT_CODE	NUMBER(3)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_UNITCODES	Yes	No	No	Yes	No	UNIT_CODE	ASC

USERS: This is a look-up table used by the application to determine user accessibility to various parts of the application.

Column List

Name	Type	P	M
USER_NAME	VARCHAR2(50)	Yes	Yes
USER_LEVEL	NUMBER(1)	No	Yes
USER_DB	NUMBER(1)	No	Yes

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_USERS	Yes	No	No	Yes	No	USER_NAME	ASC

VALIDATION_CODES: This is a look-up table for the validation_code column of the primary_data table. It defines the codes and provides equivalent codes for data import and export.

Column List

Name	Type	P	M
VALIDATION_CODE	VARCHAR2(12)	Yes	Yes
DESCRIPTION	VARCHAR2(250)	No	No
AIRS_CODE	NUMBER(4)	No	No
REASON	VARCHAR2(25)	No	No
OLD_CODE	NUMBER(5)	No	No
ESE_FLOW_CODE	CHAR(1)	No	No
AIRS_CODE_IN	CHAR(1)	No	No
TYPE	VARCHAR2(15)	No	No

Index List

Index Code	P	F	A	U	C	Column Code	Sort
PK_VALIDATIONCODES	Yes	No	No	Yes	No	VALIDATION_CODE	ASC

The Air Quality Database Management System (AQDBMS)
User's Guide

National Park Service (NPS)
Information Management Center (IMC)

Prepared by Air Resource Specialists, Inc.

March 1999	(database version 1)
Revised January 2001	(database version 2)
Revised January 2008	(screen capture changes)

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The Air Quality Database Management System (AQDBMS) User's Guide

1.0 Introduction

This guide provides users of the Air Quality Database Management System (AQDBMS), developed by Air Resource Specialists, Inc., with an overview of the system and with information for running the database interface. By referring to this guide while running the interface programs, users receive step-by-step textual instructions for completing specific tasks such as loading data into the database, validating data, and reporting data.

2.0 AQDBMS Overview

The AQDBMS is comprised of two main components:

1) An Oracle database specifically designed and developed by Air Resource Specialists, Inc. (ARS) to hold air quality network data and to accommodate the many temporal, spatial, and functional variations found within an air quality network.

2) Customized software programs developed by ARS that provide an interface to the Oracle database.

2.1 The Oracle Database

Although not necessary for operating the interface, it is helpful for users of the AQDBMS to have a basic understanding of the structure of the Oracle database. The Oracle database is a relational database containing many related *tables.* A *table* is the basic unit of data storage in an Oracle database. Table data is stored in *rows* (records) and *columns* (fields). Each table has a column or set of columns that is unique for each row as the primary key. Each table is related to one or more other tables by linking common columns. The following are descriptions of some of the database tables and relationships:

<u>Sites and AQMet Specs Tables</u>. The Sites Table contains one row for each monitoring site (current or historical) identified by a unique site number (primary key). The AQMet Specs Table includes constant information such as site abbreviation, geographic information, and the AQS state, county, and site codes.

<u>Polling Table.</u> Variable information reflecting the site's current datalogger(s) polling schedule is stored here. Each record is identified by combination of the site number and logger number (an incremental number). A unique constraint has also been placed on the polling abbreviation field (polling_abbr) of this table.

<u>Polling Line ID Table.</u> This table stores datalogger configurations and controls how data are loaded into the database from the captured datalogger files. Typically, several records exist for each configuration. Combining the polling line ID and logger field number provides the primary key on this table. These records are linked to the polling table through the Polling Detail Table.

Polling Detail Table. This table links each record in the Polling Table with the correct datalogger configuration record in the Polling Line ID Table.

Primary Data Table. Each row in this table contains the raw value, datalogger flag, validation code, validated value, and source code for a raw gaseous pollutant or meteorological parameter value for each unique combination of site number, parameter code, date and beginning hour (primary key). The validation code column is used during the validation process to store datalogger codes, to flag anomalies and to store the preliminary or final data validation code. The validated value column is initialized to -999 and is updated during the validation process. Each row also contains a placeholder for a control value that may be used during the validation process.

AQ Cal Table. This table contains the actual and indicated values for zero and precision check readings recorded for raw criteria pollutant analyzers in the monitoring network. A unique combination of site number, parameter code, date, calibration type, and value type provide the primary key. Zero and precision data are stored here for future submission to AQS.

Audit Data Table. Each row in this table contains the readings recorded during instrument audits as actual and indicated values for audit level zero through audit level five for each site's unique site number, parameter code, and date (primary key). Additional columns store information required by AQS for submitting accuracy data.

Parameter Table. This table defines each parameter (primary key) in general terms to allow grouping of the parameter codes, definition of standard output units and decimal precision, and AQS monitor codes.

Parameter Codes Table. This table contains the definition of each parameter code (primary key) referenced in other tables (such as the Primary Data Table). Specifically defined parameter codes, such as "O3-1" and "O3-2," reflect critical variations in the derivation of the data, such as instrument type or model and the associated AQS method code and parameter occurrence code (POC), units used, and decimal precision of the raw values collected. Each parameter code is derived from a base code that must exist in the Parameter Table (such as "O3").

Screening Ranges Table. This table contains records that define and control anomaly screening for each site and parameter code as raw data are loaded into the database. This design allows each screening element to be defined independently from the other. Information in this table is applied to the data each time the data are loaded into the database and the flags resulting from each screening are written to the validation code column of the Primary Data Table.

Site Status Log - Master Table. This table is a diary of site operations with the purpose of aiding both the field specialists and data validation staff with data validation procedures. Date and time columns define when the problem occurred and other events such as site visits, audits, precision checks, etc. The affected parameters column is a variable length column which allows entry of multiple parameters which are affected by the event described. Each row contains a unique combination of the site number and computer-generated reference number (primary key).

Site Status Log - Detail Table. This table contains detail information (one or more rows) describing events related to a row in the Site Status Log - Master Table. By using this separate Detail Table, duplicate information is avoided while allowing multiple entries on multiple days by multiple technicians regarding the same problem or event. Each detail row contains the site number and reference number of the related Master Table row and a computer generated line number as the primary key. The other columns include the date entered, who made the entry, and the comment (a variable length column with a maximum of 2,000 characters).

Data Validation Log - Master Table. This table contains a row for each unique combination of site number, month, and year. It is used to track the completion of each major step of the validation process, the initials of the IMC staff member completing the step, and the initials of the site operator responsible for operation of the site for the month.

Data Validation Log - Comments Table. This table logs validation comments for the site, month, and year. A row exists for each unique combination of site, month, and year, and computer-generated line number (primary key). By using a separate Detail Table, duplicate information is avoided while allowing variations on the types of information logged from month to month and from site to site.

Stack Plot Configuration – Master. This table contains stackplot configuration information. One row exists for each unique combination of site number and plot number (primary key). The master record defines the global characteristics of the plot such as titles, plot type, margins, etc.

Stack Plot Configuration – Detail. This table contains details of each stackplot parameter to be plotted on a plot. One row exists for each unique combination of site number, plot number, and input field (primary key). The information here includes plot details like line type and color, minimum and maximum graph settings, etc., and specifies where the data comes from (raw or validated data, etc.).

Look-up Tables. The Validation Codes, Source Codes, AQS Method Codes, Unit Codes, Interval Codes, and Conversion Tables are essentially "look-up tables" that have been added to the database to enforce data integrity by controlling data entry and providing full definition of the codes used. These tables generally include two columns: 1) the code column (primary key) and 2) a description column (a variable length column with a maximum of 250 characters) that define the code. They also contain equivalent codes for conversion of data during import and/or export to other data file formats.

Primary Key Constraints. Each table in the database has a column or set of columns defined as the primary key to ensure that no duplicate rows exist in the table. Oracle also uses primary keys as indexes to greatly increase the speed of data retrieval.

Not Null Constraints. A not null constraint placed on a column requires that no nulls (the absence of a value) be allowed in the column. Not null constraints are automatically applied to primary key columns. Not null constraints have also been applied to other critical data columns such as the raw value and validated value columns of the Primary Data Table.

Foreign Key Constraints (Referential Integrity). Because common columns relate tables in a relational database, the rules that govern the relationship of the columns must be maintained. Referential integrity rules enforced by foreign key constraints guarantee that these relationships are preserved. This means that no user may at any time or through any data access path enter undefined or incomplete information, nor can a user delete a row for which related rows exist. Rules enforced by foreign key constraints within the AQDBMS include, but are not limited to, the following:

- A site must exist in the Sites and AQMet Specs Tables before rows related to the site can be appended to any other table containing the site number column. A site configuration row cannot be deleted if any other table references the site number.

- A parameter code must exist in the Parameter Codes Table before a row containing the parameter code can be appended to any other table containing the parameter code column. A parameter code row cannot be deleted if any other table references the parameter code (with the exception of the Parameter Table).

- The parameter name (e.g., "O3") must exist in the Parameter Table before the parameter code (e.g., "O3-1") can be added to the Parameter Codes Table. A parameter name row cannot be deleted if any row in the Parameter Codes Table references the parameter name.

- Rows in the Site Status Log or Data Validation Log Master Tables cannot be deleted if related rows exist in the Detail Tables. Similarly, a row cannot be added to the Detail Tables if related rows do not exist in the Master Tables.

Database Triggers. A database trigger is a stored database procedure automatically invoked by the RDBMS during insert, update, or delete operations on the table for which it has been defined. Within the AQDBMS, database triggers are used to enforce the rules of allowable combinations of values that may be entered into the Primary Data Table, such as:

- If the validated value column contains any value other than "-999" then the validation code column must contain "V" (valid), "VA" (valid, adjusted from raw),"VZ" (valid, zero adjusted) or "VM" (valid, maximum adjusted).

- If the validation code column equals "VA," the control value cannot be null.

2.2 The Custom Interface

The AQDBMS includes a custom database user interface developed by ARS with Powersoft PowerBuilder Enterprise for Windows and Microsoft Visual Basic. Both are graphical application development environments that provide the tools needed to build easy to use, powerful database applications for Windows operating systems. The interface consists of menus and windows (or screens that users interact with) and makes extensive use of standard point-and-click window controls and functions, such as:

- Command buttons, checkboxes, and radio buttons.
- Drop-down lists to facilitate data entry and ensure data integrity.
- Dialog boxes that prompt the user for information or display error messages.
- Tab controls for organizing processes and user input.
- The ability to open more than one window (screen) at a time for "multi-tasking."

The custom interface is the tool used by the IMC staff for data management, validation, and reporting. The remaining sections of this document provide detailed instructions on using the interface to accomplish these tasks and presented under the following major headings:

Section 3.0	Basic Concepts and Functions
Section 4.0	System Configuration
Section 5.0	Data Collection
Section 6.0	Data Validation
Section 7.0	The Data Validation Log
Section 8.0	The Site Status Log
Section 9.0	Output Products
Section 10.0	References

➢ To launch the AQDBMS application:

1 Click the **ARS MON V2** icon on the desktop.

2 Select **NPS IMC** from the Select Database pop-up window. The Configuration frame is displayed.

3.0 Basic Concepts and Functions

The various components of the main AQDBMS module have been designed to operate in similar ways whenever possible. Several concepts and global functions are discussed here.

3.1 Application Frames

Currently, two application frames exist within the AQDBMS. For most users, the initial frame displayed after launching the application is the Data Collection and Configuration frame as shown in Figure 3-1. This frame contains the menu commands for accessing most of the configuration data of the application (See Section 4.0 System Configuration).

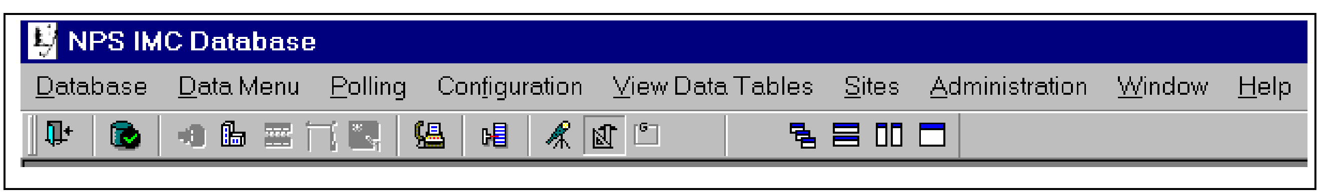


Figure 3-1. The Data Collection and Configuration Frame.

Clicking the Data Menu on the menu bar in the Data Collection and Configuration frame displays a list of additional application frames as shown in Figure 3-2. Currently, the AQ and Met Data Processing frame is the only other working frame for the IMC AQDBMS. The AQ and Met Processing frame is shown in Figure 3-3 and contains menu commands specific to validation and reporting of gaseous and meteorological data.

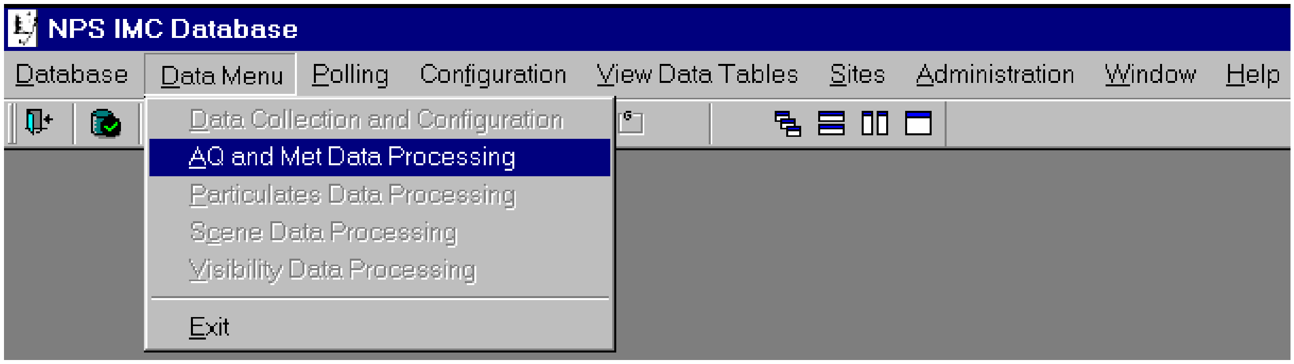


Figure 3-2. The Data Menu List of Application Frames.

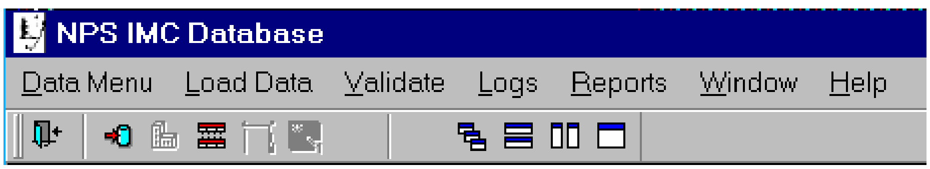


Figure 3-3. The AQ and Met Processing Frame.

3.2 Tool Bar Icons

As seen in Figures 3-1, 3-2, and 3-3, several tool bar icons are available to speed up menu command selection. Micro help has been added to each icon to indicate the menu command associated with the icon. To display the micro help, suspend the mouse cursor over the icon for 1-2 seconds.

3.3 Pop-up Calendar Control

A pop-up calendar control has been implemented to facilitate data entry of date throughout the windows of the AQDBMS. To access the control, right-click on a **date-type** data entry field. The pop-up calendar will display as shown in Figure 3-4. Use the outer, bold arrow buttons to move backward or forward one full year. Use the inner arrow buttons to move backward or forward one month. Click a *day number* to apply the selected date to the date field. Click the **X** button in the lower-right of the control to exit the pop-up without selecting a date.

Note: The pop-up calendar does not function on date fields within data windows.

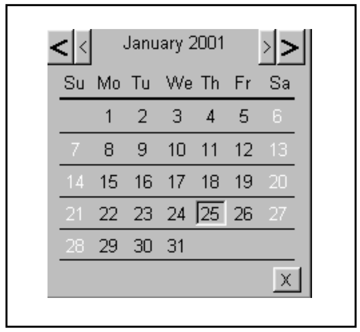


Figure 3-4. Pop-up Calendar Control.

3.4 Data Windows

Nested windows that contain rows of data are located within many of the main windows of the AQDBMS, are nested windows that contain rows of data. The rows of a data window might be displayed in tabular form or as single records. There might be a single data window or multiple data windows that are related to each other. The following subsections discuss how to perform data entry operations and how to maneuver through the rows of data windows.

3.4.1 The Data Window Menu

Most data windows have an associated pop-up menu that is accessed by clicking the right mouse button as the mouse cursor is positioned over the data window as shown in Figure 3-5. Depending on the rules governing the data window, the following options are available by selecting the option from the menu (when options are grayed out, they have been disabled for the current data window):

- **Cut -** Causes the contents of the field below the mouse cursor to be cut to the Windows clipboard.
- **Copy -** Causes the contents of the field below the mouse cursor to be copied to the Windows clipboard.
- **Paste -** Causes the contents of the Windows clipboard to be pasted into the field below the mouse cursor.
- **Insert -** Adds a row to the data window. Depending on the type of data window and the rules governing it, a new row will be inserted above the current row.
- **Add –** Adds a row to the data window at the end.
- **Delete –** Deletes the current row from data window.
- **Restore –** Restores the last deleted row to the data window.

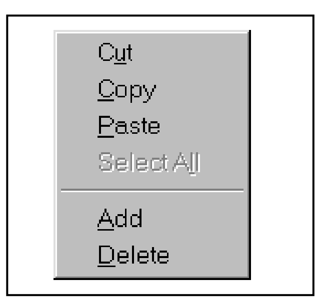


Figure 3-5. The Data Window Pop-up Menu.

3.4.2 Modifying Data

Data cannot be modified directly by the user in some of the data windows in the AQDBMS. However, many of the data windows allow the user to modify the data simply by selecting the field to be modified and entering new data. Use the following guidelines when modifying data:

- Read-only data windows are typically a gray color and are not affected by mouse clicks. Use horizontal and vertical scroll bars to view all of the data in a read-only data window.

- When entering data, click on a field to move to that field or use the <Tab> key to advance to the next field.

- Any validation rules on the field are applied to the data as the cursor leaves the field (the user tabs out or clicks on another field). If the modified data do not pass validation rules, an error message will display.

- To speed up data entry and/or to ensure data integrity, many fields can be modified by selecting data from a drop-down list box. Some fields will allow the user to type the data in <u>or</u> select an entry from a drop-down list box.

  Important Note: Changes to the data are usually committed to the database immediately. However, in some cases, the user must click a <Save> button in order to commit the changes. This is done to provide a way for the users to change their mind and not save changes. When the user attempts to leave a changed but unsaved record, a dialog window will be displayed asking the user if changes should be saved or not.

3.4.3 Moving Through the Rows of a Data Window

Use the following guidelines to move through the rows of a data window:

- Whenever data are displayed one record at a time, controls on the window will facilitate moving from one record to another. The control may be a drop-down list (such as a list of site abbreviations) or buttons that state "Next Rec"/"Prev Record."

- When records are displayed in tabular format, horizontal and/or vertical scroll bars are evident when all the data will not fit in the data window. Use the scroll bars to move through the data. Click on a row to make it the current row and to begin data entry.

- Typically, any changes made to a row are saved when the current row changes.

- Tables that are read-only do not accept mouse clicks; use horizontal and vertical scroll bars to view all of the data.

3.4.4 Moving Through Multiple Data Windows

Multiple data windows are often displayed within a single window of the AQDBMS. This allows the user to view and/or modify related records from separate tables from within one interface. The following additional guidelines apply to moving through multiple, related data windows:

- Usually, the Master Data window controls the display of the detail records. The Master Table is presented at the top of a window or on the first tab of a tab control. As the master record changes, the Detail Tables are refreshed to contain only the records that are related to the current master record.

- Sometimes, the Master Data window and related Detail Data windows will hold all records from their underlying database tables. In these cases, moving from row to row on the Master Data window will cause the Detail Data windows to scroll to the section of related records.

4.0 System Configuration

Accurate configuration is critical to the correct operation of the AQDBMS and the integrity of the data stored in the Oracle database. There are six primary configuration areas:

- Sites Configuration
- Polling and Stackplot Configuration
- Raw Data Formats Configuration
- Data Parameters Configuration
- Anomaly Screening Configuration

The following subsections discuss maintaining these configuration areas.

4.1 Sites Configuration

The Site Specifications Tables track global information about a site including its name, geographic location information and AQS codes. Records exist for all sites, current and historical, in these tables. When new sites are introduced to the network, the sites must first be added and configured here before other configurations concerning the sites can be set. AQS codes must be correctly entered for correct export of AQS formatted data. Figures 4-1 and 4-2 are examples of contents in the Sites Specifications window.

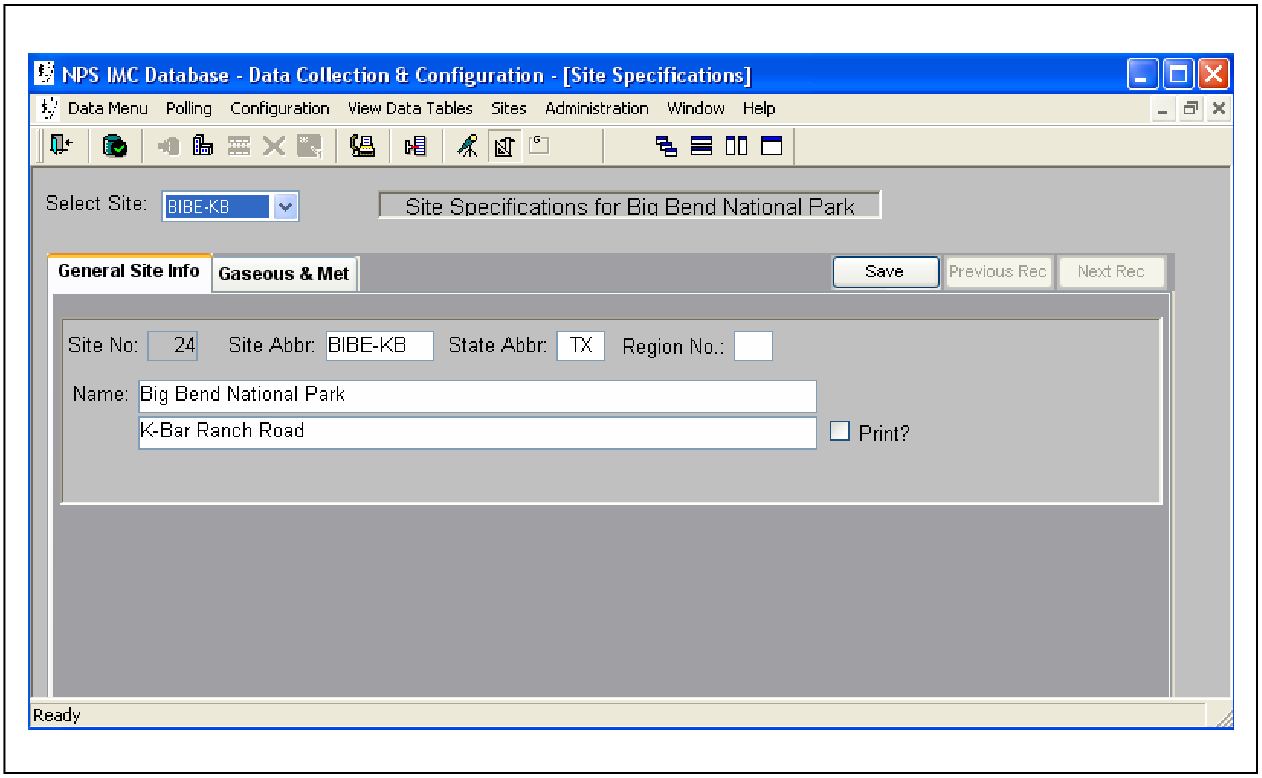


Figure 4-1. The General Site Info Page of the Site Specifications Window.

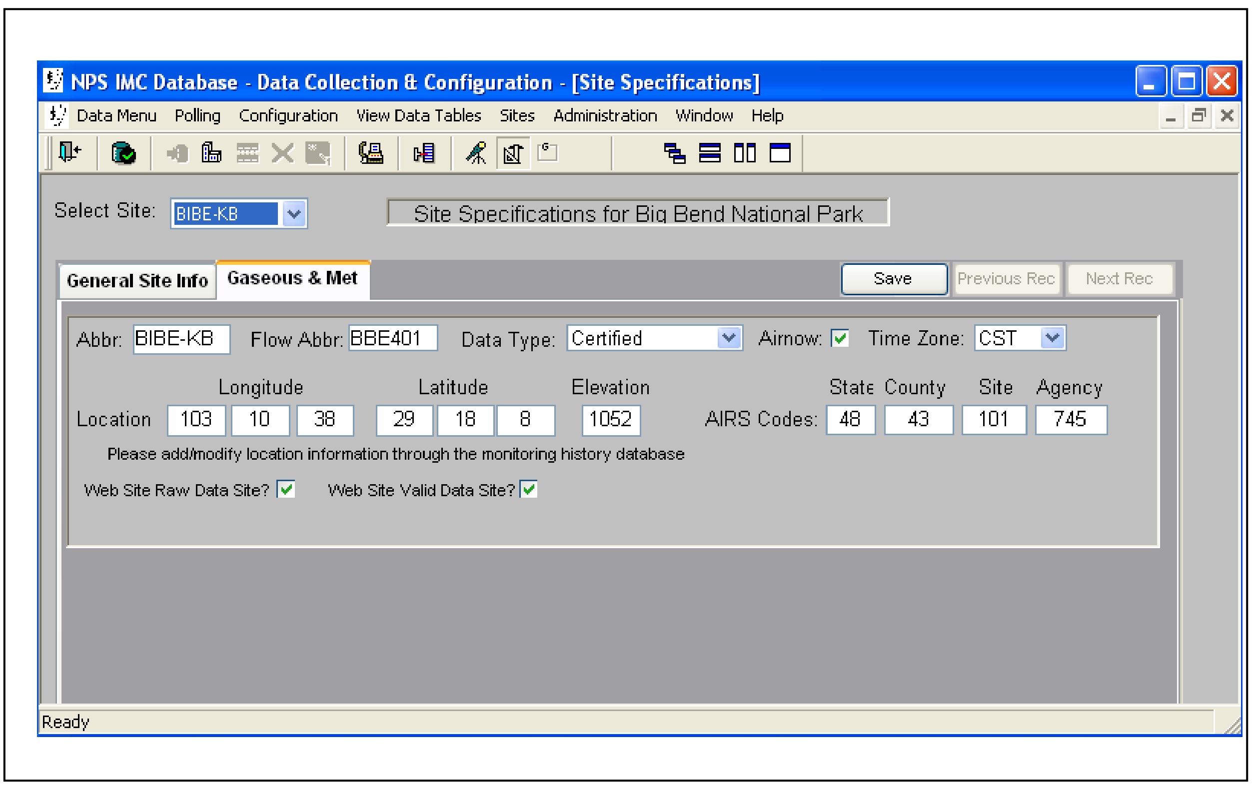


Figure 4-2. The Gaseous and Met Instrumentation Page of the Site Specifications Window.

➢ To access the Site Specifications window:

1 Select **Sites -> Sites Specifications** from the Configuration frame.
2 Select an *abbreviation* from the Select Site drop-down list box or add a new record.
3 Click on the **Gaseous & Met** tab to view, add, or modify the related information.
4 Use the Data Window menu for adding and modifying records (See Section 3.4.1 The Data Window Menu).

Site groupings allow individual sites to be grouped together for reporting purposes. A group can also contain another group as one of its members (nested groups). For ease of use, the site groups have been displayed in a tree-view data window (see Figure 4-2).

➢ To access the Site Groupings window:

1 Select **Sites** -> **Site Groupings** from the Configuration frame.
2 Click on **+** to expand groups. Click on **–** to contract groups.
3 Click on *boxes* next to group or *site names* to select.
4 Use the Data Window menu for adding, modifying, and deleting groups or group members. (See Section 3.4.1 The Data Window Menu).

4.2 Polling and Stackplot Configuration

The Polling and Stackplot Configuration interface consists of four tabs as shown in Figure 4-3:

- Site Information: Site name(s) and abbreviation.

- Polling Information: Datalogger type, telephone number, polling schedule, and configured data formats information.

- Stack Plots: Plots (pages) configured for the site.

- Stack Plot Parameters: Content of each plot (page).

➢ To access Polling and Stackplot Configuration:

1 Select **Configuration -> Polling & Stackplot** from the Configuration frame.
2 Select an *abbreviation* from the Select Site drop-down list box.

4.2.1 Polling Configuration

Figure 4-3 is an example polling configuration. The information in the polling configuration is critical for data collection and must be accurate. Errors in the polling information may cause the data to not be retrieved, be written to the database incorrectly, or not be written at all. Follow these guidelines when adding or modifying polling configurations:

- Configure new sites in the Site Specifications Configuration window before attempting to add a new polling configuration record.

- Sites may have multiple polling configurations for multiple dataloggers.
- The raw data configuration and data parameter configuration must be up-to-date before adding or modifying a site. Attempting to configure the polling information with an undefined raw data format will cause an error.

- If the *On* box is checked, a complete and accurate polling configuration is expected. Fill in all boxes. Check the *DataView* box if DataView is operating at the site. Do not check Retry. Check the *days of the week* to poll (usually all days are checked). The polling minutes are used to define the polling order of the sites within each hour. Using lower polling minutes will cause a site to be polled before other sites with higher polling minutes. Entering any minute value (including zero) into any hourly field will cause the data to be polled for that hour.

- Add or delete linked raw data configurations to a site's polling configuration from the Configured Data Format IDs data window.

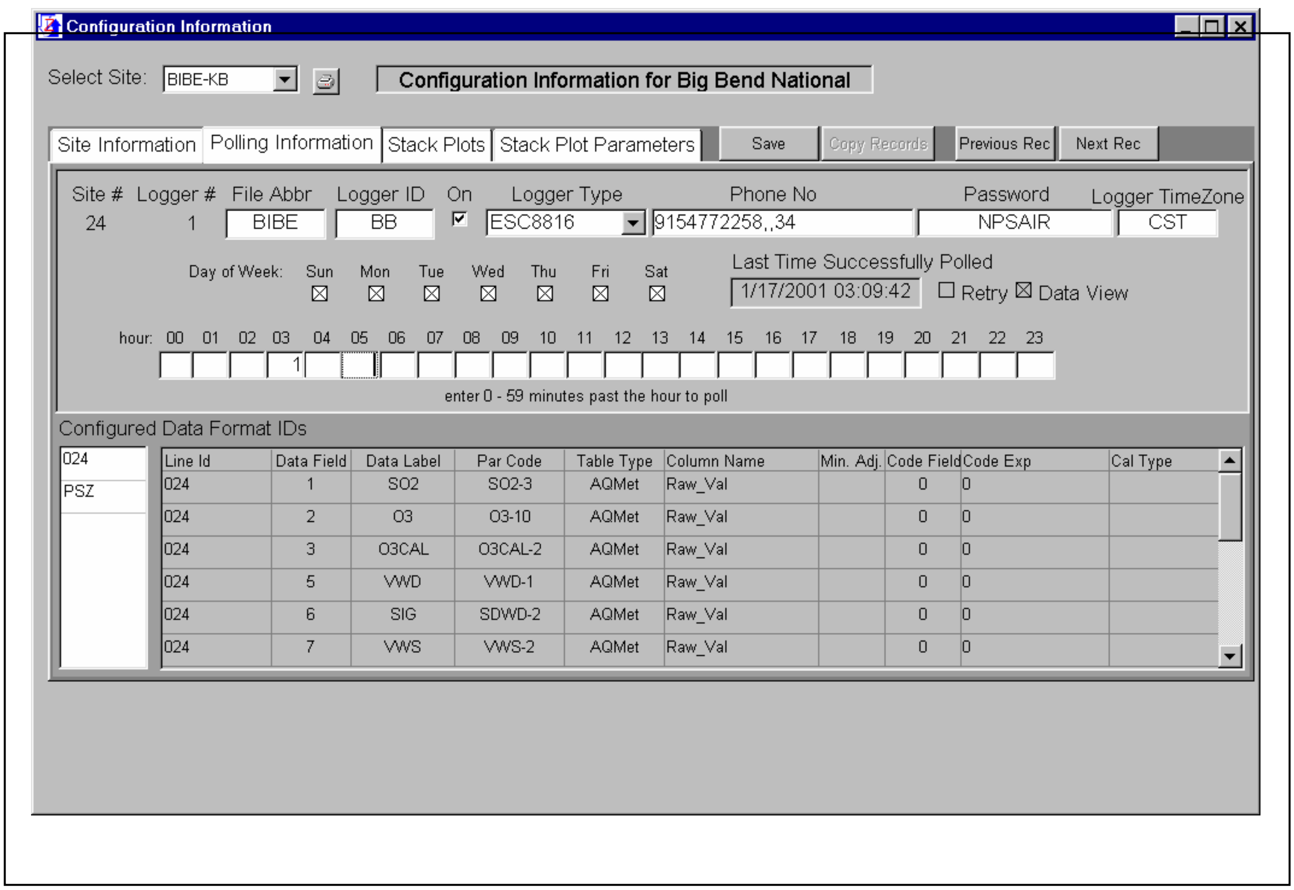


Figure 4-3. Polling Configuration.

4.2.2 Stackplot Configuration

The stackplot configuration consists of configuring each plot (titles, temporary plot file, etc.) and each graph on each plot (plotting parameters, line types, etc.). A plot represents a physical page and a graph represents a trace of data for a parameter drawn on the page. A site can have one or more plots associated with it and each plot can have one or more graphs on it.

4.2.2.1 Stackplot Page Configuration

Each plot configuration requires information specific to the plot page as shown in Figure 4-4. When configuring a plot, follow these guidelines:

- The contents of the *Stkplot File* field must be unique because it is used to create temporary ASCII files that are accessed by the Stkwin program for generating stackplots.

- The *Min. Increment* must contain the shortest interval of time that will be plotted (usually 1 or 24 Hours) on this plot page.

- Check the **Include in Daily Review** box for the plot to be generated as part of the polling process. When this box is checked, also enter the number of *Days* back to plot. Check the **Today** box to plot through the current date; leave it unchecked to plot through the day before the current date.

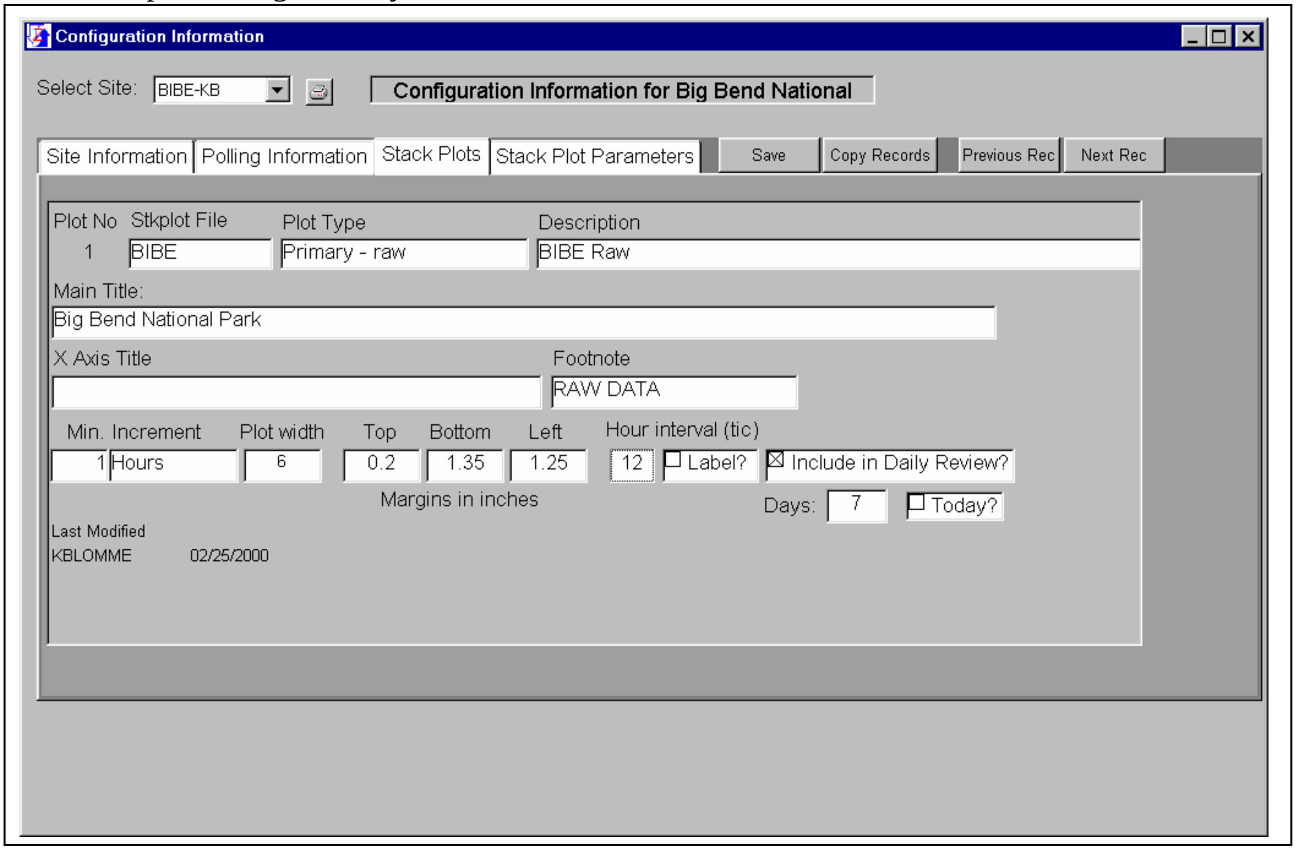


Figure 4-4. Stackplot Page Configuration.

4.2.2.2 Stackplot Parameters Configuration

Each graph on a plot has many parameters specifying how data will look on the graph and how the graph will look on the plot. Though some plotting parameters are not configurable and most of them have default settings, it is necessary to configure each graph at least once. Figure 4-5 shows an example stackplot parameter configuration. When configuring stackplot parameters follow these guidelines:

- The *Par Code*, *Table*, and *Column Name* fields must be configured properly in order for the program to find the correct data. If necessary, refer back to the polling configuration to see the specific parameter codes assigned to a site's data.

- One or two parameters can be plotted on the same graph. Use the *Yes* and *No* radio buttons to toggle this option.

- Configuring stackplot parameters takes practice and often requires several modifications before the plot looks right.

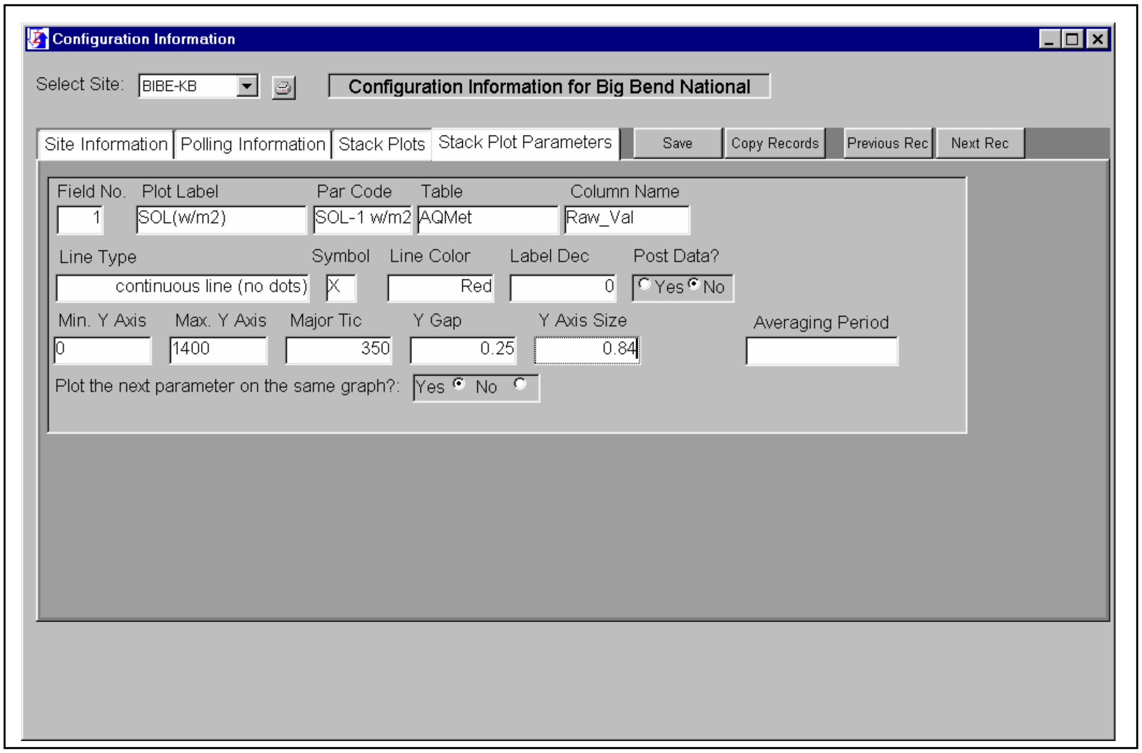


Figure 4-5. Stackplot Parameter Configuration.

4.2.2.3 Copying Stackplot Configurations

A new site being added to the network may have a configuration similar to an existing site. In this case, the Copy Records function can be used to facilitate setting up stackplot configurations as shown in Figure 4-6.

➢ To use the Copy Records function:

1 Determine which stackplot configuration most closely resembles the new configuration.

2 Select the new site's *abbreviation* from the drop-down list box and click on the **Stack Plots** tab.

3 Click the **Copy Records** button. A pop-up list box is displayed.

4 Select the *configuration determined in step 1*, then click **Continue**. The records in the Stackplot Configuration Tables for the selected configuration will be duplicated and added to the current site's configuration.

5 Modify the duplicated records as needed.

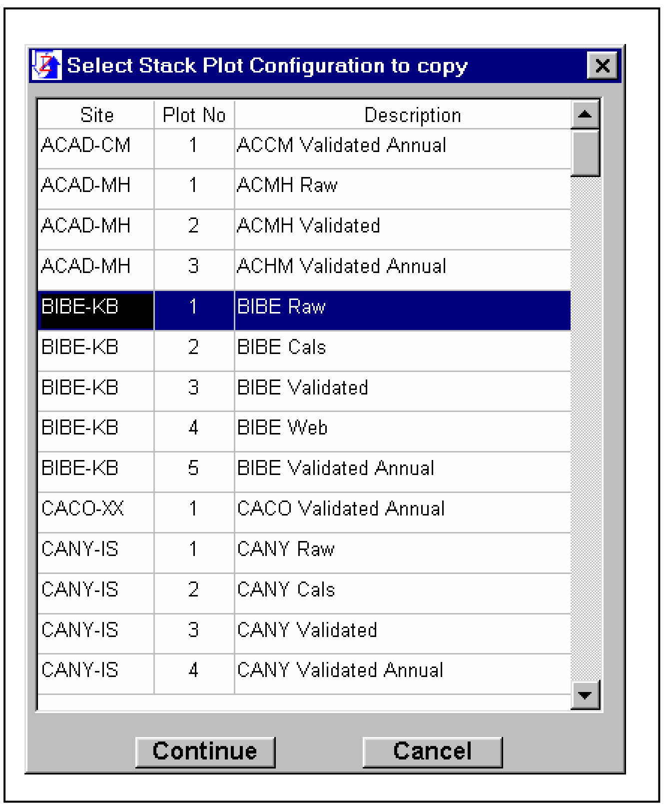


Figure 4-6. Stackplot Configuration Pop-up Window.

4.3 Raw Data Formats Configuration

A Raw Data Format configuration defines what type of data is collected by each channel in the datalogger and is used to relate the incoming raw data to information stored in the database. Figure 4-7 is an example of a Raw Data Format for hourly data. Figure 4-8 is an example of a Raw Data Format for ESC calibration sequence.

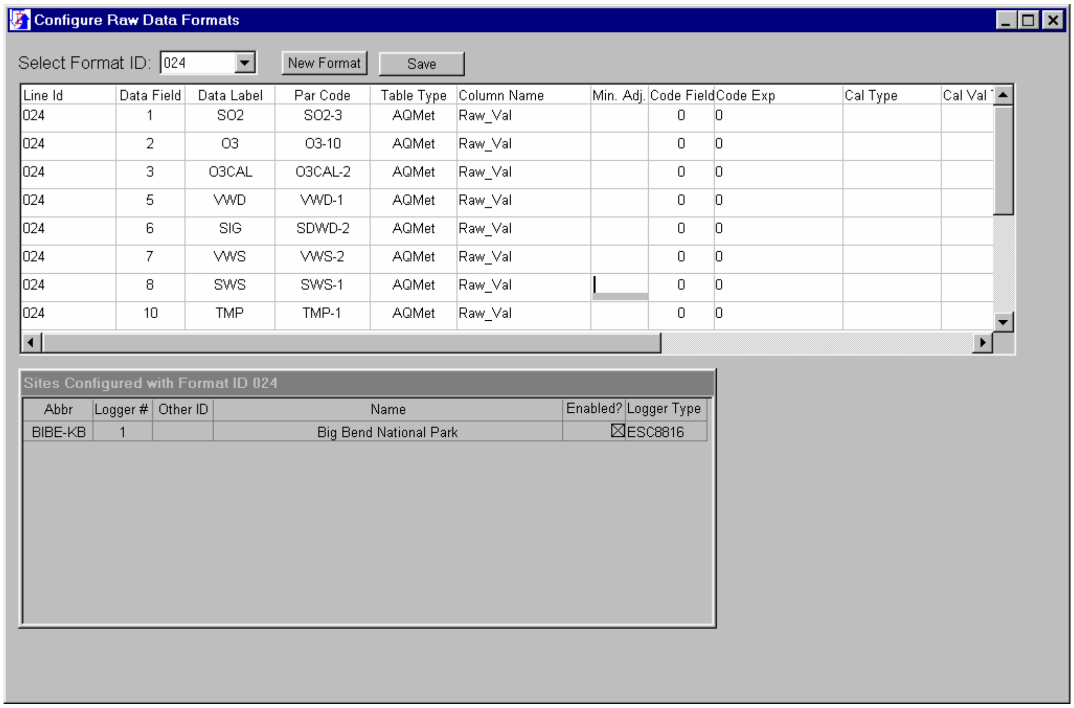


Figure 4-7. A Raw Data Format for Hourly Data.

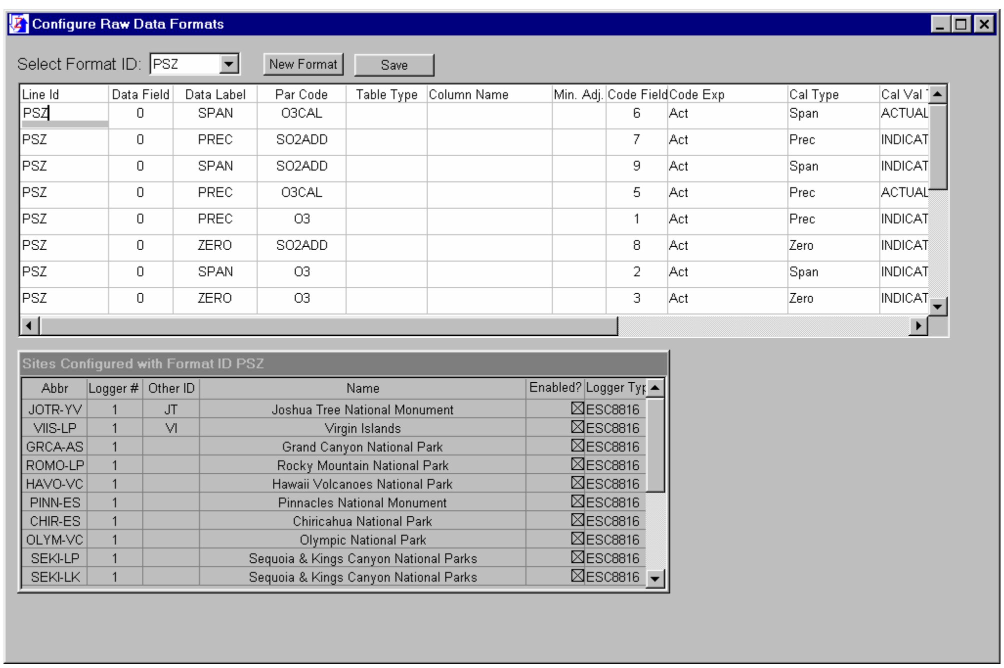


Figure 4-8. A Raw Data Format for an ESC Calibration Sequence.

➢ To access the Raw Data Formats configuration:

1 Select **Configuration -> Raw Data Formats** from the Configuration frame.

2 Select an *abbreviation* from the Select Site drop-down list box or add a new record.

When configuring Raw Data Formats follow these guidelines:

- For hourly data collected on ESC dataloggers, the Data Field and Data Label columns must reflect what the datalogger is providing in the raw data. (The Data Field column maps to the channel number.)

- The collected data type must already exist in the data parameter configuration. If it does not exist, it will not be available in the Par Code drop-down list box and cannot be used. In this case, a new data parameter is being defined and the must be added to the Data Parameters configuration before continuing.

- For calibration data collected on ESC dataloggers:

  - The Data Field column should contain 0.

  - The Data Label column must contain an appropriate label for the calibration data type (SPAN, PREC, or ZERO).

  - The Par Code column must contain the appropriate primary parameter name code rather than a specific parameter code (i.e., "O3" not "O3-10"). The data loading program assigns the correct par code by querying the hourly data.

  - The Code Field, Code Exp, Cal Type, and Cal Val Type columns tell the data loading program where in the reformatted cal file to look for the data.

  - Calibration configurations are not straightforward. Seek the help of the database administrator if a new configuration is required.

- To add a new format ID, click the **New Format** button to show a blank configuration interface.

4.4 Data Parameters Configuration

The Data Parameters configuration is used to relate incoming raw data to what is stored in the database and to define the associated AQS codes for each parameter. It also defines all historical data stored in the database.

➢ To access the Data Parameters Formats configuration:

1 Select **Configuration -> Data Parameters** formats from the Configuration frame.

The Data Parameter configuration interface, shown in Figure 4-9, includes the following five data windows:

- **Parameters:** Shows all of the types of data in the database and the associated AQS codes. It is important to note that, although raw relative humidity data may be labeled as *RH* at one site and *RELHUM* at another site, it is still relative humidity and is mapped to the parameter *RH* in the parameters window.

- **Parameter Codes:** Shows how the various raw data parameters are mapped to the appropriate parameters shown in the Parameters windows (described above). The Parameter Codes window includes specific information about each parameter, including AQS method code, units, and decimal precision. Note that for some parameters such as scalar wind speed, one site may use m/s as the units, while another may use mph. These two have different parameter codes (PAR CODE) such as SWS-1 and SWS-2.

- **Unit Codes:** Shows the units associated with the parameter currently selected (highlighted) in the Parameters window or the Parameter Codes window. Only units defined in the Unit Codes window can be associated with a parameter.

- **Conversion Formulas:** Shows the conversion formulas defined for the parameter currently selected (highlighted) in the Parameters window. The formulas are used during data reporting processes to standardize output.

- **Interval Codes:** Displayed here for convenience only; the records are not linked to the currently selected parameter or parameter code.

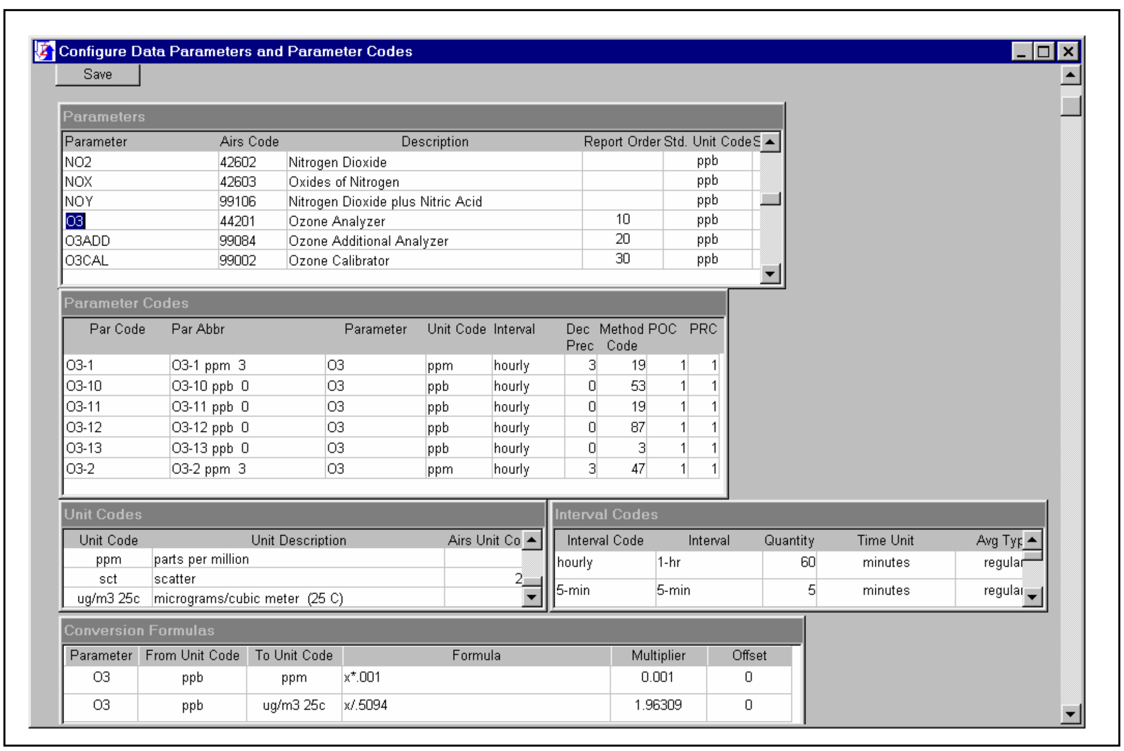


Figure 4-9. The Data Parameters Configuration.

Follow these guidelines when modifying the data parameters configuration:

- NEVER attempt to delete any records from any of the tables in the data parameters configuration. This configuration *defines* the data in the database.
- Editing the parameter information must be done with caution. Any changes made to the parameter configuration affect the definition of the data within the database and affect data polling and reporting functions.
- Adding new configurations must be done in a logical order.

4.5 Anomaly Screening Configuration

The anomaly screening configuration is used to flag raw data that fall outside of expected values so the data will be quickly inspected to rule out instrument problems and to aid the data analyst during the validation process. Currently, there is no “wizard” type interface for this configuration and, due to its complexity, only the database administrator should modify this configuration.

5.0 Data Collection

Several methods exist for placing data into the Oracle database. Usually, hourly data are loaded through a series of automated processes. Currently, a Windows operating system utility called *System Agent* is utilized to launch the application with a command line argument at a scheduled time. The AQDBMS application detects the command line argument, automatically connects to the NPS IMC database and enables the auto polling function. A system timer queries the polling configuration tables continually to determine if it is time to poll any sites. When the query returns a result set of sites and polling configurations, the program loops through the list, calling the dataloggers and loading the data into the database.

Data can also be loaded for one site for one day at a time using the *Manual* command button in the polling window. Either way, the polling program issues a call to the site, captures data for the requested date and writes it to an ASCII file, reformats the ASCII file and loads the data into the database. As data are being loaded for each site, the header columns of the ASCII file must match the datalogger column information stored in the Polling Line ID Table. Figure 5-1 shows the polling interface.

Data can also be hand-entered or blank-filled in the Data Validation interface. Data entry forms for entering non-hourly aerosol data, precision check data, and data from audit reports are also available.

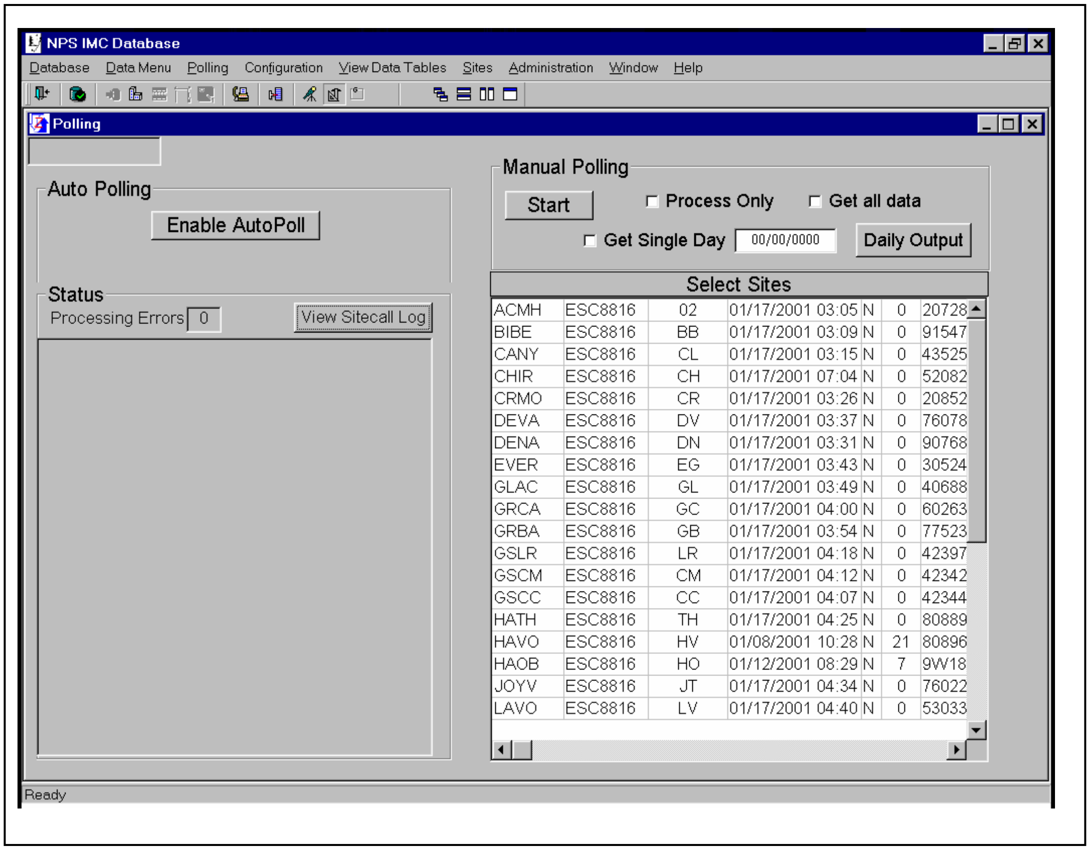


Figure 5-1.The Polling Interface.

➢ To open the Polling window:

1 Select **Polling** from the Configuration frame.

5.1 Starting the Auto Poll Process

Usually, Windows System Agent will launch the AQDBMS application and enable the auto load process. Sometimes the auto load process must be manually started.

➢ To run Auto Poll:

1 In the Polling window, click the **Enable Auto Poll** command button. The button text changes to read “Disable Auto Poll.”

5.1.1 Polling Order

The order in which the sites are polled is determined by the following:

1. Polling time specified in each site’s configuration.

2. Alphabetically by site name.

Sites with identical polling times will be polled alphabetically. To change the polling order of a site, edit the polling configuration as described.

5.1.2 Manual Data Polling

Manual data polling provides functionality not included in the automatic data collection process. Manual data collection is used in the following situations:

- When automatic data collection from a site has failed and the data are needed in the database.
- When recent data are needed for immediate use.
- When archived or edited raw data need to be written to the database without polling the site.

Manual data polling cannot be used at the same time as automatic data collection. It is necessary to disable automatic data collection.

➢ To run Manual Poll:

1 Select the *sites to poll* by clicking on them (use standard Windows keys for multi-select).

2 Select the **Process Only** checkbox if the raw data file already exists (no polling of the site(s) will be performed).

3 Select the **Get All Data** checkbox to poll a 21X or CR10 datalogger and attempt to retrieve all of the data contained therein. *This may take a long time and may return many months of data*. This option is recommended only in <u>extreme</u> situations. Note: This option only applies to Campbell dataloggers.

-or

Select the **Get Single Day** checkbox to poll an ESC datalogger for one specific day.

-or

Leave both the *Get All Data* and *Get Single Day* checkboxes unchecked. The dates polled will be from the date listed next to each site in the Select Sites list box to the current day. The date listed may also be changed by clicking in the field and entering a new date.

4 Click the **Start** button to begin processing the site(s) in the order they appear in the list.

The manual data collection process operates similarly to the automatic data collection process regarding log files, etc.

5.1.3 Reviewing the Log and Err Files

The Auto Poll and Manual Poll programs write messages to files tracking the data polling and loading processes. The log files are called *yyyymmdd.log* where *yyyy* is the year, *mm* the month number and *dd* the day number. (For example, the file 20001128.log holds the log entries for November 28, 2000) The error files are called *yyyymmdd.err*. Both files are stored in the n:\project\esc_sitecall\logs directory and can be viewed by either clicking the **View Sitecall Logs** button in the Polling window or by opening directly in any text editor. Figure 5-2 is a sample log file and Figure 5-3 is a sample err file.

```
DATA_COLLECTION: Site No: Figure 0-1 SHBM 01-25-200105:38:29 ---------- Begin
Site: SHBM ----------
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29 SHBM
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29 540999369834
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29 BM
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29 2
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29 ESC8816
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29 36896
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29
\\ars_net3\vol4\project\IMC\esc_sitecall\SHBM005a.2001r
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29
\\ars_net3\vol4\project\IMC\esc_sitecall\SHBM.dat
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29
\\ars_net3\vol4\project\IMC\esc_sitecall\SHBM.cal
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29
\\ars_net3\vol4\project\imc\esc_sitecall\logs\20010105.LOG
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29
\\ars_net3\sys\ars_soft\programs\campbell\
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29 NONE
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:29 Turning modem ON...
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:33 Turning modem ON...
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:37 HANGUP: Opening port #2
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:38 HANGUP: AT&FV1&W
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:45 HANGUP: ATH0
DATA_COLLECTION: Site No: SHBM 01-25-200105:38:54 HANGUP: DTR toggle
DATA_COLLECTION: Site No: SHBM 01-25-200105:39:09 HANGUP: Close port
DATA_COLLECTION: Site No: SHBM 01-25-200105:39:09 Turning modem OFF...
DATA_COLLECTION: Site No: SHBM 01-25-200105:39:13 Offline
DATA_COLLECTION: Site No: SHBM 01-25-200105:39:13 GetDataESC8816() started
DATA_COLLECTION: Site No: SHBM 01-25-200105:39:13 Getting ESC8816 data:
F:\COM_SOFT\ATMAPPS\XTALK32\XTALK30.exe SHBM(NPSAIR BM 01/05/01 5
\\ars_net3\vol4\project\IMC\esc_sitecall\SHBM005a.2001r
\\ars_net3\vol4\project\imc\esc_sitecall\logs\20010105.LOG
\\ars_net3\vol4\project\imc\esc_sitecall\logs\200101
DATA_COLLECTION: Site No: SHBM 01-25-200105:39:13 Executing:
F:\COM_SOFT\ATMAPPS\XTALK32\XTALK30.exe SHBM(NPSAIR BM 01/05/01 5
\\ars_net3\vol4\project\IMC\esc_sitecall\SHBM005a.2001r
\\ars_net3\vol4\project\imc\esc_sitecall\logs\20010105.LOG
\\ars_net3\vol4\project\imc\esc_sitecall\logs\20010105.ERR 1 PS
DATA_COLLECTION: Site No: SHBM 01-25-200105:39:13 OS version: Win 9x
```

Figure 5-2. A Sample Data Collection Log.

```
XTALK - shbm 1/25/2001 5:42:33 AM-XTALK data collection failed - shbm
(01/05/01)
FMT8816: SHBM 038 01/25/2001 05:42:37 >> Bad filename and/or path
```

Figure 5-3. A Sample Data Collection Error File.

5.1.4 Daily Output

In addition to polling and loading data, the Polling window performs several other functions:

- Update of stackplot files (auto mode)
- Auto printing of anomaly flag listings (auto and manual modes)
- Auto printing of datalogger summary files (auto mode)
- Generation of span files (auto and manual modes)

➢ To manually generate daily output :

1 From the Configuration menu, click **Polling**.
2 Select the *sites to poll* by clicking on them (use standard windows keys for multi-select).
3 Click the **Daily Output** button.

5.2 Viewing Data Onscreen

Hourly and calibration data can be viewed in a monthly tabular data window as shown in Figure 5-4. The data in this window can also be sorted and filtered but cannot be edited in any way.

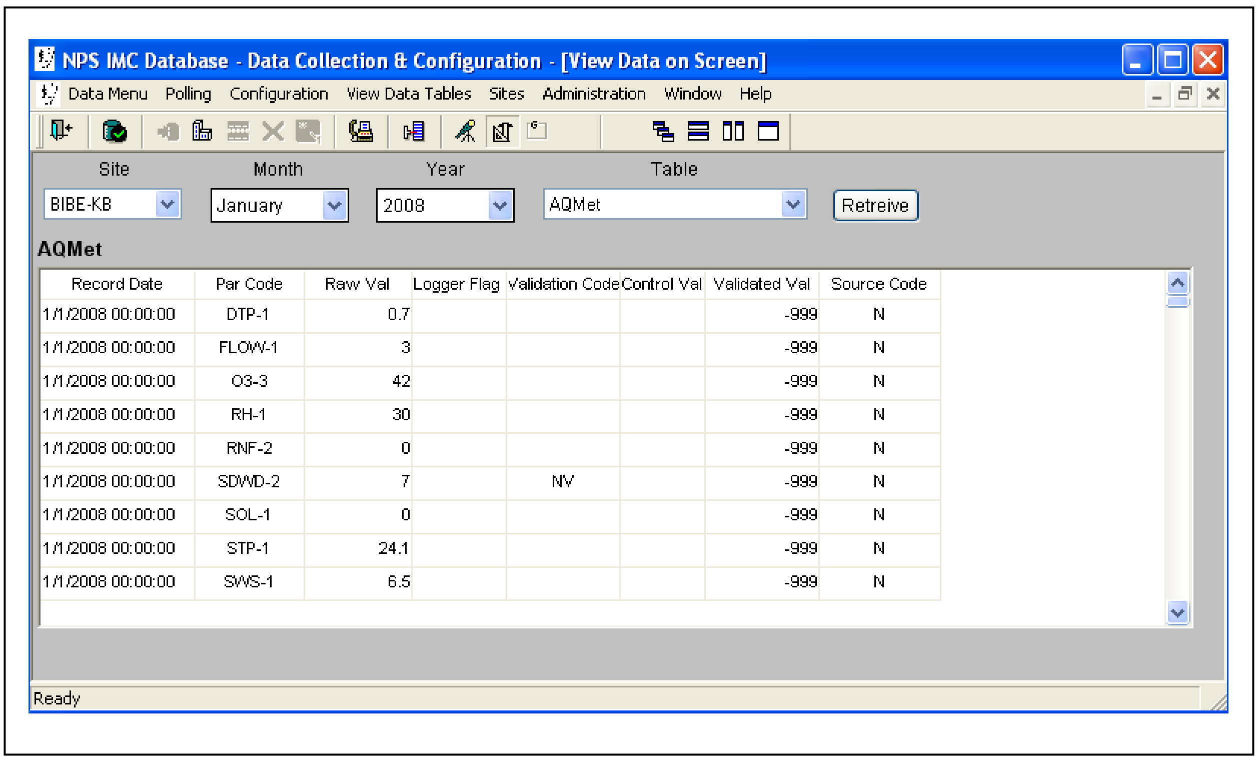


Figure 5-4. The View Tables Monthly Data Window.

➢ To view Monthly Data Windows onscreen:

1 Select **View Data Tables** from the Data Collection and Configuration frame.
2 Select a *site* from the Site drop-down box.
3 Select a *month* and *year* to view from the Month and Year drop-down boxes.
4 Select the *table type* (AQMet or AQCal) from the Table Type drop-down box.
5 Click the **Retrieve** button.

➢ To sort or filter data in the Monthly Data window:

1 Follow steps 1 – 5 of "To view Monthly Data Windows onscreen" above.
2 Right-click anywhere within the data window.
3 Select **Filter** or **Sort** from the pop-up menu. A dialog box is displayed. Follow the dialog box instructions to apply filter or sorting options. Click the **Help** button to access specific help on the dialog boxes.

5.3 Entering Audit Data From Audit Reports

The Audit Data command displays a data entry form for entering information from audit reports. The information is stored in a permanent table in the database and is used to create Accuracy Data AQS transactions. The Audit Data Entry Form is shown in Figure 5-5.

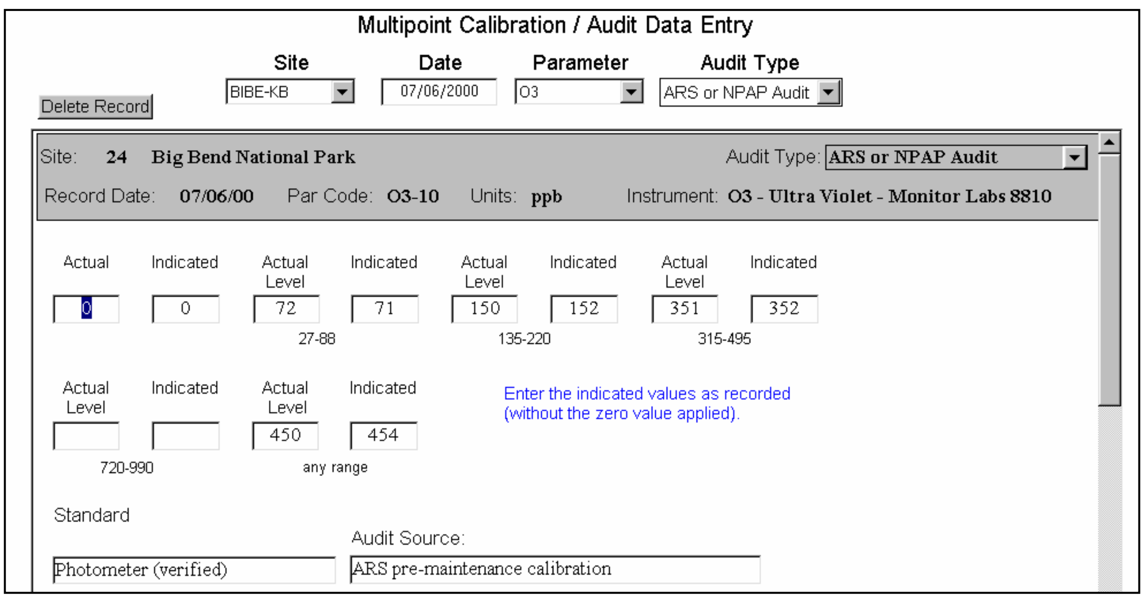


Figure 5-5. The Audit Data Entry Form.

➢ To enter audit data:

1 Select **Load Data** -> **Audit Data** from the AQ and Met Processing frame.
2 Click the **down arrow** in the Site box and select a site.
3 In the Date box, enter the *date* of the audit report in mm/dd/yy format (that is 02/11/01 for February 11, 2001).
4 Click the **down arrow** in the Parameter box and select the *parameter* that was audited.
5 Click the **down arrow** in the Audit Type box and select the *type of audit* performed.

Note: When all required information has been entered in the top part of the window, an additional data entry form appears in the lower window. Data in the shaded section have been filled in using the information already entered. The unshaded area contains data entry fields for the audit information. These fields will either be empty or will contain data previously entered for the site, date, and parameter selected. Complete the form by entering numerical audit data in the appropriate fields.

Important : Before entering the audit data, verify that the information listed in the shaded area is correct for the audit data being entered. The Delete Record button is used to delete the record if the wrong combination of site, date, parameter has been selected. Changing one of these values will not modify the current record but will create a new record or retrieve it if it already exists.

6.0 Data Validation

The Data Validation interface is used to apply validation codes to the data via two windows. The initial window provides a way to apply codes to all data points, list missing data, and blank fill data within a selected set of data. The second window displays a tabular data window of the selected data and provides a way to apply validation codes to selected data points within the window. It provides an interface for sorting and applying specific filters to the data and for hand entering data.

➢ To open the Data Validation window:

1 Select **Validate** from the AQ and Met Processing frame.

6.1 The Initial Data Validation Window

Sometimes fairly large sets of data for a site require the same validation code. For example, a power failure lasting for several hours or days requires a validation code of "PF" to be applied to the affected data. The easiest way to accomplish this is to use the initial Data Validation window that is displayed when entering the data validation interface. The user can also see a list of missing data, blank fill data, and display a data grid from this window. This window is shown in Figure 6-1.

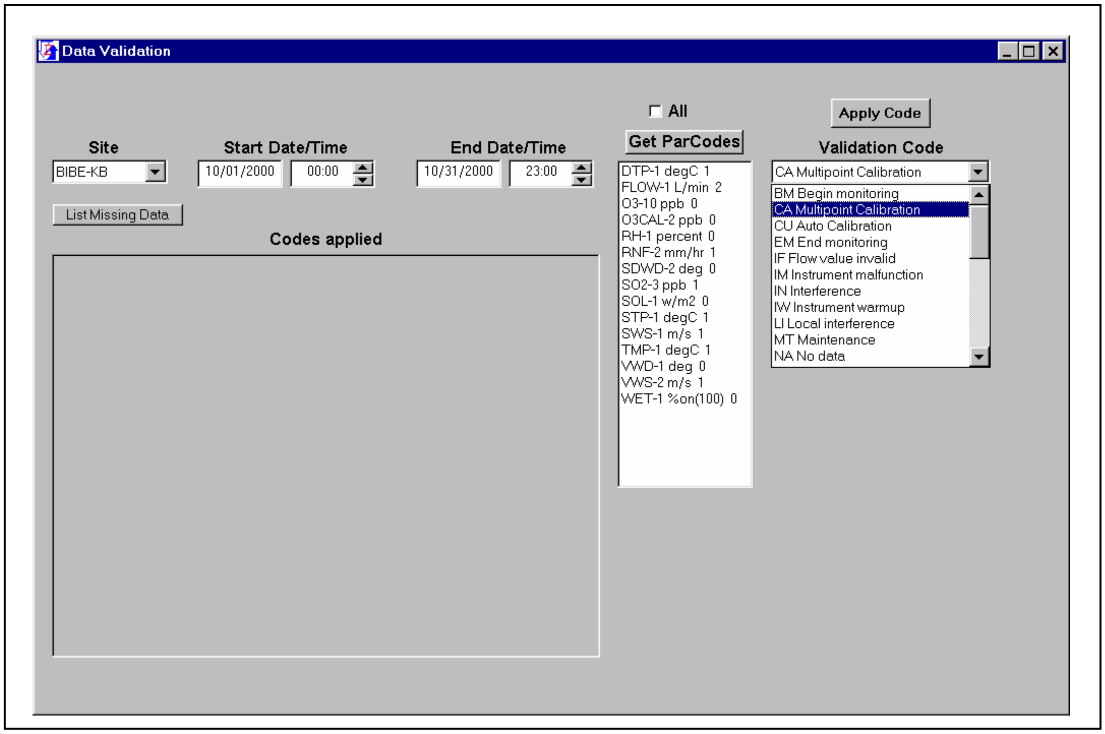


Figure 6-1. The Initial Data Validation Window.

➢ To apply validation codes:

1 Select the *site* to validate.
2 Enter the *Start Date/Time* of the data set to work on.
3 Enter the *End Date/Time* of the data set to work on.
4 Click the **Get ParCodes** button. The program queries the database and returns all the parameter codes found for the selected site and period in the list box.
5 Select (highlight) one or more *parameter codes* in the list box.
6 Select a *validation code* from the Validation Code drop-down box.
7 Click the **Apply Code** button. The process window displays a message listing the number of updated records.

Important Note: When using this method, validation codes are committed to the database table immediately.

➢ To search for missing data:

1 Follow steps 1 – 5 of "To apply validation codes" above.
2 Click the **List Missing Data** button. The cursor changes to an hourglass. When the cursor changes back to a pointer, the process has completed. Missing data within the selected data set will be listed in the process box.

➢ To blank fill data:

1 Follow steps 1 – 4 of "To apply validation codes" above.

2 Check the **blank fill** box.

3 Check the **All** box and click **Get ParCodes** to retrieve a list of all parameter codes. Select the *parameter codes* to be blank-filled for the selected site and time period.

-or

Check the pattern date and enter a *date* that contains the parameter codes that need to be blank-filled for the selected period.

4 Select a *code* from the Validation Code drop-down list box.

5 Click the **Apply Code** button. Data will be blank-filled with a value of "–999" in the raw value and validated value fields, the selected code in the validation code field, and a "B" in the source code field. **Note:** The program will not overwrite existing data. When the process is complete, the number of blank-filled rows will be indicated in the process box.

➢ To display the data grid:

1 Follow steps 1 – 4 of "To apply validation codes" above.

2 Select the *parameter code* to display. Note: If more than one parameter code is selected, only data for the first code will be displayed.

3 Click the **24x31** button. The data will be displayed in a grid of 24 hours across by days down (optimally one month). For each data point, if any code other than a "V", "VA", or "VZ" exists in the validation code field, the code will be displayed in red. Otherwise, the value found in the validated value field is displayed.

4 Click the **X** button to close the window and return to the validation window.

6.2 The Data Validation Data Window

The second window available for data validation provides an interface for applying validation codes to specific, individually selected data points. Data from all columns of the database table are displayed in tabular form as shown in Figure 6-2. The Data window data can be sorted and /or filtered. The interface also provides a means for re-screening data and for hand entering data values when necessary.

➢ To open the Data Validation Data window:

1 In the Initial Data Validation window, select the s*ite* to validate.

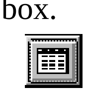
2 Enter the *Start Date/Time* of the data set to work on.

3 Enter the *End Date/Time* of the data set to work on.

4 Click the **Get ParCodes** button. The program queries the database and returns all the parameter codes found for the selected site and period in the list box.

5 Select (highlight) one or more *parameter codes* in the list box.

6 Click the **data table** picture button. The Data Validation Data window is opened and displays the selected set of data in a tabular data window.



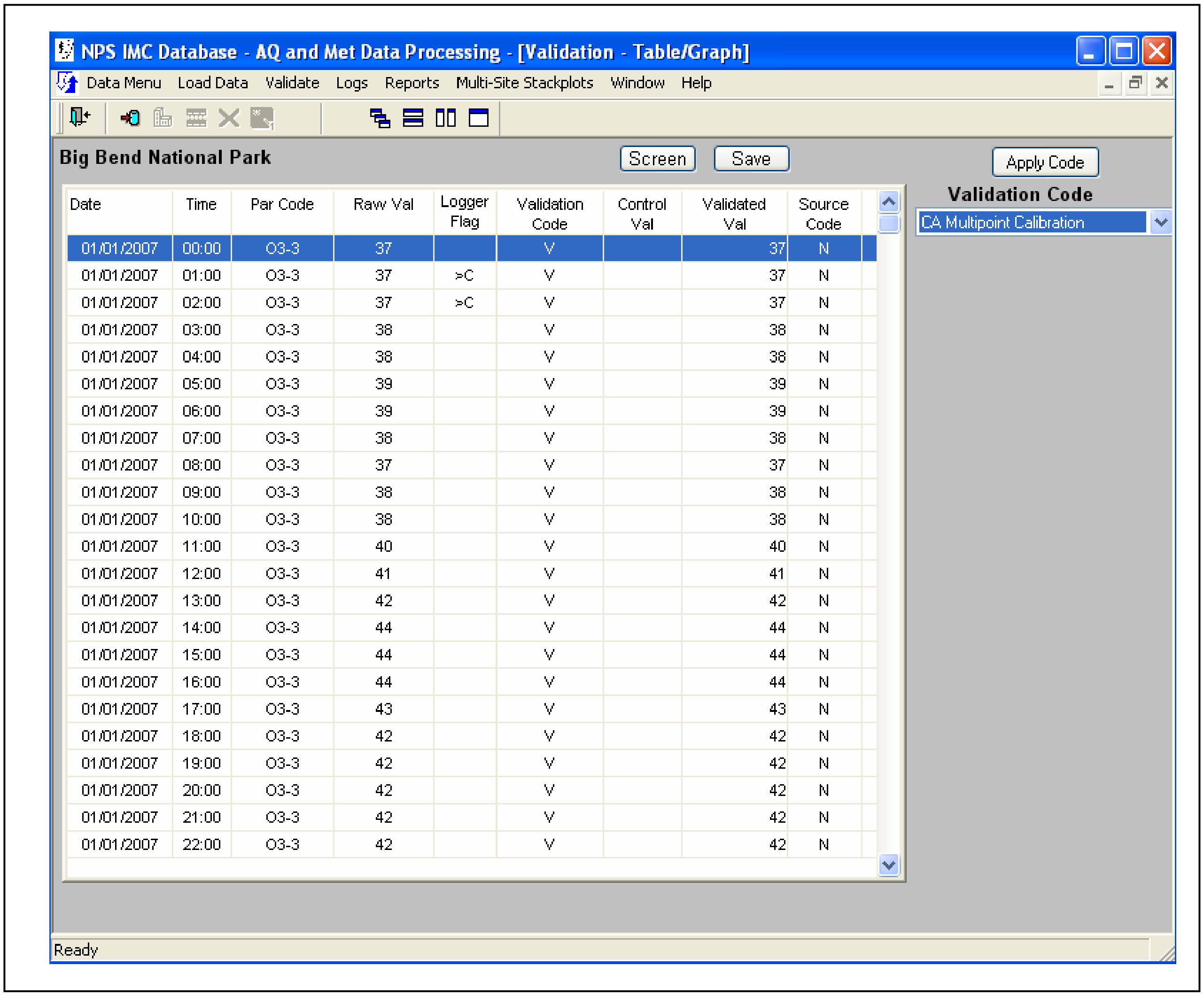


Figure 6-2. The Data Validation Data Window.

➢ To apply validation codes:

1 Follow steps 1 – 6 of "To open the Data Validation Data window" above.
2 Select (highlight) the *data points* to apply the validation code to. **Note:** This is a multi-select data window and rows can be selected with shift-click and ctrl-click in the standard Windows way.
3 Select a *code* from the Validation Code drop-down list box.
4 Click the **Apply Code** button.

➢ To sort and filter data:

1 Follow steps 1 – 6 of "To open the Data Validation Data window" above.
2 Right-click anywhere in the data window.
3 Select **Filter** or **Sort** from the pop-up menu. A dialog box is displayed. Follow the dialog box instructions to apply filter or sorting options. Click the **Help** button to access specific help on the dialog boxes.

6.2.1 Entering Control Values

Control values can be entered in the Data Validation Data window. Control values are arithmetic expressions that are applied to or replace raw values and result in adjusted validated values. The first character in the control value field must be an arithmetic operator. For example, if you determine that the raw data values for wind speed are 10 m/s less than they truly were, enter "+10" in each control value field. This action will add 10 to the raw data values and place the result in the validated data fields.

Important: When the control value field is used, the final data validation code must equal "VA" which means valid, but value adjusted.

Acceptable operators for control values:

Operator	Result
+	adds the control value to the raw value
-	subtracts the control value from the raw value
*	multiplies the raw value by the control value
/	divides the raw value by the control value
=	substitutes the control value for the raw value

➢ To enter control values:

1 Follow steps 1 – 6 of "To open the Data Validation Data window" above.
2 Select (highlight) the *data points* to apply the VA code to. **Note:** This is a multi-select data window and rows can be selected with shift-click and ctrl-click in the standard Windows way.
3 Select the *VA code* from the Validation Code drop-down list box.
4 Enter the *value* to apply in the Control Value box.
5 Click the **Apply Code** button.

6.2.2 Replacing Raw Values

On rare occasions, it may be necessary to replace raw data values in the permanent table of the database. You may determine that data from a non-digital source, such as data reduced from strip chart, is of higher quality than the digital data collected by the datalogger.

➢ To hand enter a raw value:

1 Follow steps 1 – 6 of "To open the Data Validation Data window" above.
2 Click on the **Source Code** field of the row needing a hand-entered raw value.
3 Enter a *source code* that will allow a hand-entered value (**C**, **P** or **U**).
4 Click on the **Raw Val** field and enter the *new value*. **Note:** Only raw values of -999 should be replaced in this manner. Use the value adjust method for other raw values.

6.2.3 Screening Data in the Data Validation Window

Usually data are screened for anomalies during the data loading process. When necessary, however, screening can also be done in the Data Validation Data window.

➢ To screen data:

1 Follow steps 1 – 6 of "To open the Data Validation Data window" above.
2 Click the **Screen** button. The anomaly screening program will apply the screening flags.

7.0 The Data Validation Log

The Data Validation Log is used to track the completion of each major step of the validation process. The master record logs the initials of the IMC staff member completing each validation step and when the step occurred. The Comments Table logs comments regarding data validation. Most of the output programs (see Section 9.0, Creating Output Products) query the Data Validation Log so the correct level of validation can be applied to the output. The Data Validation Log is shown in Figure 7-1.

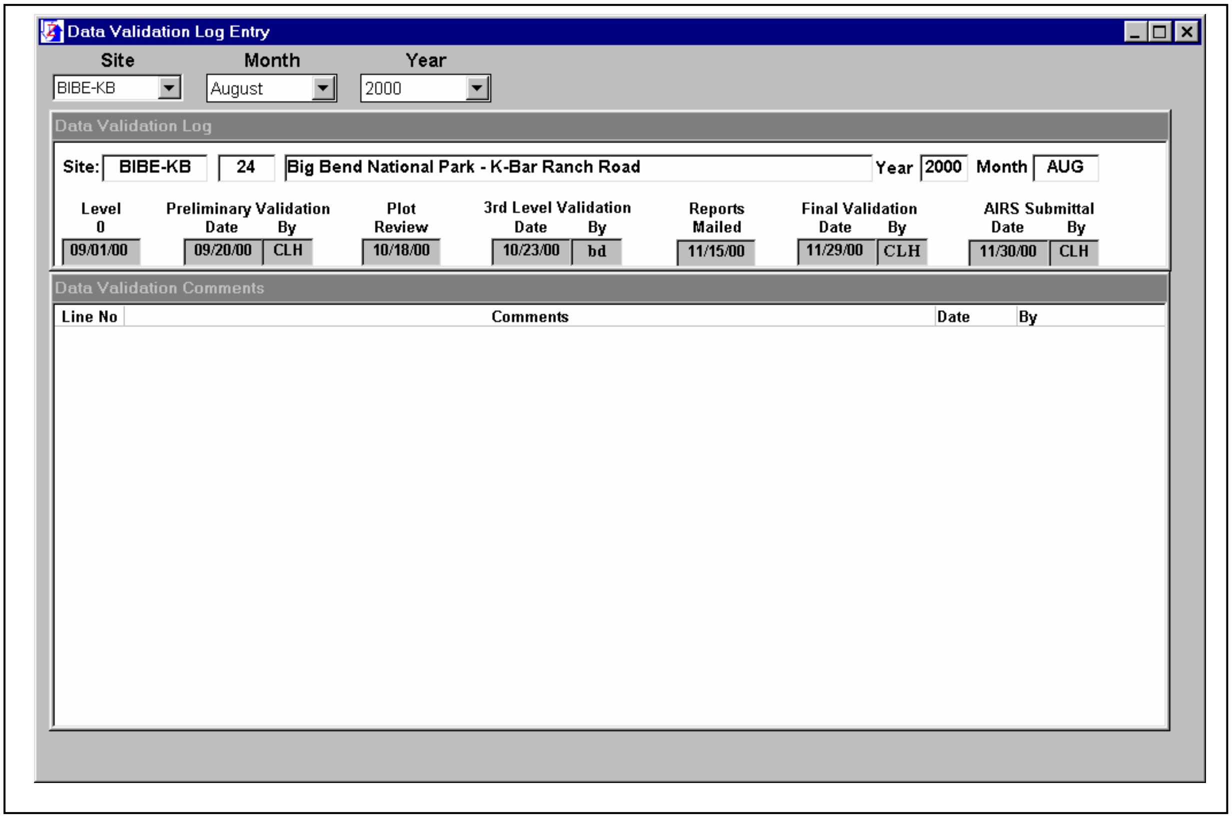


Figure 7-1. The Data Validation Log.

➢ To use the Data Validation Log:

1 Select **Logs** -> **Data Validation Log** from the AQ and Met Processing frame**.**
2 Select a *site* from Site drop-down box. If no records for the selected site exist, a "Site not Found" message is displayed. Click **OK**. Otherwise, the most recent Master Table record and related comments for the selected site are displayed.
3 Select a different *month* and/or *year* from the drop-down list boxes to display previous months records for the site.
4 Records can be added as described in Section 3.4, Data Windows. **Note:** Normally, records should not be deleted.

8.0 The Site Status Log

The Site Status Log (shown in Figure 8-1) is a diary of site-related events such as instrument malfunctions and repAQS, data adjustments, calibrations, special site visits, weather episodes, etc. that may be relevant to data validation. A basic description of each event is entered as a record in the Master Table. The master record contains the site number and name, a reference number assigned by the program, date started and stopped fields to define the period of time involved, and an affected parameters field to indicate which data parameters are possibly affected by the event. Another field indicates if the event is considered to be a problem or not. This field is used to quickly create a list of current problems found in the log. The Detail Table holds as many records as needed to record notes about each event. Normally, a master record will have at least one detail record. Entries can be added, modified, or deleted in both the Master Table and Detail Table.

Before entering information into the Site Status Log, determine if it is a note relating to a previously entered event or if it relates to a new event. If this is a new event, first insert a new Master Table record for the site and then enter the detail notes. If it relates to a previously entered event, locate the master record in the log and then enter the new detail notes.

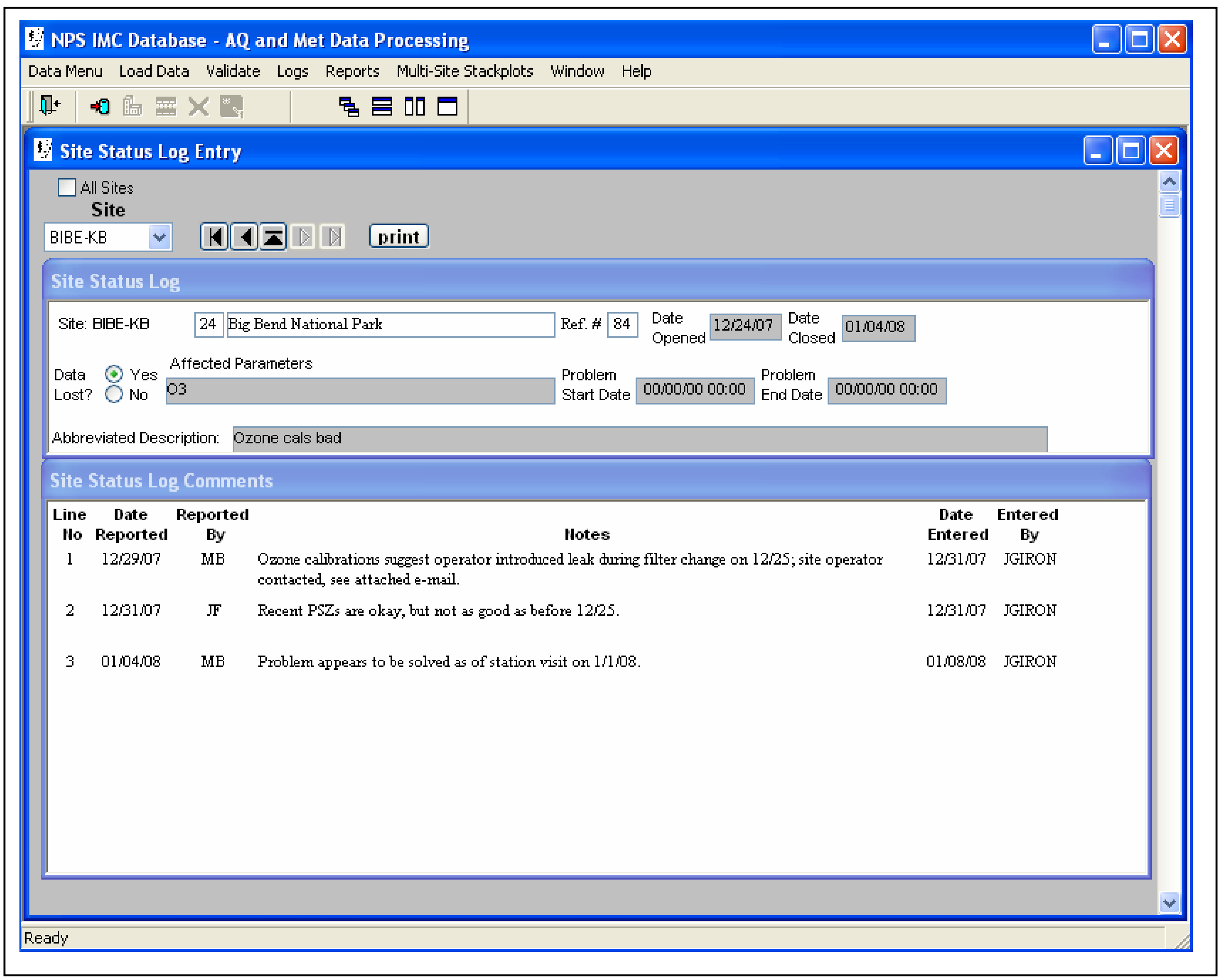
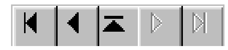


Figure 8-1. The Site Status Log.

➢ To use the Site Status Log:

1 Select **Logs -> Site Status Log -> Data Entry** from the AQ and Met Processing frame.

2 Select a *site* from Site drop-down box. If no records for the selected site exist, a "Site not Found" message is displayed. Click **OK**. Otherwise, the most recent Master Table record and related comments for the selected site are displayed.

3 Use the VCR buttons to move from record to record for the site. 

4 Records can be added as described in Section 3.4, Data Windows. **Note:** Normally, records should not be deleted.

Tip: To enter affected parameters, click in the **Affected Parameters** field then click the **right mouse** button. A drop-down list box is displayed. Click the **down arrow** on the box and then select a *parameter* from the list. The parameter will be added to the affected parameters field. Repeat until all affected parameters have been selected. You may also type directly in this field.

Tip: Use the *Problem? Yes* indicator for an event that can be described as problematic and requires further action.

Tip: Fill in the *Date Closed* field when all issues related to the event have been resolved.

Tip: Each detail record note field holds up to 2,000 characters. If you need more space, insert another row in the Detail Table.

9.0 Output Products

The AQDBMS includes programs that provide a variety of hardcopy products including data summaries and graphical representations of the data (plots) as well as summary lists from the Site Status and Data Validation Logs. Table 9-1 lists the printed output products provided, how to generate them, additional information about generating each product, and output options that are available for each. Output options include sending the output to: a printer, the screen, a PDF file (Adobe Portable Document Format), and writing to an ASCII file.

Important Note: When measurement units of a parameter vary over time, output programs convert values as necessary to match the unit in force at the end of the selected period or to a standard unit, depending on the design specifications for the particular product.

Table 9-1

Output Products and Options

Product	How To Generate	Additional Info	Output Options
3-year Summary Plot. A stacked bar chart comparing monthly values over a 3-year period of a user-selected pollutant parameter. Three graphs contain the second highest value, the highest 3-hour average and highest 24-hour average concentrations by month over a 3-year period with the values grouped by month.	**Three-Year Summary** desktop icon	Plots pollutant parameters only in ppb, ppm, or ug/m^3.	Printer Screen PDF
Bar Plot. A bar/line graph showing the yearly variation of a pollutant grouped by month. The highest value, second highest value, highest 24-hour average during a month, and the monthly average are plotted for a 13-month period.	**Bar Plot** desktop icon	Plots pollutant parameters only in ppb, ppm, or ug/m^3.	Printer Screen PDF
Current Problems in the Site Status Log. Lists the current open problems in site/date order from the Site Status Log.	Select **Logs-> Site Status Log -> List Current Problems** from the AQ and Met Processing frame		Printer Screen
Data Collection Statistics – All parameters for the period. Number possible and valid for each site selected and the parameters monitored at the site during the selected period.	Select **Reports** from the AQ and Met Processing frame		Printer Screen PDF
Data Collection Statistics – Group of Sites. Number possible and valid for each site selected and the selected parameters monitored at the sites during the selected period on one report.	Select **Reports** from the AQ and Met Processing frame	Select parameters from the parameters list.	Printer Screen PDF
Data Collection Statistics – Selected Parameters. Number possible and valid for each site selected and the selected parameters monitored at the site during the selected period.	Select **Reports** from the **“**AQ and Met Processing” frame	Select parameters from the parameters list.	Printer Screen PDF
Diurnal Plot. A line graph showing the average daily variation of a given parameter. Three lines are plotted representing the maximum, minimum, average and standard deviation of the parameter for each hour of the day for user selected site and period of time.	**Diurnal Plot** desktop icon.		Printer Screen PDF
Export Data to ASCII comma delimited (CSV) row format	Select **Reports** from the AQ and Met Processing frame		File
Export audit data to AQS format	Select **Reports** from the AQ and Met Processing frame		File

-- continued --

Table 9-1 (Continued)

Output Products and Options

Product	How To Generate	Additional Info	Output Options
Export Data to ASCII fixed length columnar format	Select **Reports** from the AQ and Met Processing frame		File
Export Data to ESC specified format. Creates text files for each selected site/period in a special form for providing to an outside contractor.	Select **Reports** from the AQ and Met Processing frame	Select all parameters or deselect for flow only	File
Export hourly data to AQS format	Select **Reports** from the AQ and Met Processing frame		File
Export precision data to AQS format	Select **Reports** from the AQ and Met Processing frame		File
Highest 8-hour running averages (hour beginning) - designed for ozone but will work for any parameter. Lists the top selected number of 8-hour running averages.	Select **Reports** from the AQ and Met Processing frame	Select parameters from the parameter list. Select number of values to list.	Printer Screen PDF
Highest Daily Maximum 8-hour running averages (hour beginning) - designed for ozone but will work for any parameter. Lists the top selected number of 8-hour running averages daily maximums.	Select **Reports** from the AQ and Met Processing frame	Select parameters from the parameter list. Select number of values to list.	Printer Screen PDF
Highest Values – The highest values found for the selected site/period/parameter.	Select **Reports** from the AQ and Met Processing frame	Select parameters from the parameter list. Select number of values to list.	Printer Screen PDF
Meteorological Data Summary. Pertinent met data statistics for the selected site/period.	Select **Reports** from the AQ and Met Processing frame		Printer Screen PDF

-- continued --

Table 9-1 (Continued)

Output Products and Options

Product	How To Generate	Additional Info	Output Options
Monthly Grids for selected parameters. All values or invalid codes and statistics for one site/month/parameter.	Select **Reports** from the AQ and Met Processing frame	Select parameters from the parameters list.	Printer File PDF
O3 – Episodes with Concentrations >100 ppb. Lists the date/time and validated values for the selected site/period where the ozone concentrations is > 100 ppb.	Select **Reports** from the AQ and Met Processing frame		Printer Screen PDF
O3 - Highest Concentrations. Ten highest one-hour averages for the selected site/period.	Select **Reports** from the AQ and Met Processing frame		Printer Screen PDF
O3 – RAW Episodes with Concentrations >100 ppb. Lists the date/time and raw values for all sites for the selected period where the ozone concentrations is > 100 ppb.	Select **Reports** from the AQ and Met Processing frame		Printer Screen PDF
Ozone Quick Look (annual only). Creates an annual Quick Look table (AQS format) for ozone for the selected site/year.	Select **Reports** from the AQ and Met Processing frame		Printer Screen PDF
Ozone Rank for all sites. Creates an annual report table of ozone rank listings of 2nd highest 1-hour averages, 4th highest 8-hour averages, and annual SUM60 exposure index for all sites.	Select **Reports** from the AQ and Met Processing frame	This report takes a long time to run (perhaps an hour or more).	Printer Screen PDF
Ozone Standards Report (annual only). Creates an annual ozone standards report for the selected site/year.	Select **Reports** from the AQ and Met Processing frame		Printer Screen PDF
Ozone with 8-hour averages > 84 ppb. Lists the date/time (hour beginning) and raw or validated values (as selected) for the selected site/period where the 8-hour average was > 84 ppb.	Select **Reports** from the AQ and Met Processing frame		Printer Screen PDF
Precision Check Summary. If precision check data exist for the selected site/parameter/period, a table with quarterly summaries is produced. Period is 1/1 through 12/31 based on the start year.	Select **Reports** from the AQ and Met Processing frame	Select parameters from the parameter list.	Printer Screen PDF

-- continued --

Table 9-1 (Continued)

Output Products and Options

Product	How To Generate	Additional Info	Output Options
Progress Report. A report table indicating validation progress for the past 13 months. Based on the Data Validation Log.	Select **Reports** from the AQ and Met Processing frame		Printer Screen PDF
Rose Plot. A specialized graph showing the wind or pollutant frequency relative to wind direction for a user-selected site and period of time.	**Rose Plot** desktop icon.		Printer Screen PDF
SO2 - Highest Concentrations. Five highest one-hour averages, five highest 3-hour block averages, and five highest 24-hour averages for the selected site/period.	Select **Reports** from the **"**AQ and Met Processing frame		Printer Screen PDF
Stackplot. A time plot of multiple graphs representing user selected data sets. Many data sets may be plotted on the y-axis of "stacked" graphs vs. a single x-axis of time.	**Stackplot** from desktop icon.		Printer Screen PDF
Stackplots – from configuration files. Creates text files of raw or validated values for the selected sites/period based on the Stackplot configuration records. See **Stackplot.**	Select **Reports** from the AQ and Met Processing frame	Select type of plots to generate and to reuse or replace data files	File
Yearly Frequency Distribution for O3 or SO2. Creates annual frequency distribution reports for the selected site/year for O^3 and SO^2 only.	Select **Reports** from the AQ and Met Processing frame		Printer Screen PDF

9.1 The Reports Interface

The Reports interface provides a single interface for producing various types of output products. The initial display of the reports interface is shown in Figure 9-1. This interface has been developed with the following two facts in mind:

1. Required user input (such as sites, dates, parameters, etc.) to generate a product varies from product to product.

2. Sometimes, the user wants to quickly view a single product on screen. Other times, an entire suite of products for all the current sites are required.

To meet the challenge of the first, a tab control has been used to help the user enter the specific input required for the selected product. The content of each tab page updates dynamically to reflect the specific options available for the selected product. For the second, the interface allows the user to "Run" a job immediately or "Submit" jobs to a queue to later be run as a batch of jobs.

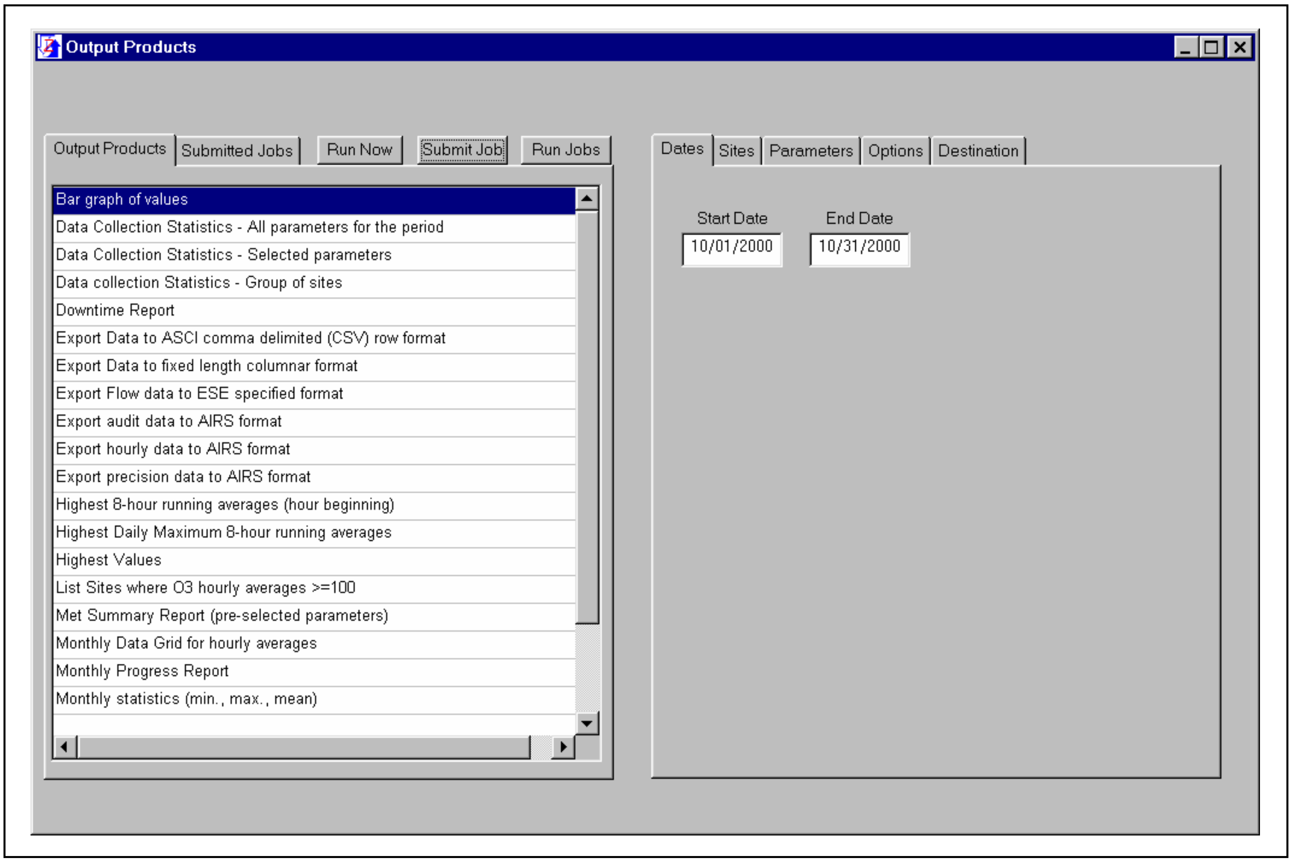


Figure 9-1. The Reports Interface.

➢ To use the Reports interface:

1 Select **Reports** from the AQ and Met Processing frame.

2 Select a *product* to generate from the list displayed on the Output Products tab.

3 Click on each **enabled tab** of the tab control to input the required information and select options specific to the selected product. (See Section 9.1.1, The Reports Interface Tab Control).

4 Click **Run Now** to run the job immediately or click **Submit Job** to add the job to the submitted jobs list.

5 Click **Run Jobs** to begin running the jobs in the submitted jobs list.

9.1.1 The Reports Interface Tab Control

The tab control on the left side of the reports interface has five tab pages. Access to each page is updated when the user selects a product in the Output Products list. If the tab for a page is disabled, the page content does not relate to the selected product. The tab pages are *Dates*, *Sites*, *Parameters*, *Options*, and *Destinations.* The pages are discussed in the following subsections.

9.1.1.1 The Dates Tab

This tab page displays one or more fields for the user to input the desired time period of data to be included in the output product. Usually, there are *Start Date* and *End Date* fields that require dates in mm/dd/yy format. Other products may need only a year to be entered. The Dates tab page is shown in Figure 9-1.

9.1.1.2 The Sites Tab

The Sites tab page displays a tree view of site groups as configured (see Section 4.1, Sites Configuration). Groups and/or individual sites can be selected to be included in the output job. Figure 9-2 shows the Sites tab.

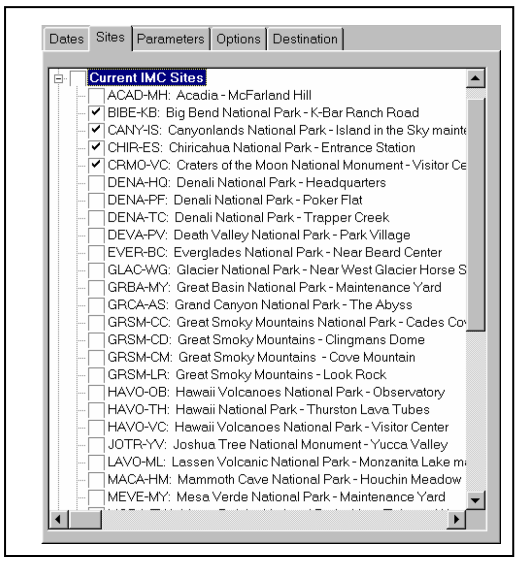


Figure 9-2. The Sites Tab Page in the Reports Interface.

9.1.1.3 The Parameters Tab

The Parameters tab page displays a list of all parameters as shown in Figure 9-3. The user can also choose the output units for each selected parameter and the output generator will convert the values as necessary.

➢ To choose output units:

1 Click in the **Output Units** column of the selected parameter.

2 From the drop-down list, select an available *Unit Code*. **Note**: Only unit codes with defined conversion formulas are listed.

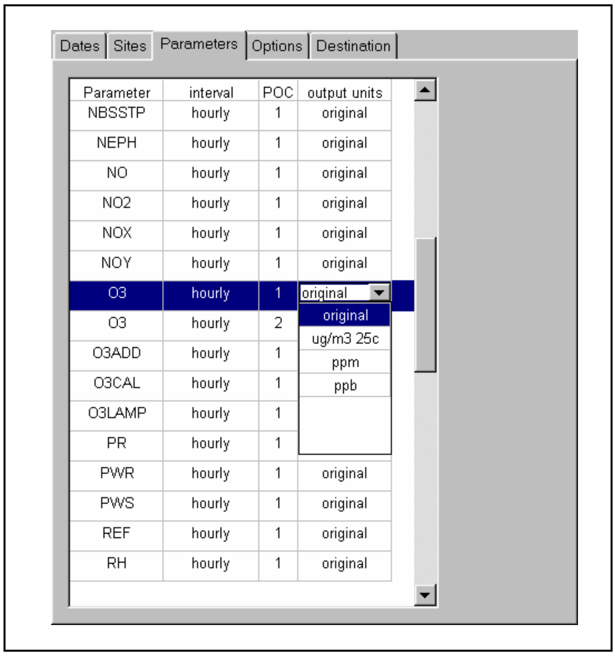


Figure 9-3. The Parameters Tab of the Reports Interface.

9.1.1.4 The Options Tab

The tab displays additional options for the selected product. An example of the Options tab when the *Stkplots – from configuration tables* product is selected is shown in Figure 9-4. Two sections are found on the page; Standard Options and Special Options. The standard section includes the following:

- Radio buttons for selecting a Validation Level option. Choose **Validation Log** (default option) for the program to query the Data Validation Log for the validation level information. Choose **Raw**, **Preliminary**, or **Final** to force the level to the selected option.

- A page number field to input a report page number.

- A checkbox to place all of the currently selected sites on one page or continuous output instead of separate pages or files for each site.

The Special section includes special options for the selected report. Examples of special options are:

- A **Raw Data** checkbox. Checking this box instructs the program to use raw data and not validated data in the product.

- **Number of Values** to list. Instructs the program to include the number of values entered on the product. For example, to list the top 10 **Highest Hourly Averages**.

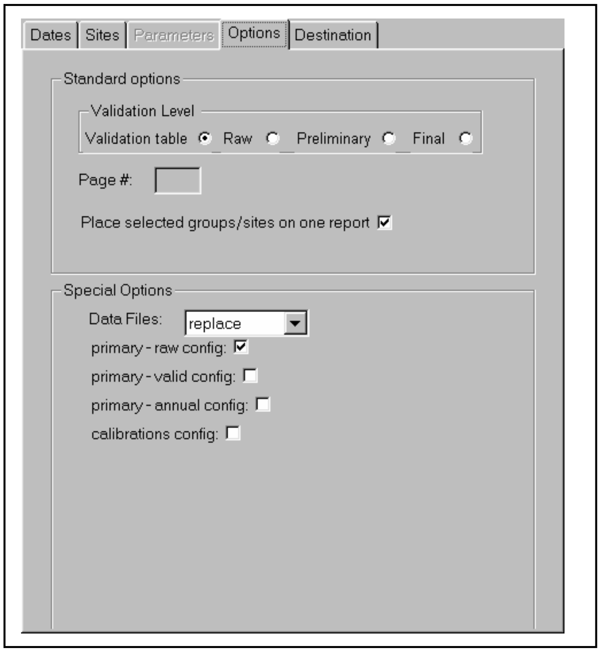


Figure 9-4. The Options Tab of the Reports Interface.

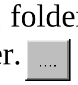
9.1.1.5 The Destinations Tab

The Destinations tab displays options on the type of output to produce as shown in Figure 9-5. Again, this tab updates dynamically depending on the product selected. Only the possible options for the selected product are enabled. More than one option can be selected. Destination options are:

- **Output to screen**. This option causes the output generator to pause after each product has been created and display the product on the screen before going on to the next. Click the **Print** button from the on-screen display to send the output product to the printer. Click the **Continue** button to close the on-screen display.

- **Output to printer**. This option sends the output directly to the currently selected Windows printer.

- **Output to PDF file**. This option uses the Adobe Portable Document File (PDF) Writer to create PDF files of the output. When the checkbox is clicked, an input field displays prompting the user to enter a destination folder for the generated PDF files. The complete path and folder name can be typed in or click the **Browse**  button to point to a destination folder. **Important Note:** The PDF Writer must be installed on the user's workstation for this option to work properly.

- **Output to text file**. This option writes the output to ASCII text files. When the checkbox is clicked, an input field displays prompting the user to enter a destination folder for the text files. The complete path and folder name can be typed in or click the **Browse** button to point to a destination folder. 

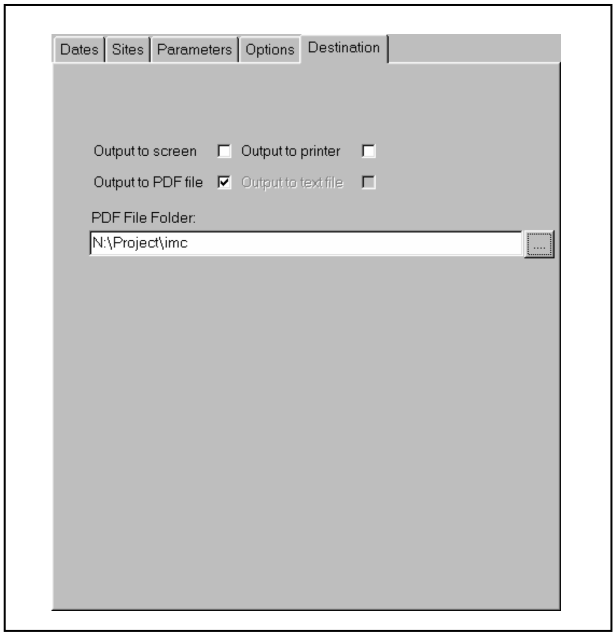


Figure 9-5. The Destinations Tab of the Reports Interface.

9.2 AQDBMS Graphics Products

Four programs are provided to create graphical representations of AQDBMS data directly from the database. The Stackplot program runs in a manner different from the other graphics programs and is described in Section 9.2.6. The AQDBMS graphics programs provide the following common features:

- Execution directly from the AQDBMS or the Windows desktop
- Single-site plot vs. *submit file* option to create multiple-site plots
- Printer destination and setup selection
- Start and end date selection
- Monthly, quarterly, and annual plots (except One-Year and Three-Year Summary plots)
- Plot title customization
- Plotting scale adjustment
- Force *Final Validation* footnote for historical data
- Automatic printing option
- Windows metafile output

9.2.1 Description of AQDBMS Products

A ***One-Year (13-month) Summary Bar Plot*** summarizes user-selected pollutant parameters in a bar chart and line-graph over a 13-month period to illustrate seasonal changes over that period. Information presented on the plot includes:

- Highest hourly average
- Second highest 1-hour average
- Highest 24-hour average
- Monthly average
- NAAQS

A ***Diurnal Plot*** summarizes diurnal characteristics of user-selected pollutant parameter. For each hour of the day during the user-selected period the plot shows:

- Maximum hourly average
- Mean hourly average with standard deviation
- Minimum hourly average
- Number of samples per hour
- NAAQS standard

A ***Rose Plot*** summarizes the relationship between wind speed or a user-selected pollutant parameter in a standard wind rose.

A ***Three-year Summary Plot*** summarizes user-selected pollutant parameters in a bar chart that compares the second highest 1-hour average on a monthly basis.

These graphics products query data directly from the AQDBMS. The user interface for these programs have many similar features that are described in the next section. Options unique to each of these products are described in subsections following this.

9.2.2 Creating Plots From the AQDBMS Graphics Programs

The AQDBMS graphics programs may be run directly from a Windows desktop icon.

➢ To create a plot:

1 Double-click the *icon* for the desired graphics product on the Windows desktop.

2 Set up the printer:

- **a** From the File menu, choose **Select Printer**.

b Select the desired printer *destination*.

c Set the *paper orientation* for the current graphic product (all are *portrait* except the One-Year Summary plot, which is *landscape).*

3 Select a *site* from the Select Site drop-down list box.

4 Enter the *start and end dates* for the period to be plotted in the Start and End boxes.

5 Click the **Get Parameter List** button. The program retrieves a parameter code list for the selected site/period.

6 Select the *parameter* to be plotted from the Available Parameter List drop-down list box.

7 Select applicable *options.* Each type of plot has one or more options that can be changed. See the following sections for a description of these options.

8 To print the plot automatically, click the **AutoPrint** checkbox.

Note: This checkbox stays in effect until switched off or until the program is exited so that each new site/date/parameter plotted is automatically printed.

9 Click the **Draw Plot** button. The program retrieves and plots the data.

10 If needed, modify the default graph scaling values, then click the **Redraw** button.

11 Click the **Print** button to print the plot.

9.2.3 Creating Plots for Multiple Sites From the AQDBMS Graphics Programs

Plots can be created for multiple sites/parameters for the same time period. To create multiple plots in a single run, a submit file containing a list of the sites/parameters to be plotted is created in advance. The sites/parameters included in a submit file will be plotted with common options. Sites with parameters that do not use common options--such as a scaling change--must be run in single site mode. Create separate submit files for each of the graphics products.

➢ To create a submit file:

1 Open a new file in a text file editor such as Windows Notepad (do not use a word processor such as Word for Windows).

2 On the first line of this file:

a Type a four-character *site abbreviation* followed by a *comma* **<,>**.

b Type a *parameter abbreviation* followed by a *hyphen* **<->** and a *comma* **<,>.**

c Type a **Y** followed by a *comma* **<,>**.

d Type three more *commas*, then press **<Enter>.** For example, type **BIBE,O3-4,Y,,,,** to plot ozone data for Big Bend National Park.

3 Repeat Step 2 for each combination of site/parameter that you want to include in the batch of plots.

4 From the File menu, select **Save As**. Save the file in the folder and with the filename of your choice.

➢ To create plots for multiple sites:

1 Double-click the *icon* for the desired graphics product on the Windows desktop.

2 Set up the printer:

a From the File menu, choose **Select Printer**.

b Select the desired printer *destination*.

c Set the *paper orientation* for the current graphic product (all are *portrait* except the One-Year Summary plot, which is *landscape).*

3 Enter the *start and end dates* for the period to be plotted in the Start and End boxes.

4 Select applicable options. Each type of plot has one or more options that can be changed. These options are described in Sections 9.2.4, Common Options in the AQDBMS Graphics Programs, and Section 9.5, Plot-Specific Options in the AQDBMS Graphics Programs.

5 To not automatically print the plots, click the **AutoPrint** checkbox to deselect the auto printing feature.

Note: The *Run Submit File* option automatically switches the AutoPrint checkbox to on. The AutoPrint checkbox may be switched off any time during the plotting process. The program may not respond immediately, however, if data are being retrieved from the AQDBMS depending on the length of the period being plotted.

6 From the File menu, select **Run a Submit File**.

7 Select the *submit file* you previously created and saved from the File-open dialogue box and click **OK**.

9.2.4 Common Options in the AQDBMS Graphics Programs

The AQDBMS graphics programs have several common options that allow the user to manage how the plots are generated and to manipulate the output. These common options are described in this section. Plot-specific options are described below:

- <u>Draw Plot versus Redraw Buttons</u>: The Draw Plot button always starts a new plot by retrieving data from the database, creating the plot title, setting the plot units, calculating relevant statistics, and drawing the plot. The Redraw button redraws the current plot incorporating changes made to the title, scaling, or other cosmetic option changes, and does not retrieve new data from the database. A change in any of the primary data selection options such as site, period, parameter, or quarterly plot will not be accounted for in a Redraw. These option changes require a new plot to be drawn.

- <u>Customizing the Plot Title:</u> The plot title is created from default information based on the site, parameter, and period selected. On single-site plot runs, the operator may edit the automatically defined title after the plot is displayed on the screen. After editing is complete, click the **Redraw** button.

- <u>Creating Monthly, Quarterly, Annual Plots:</u> The AQDBMS graphics products may be plotted in monthly, quarterly, or annual plots except for the One-Year and Three-Year Summary plots that by definition are plotted on an annual basis. The start and end dates define a monthly versus annual period. An annual period may also be plotted as four quarterly plots on a single page by clicking on the **Quarterly Plots** checkbox before drawing the plot. Other periods may not be selected since the statistics inherent to these plots are time-dependent.

- Adjusting plotting scales: The default plotting scale is parameter-dependant and is set in the parameter definition table in the AQDBMS. The vertical or y-axis scale may be adjusted for variations in data on a single-site plot run. If a site/parameter is consistently abnormal, it may be useful to exclude it from a submit file.

- Adobe PDF output: It is possible to send the plot output to an Adobe PDF file for transporting the image electronically. Click the **Auto PDF** checkbox before printing the plot if this is desired.

9.2.5 Plot-Specific Options in the AQDBMS Graphics Programs

Each of the AQDBMS graphics programs has set-up options and other information specific to its purpose and how the program functions:

- One-Year (13-month) Summary Plot Setup Options: *The One-Year (13-month) Summary Plot* allows the operator to compare pollutant data over a 13-month period. It has few options and is simple to run. The associated statistics assume that the start and end dates include a 13-month period (01/01/96 to 01/31/97 for example).

- Diurnal Plot Setup Options: The Diurnal Plot only has one unique option. The operator may choose to not plot a minimum hourly average line. This option is useful when the data consistently has a minimum value of zero.

- Rose Plot Setup Options: The Rose Plot program has several unique options:
  - 40% Circle – click this checkbox if a rose petal exceeds 40%. This will scale the outermost circle to 40% instead of the default 20%.
  - Make a .ROS File – click this checkbox if an ASCII rose frequency distribution data file is desired. This table contains 16 rows of wind direction versus columns of wind speed or hourly pollutant concentrations. The file is written to the \\ars_net3\npsair\dpc\ros folder and named *ssssAyy.Rpp* where *ssss* is the site abbreviation, *A* indicates annual data, *yy* the year, and *pp* the parameter. For example, BIBEA98.RO3 contains the frequency distribution data for Big Bend National Park ozone/wind direction for all of 1995. For quarterly data, the *A* is replaced with Q1, Q2, etc. For example, BIBEQ198.RSW contains the frequency distribution data for wind speed/wind direction at Big Bend National Park for January through March 1998.

- Three-year Summary Plot Setup Options: The Three-year Summary Plot has no unique options.

9.2.6 The Stackplot Graphics Program

A stackplot may include single or multiple user-selected parameters on line or bar graphs plotted against time on the x-axis. Up to 16 parameters may be plotted on up to 8 separate graphs (1 or 2 parameters per graph) in a stack. Temporal data variations are then easy to compare. Stackplot provides a variety of options. Setting up a stackplot is complex due to the large number of possible data combinations and options. Therefore, a set of standard setup files

(.STK file*)* have been created for plots that are created on a regular basis with only a change in the time period to be plotted. These files are maintained in a standard location for access from the AQDBMS.

➢ To run Stackplot:

1 Select **Stackplots – from configuration tables** from Output Products tab in the AQDBMS Reports Interface (see Section 9.1, The Reports Interface).

-or

1 Launch the Stackplot program from the desktop icon.
2 From the File menu in the Stackplot program window, select **Open**.
3 Select the *Stackplot configuration file* (.stk) or *submit file* (.sbm) to open.

Note: For instructions on creating Stackplot configuration (.stk) files, see the document titled *STKWIN User Documentation* (ARS, 2008) and Section 4.2.2, Stackplot Configuration of this document. For instructions on creating submit (.sbm) files, see Section 9.2.3 Creating Plots for Multiple Sites From the AQDBMS Graphics Programs.

9.3 Printer Settings for HP Laserjet Printers

The output products have been printed extensively on Hewlett-Packard (HP) Laserjet printers. ARS has determined optimum settings each the two types of output products and default values defined for those settings.

10.0 References

Air Resource Specialists, Inc. (ARS), 2008, STKWIN User Documentation.

STKWIN

A Program to Generate Stacked Plots
Of Time-Dependant Data Sets

USER DOCUMENTATION

Code Revision 1.20070801

Documentation Revision date: January 23, 2008

Air Resource Specialists, Inc.

INTRODUCTION

STKWIN creates single or stacked graphs with up to 20 data sets in up to 10 graphs per page plotted against time as the independent variable. Although it is possible to plot more than 10 individual graphs on a plot page, labeling the y-axes becomes difficult due to crowding. The X-axis or independent variable is time and only time (or something faked into looking like time). If you need to plot scatter plots of 2 independent variables try another software package. STKWIN was written for the purpose of stacking time-dependant data sets. The input date and plot date may be specified as either calendar (yymmdd or yyyymmdd) or Julian (jjj) independently. Input data may be fixed format (standard FORTRAN i/o format statement) or free-format.

The input data may be real or integer but the input format must specify real (F) format. Except for the date and time fields which must be first on the record and integer, input data may be in any order and plotted in any order. Two data fields may be plotted together on the same graph. Multiple plots per STKWIN run may be made.

Details of all these things follow...read on.

PROGRAM STKWIN

A STKWIN plot consists of a single x axis (time) with any number of days (limited by resolution of plot) per page. A single plot may be divided vertically into any number of individual graphs, (<10 graphs per plot due to axis label and data resolution restrictions) and up to two data fields may be plotted per graph. Note the terminology; a **plot** fills a page and consists of 1 or more **graphs**; each **graph** may contain 1 or 2 **data sets**. Figure 1 is an example plot with 6 graphs and 2 variables per graph.

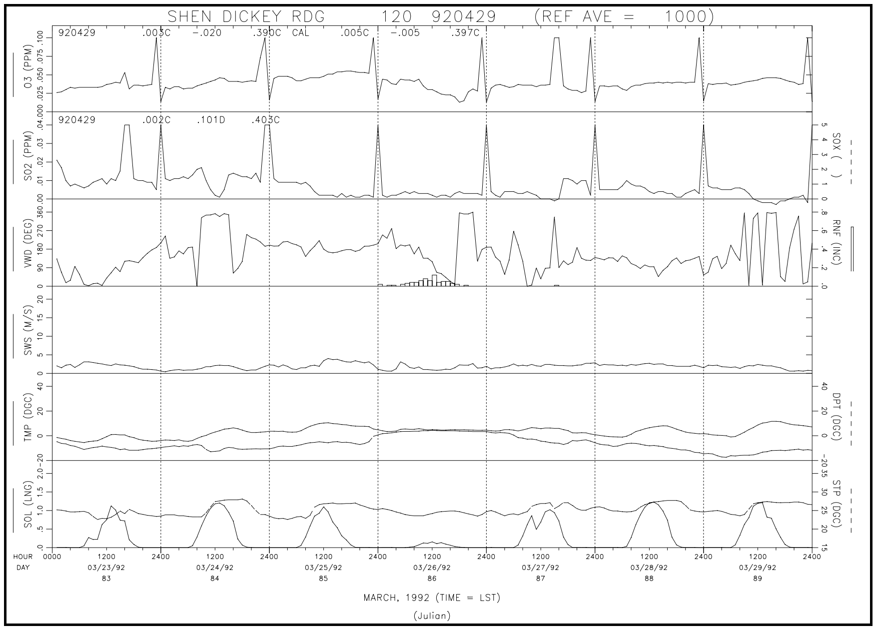


Figure 1. Example STKWIN output.

The data may be represented with:

- **Bars**
- **Continuous Lines**
- **Dots + Lines**
- **Dots Only**
- **One data set per graph**
- **Two data sets per graph**

Parameters that define this option and others are written in a plot control file (.STK file). The data to be plotted is contained in a separate file (.DAT file).

PLOT CONTROL FILE

The plot control file defines all user defined options for the plot (refer to Figure 2 for an example). This file is a ***FORTRAN NAMELIST*** formatted file. The syntax of the control file is critical. The file name extension should be ***.STK*** for consistency.

There are three namelist groups of parameters required in the control file. Each set must be preceded by the appropriate ***NAMELIST*** group name as described below:

NAMELIST GROUP	DESCRIPTION
STKFILES	general parameters that define the input data file
PAGE_DEF	general parameters that define the overall plot appearance
VAR_DEF	specific parameters that define each dependant variable graph

Parameters are defined in the next section.

```
&STKFILES
   INPUT_FILE      = 'GCAP_UNF.98A'
   DATA_FORMAT     = 'FREE_NO_HEADER'
   NUM_IN_FIELDS   =  6
   NUM_TO_GRAPH    =  6
   DATA_DATE       = 'CALENDAR'
   GMT_DIF         =  0
   MISSING         = -99
   TIME_UNITS      = 'HOUR'
   PERIOD          =  1
   File_Tag        = T
 /
 &PAGE_DEF
   Page_Orientation= 'LANDSCAPE'
   Date_Format     = 'DD'
   Footnote        = ''
   Main_Title      = 'GRAND CANYON AIRPORT, ARIZONA - Unfiltered Nephelometer and Meteorological Data'
   Plot_Date       = 'CALENDAR'
   Time_Zone       = 'LST'
   X_Title         = 'OCTOBER 1998',  'NOVEMBER 1998',  'DECEMBER 1998'

   N_GRAPHS        =  6
   N_PLOTS         =  3
   MONTH           =  10,  11,  12
   FIRST_DAY       =  1,  1,  1
   N_DAYS          =  31,  30,  31
   YEAR            =  1998,  1998,  1998

   Bar_Width       =  4.166667E-02
   B_MARGIN        =  1.25
   CHAR_CHH        =  6
   FIRST_FIELD     =  1
   HOUR_INTERVAL   =  12
   LAST_FIELD      =  6
   LINE_WIDTH      =  1
   L_MARGIN        =  1.3125
   MAIN_CHH        =  0.12
   SYM_SIZE        =  3
   T_MARGIN        =  0
   WKID            =  1
   X_LABEL_INTERVAL=  1
   X_PLOT_SIZE     =  8.4
   X_TITLE_MARGIN  =  0

   Clip            = F
   Colorop         = T
   DASH_OP         = F
   Frame           = F
   HOUR_LABELS     = F
   PLOT_DOW        = F
   Title_top       = T
   XGRID           = T
   YGRID           = T
 /
 &VAR_DEF
    INPUT_FIELD    =  5                ,  4             ,  3             ,  1             ,  2             ,  6
    FIELD_NAME     = 'WD StDev (deg)'  , 'WD (deg)'     , 'WS (m/s)'     , 'AT (C)'       , 'RH (%RH)'     , 'Bsp (Mm-1)'
    COMMENT        = ''                , ''             , ''             , ''             , ''             , ''
    YMIN           =  0                ,  0             ,  0             , -10            ,  0             ,  0
    YMAX           =  100              ,  360           ,  20            ,  50            ,  100           ,  160
    MAJOR_TIC      =  25               ,  90            ,  5             ,  20            ,  25            ,  40
    LINE_TYPE      =  1                ,  3             ,  1             ,  1             ,  1             ,  1
    LABEL_DEC      =  0                ,  0             ,  0             ,  0             ,  0             ,  0
    LINE_COLOR     =  5                ,  2             ,  6             ,  4             ,  7             ,  6
    ygap           =  .15              ,  .15           ,  .15           ,  .15           ,  .15           ,  .15
    Y_AXIS_SIZE    =  .7               ,  .7            ,  .7            ,  .7            ,  .7            ,  1.6
    ICLOSED        = F                 , F              , F              , F              , F              , T
    ILOG           = F                 , F              , F              , F              , F              , F
    IKEY           = T                 , T              , T              , T              , T              , T
    SYMBOL         = 'o'               , 'o'            , 'o'            , 'o'            , 'o'            , 'o'
    IPOST          = F                 , F              , F              , F              , F              , F
    POST_ALIGN     = 'L'               , 'L'            , 'L'            , 'L'            , 'L'            , 'L'
    POST_CHH       =  5                ,  5             ,  5             ,  5             ,  5             ,  5
    POST_FORM      = '0.0'             , '0.0'          , '0.0'          , '0.0'          , '0.0'          , '0.0'
 /
```

Figure 2. Example Plot Control File (.STK file).

SETUP OPTIONS

File/Open: Open one of the following types of files
- stackplot configuration (stkfile) – stackplot configuration
- data file – data file containing data to be plotted
- submit file – file with list of stkfiles to be plotted

Note that any of the files shown in the Open Files dialogue box may be opened in an editor, modified, and saved to the same location prior to clicking the **Open** button if you need to make adjustments to the file.

File/Select Output Device: use this to change your output device. When Stkwin is closed, it will ask if you wish to reset the printer default to a different device. This process is the same as clicking on Printers and changing/resetting the default printer.

File/Edit Printer Graphics Settings: use this to modify standard printer settings for width and dash-dots for different printers.

File/ Recent File List: Recent stkfiles opened at your workstation may be recalled here. You may also clear this list by choosing **File/ Clear Recent File List.**

Plotting options:
- **Draw/Restart**, **Redraw & Print**– after initially opening a stkfile or submit file, click the **Draw** button to begin processing and displaying the plot. The **Draw** button text will change to **Restart.**
  - Click **Restart** if the input data changes or start/stop dates change. Forces a re-read of the data file.
  - Click **Redraw i**f you change the plot configuration only. This simply redraws the plot but does not re-read the data file. For large, high-resolution plots, this would be much faster than **Restart.**
  - Click **Print** to send the plot to the current output device. If **Auto Print** is chosen, you do not need to click the **Print** button (see description of the **Auto Print** button below)
- **Next –** click to move to the next plot. This may be the next time period within a stkfile or the next stkfile. If a submit file has been opened, all files to be processed are listed in the ***Stack file*** text box. If you wish to skip to a stkfile farther down the list, double-click the name in the ***Stack file*** text box and click **Restart.**
- **Draw to Screen –** draws each plot to screen. This can be turned off for large batch printing jobs to save time
- **Continuous –** after opening a stkfile or submit file, and the **Draw** button is clicked, all plots waiting in the queue will be drawn continuously. This is helpful for batch print jobs from a submit file.
- **Auto Print –** after **Draw** button is clicked, each plot will automatically be sent to the current output device
- **Auto PDF –** selects the Adobe PDF printer driver as the output device (if installed). Plots generated will automatically be named. The output path is selected after clicking this box.
- **No Dashed Lines –** draw dashed lines as solid.
- **Heavier Data Line –** draws the data line heavier. This may be used to enhance data lines for presentation or for printers that do not print a very heavy line. Use this in combination with the **Edit Printer Graphics Settings** described above.
- **Page # Leader –** enter a report section here such as ***"3-".*** Each plot will have a different page number starting with the number specified in **First Page**
- **Monitor Processing –** update the status text box with processing information
- **Portrait/Landscape –** change the basic orientation of the page. You will need to adjust the X- and Y- axis lengths in the stkfile to accommodate this change.
- **Full Screen –** draws the plot full screen. Click the **Close** button when done to return to the control interface.
- **Plot Options –**
  - **Stkfile Parameter edit screen – edit the parameters that describe the content of the data file**
  - **Page_Def Parameters edit screen – edit the parameters that describe the plot page**
  - **Var_Def parameters edit screen – edit the parameters that describe each graph**

  The contents of a stkfile are described in detail in the next sections. Changes made in the **Plot Options** sections may be saved to the current stkfile for future use.
- **Screen Font Size -** change the screen font size of characters on the plot. Does not affect the hardcopy.

STACKPLOT CONFIGURATION FILE (stkfile) FORMAT

Plot definition parameters are stored in the *.STK* file in namelist format based on the NAMELIST convention (see example below). These parameters may be changed in the STKWIN program (**Plot Options)** and then saved or this file can be directly edited using any text editor. However, the file format must be properly maintained as described here.

```
&STKFILES                      <-------------------------------------namelist group name
INPUT_FILE=      'TEST.MET'    <-------------------------     |
DATA_FORMAT=     '(2I8,11F8.0)'                               |
NUM_IN_FIELDS=   11                                           |
NUM_to_graph=    10                                           |
DATA_DATE=       'JULIAN'                                     |group parameters
T_DIF=         -700                                           |
MISSING=         999.00                                       |
TIME_UNITS=      'MINUTES'                                    |
PERIOD=          5.0000        <-------------------------     |
/                              <----------------------------------- namelist group terminator
```

The name of the namelist group is the first item in the namelist. The first character in the namelist name must be the ***&*** (ampersand) character. Each variable within that set is then defined with the **exact** spelling of the variable name (case independent - **_** (underline) required if present) followed by the **=** (equals sign) and followed by the actual value to assign to that variable. Each namelist group must be terminated with a **/** (forward slash) character. All **text** input must be enclosed in single apostrophes. Numerical data must follow standard syntax for integer/real format. Variables are described below with the variable description. Logical data type is specified with either a ***T*** or a ***F*** for true or false.

Not all variables are required in the control file. The following tables define if a variable is required or optional and what the default value is if it is not included in the file.

NAMELIST PARAMETER DESCRIPTIONS

Namelist Group - *&STKFILES*

Namelist group *&STKFILES* describes the input data file. All data to be plotted must be in this file.

TABLE 1. STKFILES NAMELIST GROUP VARIABLE DEFINITIONS

NAME	DESCRIPTION	ACCEPTABLE VALUE	DATA TYPE
INPUT_FILE	Data file name	DOS file name	Alpha (‘ ‘)
DATA_FORMAT	Data format	FORTRAN, ‘FREE’, FIXED or ‘FREE_NO_HEADER’[DF]	Alpha(‘ ‘)
NUM_IN_FIELDS	# of input fields	<20	integer
NUM_TO_GRAPH	# of fields to plot	≤20[NG]	integer
DATA_DATE	Data date type	JULIAN, CALENDAR	Alpha (‘ ‘)
DATA_DATE_FORMAT	Data date format	As yyyy, mm, dd	Alpha (‘ ‘)
GMT_DIF	Time correction[TC]	Plus/minus hundred hours	integer
MISSING	Missing data value	Plus/minus value[mv]	real/integer
TIME_UNITS	Time units	HOURS, MINUTES	Alpha (‘ ‘)
PERIOD	# of time units[P]	Number	real

[DF] – See data input file below section for details
[TC] – Time correction for GMT, DST, etc. (in hundred hours)
[P] - # of Time units between data readings
[NG] – Num_to_graph is limited to 2*N_graphs (see next page)
[MV] – Missing values – any input value <= to this value will not be plotted
All parameters are required

NAMELIST GROUP - *&PAGE_DEF* - Namelist group *&PAGE_DEF* describes the appearance of the plot.

TABLE 4. PAGE_DEF NAMELIST GROUP VARIABLE DEFINITIONS

TYPE	NAME	DESCRIPTION	ACCEPTABLE VALUE	DATA TYPE	REQUIRED	DEFAULT
PLOT LAYOUT	N_plots	# of plots (pages)	<52	Integer	Yes	
	N_GRAPHS***	Ignored (see footnote)				
	First_field	First field to plot	1-num_to_graph	Integer	No	1
	Last_field	Last field to plot	1-num_to_graph	Integer	No	Num_to_graph
	X_PLOT_SIZE	Size of x-axis in inches	Decimal inch	Real	Yes	
MARGINS	B_MARGIN	Bottom of page <-> bottom edge of 1st graph	Decimal inch	Real	Yes	
	L_MARGIN	Bottom of page <-> left edge of graphs	Decimal inch	Real	Yes	
	T_MARGIN	Bottom of main title <-> top of top graph	Decimal inch	Real	Yes	
	X_TITLE_ MARGIN	Bottom of x-title <-> bottom of 1st graph	Decimal inch	Real	yes	
DATE RANGE	YEAR[date]	Data year	Yyyy	Integer	Yes	
	MONTH(1-n^{NP})	# of month to plot	1-12[M]	Integer	Yes	
	First_day(1-n^{NP})	First day to plot	[FD]	Integer	Yes	
	N_days(1-n^{NP})	# of days to plot	[FD]	Integer	Yes	
TITLING (main)	MAIN_TITLE	Main Page title	'Text ' [MT]	Str (' ')	Yes	
	MAIN_CHH	Character size of main title	Decimal inches or PTs	Real	Yes	
	TITLE_TOP	Main title on top	T(rue) F(alse)	logical	No	Bottom of page
TITLING (x-axis)	X_TITLE	X-axis title	'Text'	Str	No	Month, Year
	PLOT_DATE	Type of date in x-axis	Julian, calendar, or both	Str (' ')	Yes	
	TIME_ZONE	Data time zone	3 characters (MST, LST)	Str (' ')	Yes	
	DATE_ FORMAT	Date label format	Any comb. Of MMDDYY	Str (' ')	Yes	
	X_LABEL_ INTERVAL	# of days between date labels on x-axis. Negative to turn label vertical	1-n where n is the number of days in the plot	integer	Yes	
	HOUR_LABELS	Hour label option	T(rue), F(alse)	logical	No	
	HOUR_INTERVAL	# of hours between hour labels on x-axis	1-24	integer	Yes	
	PLOT_DOW	Draw the day-of-week	T(rue), F(alse)	logical	no	False
OTHER OPTIONS	PAGE_ ORIENTATION	Page orientation	'Landscape', or 'Portrait'	Str	no	Current default printer value
	FRAME	Frame option	T(rue) F(alse)	logical	No	True
	DASH_OP	Dashed line option[DL]	T(rue) F(alse)	logical	No	True

***n_graphs parameter is now ignored - first_field, last_field and line_type defines n_graphs

TABLE 4. PAGE_DEF NAMELIST GROUP VARIABLE DEFINITIONS (continued)						
TYPE	**NAME**	**DESCRIPTION**	**ACCEPTABLE VALUE**	**DATA TYPE**	**REQUIRED**	**DEFAULT**
OPTIONS (continued)	COLOROP	Color option	T(rue) F(alse)	logical	No	True
	CLIP	Clip option	T(rue) F(alse)	logical	No	False
	FOOTNOTE	Add footnote in lower left corner	'Text'	Str	No	--
	CHAR_CHH	Plot body character size	Decimal inch or PTs	real	No	?
	SYM_SIZE	Scatter plot symbol character size	Decimal inch or PTs	real	No	?
	LINE_WIDTH	Line "weight" of all of plot	1-3	integer	No	1
	YGRID	Add y-grid lines	T(rue) F(alse)	Logical	No	F
	BAR_WIDTH	Width of barchart bar	Decimal number (inches)	Real	No	Proportional
	XGRID	Add x-grid lines	T(rue) F(alse)	Logical	No	F

[NP] – Month, First_day, and N_days are repeated 1-N_plots (pages)

[DATE] – Can override at execution time by STARTDATE and STOPDATE
[NG -] Limited by physical space available on a page - $\leq$6 is optimum
[M] - ignored if Julian data
[FD] - Julian or calendar day (of month if calendar) depending on input date type
[DL] - Make the 2nd line of a 2 variable graph dashed.
[WKID] - 1(display); 2(printer); 3(plotter); 4(metafile). This can be overridden from the STKWIN command line.

MT – Use the ~ (tilde) character to wrap text to a new line

NAMELIST GROUP - &VAR_DEF

This namelist group defines each data field to be plotted. Each of the variables defined in &VAR_DEF is repeated once for each data field to be plotted (do not repeat the ***NAMELIST*** group name). The first set is the lowest plot on the page with legend on the left. If two data fields are to be plotted on a graph, the second legend is on the right side of the graph. Each data set may be selected independently from the input data file by specifying the input field (input_field) # for each data set (1 being the first plotted data field - not including the date and/or time fields). For example - input field 7 could be plotted in the 3rd graph from the bottom by specifying it 3rd (Input_field(3)=7...etc.).

TABLE 5. VAR_DEF NAMELIST GROUP VARIABLE DEFINITION

NAME	DESCRIPTION	ACCEPTABLE VALUE	DATA TYPE	REQUIRED	DEFAULT
INPUT_FIELD(n)[NG]	Input field #	1-Num_to_graph	integer	Yes	
FIELD_NAME(n)	Y-axis title	<20 characters	Str (' ')	Yes	
Comment(n)[leg]	Graph legend	<80 characters	Str (' ')	No	
YMIN(n)	Y-axis minimum	---	real	Yes	
YMAX(n))	Y-axis maximum	---	real	Yes	
MAJOR_TIC(n)) [NT]	Y-axis major tics	---	real	Yes	
LINE_TYPE(n)[LT]	Graph line type	-3 to +3	integer	Yes	
LABEL_DEC(n)	Y label # decimal	0-___	integer	No	2
Line_Color(n)	Line/dot color	Color index [c]	Integer	No	0 (black)
Y_GAP	Space between graphs	Decimal inch	Real	yes	
Y_AXIS_SIZE	y-axis size	Decimal inch	real	Yes	
ICLOSED	y-axis continuous	T(rue), F(alse)	logical	yes	
ILOG	y-axis lognormal	T(rue), F(alse)	logical	yes	
IKEY	Draw data set line key	T(rue), F(alse)	logical	yes	
SYMBOL	Character for symbol graph	Alpha/numeric	Str (' ')	no	'solid dot'
IPOST	Draw data values	T(rue), F(alse)	logical	yes	
POST_ALIGN	Alignment of posted value	Left, right, top, bottom	Str	Yes	
POST_CHH	Character height of value	Decimal inch or PTs	real	Yes	
POST_FORM	Format of posted #	'0.0' (VB style format)	Str (' ')	Yes	0.0

[NG] - each of these variables must be repeated 1-Num_to_graph times
[leg] - string of text placed in the upper left corner of the graph
[LT] - Line_type defined as:
0 a bar chart (can only be single graph or 2nd set in graph)
1 continuous lines (no dots)
2 single dots + lines
3 single dots only
+ one data set per graph
- two data sets per graph (this one and the following) the first set has its legend and axis labels on the left, the second on the right. the second Line_type of a double graph <u>must be >0</u>

[c] – Paint by the numbers – 0=black, 1=white, w=red, 3=green, 4=blue, 5=yellow, 6=cyan, 7=magenta, 8=gray

[NT] -Major_tic - Enter a 0 (zero) for no axis labels or tics.

INPUT DATA FORMAT

The input data consists of:

- 1 record per date/time
- each record contains fields of date, time, and time-dependant data to be plotted.

The data may be ***comma-separated free format*** or ***fixed-format*** columns.

Here are a few things to keep in mind when setting up the data and input format.

1) **Site name/numbers. Stkplot does not use site name/numbers.** If your file has a site name/number at the beginning of each record you must use the FORTRAN fixed format so you can exclude the site name/number. For Example:

the data file contains –

```
BIBE 341    2120    7.02   40.97   11.29   109.6    9.07   11.29   11.16     110    8.93
BIBE 341    2125   6.911   41.34   12.22     107    9.26   12.22   12.06   106.7    9.29
```

The format would be specified as:
`DATA_FORMAT='(5X,2I8,10F8.0)'`
where the 5X tells the input reader to ignore the 1st 5 characters of each record.

2) **Date format type.**
CALENDAR
The date for ***CALENDAR*** data must be some form of ***yyy, ymm, dd.*** Examples:
yymmdd, yyyymmdd, mm/dd/yyyy
JULIAN
The date format for ***JULIAN*** data must be ddd. No month or year

3) **Time.** The time on each record must be in the form ***hhmm*** (no colon).

4) **Data Format.**
- All time dependant data is considered floating-point during plotting but may be integer in the data file.
- Data formats:
  - FREE - comma delimited file with or without header line(s)
  - FREE_NO_HEADER - comma delimited file without header line(s) - very useful for faster processing of large high resolution files
  - FIXED - space-delimited, fixed-width columns of data. The column width and format of every line must be exactly alike
  - FORTRAN fixed format - similar to FIXED but with definition of decimal/integer. This format must include 2 integer descriptors at the beginning for date & time (see example below)

Free format data can be read with a fixed format to solve inconsistencies in the data. The decimal point and comma in the data file override the format and the format handles the minimum required number of decimal places. The following 2 lines illustrate a problem that can be solved by using fixed format:

the data file contains –

```
341    2120    7.02   40.97   11.29   109.6    9.07   11.29   11.16     110    8.93    .446
341    2125   6.911   41.34   12.22     107    9.26   12.22   12.06   106.7    9.29    .437
```

The format would be specified as: DATA_FORMAT='(2I8,10F8.0)'.
The F8.0 ensures that the 107 above will be read properly and the decimal points within the other data will override this format (109.60)

5) **Other notes / weirdnesses:**
- If the first plotted day is less than the first data day, a bogus initial data record must be inserted with that first date and all plottable data set to the missing value.

- **Date-axis title.** Plots will do whatever you tell it to in the startday and number of days parameters. Thus, a plot can span month and year boundaries. The default X-axis title will specify either the julian first day or the month of the first day of the plot. You can override the default date-axis title in the x

```
19981208 0000 -17.95  90.10   0.76  54.58  41.58      12
19981208 0100 -18.05  89.80   0.67  41.40  46.39      13
19981208 0200 -16.51  91.50   0.92  47.61  24.98       6
19981208 0300 -15.48  92.80   0.65  61.41  37.26       9
19981208 0400 -16.32  91.70   0.67  82.60  61.41       9
19981208 0500 -16.27  91.70   0.56  93.70  49.32      12
19981208 0600 -16.66  91.20   0.51  86.10  43.88      24
19981208 0700 -16.27  91.10   0.55  72.50  43.92      24
19981208 0800 -15.34  92.00   0.67  61.67  36.97      52
19981208 0900 -11.37  94.70   0.79  47.28  30.39      11
19981208 1000  -4.50 100.90   1.78  39.67  18.07       7
19981208 1100  -1.66 102.40   2.25  57.22  23.87       4
19981208 1200  -0.91 102.90   2.52  49.64  21.10       2
19981208 1300  -0.47 102.60   2.76  52.54  22.19       4
19981208 1400   1.24  98.70   2.59  51.64  24.93       1
19981208 1500   2.99  85.70   2.19  21.00  24.92       1
19981208 1600   1.28  81.10   2.59  32.01  14.84       2
19981208 1700   1.88  79.80   1.40  39.15  27.38      18
19981208 1800  -2.64  83.40   1.18  33.16  19.47      20
19981208 1900  -5.63  89.30   0.56  31.95  22.53      12
19981208 2000  -8.24  89.60   0.91  45.63  22.63       7
19981208 2100 -10.21  88.30   0.79  37.49  27.80       6
19981208 2200 -11.90  88.20   0.94  32.55  13.96       7
19981208 2300 -12.94  87.70   1.10  29.58   8.41       2
```

An example data file is shown in figure 3.

Figure 3. Example Data File.

COMMAND LINE OPTIONS

Optional command line parameters may also be used for plot output.

TABLE 1. COMMAND LINE OPTIONS			
Name	**Description**	**Acceptable Argument**	**Default**
Autoprint	Auto prints plots	--	Off
Autoexit	Exits STKWIN at completion	--	Off
AutoPDF	Automatically prints to Adobe PDF file. Windows default printer must be set to hardcopy printer device before execution. PDFFile option **MUST** be included[1]	--	Off
PDFfile=	Sets path and name of PDF file	PDFFILE=[d]:\[path]\file.pdf	none
Continuous	Runs ALL plots of multiple plot set (n_plots>1 or submit file) continuously (useful for "batch" hardcopy jobs)	--	Off
Maxplot	Full screen plot		Off
Startdate=	Set first date to plot	STARTDATE=mm/dd/yyyy	Set in .STK file
Stopdate=	Set last date to plot	STOPDATE=mm/dd/yyyy	Set in .STK file
Stkfile=	Sets name of .STK file	STKFILE=[d]:\[path]\file.stk	--
Datfile=	Sets name of .DAT file	DATFILE=[d]:\[path]\file.DAT	Set in .STK file
ViewOnly	Blocks user from option menus. Close command button closes Stkwin.		Off
PrintOnly	Prints – does not display. Error if no stkfile argument.		Off
Submit file	File of multiple .STK files	[d]:\path\file.SBM	--

1 As of 01/31/05, the AutoPDF option will only work with Adobe PDFWRITER version 4 or 5.

SUBMIT FILES

A *Submit file* (*.SBM)* is a file containing a list of *.STK* files to be plotted together as a *batch*. Each *.STK* file is listed in the *.SBM* file one per line and must reside in the same directory (folder) as the *.SBM* file.

COMMAND EXAMPLES (SET IN *WIN95 SHHORTCUT PROPERTIES)*:

STKWIN MONTHLY.SBM

Runs a submit job called *monthly.sbm* which contains a list of *.stk* files to review on screen one at a time.

STKWIN REVIEW.SBM AUTOPRINT CONTINUOUS AUTOEXIT STARTDATE=12/01/98 STOPDATE=12/08/98

Runs a submit job called *review.sbm* which contains a list of *.stk* files to plot to hardcopy (default printer) for the period 12/1/98 to 12/8/98 and automatically exit *STKWIN*.

STKWIN STKFILE=GRCA.STK DATFILE=GRCA1298.DAT

Runs *GRCA.STK* plot control file with *GRCA1298.DAT* as the data input file.

STKWIN EXECUTION NOTES

STKWIN may be run on a Microsoft Windows 98, 2000, XP, or NT machine.

If you are plotting hardcopy, the default printer is used.

Adobe PDF files may optionally be generated if a ***pdfwriter*** printer driver (or equivalent) has been installed on the machine. The ***Print to PDF*** will not be visible in Stackwin if the driver has not been installaed.

Microsoft WINDOWS File Association

Microsoft Windows can be configured to run *STKWIN* by double-clicking a *.STK* file in *Windows Explorer*. To configure this option in *Windows Explorer:*

- right-click a ***.STK*** *file*
- click ***Open With***
- select Stkwin from the list
- -or- if not listed
- Choose Program
- Other
- F:\ARS_SOFT\STKWIN.EXE
- Always use this program to run this type of file
- OK

Thereafter, double-clicking a .STK file will always run load the file in STKWIN and draw the plot.