Air Quality Monitoring Protocol for Denali National Park & Preserve, Alaska

Standard Operating Procedure (SOP) # 1

Implementation of Nationwide Air Quality Monitoring Network Programs in Denali National Park & Preserve

Version 1.0 (November 2004)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure briefly describes implementation of nationwide air quality monitoring programs in Denali National Park & Preserve. The nationwide programs that the park currently participates in are:

1. National Atmospheric Deposition Program **(NADP)**
2. Interagency Monitoring of Protected Visual Environments **(IMPROVE)**
3. NPS Gaseous Pollutant Monitoring Network **(ozone monitoring)**
4. Clean Air Status and Trends Network **(CASTNet)**

Each nationwide air quality monitoring network establishes its own standardized sampling and analytical methods, which are peer reviewed during program development. Subsequent method changes are reviewed by scientists from all agencies represented in the networks, generally through formal steering committee participation. The nationwide air quality monitoring network protocols therefore serve as the park air quality monitoring protocols, organized here as SOPs 2 through 4. The Denali air quality program manager participates in reviewing and editing the nationwide SOPs, and occasionally suggests method changes that are adopted by the nationwide air quality monitoring networks.

The NADP program was the first large-scale interagency air quality monitoring network established in the United States. When it adopted a weekly schedule for sample changes, Tuesday was chosen as the sample change day since it is the earliest day of the work week unaffected by Monday holidays. Subsequent nationwide monitoring networks have often collocated their sites with NADP, and usually adopt Tuesday as the weekly sample change day, in order to take advantage of the presence of the NADP site operator.

Successful implementation of the nationwide air quality monitoring programs requires weekly sample changes throughout the year. Site operator and backup site operator training are essential for achieving continuity and good data capture, not because sample changes are difficult, but because the sample change protocols are very detailed. Small sample change errors, such as forgetting when to use gloves or incorrectly installing sample filters, can result in sample contamination or data loss. In order to maintain the park's high standards for sample changes conducted by backup site operators, a site-specific SOP has been developed. Unlike the nationwide network SOPs, which are comprehensive for each monitoring network, the site-specific backup operator instructions include succinct and detailed instructions for each type of instrument at the park air quality monitoring station. It is designed so that rusty backup operators can follow the instructions to remember each step of sample changes sequentially. Backup operators go through two complete training sessions before they conduct sample changes in the primary site operator's absence, and conduct either a backup or practice sample change at least once a year.

Each nationwide air quality monitoring network provides instrument troubleshooting assistance over the telephone. Network phone numbers are posted in the air quality monitoring shelter, and are printed in the network SOPs and the backup site operator SOP. Network technicians assist site operators with fixing malfunctioning instruments on site when possible, or if an instrument is broken beyond repair, they send a replacement from the pool of instruments owned by the network. Technicians also assist new and backup site operators with sample change questions.

The nationwide air quality monitoring networks each have quality assurance and quality control guidelines, which vary from network to network. At the park, audits and instrument calibrations are conducted on a regular schedule. The NADP network sends a contract auditor to the site once every three years to calibrate instruments and observe site operator techniques. Park personnel assist with annual blind audits of the NADP network analytical laboratory, and test park laboratory analyses twice a year through network intersite comparison checks. The IMPROVE instruments are calibrated and maintained once a year by network representatives. Twice a year, the ozone, meteorological, and CASTNet instruments are calibrated on site by the same contract technicians who provide telephone troubleshooting assistance.

Data for each nationwide monitoring network are collected, validated, and archived by network personnel. Data quality assurance and quality control standards are determined at the nationwide network level. Although copies of all datasets are kept at Denali, they are not considered to be archival copies. Each nationwide monitoring network also analyzes and reports the data. The IMPROVE network publishes data synthesis reports once every three years, and the other networks produce annual data summaries. Spatial and temporal trends are reported to varying degrees by the networks. Reports and validated data are available online at the monitoring network web sites, which are listed in the air quality monitoring protocol narrative.

Air Quality Monitoring Protocol for Denali National Park & Preserve, Alaska

Standard Operating Procedure (SOP) # 2

National Atmospheric Deposition Program
National Trends Network
Site Operation Manual

Version 3.0 (NADP Manual 1999-01, July 1999)

NADP Manual 1999-01

NATIONAL TRENDS NETWORK SITE OPERATION MANUAL

NATIONAL ATMOSPHERIC DEPOSITION PROGRAM

A Cooperative Research Support Program of the
State Agricultural Experiment Stations (NRSP-3)
Federal and State Agencies
and Private Research Organizations

For information about the
National Atmospheric Deposition Program (NADP), contact:

NADP Program Office
Illinois State Water Survey
2204 Griffith Drive
Champaign, IL 61820-7495

NADP Home Page: http//nadp.sws.uiuc.edu
E-mail: nadp@sws.uiuc.edu
Phone: 217/333-2213
Fax: 217/244-0220

The Illinois State Water Survey is an Affiliated Agency of the University of Illinois and a Division of the Illinois Department of Natural Resources.

NATIONAL TRENDS NETWORK
SITE OPERATION MANUAL

prepared by Scotty R. Dossett and Van C. Bowersox
NATIONAL ATMOSPHERIC DEPOSITION PROGRAM
Illinois State Water Survey
2204 Griffith Drive
Champaign, Illinois 61820-7495
July 1999

Dossett, Scotty R., and Van C. Bowersox. 1999. *National Trends Network Site Operation Manual.* National Atmospheric Deposition Program Office at the Illinois State Water Survey. NADP Manual 1999-01. Champaign, IL.

This manual was printed on recycled and recyclable papers

CONTENTS

1 Introduction 1-1
1.1 Atmospheric Deposition: Why Be Concerned? 1-1
1.2 NADP Monitoring: Program History and Objectives 1-2
1.3 NADP Status: Current and Future 1-3
1.4 References 1-6

2 National Trends Network Monitoring Program 2-1
2.1 NTN Monitoring Strategy 2-1
2.2 Site Selection 2-1
2.3 Field Site Operations 2-2
2.3.1 The Standard Sampling Period 2-5
2.3.2 Sample Types 2-5
2.3.2.1 Wet-Deposition-Only Sample 2-5
2.3.2.2 Bulk Sample 2-5
2.3.2.3 Undefined Sample 2-6
2.4 Site Support and Management 2-6
2.4.1 Sponsoring Agency Responsibilities 2-6
2.4.2 Operating Agency Responsibilities 2-7
2.5 Site Personnel 2-7
2.5.1 The Site Operator 2-7
2.5.2 The Site Supervisor 2-8
2.6 Technical Support 2-9
2.6.1 Central Analytical Laboratory 2-9
2.6.2 Program Office 2-10
2.6.3 USGS and USEPA Quality Assurance Programs 2-11
2.7 References 2-12

3 NTN Site Operating Procedures 3-1
3.1 General Guidelines 3-1
3.2 Field Procedures 3-1
3.2.1 Preparing for Sample Collection 3-1
3.2.1.1 Check Mailer Contents upon Receipt 3-1
3.2.1.2 Prepare to Service Field Site 3-2
3.2.2 Changing Wet-Side Field Bucket and Checking Equipment 3-2
3.2.2.1 Weekly Sampling Routine 3-3
3.2.2.2 Bulk Sampling 3-6
3.2.3 Maintaining Dry-Side Bucket and Foam Lid Seal 3-6
3.2.3.1 Cleaning Dry-Side Buckets at Field Laboratory 3-6
3.2.3.2 Changing Dry-Side Buckets and Cleaning Foam Lid Seal 3-7
3.2.4 Nonstandard Sample Periods 3-7
3.2.5 Servicing the Belfort Recording Raingage 3-8
3.2.6 Summary of Field Procedures 3-10

3.3 Completing Field Observer Report Form (FORF) 3-10
3.3.1 SITE, Block 1 3-12
3.3.2 OBSERVER, Block 2 3-12
3.3.3 BUCKET ON/OFF, Block 3 3-12
3.3.4 SITE OPERATIONS, Block 4 3-13
3.3.5 SAMPLE CONDITION, Block 5 3-13
3.3.6 BUCKET SAMPLE WEIGHT, Block 6 3-14
3.3.6.1 Measure Any Leakage 3-14
3.3.6.2 Weigh the Sample 3-15
3.3.7 PRECIPITATION RECORD, Block 7 3-15
3.3.7.1 Precipitation Type 3-16
3.3.7.2 Precipitation Amounts 3-16
3.3.7.3 Weight Recheck and Collection Efficiency 3-16
3.3.7.4 Detailed Interpretation of Precipitation and Event Recorder Traces 3-17
3.3.7.4.1 Chart Features 3-17
3.3.7.4.2 Event Recorder Transcription 3-19
3.3.7.4.3 Reading the Raingage Chart 3-20
3.3.7.4.4 Reporting Daily Precipitation Amounts: Arranging Events to Fit Field Form 3-21
3.3.8 SAMPLE CHEMISTRY, Block 8 3-22
3.3.8.1 Transferring Liquid from Field Bucket 3-22
3.3.8.1.1 Decanting into Sample Bottle 3-23
3.3.8.1.2 Sample Bottle Usage 3-24
3.3.8.2 General Field Laboratory Analysis 3-24
3.3.8.2.1 Filling Vials for Field Chemistry Measurements 3-25
3.3.8.3 Conductance Measurement 3-26
3.3.8.3.1 Standardize Meter and Cell 3-26
3.3.8.3.2 Measure Conductance of Distilled Water 3-26
3.3.8.3.3 Measure Quality Control Check Sample Conductance 3-26
3.3.8.3.4 Measure Precipitation Sample Conductance 3-27
3.3.8.3.5 Store Conductance Cell 3-27
3.3.8.4 pH Measurement 3-27
3.3.8.4.1 Prepare pH Meter and Electrode for Testing 3-27
3.3.8.4.2 Calibrate pH Meter 3-28
3.3.8.4.3 Purge pH Electrode Tip with Distilled Water 3-28
3.3.8.4.4 Measure Quality Control Check Sample pH 3-29
3.3.8.4.5 Measure Precipitation Sample pH 3-29
3.3.8.4.6 Store pH Electrode 3-29
3.3.9 SUPPLIES, Block 9 3-29
3.3.10 REMARKS, Block 10 3-30
3.4 Mailing Instructions 3-30
3.4.1 Field Buckets 3-30
3.4.2 Sample Bottles 3-31
3.4.3 Final Items 3-31
3.5 Recordkeeping at the Site 3-32

4 Preliminary Data Printouts 4-1
4.1 Report Headings 4-1
4.2 CAL Field Printout 4-2
4.3 CAL Preliminary Printout 4-5
4.4 Monthly News and Notes 4-7
4.5 Usage Reminder 4-7

5 Field Site Maintenance 5-1
5.1 Immediate Site Area Maintenance 5-1
5.1.1 Vegetation Maintenance 5-2
5.1.2 Obstructions in Wind Field 5-2
5.2 Field Site Equipment Maintenance 5-2
5.2.1 Aerochem Metrics 301 Precipitation Collector (see also Appendix C) 5-2
5.2.1.1 Sensor and Motor Box Checks 5-2
5.2.1.2 Sensor Head Cleaning 5-3
5.2.1.3 Dry-Side Changes, Lid Seal Cleaning and Replacement 5-3
5.2.1.4 Winter Operation 5-4
5.2.2 Belfort B5-780 Recording Raingage (see also Appendix D) 5-5
5.2.2.1 Winter Operation 5-5
5.2.2.2 Calibration, Turnover, and Sensitivity Checks 5-6
5.2.2.2.1 Calibration 5-6
5.2.2.2.2 Turnover Check 5-7
5.2.2.2.3 Sensitivity Check 5-7
5.3 Replacement of Field Equipment Components 5-7
5.4 Power Requirements for Field Site Operation 5-7
5.4.1 110 Volt AC Line Power 5-8
5.4.2 12 Volt DC Power 5-8
5.5 References 5-9

6 Quality Assurance Programs 6-1
6.1 NTN Site Systems and Performance Survey 6-1
6.2 Blind-Audit Program 6-2
6.3 Intersite Comparison Program 6-3
6.4 Collocated Sampler Program 6-3
6.5 Field Blank Program 6-4
6.6 References 6-4

7 Directory 7-1
7.1 NADP - Central Analytical Laboratory 7-1
7.2 NADP Program Office 7-2
7.3 External Quality Assurance Programs 7-3
7.4 Instrument Manufacturers 7-3

Appendices

A. National Trends Network Equipment Requirements A-1
B. pH and Conductivity Measurement Troubleshooting Guide B-1
C. Precipitation Collector Troubleshooting Guide C-1
D. Recording Raingage Troubleshooting Guide D-1

LIST OF FIGURES

Figure 1-1. The atmospheric cycle of air pollutants 1-1
Figure 1-2. National Trends Network (December 31, 1998) .. 1-4
Figure 2-1. A typical NTN site 2-1
Figure 2-2. Ecoregions of the conterminous United States showing Domain, Division, and Province (after Bailey, 1976) 2-3
Figure 2-3. Technical support of NTN sites 2-9
Figure 3-1. Pack the mailer for the field site 3-2
Figure 3-2. Check the sensor temperature 3-3
Figure 3-3. Activate the sensor with water 3-4
Figure 3-4. Put the lid on the bucket 3-4
Figure 3-5. Note comments on the plastic bag 3-5
Figure 3-6. Check that event recorder pen is up 3-5
Figure 3-7. Check the lid seal fit 3-5
Figure 3-8. Mark the pen position 3-8
Figure 3-9. Check the operation of the event recorder 3-9
Figure 3-10. Field Observer Report Form 3-11
Figure 3-11. Block 1 3-12
Figure 3-12. Block 2 3-12
Figure 3-13. Block 3 3-12
Figure 3-14. Block 4 3-13
Figure 3-15. Block 5 3-13
Figure 3-16. Block 6 3-14
Figure 3-17. Measure sample leakage 3-14
Figure 3-18. Upper portion of Block 7 3-15
Figure 3-19. Lower portion of Block 7, weight recheck 3-17
Figure 3-20. Sample raingage chart 3-18
Figure 3-21. Raingage chart section 3-19
Figure 3-22. Transcribe event recorder trace 3-19
Figure 3-23. Chart point 0 3-20
Figure 3-24. Chart point 1 3-20
Figure 3-25. Chart point 2 3-20
Figure 3-26. Chart point 4 3-21
Figure 3-27. Chart point 8 3-21
Figure 3-28. Decant the liquid 3-23
Figure 3-29. Block 8 3-24
Figure 3-30. Rinse and fill four vials 3-25
Figure 3-31. Measure the conductance standard 3-26
Figure 3-32. Remove the soaker bottle 3-27
Figure 3-33. Insert the electrode into the vial 3-28
Figure 3-34. Block 9 3-29
Figure 3-35. Block 10 3-30
Figure 3-36. Make sure the CAL address shows 3-31
Figure 4-1. CAL field printout 4-3

Figure 4-2. CAL preliminary printout 4-6
Figure 5-1. An idealized site 5-1
Figure 5-2. Removing the lid seal 5-4
Figure 5-3. An idealized DC solar system 5-8

TABLES

Table 3-1. Chart Precipitation Record 3-22
Table 3-2. Daily Precipitation Record 3-22
Table 5-5. Catch Bucket Freezing Temperature 5-6

ACKNOWLEDGMENTS

This manual was revised with guidance from the Network Operations Subcommittee of the National Atmospheric Deposition Program.

Contributors to previous versions include Van C. Bowersox, Jacqueline Peden, Mark Peden, Richard Semonin, Gary J. Stensland, and Scotty R. Dossett of the Illinois State Water Survey; D.L. Sisterson and P.M. Irving of Argonne National Laboratories; and David Bigelow, Nicholas Field, Gary Lear, Susan Smith, and Carol Simmons of the Natural Resource Ecology Laboratory, Colorado State University; and Herbert Volchock (deceased) of the U.S. Department of Energy, Health and Safety Laboratory.

Several Illinois State Water Survey staff contributed their computer, word processing, graphics design, and editing expertise. The authors wish to thank Greg Dzurisin, Joyce Fringer, Linda Hascall, and Eva Kingston for their assistance.

This version was edited by members of the NADP Network Operations Subcommittee. The authors wish to thank the following individuals for their efforts:

Joel Frisch, U.S. Geological Survey Office of Atmospheric Deposition Analysis
Susan Randall Johnson, Minnesota Pollution Control Agency
John Robertson, Past Program Chair
Jane Rothert, Illinois State Water Survey
Jim Trochta, Wisconsin Department of Natural Resources

FOREWORD

This manual is a detailed guide for the operation of a National Atmospheric Deposition Program/ National Trends Network (NTN) wet deposition monitoring station. A description of program history and organization is included so that Site Operators can understand the development of the network.

We would appreciate receiving your comments or suggestions about the content or the style of this manual. Please forward your ideas to:

NADP Program Office
Illinois State Water Survey
2204 Griffith Drive
Champaign, IL 61820-7495
Phone: 217/333-2213
Fax: 217/244-0220
E-mail: nadp@sws.uiuc.edu
NADP Home Page: http://nadp.sws.uiuc.edu

The procedures outlined in this manual do not address safety problems associated with the operation of the monitoring station. Each Site Operator and Supervisor are responsible for establishing appropriate safety and health practices.

SUMMARY OF REVISIONS

This manual is the third revision of the original 1978 *Field Observer Instruction Manual* by Richard Semonin and Herbert Volchock. Several procedural changes have occurred within the program since the original manual was printed. The table below lists additions and changes in NTN Site Operation protocols since 1994. For information regarding procedural changes prior to 1994, please contact the Program Office (see inside front cover for contact information).

Revisions	*Date*
Major revision of all sections of the manual with an emphasis on updating information, language, graphics, and on producing an all-electronic document. Specific changes include:	July 99

- Reorder of the Summary of Revisions.

- Revision of text to accommodate the title change of the network from the National Atmospheric Deposition Program to the National Trends Network (NTN).

- Revision of text to eliminate references to dry-side field bucket sampling. In October 98 the submission of these for analysis and reporting was discontinued.

- Revision of Field Observer Report Form (FORF) for project name, sponsorship, contact information, and elimination of dry-side sampling and supplies provided by the Central Analytical Laboratory (CAL). Changes include:

Header	• Revision of support listing • Changes and additions to main header to list CAL site liaison information • Revision of "for office use only" block
Block 1	Study block deleted
Block 3	Eliminated, and subsequent blocks reordered (i.e., Block 4 "Bucket" now Block 3)
Block 7	Elements added to 1) direct observer to segregate precipitation type and amount, 2) discern sample bottle box.
Block 8	Boxes for "Precipitation Sample Corrected" and "Precipitation Sample pH" were made bold.
Block 9	Ordering of supplies rearranged

- Inclusion of graphics and photos in Sections 1, 2, and 3 to diversify the text and to augment procedural explanations.

Revisions *Date*

- Revision of Section 3 to separate FORF blocks into discrete sections and integrate the evaluation of the recording raingage chart and sample chemistry into their specific blocks. Addition of graphics depicting each block within its respective section. July 99

- Revision of the Section 3 Field Chemistry section:
  - Include use of a 4.9 pH, 14 (µS/cm) quality control (QC) check sample.
  - Delete the reference to external calibration of conductivity meters.
  - Include a distilled water measurement procedure between the buffers and the QC check sample during pH measurements.

- Modification of Section 5 to add special procedures throughout text.

- Revision of Section 6 to add information dealing with a new U.S. Geological Field Blank program.
- Revision and expansion of Section 7.

The network switched to an enhanced sample transfer protocol. A snap-on lid is used to retrieve the sample from the field site. Any liquid in the field bucket is decanted into a 1-liter (L) high-density polyethylene bottle for shipment to the Central Analytical Laboratory. Instead of using a syringe to withdraw a 20-mL aliquot for field chemistry, the vials used are filled from the 1-L bottle. Any sample volume in excess of ~900 grams is discarded. Since the entire sample is no longer available, the evaluation of contaminants in the sample and the field sample weight shifts from the CAL to the site. The sample is no longer in contact with the "O-ring" gasket found in the old style hammer-on lids. Section 3 of the manual was substantially edited to accommodate new procedures. Jan 94

1 Introduction

1.1 Atmospheric Deposition: Why Be Concerned?

Every year the National Atmospheric Deposition Program (NADP) fulfills thousands of requests for data, maps, and other information through its World-Wide-Web site. These requests come from scientists and policy-makers and from students and other people interested in using NADP data to address important questions about the health of our atmosphere. The NADP is now in its third decade and has a continuous record of more than 20 years of precipitation chemistry data at some sites. The length and quality of the NADP data record are due to the steadfast efforts of NADP Site Operators who have spent several hundred thousand hours collecting and measuring samples. Why do we keep such diligent vigil over what's in our precipitation? The answer lies in our need to monitor how human activities and the forces of nature affect our air and precipitation quality, i.e., the health of our atmosphere. The information we gain will equip us to make more responsible decisions about how to preserve and improve our air quality and how to manage our agricultural, forest, aquatic, cultural, and energy resources.

As rain or snow forms and falls, it scavenges or removes particles and gases from the air. Precipitation deposits these substances on the earth's surface. Differences in the chemical makeup of precipitation from one sampling site to another reflect differences in the form or quantity of pollutants scavenged from the atmosphere at these sites. Changes in precipitation chemistry at a site occur from week to week and from year to year. Monitoring precipitation chemistry over space and time helps us describe the chemical climate in a region and throughout the country. Many factors affect the chemical climate: emissions of pollutants to the atmosphere, how these pollutants are mixed or dispersed in the air, how they are transported by the wind, how they chemically change or transform during transport, and finally how they are scavenged by precipitation or removed as dry deposition (Figure 1-1). This description makes it apparent that the interplay of meteorology and atmospheric chemistry affect precipitation chemistry in defining our chemical climate.

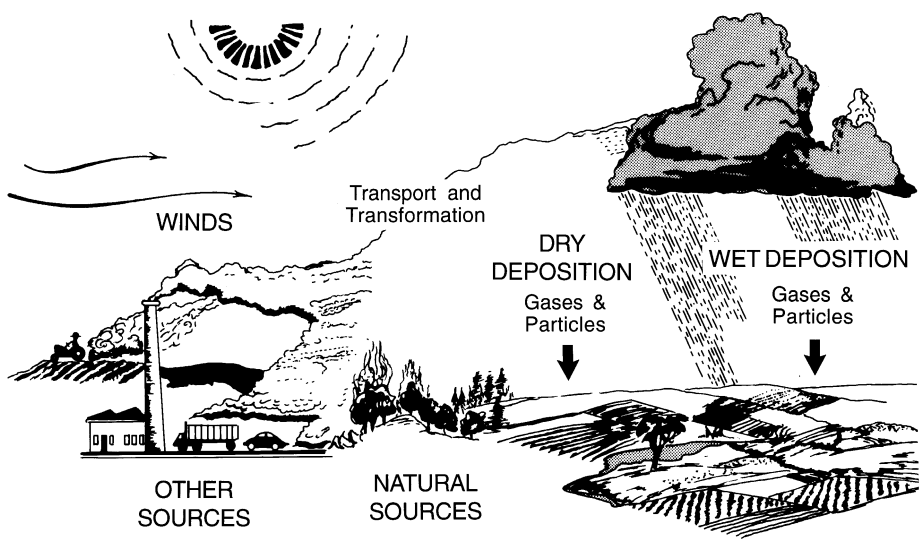


Figure 1-1. The atmospheric cycle of air pollutants.

Figure 1-1 depicts how pollutants cycle through the atmosphere. Some pollutants remain relatively unchanged during this cycle. For example, soil particles may be transported without change from a source area, such as a field, to a sink, such as a forest downwind of the field. During this source-to-sink cycle, other pollutants undergo physical and chemical changes. For example, sulfur dioxide is a gas when emitted from its point source, a tall smokestack. Before being scavenged by precipitation or removed as dry deposition, sulfur dioxide may be transformed into tiny sulfuric acid droplets or into ammonium bisulfate particles. Whether pollutants are merely relocated or are chemically transformed during this atmospheric cycle, it is now recognized that atmospheric deposition significantly affects the supply of both essential and potentially injurious compounds available to natural systems. It also affects the weathering and corrosion rates of building materials and structures, our cultural resources.

Atmospheric deposition affects the nutrient status, growth, and development of plants on land and in surface waters. It may benefit agricultural crops by adding nutrients that promote growth. Plant growth also may be stimulated when the acids in precipitation accelerate the weathering of soils, making minerals more readily available. Growth stimulation in certain unmanaged forests, however, may make the trees less hardy and more vulnerable to the stresses of cold weather and disease. Adding nutrients to surface waters may boost algal production, and when these algae die, they sometimes deplete the oxygen supply below levels that support fish. The health and reproductive capacity of fish can also be influenced by the atmospheric deposition of acids and other trace constituents. Where precipitation is acidic, it can speed the corrosion of exposed metals and the weathering of unprotected stone building surfaces and statues. In these examples, atmospheric deposition has an influence on biological and geological systems, playing an important role in the biogeochemical cycle, and it modifies natural weathering and corrosion processes.

Because precipitation is an efficient scavenger of the particles and gases dispersed in the atmosphere, precipitation chemistry is a good indicator of the pollutants in our air. Changes in the chemical composition of precipitation reflect changes in atmospheric composition. Atmospheric deposition plays an important role in the biogeochemical cycle and in the weathering and corrosion of exposed building surfaces and statues. Pollutant emissions are expected to change because of legislated reductions and inadvertent changes in natural sources. There is a continuing need to make careful measurements of precipitation chemistry and thus monitor the health of our atmosphere.

1.2 NADP Monitoring: Program History and Objectives

In October 1977, the North Central Region of the State Agricultural Experiment Stations (SAES) established Project NC-141, entitled “Chemical Changes in Atmospheric Deposition and Effects on Agricultural and Forested Land and Surface Waters in the United States.” Interest in Project NC-141 grew out of concern over reports of increasing acidity of rain and snow in the eastern United States and from the recognition that human activities had greatly increased the emissions and deposition of atmospheric pollutants. An expert panel meeting at the National Academy of Sciences in 1976 recommended that a nationwide network be installed to measure the spatial and temporal trends in atmospheric deposition. Scientists could use data from this network to examine the connection between emissions and precipitation chemistry and between precipitation chemistry and potential impacts on agriculture, forests, rangelands, streams, and lakes. Among the first accomplishments

of Project NC-141 was to begin installing a network of sampling sites. The first sites in the NADP monitoring network began operations in the summer of 1978, and by the end of that year 22 sites had joined the network.

All four SAES regions endorsed NADP as Interregional Project IR-7 in 1982. This endorsement accompanied the growth of the network to 106 sites in 41 states plus a site in American Samoa and three sites installed alongside Canadian network sites in the provinces of Alberta, Ontario, and Nova Scotia. A decade later, the SAES reclassified IR-7 as National Research Support Project NRSP-3, entitled "The National Atmospheric Deposition Program–A Long-term Monitoring Program in Support of Research on Effects of Atmospheric Chemical Deposition." The objective of Project NRSP-3 is to provide a national framework for collecting and disseminating quality-assured atmospheric deposition data:

1. To characterize geographic patterns and temporal trends in biologically important chemical deposition.

2. To support research activities related to (a) the productivity of managed and natural systems; (b) the chemistry of surface and ground waters, including estuaries; (c) the health of domestic animals, wildlife, and fish; (d) human health; (e) the effects of atmospheric deposition on visibility and materials; and (f) discerning source-receptor relationships.

In October 1981, the U.S. Congress established the National Acid Precipitation Assessment Program (NAPAP) to increase our understanding of the causes and effects of acid precipitation. Federal agencies worked together in this comprehensive ten-year program to conduct research, monitoring, and assessment activities intended to develop a firm scientific basis for reducing the effects of acid precipitation. This program sought to operate a long-term, high-quality National Trends Network (NTN) to detect and measure acid precipitation. Under the NAPAP design, the U.S. Geological Survey (USGS) was charged with leading network development and operation. The NADP siting criteria, operating equipment, procedures, and analytical laboratory were adopted by NTN, and the two networks merged with the designation NADP/NTN. Recognizing that the network needed more sites to have representative data on precipitation chemistry in all ecoregions, the federal agencies supported the installation of new sites, particularly in the western United States (Robertson and Wilson, 1985). By the end of 1985, the network had grown to nearly 190 sites. In 1998, the network designation, NADP/NTN, was shortened to NTN.

1.3 NADP Status: Current and Future

Figure 1-2 shows the active sites in the NTN as of December 31, 1998. The network operates in 46 states, has 200 active sites, and extends from Puerto Rico and the Virgin Islands in the east to Alaska in the west. Two of the network sites are paired collocated sites, operating two collectors and precipitation gages. Collocated sampling is one component of the network quality assurance program. Another is collecting samples at sites where other networks collect samples. For example, NTN operates two network-comparison sites alongside federal Canadian sites in the Canadian Air and Precipitation Monitoring Network (CAPMoN): one site in Quebec Province, Canada, the other in central Pennsylvania. Collocated and network-comparison sampling are quality assurance activities designed to evaluate the overall precision and comparability, respectively, of network data.

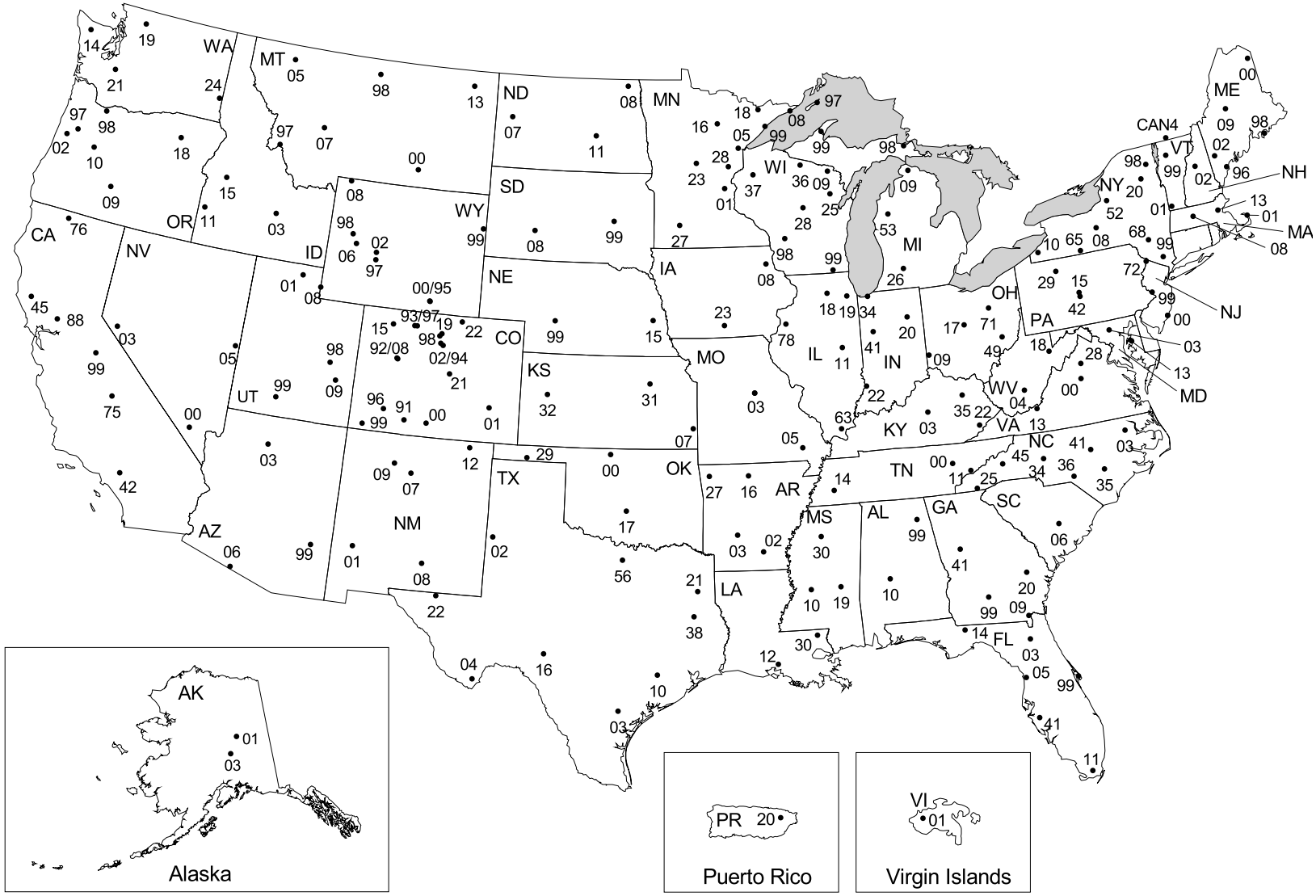


Figure 1-2. National Trends Network (December 31, 1998).

NAPAP, the ten-year program responsible for the design and operation of the NTN, continues under the most recent amendments to the federal Clean Air Act. NTN data are necessary to evaluate the status and effectiveness of the acid deposition control program implemented under these amendments. The Act seeks to reduce the adverse effects of acid deposition through reductions in annual emissions of sulfur dioxide and nitrogen oxides. The first round of sulfur dioxide emission reductions occurred on January 1, 1995. According to the Act, a second round of reductions must occur before January 1, 2000, lowering the total annual sulfur dioxide emissions to 10 million tons below 1980 levels. With nearly 200 sites measuring precipitation chemistry in the major ecoregions of the United States, the NTN is well-positioned to provide the data necessary to assess the location and magnitude of changes in precipitation chemistry resulting from these emissions reductions.

Complementing the NTN is a research network, the Atmospheric Integrated Research Monitoring Network (AIRMoN), that focuses on detecting how sources and meteorology affect precipitation chemistry on a day-to-day basis. AIRMoN joined NADP in October 1992. Data from this network are combined with results from atmospheric models that track air movements. Together, the AIRMoN measurements and air parcel trajectories are used to investigate the nature of the relationship between sources and precipitation chemistry. AIRMoN also evaluates new sample collection methods and preservation methods designed to arrest the biodegradation of ammonium, an important nutrient, and losses of free acidity. As of December 31, 1998, there are ten AIRMoN sites, all located in the eastern United States.

Another network, the Mercury Deposition Network (MDN), with 38 sites as of December 31, 1998, joined NADP in January 1996. MDN reports the total mercury concentrations in all samples and methyl mercury concentrations in some samples. Nearly 40 states have advisories against consuming fish from certain lakes because of high mercury concentrations in the fish tissues. MDN data enable researchers to examine the importance of the atmospheric transport and deposition of mercury from distant sources as a cause of this problem.

With the addition of AIRMoN and MDN, NADP now operates three precipitation chemistry networks. Data from these networks are used to address a number of important contemporary issues. For example, NADP data are being used:

- To assess the effect of sulfur dioxide emissions reductions on sulfate in precipitation.
- To update the recommendations for sulfur fertilizer applications in light of the lower sulfur amounts deposited by precipitation in many areas of the country.
- To estimate the amount and importance of atmospheric inorganic nitrogen deposited to inland and coastal waters in which nutrient enrichment degrades the water quality.
- To explore the causes of the downward trend in base cation concentrations in precipitation and the effect this may have on the fertility of some acidic forest soils.
- To continue to monitor how acidic lakes and forests respond to the changing chemistry of precipitation.
- To examine the relationship between pollutant sources, air quality, and precipitation quality.
- To determine the deposition rate of mercury to lakes and streams and evaluate the relative importance of atmospheric deposition and other sources of mercury in causing high mercury levels in fish.

Support for NADP comes from a diverse group of sponsors and participants, ranging from landowners that provide a site location to federal agencies that fund dozens of sites. These include a high school, the U.S. Military Academy, the Kennedy Space Center, Native American tribal organizations, private companies, city governments, state agencies, universities, Forest Experiment Stations, State Agricultural Experiment Stations, national laboratories, agencies of the Canadian government, the U.S. Geological Survey, the National Oceanic and Atmospheric Administration, the U.S. Environmental Protection Agency, the National Park Service, the U.S. Forest Service, the Bureau of Land Management, the U.S. Fish & Wildlife Service, the Tennessee Valley Authority, and the Cooperative State Research, Education, and Extension Service.

The dedication of NADP sponsors and Site Operators continues to make NADP one of the most successful cooperative programs in the United States. Here's what scientists have said in review of the NADP, "The monitoring program is perhaps the most significant long-term, continuous, and comprehensive sampling and analysis program to be undertaken in the environmental sciences" (Jansen et al., 1988). Extending this record so that future peer reviewers can say no less is the challenge of every person involved with the NADP today.

1.4 References

Jansen, J., K. Aspila, M. Hoffman, G. Ohlert, and J. Winchester. 1988. *Session Summary Report. NAPAP Task Group IV, Wet Deposition Monitoring Peer Review*. National Acid Precipitation Assessment Program, 722 Jackson Place, NW, Washington, D.C.

Robertson, J., and J. Wilson. 1985. *Design of the National Trends Network for Monitoring the Chemistry of Atmospheric Precipitation*. U.S. Geological Survey, Circular 964, Alexandria, VA.

2 National Trends Network Monitoring Program

2.1 NTN Monitoring Strategy

In establishing the NTN, sponsors and participants have sought to ensure long-term commitment and uniformity of siting criteria, sampling protocols, analytical methods, and data validation procedures. Complemented by long-term operations, this uniformity is essential to obtain data on how the chemical climate in the nation's ecoregions is changing over seasons, years, and decades. This uniformity helps to ensure that data are geographically representative and comparable from site to site. To this end, NTN participation requires use of prescribed field instruments to collect and measure precipitation (see Figure 2-1 and Appendix A). Sites also must conform to fixed site selection and installation criteria and must follow identical procedures for collecting, handling, and measuring samples. Although the amount and type of data may vary, certain minimum data must accompany every sample.

Figure 2-1. A typical NTN site.

Every NTN sample is sent to the Central Analytical Laboratory (CAL), operated by the Illinois State Water Survey in Champaign, Illinois. The CAL provides site support, chemical analysis, and data validation services for the NTN. As overall indicators of precipitation quality, the CAL measures pH and conductivity, which are also measured at field sites. The CAL also analyzes samples for the following constituents: sulfate (SO_4^{2-}), chloride (Cl^-), nitrate (NO_3^-), ammonium (NH_4^+), orthophosphate (PO_4^{3-}), sodium (Na^+), potassium (K^+), calcium (Ca^{2+}), and magnesium (Mg^{2+}). These ions characterize the inorganic chemistry of precipitation. For example, NO_3^-, NH_4^+, and PO_4^{3-} are the principal inorganic nutrients in precipitation. Hydrogen ion (H^+, measured as pH), SO_4^{2-}, and NO_3^- are the well-known constituents of "acid rain"; and Ca^{2+}, Mg^{2+}, and K^+ are important base cations in precipitation. Field and laboratory data are verified and screened at the CAL, following a standard set of data validation procedures to ensure accuracy and representativeness of NTN data.

Finally, the U.S. Geological Survey (USGS) and U.S. Environmental Protection Agency (USEPA) administer external quality assurance programs that continuously review and evaluate field sites, their operations, and those of the CAL.

2.2 Site Selection

NTN sites were selected to provide *regionally representative* data for use in characterizing the geographic patterns and temporal trends in atmospheric chemical deposition. To avoid unrepresentative influences from nearby sources, NTN sites were installed predominantly away from urban areas and point sources of pollution, such as coal-fired power plants or other industrial operations. A

regionally representative site typifies an area or region, which is distinguished from other regions by vegetation, soil types, climate, or other properties. An overarching consideration in the NTN design (Robertson and Wilson, 1985) was to measure atmospheric deposition in every ecologically similar region, i.e., an ecoregion, as defined by Bailey (1978). The number of sites in the ecoregions was set in proportion to the ecoregion areas, shown in Figure 2-2. This basic distribution of sites was augmented by other important considerations, such as

- location of atmospheric pollutant sources.
- amount and frequency of precipitation.
- location of rapid changes (i.e., sharp spatial gradients) in atmospheric deposition.
- measurement of pollutant fluxes across national borders.
- chemical deposition to sensitive agricultural, aquatic, and forested areas.

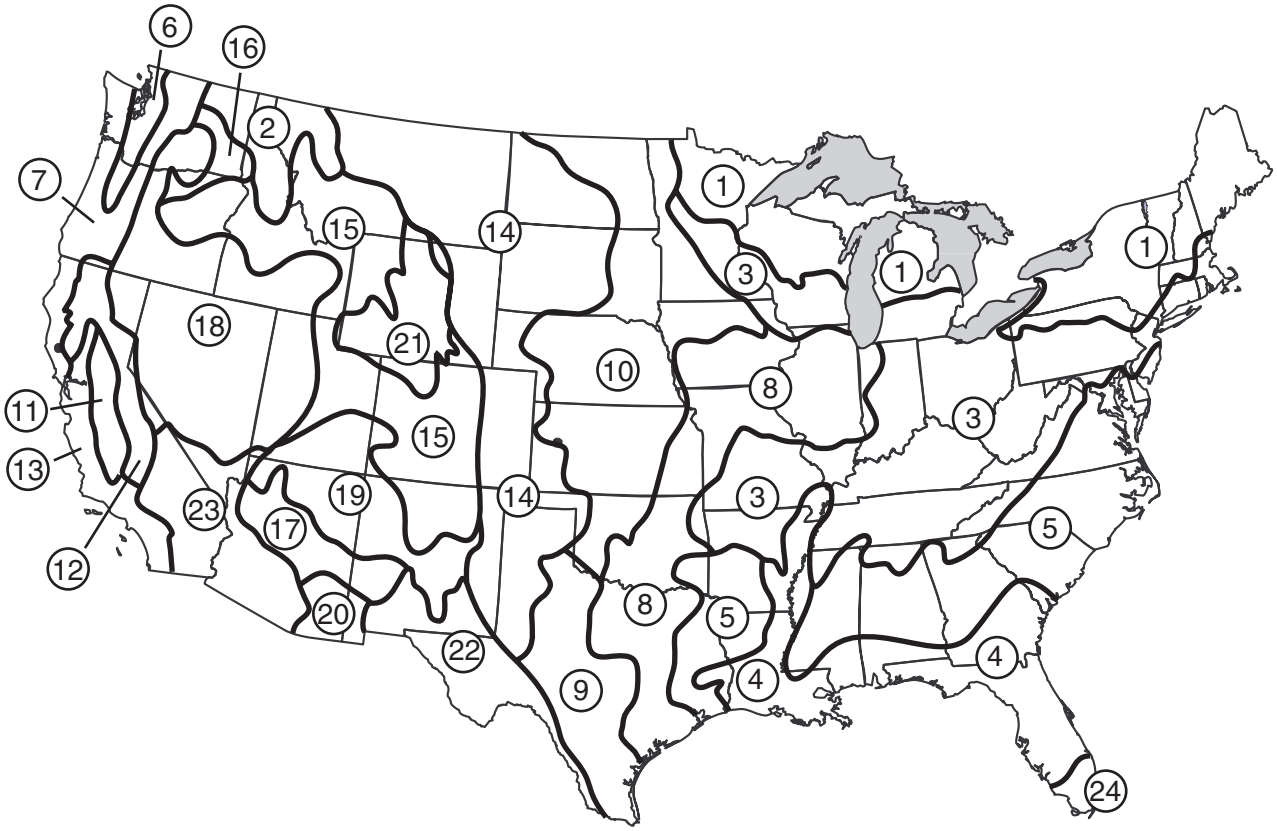
Finally, where it was possible to support deposition effects research, sites were located where biological, limnological, geological, atmospheric chemistry, or related studies were already underway.

New sites continue to be added to the NTN to support research on emerging topics such as biogeochemical cycling in watersheds, excess nutrients in estuarine waters, and other problems. Protocols for establishing NTN monitoring sites are contained in the *NADP/NTN Instruction Manual: Site Selection and Installation* (NADP, 1984), which is available from the NADP Program Office (see Section 7.2 for contact information).

2.3 Field Site Operations

Atmospheric deposition occurs as wet and dry deposition. Wet deposition includes the mixture of dissolved gases and particles and undissolved particles that occur in liquid or frozen precipitation (i.e., rain, snow, sleet, and hail). These substances are present in precipitation at part per million, or lower, levels. These very dilute concentrations require that extreme care be exercised to avoid introducing contamination when collecting, handling, and measuring samples. All sample containers are cleaned and provided only by the CAL. To minimize contamination, the CAL follows rigorous cleaning procedures using ultra-pure deionized water. Another source of contamination of wet deposition samples is dry deposition, which occurs continuously and includes gases and particles transferred to the earth's surface by physical processes other than precipitation. Gravitational settling, wind-driven impaction, absorption of airborne pollutants, dew, frost, and fog are all dry deposition mechanisms. A wet-deposition-only sample is a wet deposition sample collected only during precipitation so that significant dry deposition is excluded. Collection of uncontaminated wet-deposition-only samples is the primary goal of NTN field site operations.

The NTN requires that every site use two commercially available instruments for the collection and measurement of precipitation: the Aerochem Metrics 301 precipitation collector (ACM) and the Belfort B5-780 recording raingage, which are pictured in Figure 2-1. The electrically powered ACM collector automatically collects precipitation samples for chemical analysis, and the Belfort gage mechanically measures and records the amount of precipitation. Appendix A lists the field site equipment requirements.



HUMID TEMPERATE

Warm Continental
1 Laurentian Mixed Forest
2 Columbia Forest
Hot Continental
3 Eastern Deciduous Forest
Subtropical
4 Outer Coastal Plain Forest
5 Southeastern Mixed Forest
Marine
6 Willamette-Puget Forest
7 Pacific Forest
Prairie
8 Prairie Parkland
9 Prairie Brushland
10 Tall-Grass Prairie
Mediterranean
11 California Grassland
12 Sierran Forest
13 California Chaparral

DRY

Steppe
14 Great Plains-Shortgrass Prairie
15 Rocky Mountain Forest
16 Palouse Grassland
17 Upper Gila Mountains Forest
18 Intermountain Sagebrush
19 Colorado Plateau
20 Mexican Highland Scrub Steppe
21 Wyoming Basin
Desert
22 Chihuahuan Desert
23 American Desert

HUMID TROPICAL

Savanna
24 Everglades

HUMID TEMPERATE = Domain
Warm Continental = Division
1 Laurentian Mixed Forest = Province

Figure 2-2. Ecoregions of the conterminous United States showing Domain, Division, and Province (after Bailey, 1976).

The ACM collector has side-by-side 3.5-gallon linear polyethylene (LPE) buckets, one labeled *WET* and the other labeled *DRY* on the instrument base. (Elsewhere in this manual, the terms wet-side bucket or wet side of the collector are used to refer to the side of the ACM collector labeled *WET*; a similar convention applies to the side labeled *DRY.*) Between precipitation events a motor-driven lid covers the wet-side bucket. The underside of this lid has a compressible pad (called a lid seal) that seals the wet-side bucket from exposure to the atmosphere. When precipitation occurs, a sensor activates the motor, which moves the lid from the wet-side bucket to the dry-side bucket. While precipitation accumulates in the wet-side bucket, the dry-side bucket protects the lid seal from contamination by splash and dry deposition. The sensor is heated so that when precipitation ends, it dries and activates the motor to once again cover the wet-side bucket. For NTN, the purpose of the wet-side bucket is to collect wet-deposition-only samples. The purpose of the lid seal is to protect these wet-deposition-only samples from evaporation and contamination by dry deposition. The dry-side bucket serves two purposes: (1) to protect the lid seal from contamination during precipitation, and (2) to collect precipitation that is missed by the wet-side bucket so that this missed precipitation can be reported. Because of malfunctions in the ACM sensor, motor, power supply, etc., not all samples are wet-deposition-only. Section 2.3.2 defines the three NTN sample types for which the definitions are based on the exposure of the wet-side bucket to atmospheric (wet and dry) deposition.

The Belfort gage is a spring-scale device with a wind-up or battery-powered clock that spins a recording chart drum. The Belfort catch bucket is always open to receive precipitation. Precipitation that accumulates in the catch bucket compresses the spring scale. Through a mechanical linkage, the spring scale deflects a pen in proportion to the precipitation amount. This pen records the precipitation amount on the chart drum. Since the chart drum makes one complete revolution every 8 days, it records the amount and time of precipitation. In addition, the gage is equipped with an event recorder that records the duration of the opening of the wet-side bucket. The purpose of the Belfort gage is to measure precipitation with a device that is independent of the automated ACM collector and is specifically designed to record precipitation amounts. The purpose of the event recorder is to record the opening and closing of the wet-side bucket in a way that can be readily compared with the occurrence of precipitation. This comparison is an important way to verify that the sample in the wet-side bucket is a wet-deposition-only sample.

Every Tuesday Morning (NADP,1994), the NTN training video available from the CAL (see Section 7.1 for contact information), describes the procedures that every Site Operator is expected to follow (see Section 2.5.1 for responsibilities). Every Tuesday morning, the Site Operator travels to the field site, notes any changes or unusual circumstances in the immediate area, collects the bucket from the wet side of the ACM collector and replaces it with a CAL-cleaned bucket, changes the chart in the Belfort gage, and performs checks to ensure the field equipment is operating properly. The Site Operator then transports the bucket and gage chart to the field lab where the bucket is weighed and the sample it contains (up to 1 liter) is transferred to a sample bottle. If the sample weighs 70 grams or more, a portion is poured from the sample bottle and used for field chemistry measurements. The remaining sample is sent to the CAL for chemical analysis. All data and information for the sample are recorded on the NTN Field Observer Report Form (FORF) sent to the CAL along with the sample bottle, gage chart, and used bucket.

2.3.1 The Standard Sampling Period

The sampling period is the time interval that begins when the bucket is installed in the wet side of the ACM collector and ends when it is removed. Below are several descriptions of standard sampling periods:

- Samples accumulate for 1 week, Tuesday to Tuesday.
- Wet-side buckets are removed and replaced at approximately 9 a.m. (0900 hours) local time each Tuesday. If it is raining or snowing at collection time, buckets are changed after precipitation stops or as dictated by the Site Operator's travel schedule. To be included in the NTN data and statistical summaries, samples must have sampling periods from 6 to 8 days (144 to 192 hours).
- Wet-side buckets are replaced weekly, measured, and sent to the CAL even when no precipitation was collected. Buckets containing no precipitation may be used for "field blanks," which are checked for the same ions as precipitation and are used to assess possible contamination. "Field blanks" are part of the NTN quality assurance program and are described in Section 6.5.

Every 8 weeks the dry-side bucket is replaced with a bucket cleaned on site. The lid seal, too, is cleaned on this same schedule. See Section 3.2.3 for a detailed description of these procedures.

2.3.2 Sample Types

2.3.2.1 Wet-Deposition-Only Sample

A wet-deposition-only sample is a wet deposition sample collected only during precipitation so that significant dry deposition is excluded. Collection of uncontaminated wet-deposition-only samples is the highest priority of NTN field site operations. During normal operation of the ACM collector, the wet-side bucket is uncovered when precipitation is occurring and is covered when precipitation is not occurring, i.e., during dry weather. Short periods of exposure to dry weather may occur, however, while the sensor is drying after precipitation ends. To accommodate this limitation in the ACM sensor performance, the NTN applies an operational definition of a wet-deposition-only sample as a sample that has been exposed to dry weather for 6 hours or less during the 1-week sampling period. Another limitation of the ACM sensor is its insensitivity to drizzle and light snow, which causes the precipitation amount in the bucket to be lower than the amount in the Belfort gage. Note that the operational definition is based on the sample's limited exposure to dry deposition, not on the agreement between precipitation depths in the wet-side bucket and in the Belfort gage (referred to as "collection efficiency" and discussed in Section 3.3.7.3).

2.3.2.2 Bulk Sample

A wet-side bucket exposed continuously to the atmosphere during the entire sampling period is defined as a bulk sample. A bulk sample is collected when the ACM lid is positioned and secured over the dry-side bucket by the Site Operator. The Site Operator chooses this protocol because the ACM collector has failed the tests to open and close normally during precipitation and dry weather, respectively. An ACM collector malfunction or power problem is the most common cause of the problem. While collecting a wet-deposition-only sample is the highest priority for NTN field operations, collecting a bulk sample is preferable to collecting no sample or an undefined sample (see

Section 2.3.2.3). That's because exposure of bulk samples to the atmosphere is well-defined. Bulk samples are flagged in the NTN database so that data users can distinguish them from wet-deposition-only samples.

2.3.2.3 Undefined Sample

Any sample that is not a wet-deposition-only or bulk sample is an undefined sample. An undefined sample occurs when the ACM collector malfunctions or fails and the wet-side bucket is open during dry weather for more than 6 hours. Typically, this equipment problem occurs during a sampling period, making it difficult to ascertain exactly when abnormal exposure of the wet-side bucket began. One example is when the ACM sensor heater stops working and the sensor dries only under ambient conditions. If a nighttime rain shower occurs during this scenario, the wet-side bucket may remain open until the sensor is heated the next day by the sun. Another example is when a switch fails and the ACM lid cycles continuously between the buckets. In both examples, detailed documentation would be needed to communicate the conditions under which the wet-side buckets were exposed to wet and dry deposition. Since this documentation is not available, the NTN defines these samples as undefined samples and flags the data as invalid.

2.4 Site Support and Management

Section 1.2 describes the origin and evolution of NADP, which is SAES National Research Support Project-3, a long-term monitoring program in support of research on the effects of atmospheric chemical deposition. Project NRSP-3 forms the basis for agencies of the federal government, state and local governments, and other public and private research organizations to cooperate in pursuit of commonly held goals and objectives. It also provides the organizational framework for governing the NTN. NTN methods and procedures are set by the NADP Technical Committee. All site Sponsoring and Operating Agencies are representatives, as are other interested persons, including scientists, technicians, policy-makers, and managers who attend the annual meeting. Interested persons are encouraged to become active in the Technical Committee and in one or more of its three subcommittees, the Network Operations Subcommittee, the Data Management and Analysis Subcommittee, and the Environmental Effects Subcommittee. The NADP Web page (see Section 7 for the address) contains up-to-date information on past and upcoming meetings.

Every NTN site has a Sponsoring Agency and an Operating Agency. For some sites the Sponsoring and Operating Agencies may be the same. These Agencies are generally responsible for ensuring that the equipment, facilities, materials, resources, and people are available to run the site and for paying for CAL and NADP Program Office services. All sites are expected to have the required equipment and to follow the NTN standard operating procedures described in Section 3.

2.4.1 Sponsoring Agency Responsibilities

Describing the nation's chemical climate requires a high-quality data set. Success in meeting this goal requires the stable long-term commitment of NTN's Sponsoring Agencies. Sponsoring Agencies support one or more sites and are members of the NADP Technical Committee. Each site must have a Sponsoring Agency in order to participate in the NTN.

Sponsoring Agency responsibilities include:

- Providing funds to pay for NTN participation, which includes the services provided by the CAL and NADP Program Office.
- Partnering with an Operating Agency (see Section 2.4.2) to ensure a site has the material resources and people to maintain and operate the site in compliance with NTN requirements and standard operating procedures.
- Participation in the NADP Technical Committee and Subcommittees.

2.4.2 Operating Agency Responsibilities

Each NTN site has an Operating Agency that ensures the site is equipped properly, the equipment is installed in compliance with network siting criteria, and that standard site operational procedures are followed. Operating Agencies and Sponsoring Agencies cooperate to provide the resources necessary to fulfill these obligations. Operating Agencies designate a Site Supervisor (see Section 2.5.2) who oversees site operations and assists in solving operational or other problems. Operating Agencies are members of the NADP Technical Committee.

Operating Agency responsibilities include:

- Providing and maintaining an ACM collector and Belfort gage equipped with an event recorder to collect and measure precipitation at the field site and a weighing scale, pH meter, and conductivity meter/cell to measure the sample weight, pH, and conductivity in the field laboratory (see Appendix A).
- Arranging for the resources to install, operate, and maintain a field site and field laboratory, including (1) land-use (e.g., lease) agreements, (2) site security, (3) travel to the site, (4) compliance with site installation criteria, (5) adequate DC (solar/battery) or AC power for the ACM collector, (6) repair/replacement of pH meter and conductivity meter/cell as needed, (7) initial training of the Site Operator, and (8) the cost of sending samples to the CAL.
- Providing a Site Operator (see Section 2.5.1) who operates and maintains the site and helping the Site Operator to solve operational or siting problems when they arise.
- Participating in the NADP Technical Committee and Subcommittees.

2.5 Site Personnel

Each site has a designated Site Operator and Site Supervisor who perform the routine and occasional special tasks necessary to operate the site in accordance with standard NTN procedures and criteria.

2.5.1 The Site Operator

The Site Operator has primary responsibility for monitoring equipment operation and maintenance, physical maintenance of the site, weekly collection and measurement of samples, sample documentation, and submission of samples and documentation to the CAL. One or more observers may assist the Site Operator in these responsibilities. Excluding travel to the site, Site Operators

generally spend about 2 hours performing their weekly duties. Through their diligence to these duties, Site Operators are largely responsible for determining the quality of NTN data. Their cooperation and dedication continue to make NTN one of the most successful environmental monitoring programs anywhere.

Site Operator duties include:

- Travel to the field site and inspect the site and equipment every Tuesday.
- Collect the wet-side bucket from the ACM collector and the Belfort gage chart.
- Install a new Belfort gage chart and clean ACM collector bucket for the next sample.
- Perform routine equipment maintenance or repairs as needed or prescribed.
- Transport the bucket and Belfort gage chart to the field laboratory.
- Weigh the bucket and transfer the sample it contains to a sample bottle.
- For samples of 70 grams or more, remove a portion from the sample bottle to measure sample pH and conductivity.
- Read and interpret the event recorder and precipitation records on the Belfort gage chart.
- Record the precipitation data, field chemistry data, and all other sample data and information on the NTN FORF.
- Ship the sample bottle, used bucket, completed FORF, and Belfort gage chart to the CAL within 48 hours of sample collection.
- Perform occasional special maintenance (see Section 5) or quality assurance tasks in cooperation with the CAL or other agencies.
- Contact the CAL with any questions about equipment or procedures.

Section 3 describes the Site Operator procedures in detail. Another resource is the training video, *Every Tuesday Morning*, which demonstrates the procedures that Site Operators follow. All Site Operators should have a copy of this video. See Section 7.1 for information on where to get a copy of the video. In addition, the NADP Program Office sponsors an annual Site Operator Training Course, and Site Operators are encouraged to attend. See Section 7.2 for contact information about the next course.

2.5.2 The Site Supervisor

The Site Supervisor is responsible for overseeing site operations and for ensuring that protocols are followed. A Site Supervisor may be on site or remote; however, the tasks remain essentially the same.

A Site Supervisor:

- Ensures that the Site Operator follows standard NTN site operational procedures.
- Reviews the site data, especially the reports and summaries issued by the CAL and NADP Program Office, to look for anomalies and possible problems.
- Assists the Site Operator in troubleshooting operational or procedural problems and works with the Sponsoring or Operating Agencies to arrange for resources needed to correct these problems.

2.6 Technical Support

Sites receive technical support from four organizations: (1) the NTN Central Analytical Laboratory (CAL), (2) the NADP Program Office, (3) the USGS Branch of Quality Systems, and (4) a USEPA contractor, Advanced Technology Systems (ATS), Incorporated, which conducts site systems and performance surveys. Technical support from these organizations covers a broad range of topics, including guidance in installing sites, day-to-day help in troubleshooting equipment malfunctions, assistance with pH and conductivity measurement problems, and conducting site performance evaluations. Figure 2-3 illustrates the relationship between these organizations and NTN sites.

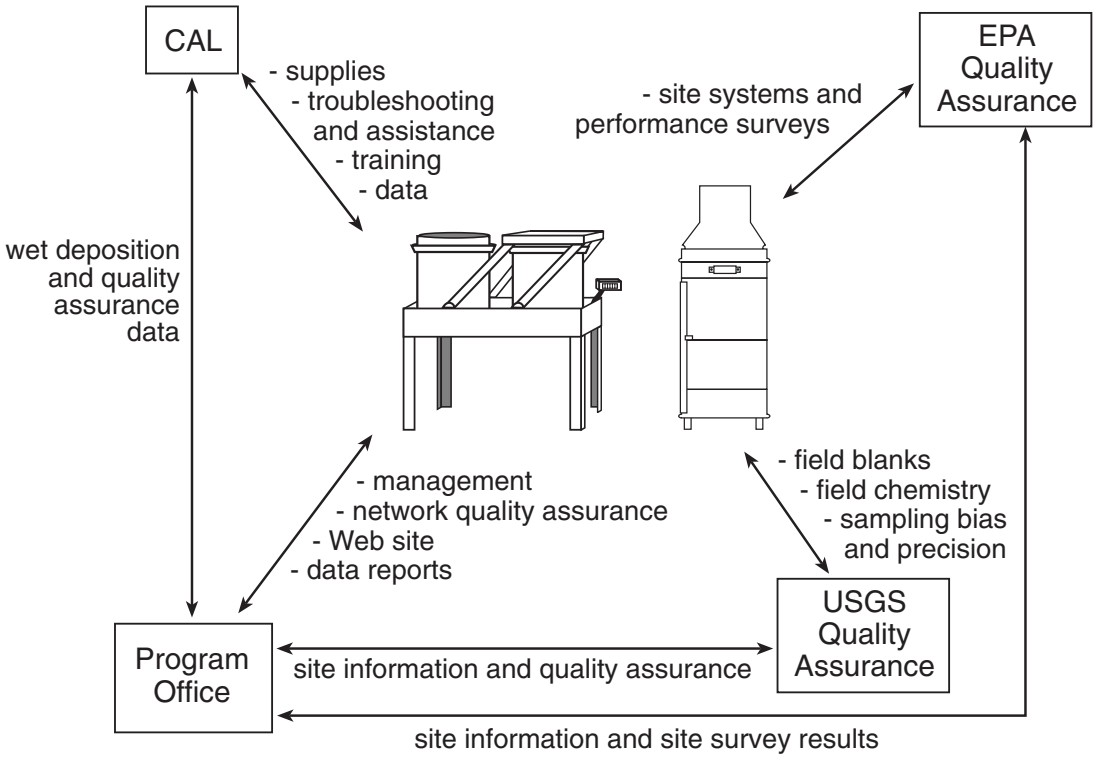


Figure 2-3. Technical support of NTN sites.

Section 7 lists contact information for these organizations.

2.6.1 Central Analytical Laboratory

All NTN samples are sent to the CAL at the Illinois State Water Survey (ISWS). The CAL provides site support, chemical analysis, and data reporting and validation services. This includes providing certain supplies needed for site operations, providing information on site operational problems and procedures, providing chemical analyses of samples, and verifying, screening, and reporting the data.

On receipt of a sample, the CAL replaces the used bucket, lid, and sample bottle with clean ones and returns these supplies to the site. Other expendable supplies (see Section 3.3.9 for a list of supplies available from the CAL) are included when indicated on the NTN FORF. In addition, the CAL supplies parts from the NADP Network Equipment Depot (NED). One of these items, the foam lid seal for the ACM collector, is replaced annually at all sites. It is also replaced if it becomes damaged. The CAL replaces other parts when they fail to operate properly. Replacement parts from the NED include the ACM motor box and sensor, the weighing mechanism and clock for the Belfort gage, and the event recorder, which records the opening and closing of the wet-side bucket of the ACM collector and is mounted in the Belfort gage.

Staff at the CAL enter data from each FORF into a database management system and check data completeness and accuracy. Field data from the FORF are combined with the chemical analytical data from the laboratory and the combined data set is reviewed. Each month Site Operators and Site Supervisors receive a preliminary data report from the CAL (see Section 4). These reports contain notes and descriptions of errors that alert Site Operators and Supervisors of potential problems or inconsistencies requiring corrections or further checks to confirm data accuracy. In addition, CAL staff screen the data to flag samples that have been grossly mishandled, are contaminated, or are not wet-deposition-only samples. Most importantly the CAL provides full-time assistance to help site personnel identify and solve equipment, operational, or procedural problems; help resolve data problems; and answer questions. Communications between site personnel and the CAL are by toll-free telephone or FAX or e-mail (see Section 7.1 for contact information). When the data verification and quality assurance checks have been completed, the data are delivered to the NADP Program Office. The CAL also conducts annual training courses for Site Operators.

2.6.2 Program Office

The NADP Program Office provides overall management of the NTN by coordinating the network activities of the Sponsoring Agencies, Operating Agencies, Site Supervisors, and Site Operators. It also manages the network quality assurance program by coordinating the quality assurance activities of the CAL, the USGS, and the USEPA. The Office receives quality-assured data from the CAL and stores and manages these data in the NADP database. Primary access to NTN data is through the NADP Web site (http://nadp.sws.uiuc.edu) maintained by the Program Office. The Program Office also issues data summaries, reports, and brochures, and is responsible for archiving network documents and making copies available on request. Information about locating and installing a site or site equipment and about the cost of participation in the NTN is also available from the Program Office. The Program Office manages the agreement that establishes the services provided by the CAL, and it manages the NED and provides for the repair and refurbishment of NED equipment. Other responsibilities of this Office include coordination of the activities of the NADP Technical Committee, its Subcommittees, and other Committees, and coordination with other U.S. and international networks. Finally, the Program Office is responsible for arranging the annual Site Operator training course conducted by the CAL.

2.6.3 USGS and USEPA Quality Assurance Programs

The USGS and USEPA support a number of quality assurance programs that address field site operations. Results of these programs provide the NADP Program Office, funding agencies, and site personnel with information on whether siting criteria are met, equipment meets operational specifications, standard operational procedures are followed, and measurement bias and precision meet NTN targets. Both agencies issue reports of their findings. Copies can be obtained from the NADP Program Office (see Section 7 for an address).

Current USGS and USEPA quality assurance programs are listed below and are described more completely in Section 6:

- *NTN Site Systems and Performance Surveys (ATS, Inc., under USEPA contract)*. Trained inspectors visit each site approximately every 2 years to check for siting and equipment problems, ensure that standard NTN procedures are followed, and provide Site Operators with assistance in making equipment adjustments or solving problems. At the conclusion of the visit, a brief report is delivered to the Site Operator and Supervisor, and a complete report is sent to the CAL.
- *Blind-Audit Program (USGS*). Site Operators send the CAL a synthetic sample disguised as a wet deposition sample. The sample analysis is used to assess possible biases in NTN measurements resulting from the sample containers, handling, and analysis. A site sends one blind-audit sample to the CAL about once every other year.
- *Intersite Comparison Program (USGS)*. Site Operators report the pH and conductivity measurements of a synthetic solution of composition unknown to them. These tests are performed twice a year. Assistance is available to Operators who have problems with these measurements (see Appendix B, which deals with troubleshooting pH and conductivity measurement problems).
- *Collocated-Sampler Program (USGS)*. Site Operators run paired, collocated ACM collectors and Belfort gages, collecting two samples and changing two raingage charts each week. At the field site and at the CAL, these samples are treated independently as if from separate sites. Data from this program provide estimates of the overall precision of NTN wet deposition measurements from the point of sample collection through data verification and screening. Collocated samplers are operated at a site for 1 year; then the second set of equipment is moved to another network site.
- *Field Blank Program (USGS)*. Site Operators add a synthetic solution to the wet-side bucket at the end of a sampling period when no precipitation occurred. The Operator handles the solution as if it were a wet deposition sample, sending it to the CAL for analysis. The sample analysis is used to assess possible biases in NTN measurements from a sample container left in the ACM collector for an entire sampling period, then handled and analyzed as if it were a precipitation sample.

For a listing and contact information of the agencies and individuals involved in these programs, see Section 7.

2.7 References

Bailey, R.G. 1976. *Ecoregions of the United States.* Scale 1:7,500,000. U.S. Forest Service Intermountain Region, Ogden, UT.

Bailey, R.G. 1978. *Description of the Ecoregions of the United States.* U.S. Forest Service Intermountain Region, Ogden, UT.

NADP. 1984. *Instruction Manual: NADP/NTN Site Selection and Installation*. NADP Program Office, Champaign, IL.

NADP. 1994. *Every Tuesday Morning - 1994, NADP/NTN Deposition Monitoring Training Aid for Site Operators.* (S. Dossett and J. Frisch, eds.) NADP Program Office, Champaign, IL.

Robertson, J., and J. Wilson. 1985. *Design of the National Trends Network for Monitoring the Chemistry of Atmospheric Precipitation*. U.S. Geological Survey, Circular 964, Alexandria, VA.

3 NTN Site Operating Procedures

This section contains detailed procedures for the operation of an NTN field site. It includes information about regular equipment checks, collecting samples from the field, performing field chemistry measurements, recording data, and shipping samples to the laboratory.

Following these procedures helps to ensure the uniform, high-quality data that NTN seeks and to minimize the possibility that data will be invalidated.

3.1 General Guidelines

The success of the NTN depends upon each Site Operator's continuing commitment to follow the procedures outlined in this manual. Each Site Operator is expected to adhere to these general guidelines:

- Measure wet deposition using only an Aerochem Metrics (ACM) 301 precipitation collector and Belfort B5-780 recording raingage equipped with an event recorder.
- Maintain equipment in good working order.
- Maintain areas surrounding the collector as described in Section 5 of this manual.
- Submit prospective site or equipment moves or modifications to the Program Office for review prior to implementation.

And, most important:

- Follow the weekly Tuesday to Tuesday sample collection schedule and submit samples with a completed Field Observer Report Form (FORF) and raingage chart to the Central Analytical Laboratory (CAL) for analysis.

3.2 Field Procedures

In this section the terms *field bucket* and *sample bottle* are used. The ACM collector has side-by-side buckets, one labeled *WET* and the other *DRY* on the instrument base. The term *field bucket,* is used for the bucket installed on the *WET* side of the collector. The *sample bottle* is the 1-liter bottle used to send the sample to the CAL.

3.2.1 Preparing for Sample Collection

3.2.1.1 Check Mailer Contents upon Receipt

Each site is allocated a supply of at least six mailers. At any time two or three mailers should be available on site. **Rotate through the stock of mailers at least every 6 weeks.**

Open and inspect the black mailer from the CAL immediately upon receipt to verify that all supplies are present and in good condition. The mailer should contain:

- A 1-liter high-density polyethylene (HDPE) wide-mouth sample bottle (bagged)

- A standard NTN 3.5-gallon linear polyethylene (LPE) field bucket (bagged)
- A snap-on lid for the field bucket (bagged)
- Supplies or items you have requested via a previous FORF (see Section 3.3.9) or other items from the CAL

Remove the sample bottle from the mailer and carefully store it in its plastic zippered bag in a clean, dry place in the laboratory. **Never take the sample bottle to the field site.**

3.2.1.2 Prepare to Service Field Site

To change the bucket on the collector and service the recording raingage, take the following supplies to the field site (Figure 3-1):

- The black mailer containing the bagged field bucket and snap-on lid
- A notebook and pen to record comments about contamination in the bucket, equipment malfunctions, and activities near the site (burning, farming, etc.)
- A permanent ink marker to write comments directly onto the field bucket bag
- A few lab wipes or tissues in case something needs to be wiped clean (to remove bird droppings on the sensor, for example)
- A plastic squeeze bottle containing distilled water to activate the sensor on the ACM collector
- A raingage chart No. 5-4046-BI for the Belfort. **Note:** Use only this chart. It was especially prepared for NTN.

Figure 3-1. Pack the mailer for the field site.

3.2.2 Changing Wet-Side Field Bucket and Checking Equipment

Replace the field bucket on the collector every Tuesday morning at 0900 hours local time. Slowly and carefully change the bucket using the procedures described below. Note any contaminants present in the wet-side field bucket and precipitation in the dry-side bucket.

If precipitation occurs during the site visit, there are two collection options available, depending on time and travel schedules:

1. Collect the sample after precipitation stops. This is the easiest option if a brief shower occurs and a break in precipitation is imminent. Otherwise, the sample can be collected later on Tuesday.

2. Collect the sample during precipitation. Be careful to prevent contamination from clothing, an umbrella, the collector lid, or the bucket lid from entering the field bucket.

Time and travel schedules and steady precipitation may make option 2 necessary. If possible, wait until the precipitation slows. Whatever the situation, extra care is necessary. Unless safety is a concern, do not skip the Tuesday collection.

For inclusion in NTN summaries, samples must have sampling periods of 6 to 8 days (144 to 192 hours). If you cannot reach the site within 1 or 2 hours of 0900 hours, make sure the sampling period fits into the above time frame.

Never touch sampling surfaces. Precipitation samples have very low ion concentrations, and any contamination could result in unrepresentative data. For example, one drop of human perspiration invalidates a sample for sodium, chloride, ammonium, and possibly other ions. A fingerprint inside a bucket or lid may contain more sodium than the entire sample.

Check the main functions of the collector each week. These functions are the motor box *off* and *on* switching functions, the sensor heating and switching functions, and the operation of the event recorder in the raingage. Use the Precipitation Collector Troubleshooting Guide, Appendix C, to diagnose and resolve any problem. Contact the CAL at 1-800-952-7353 for additional help to solve the problem or determine which components require replacement and which precipitation samples may have been affected.

If the collector fails any of the function checks:

- Try to confirm that the collector is getting power.
- If the collector is cycling back and forth, unplug the sensor to see what happens.
- If the drive motor does not respond to the sensor being wet, try to push the clutch mechanism 2 or 3 inches to see what happens (see Appendix C).

3.2.2.1 Weekly Sampling Routine

1. Approach the collector and work from the downwind side to reduce windblown contaminants. Inspect the site and equipment for damage.

Initial Collector Checks

2. Check the temperature of the sensor on the collector by touching the sensor plate (Figure 3-2). Unless the collector has been open within the last few minutes, it should feel cool.

3. Inspect the dry-side bucket and note the presence of any precipitation. Large amounts of precipitation in the dry-side bucket may indicate a collector malfunction. Estimate the precipitation volume in the dry-side bucket. Later you will record this observation.

Figure 3-2. Check the sensor temperature.

4. Open the black mailer and set the lid inside up on the ground.

5. Activate the sensor grid by applying a few drops of water (Figure 3-3). **Do not use metal to short the grid as this may damage it**. The collector should open immediately, the collector lid should move to cover the dry-side bucket, and then the drive motor should turn off. Observe this movement. The collector lid should operate freely with little motor noise, and the lid seal should rest snugly on the dry-side bucket.

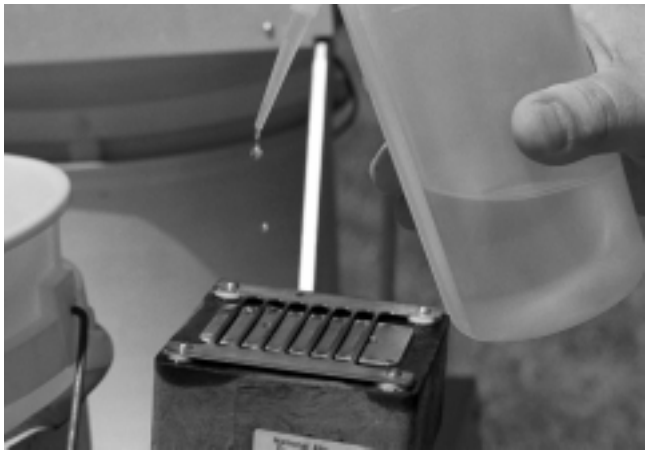


Figure 3-3. Activate the sensor with water.

6. After the collector has been open for at least 5 minutes, check the sensor with your finger. The sensor plate should feel warm.

7. Carefully examine the wet-side bucket for contamination. In your notebook you will make detailed notes describing any contamination (see step 10). This is very important since some contaminants, such as bird droppings or soil particles, get mixed into the sample during transport and go unnoticed. **Never remove contaminants from the bucket.**

Changing the field bucket

8. Remove the bagged snap-on lid from the black mailer. Undo the twist-tie and while grasping the lid through the outside of the bag, carefully pull the bag over your arm. Seal the lid onto the field bucket by pushing down on the center in typical "Tupperware" fashion. Be careful not to touch the inside of the lid or bucket while you snap it into place (Figure 3-4).

9. Remove the sealed field bucket from the collector. Place it into the plastic bag that previously held the clean lid and secure it with the twist tie. Set the bucket in the black mailer.

10. In the notebook and also on the outside of the plastic bag, use a permanent marker to write the site ID, date and time off, and the presence of any soil, bugs, bird droppings, etc. as described in Step 7. **Do not write on the snap-on lid or field bucket (Figure 3-5).** Note that the time of the bucket change will be used to complete two separate FORFs: (1) the previous week's bucket *off* time and (2) new bucket *on* time.

Figure 3-4. Put the lid on the bucket.

11. Check the event recorder operation. Inspect the recording raingage while the collector is open. Check to make sure the event recorder pen (upper pen) is in the *up* position (Figure 3-6). This position indicates that the motor box and the event recorder are both operating correctly.

12. Install the clean field bucket on the collector using the bag as a glove. **Do not touch any inside surfaces of the bucket**. Do not remove the bucket from its bag until you are ready to place it on the collector.

Figure 3-5. Note comments on the plastic bag.

Final Collector Checks

13. Check to see that the sensor is hot to the touch (Figure 3-2). Blow any remaining water off the sensor. Observe the collector lid movement as it covers the wet-side bucket. It should move smoothly and complete its cycle in less than 15 seconds.

14. Check to make sure the lid seal fits snugly over the wet-side bucket (Figure 3-7). If the seal is not snug or the vinyl cover is ripped or cracked, request a new one. Call the CAL promptly and circle *lid seal pad* on the FORF (Block 9). A damaged lid seal or one that fits poorly can contaminate the sample.

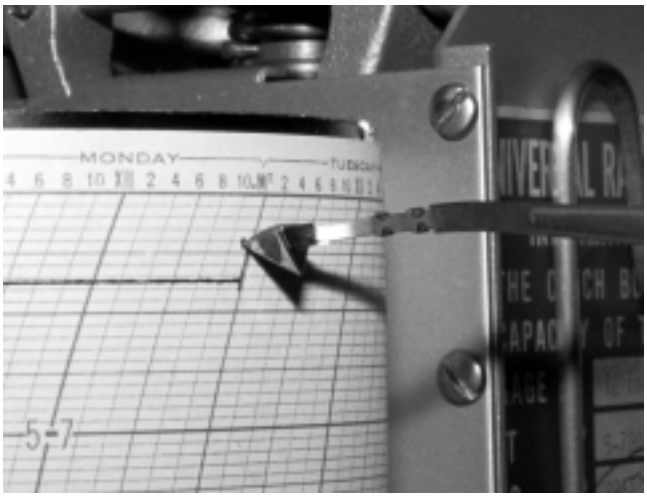


Figure 3-6. Check that event recorder pen is up.

If the collector fails any sensor or motor box checks, place it into bulk sampling mode (see Section 3.2.2.2) and call the CAL.

15. Prepare to transport the sample to the field laboratory. Secure the mailer lid with all four straps.

16. Transport the sample to the field laboratory carefully to prevent leakage,

Figure 3-7. Check the lid seal fit.

which can compromise all precipitation weight information and cause contamination. If leakage occurs, measure it as discussed in Section 3.3.6.1. The twist-tied bag will help to confine leakage. The bag also prevents packing material fibers from contaminating the sample. **Never return spilled sample to the bucket.**

If you spill the sample or drop the bucket, note this on the FORF (Block 10). Note whether the sample could have been contaminated. If the rim of the bucket or the inside of the lid contacts any foreign surfaces, the sample is potentially contaminated.

3.2.2.2 Bulk Sampling

If the ACM collector, sensor, or motor box fail to operate correctly, collect a bulk sample (see description in Section 2.3.2.2). If you collect a bulk sample, note this on the FORF (Block 10) and promptly notify the CAL. Bulk sampling requires that the wet-side bucket be uncovered for the entire sampling period.

Method A

If the collector motor box will move the collector lid, activate the sensor. When the lid is on top of the dry-side bucket and just starting to compress the lid seal, unplug the collector from all power sources.

Method B

If the collector motor box will not move the collector lid, reach under the main frame of the collector and push the clutch arm counterclockwise (see Appendix C). The clutch will disengage (a little effort may be required), and the lid mechanism will be free of the drive system. Manually position the lid over the dry-side bucket. Unplug the collector to prevent unexpected reactivation of the motor box.

3.2.3 Maintaining Dry-Side Bucket and Foam Lid Seal

On the first Tuesday of every month change the dry-side bucket when you perform the wet-side bucket change. This is necessary to help ensure a clean surface for the lid seal to rest upon during precipitation. Each site should have two 3.5-gallon LPE buckets dedicated to dry-side use: one bucket installed on the collector and the other cleaned, bagged, and ready to use as a replacement. Both buckets should be plainly marked in permanent marker: *DRY-SIDE USE ONLY.*

> **Caution:** Using a *Dry-Side Use Only* bucket to collect a wet-side sample will invalidate the wet-side sample.

3.2.3.1 Cleaning Dry-Side Buckets at Field Laboratory

- Rinse the bucket inside and out with lots of tap water. Scrub the bucket with a sponge or paper towel to remove any debris and dirt films.

- To prevent any chemical residues from forming, do not use detergents or alcohol.
- After cleaning the bucket with tap water, rinse it with distilled water and shake off excess.
- Place the bucket in a spare CAL bag and fasten it with a twist tie.

3.2.3.2 Changing Dry-Side Buckets and Cleaning Foam Lid Seal

1. When you change the dry-side bucket, take the replacement bucket (that was cleaned as detailed in Section 3.2.3.1), a squeeze bottle with distilled water, and some lint-free tissues to the field site. If you do not have a replacement bucket, remove a clean bucket from your supply of mailers. Label it plainly with a permanent marker: *DRY-SIDE USE ONLY*, and use it as one of two dry-side buckets. Return the empty mailer to the CAL to be refilled and sent back to you.

2. Before operating the collector, remove the "old" dry-side bucket, set it aside, and note the presence of any precipitation.

3. Remove the wet-side bucket according to the instructions in Section 3.2.2.

4. While both buckets are out of the collector:

- Assuming the sensor is wet, dry it, and if it is dry, wet it to cause the collector lid to move. When the lid is halfway between the wet-side and dry-side buckets, unplug the power to the collector.
- Wipe the underside of the lid seal to remove any accumulated debris. Use a clean, lint-free tissue dampened with distilled water.
- Let the foam lid seal air dry.
- Wipe the top of the roof, the frame of the collector, and the sensor to remove bird droppings or other accumulations that could enter into the sample bucket from these surfaces.

5. Install the new *DRY-SIDE USE ONLY* bucket. Plug in the collector.

6. Install the new wet-side bucket.

7. Note which surfaces have been cleaned in Block 10 of the FORF.

If it is snowing, raining, or the site is experiencing freezing temperatures, you may not be able to use the lint-free tissue dampened with distilled water to wipe the underside of the lid seal. In these cases, dry wipe the lid seal, the top of the collector lid, the collector frame, and the sensor.

3.2.4 Nonstandard Sample Periods

Severe weather that renders the site inaccessible or unsafe may make it impossible to follow a standard sampling period. Most samples collected for periods outside of the 6- to 8-day (or 144- to 192-hour) interval are invalid for NTN data summaries. However, any sample changed early when heavy precipitation threatens to overflow the field bucket is valid.

If a sample has a nonstandard period, process it, perform the field chemistry measurements, and submit it. It will be analyzed at the CAL, and the data will be made available to users on request.

Always note any variance from standard sampling in Block 10 of the FORF and adjust the Precipitation Record (Block 7) to show the precipitation amount for each day of the sampling period whether long or short. Use the following procedures to minimize the problems of nonstandard sampling periods:

- Try to keep the sampling period between 144 and 192 hours. If you cannot change the bucket on Tuesday, replace it Monday (preferably late in the day) or Wednesday (preferably early in the day). This should not be a frequent practice, however.
- If heavy rain or snow threatens to fill the field bucket before the sampling period reaches 144 hours, break the sampling period into two periods. Change the bucket before it overflows (about 9 inches of rainfall), especially if more precipitation is forecast. Process each bucket independently with a separate FORF and ship it to the CAL as soon as possible. Annotate the FORF to describe incidents of snow mounding over the bucket or potential water loss due to overflow.
- When the site is inaccessible or conditions make travel unsafe, it may be necessary to collect a sample for a period longer than 192 hours. In this situation, change the field bucket as soon as possible. Do not skip the week and collect a 2-week sample. The raingage clock may stop and other equipment problems may result.

3.2.5 Servicing the Belfort Recording Raingage

Caution: The purple ink used in the raingage pens will stain your hands and clothes. USE CARE WHEN HANDLING IT. You may want to wear a pair of disposable gloves if extensive pen maintenance is required.

1. Open the raingage access door and move both pens up and down to mark their stop positions on the chart (Figure 3-8). The top pen is the event recorder pen, which records the openings of the collector. The bottom pen records the amount of precipitation. Note: The event recorder pen should be in the *down* position if the collector is covering the wet-side bucket and *up* if closed over the dry-side bucket. If this is not the case, call the CAL.

2. Lift the pens from the chart by pulling the pen shifter toward the access door.

3. Remove the chart drum. Record the time and date off in the appropriate place on the chart.

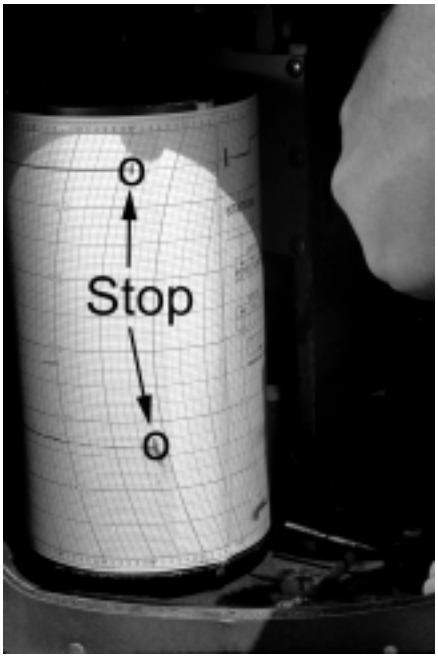


Figure 3-8. Mark the pen position.

4. Scan the event recorder trace to be sure that the collector opened and closed with each precipitation event (Figure 3-9). If the collector operated properly, the duration of the event recorder opening and the duration of precipitation will be approximately equal (see Section 3.3.7.4). **Severe collector or raingage malfunction are indicated by long *up* event recorder periods when no precipitation occurs or long *down* periods during substantial precipitation. If this is the case, call the CAL.**

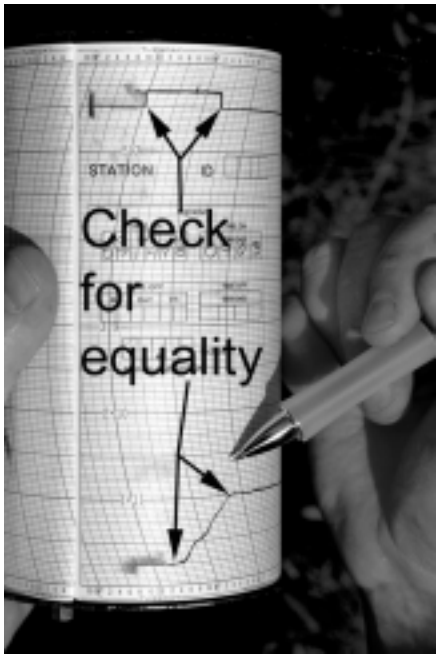


Figure 3-9. Check the operation of the event recorder.

5. Wind the clock. **Caution**: it is easy to overwind. Stop when you begin to feel resistance.

6. Remove and empty the catch bucket. Do not empty the bucket during winter operation because it contains antifreeze solution (see Section 5.2.2). Instead, stir the antifreeze solution to mix it well.

7. Remove the *old* chart by removing the chart clip. Store the chart in a clean, dry place where the wet ink will not be smeared.

8. Place the *new* chart on the drum:

- Fold under the right tab of the chart.
- Align the left edge of the graph section of the chart with the hole in the lower drum rim and the chart clip notch at the top of the drum.
- Wrap the chart counterclockwise around the drum.
- Insert the chart clip down through the folded (right tab) edge of the chart while keeping the clip tight against the fold.
- Lock the clip down by sliding the end through the hole in the lower drum rim and slipping the bend of the clip into the notch at the drum top.
- Using your hand, slide the chart down evenly against the drum rim.

9. Record the time and date on in the appropriate place on the chart.

10. Install the drum on the clock mechanism ensuring that the gears engage.

11. Push the pen shifter toward the chart drum. Rotate the chart drum until the precipitation pen (lower pen) reflects the local time. Mark the beginning of the precipitation and event recorder traces by moving the pens up and down.

12. Move the drum forward and back slightly to create a “+” where the chart starts.

13. Check the ink level of each pen and refill if necessary. The pen ink absorbs water from the air and can double its original volume. Be conservative when adding ink. If the lines on

the chart are light or smeared, the ink has possibly become diluted with water. Use tissue paper to absorb the ink from the pen nibs. Replace the diluted ink with fresh ink. **Note: Keep the ink bottle in the gage rather than carrying it back and forth each week from the laboratory.**

14. As a final check, make sure both the event recorder pen and the precipitation amount pen are recording properly.

3.2.6 Summary of Field Procedures

Item	*Procedures*
Wet-side bucket	• Inspect for contamination. • Remove from collector avoiding contact with all sampling surfaces. • Carefully install new wet-side bucket. • Pack field bucket containing sample into black mailer. • Record time, date, and contamination information on the bag containing the field bucket.
Precipitation collector	• Trigger sensor to uncover wet-side bucket and ensure normal operation of drive unit and sensor heater. • Inspect lid seal and dry-side bucket.
Recording raingage	• Remove chart and record time and date off. • Wind clock. • Compare event recorder and precipitation traces. • Install new raingage chart and note time and date on. • Start the pens inking by making a “+”.
All devices	• Perform any final checks and resolve any collector or raingage malfunctions. This may require help from the CAL and initiation of bulk mode sampling (see Section 3.2.2.2).

Note: If problems with equipment or procedures occur, call the CAL at 1-800-952-7353.

3.3 Completing Field Observer Report Form (FORF)

- Use the FORF (Figure 3-10) supplied by the CAL to record essential information about field and laboratory operations. This entire form (including any comments in Block 10, Remarks) is entered into the NTN database.

NATIONAL ATMOSPHERIC DEPOSITION PROGRAM

A Cooperative Research Support Program of the State Agricultural Experiment Stations (NRSP-3) Federal and State Agencies and Private Research Organizations

NATIONAL TRENDS NETWORK
FIELD OBSERVER REPORT FORM (FORF)

Send Completed Form with Each Mailer

Problems? Call the CAL at 1-800-952-7353, or

e-mail: sdossett@uiuc.edu, or fax: 217-333-0249

FOR OFFICE USE ONLY

N

BAG LEAK SP SL

1. SITE

Name _____ ID

2. OBSERVER

Print name _____ Initials

3. BUCKET

	Date MO	DAY	YR	Time 0001-2400
ON				
OFF				

4. SITE OPERATIONS

Check yes or no for all samples. If no for Item 1 or 2, describe in Block 10 and call CAL.

YES	NO
2	1
2	1
2	1

1. The **sensor heater** and **motor box** operated properly and the **event recorder** indicates the collector lid opened and closed promptly for each precipitation event.
2. Raingage operated properly during the week.
3. Collector opened and closed at least once during the week, **other than for testing**.

5. SAMPLE CONDITION

*Check yes or no for all samples. Describe **all** contamination in Block 10, including any not listed here.*

YES	NO
2	1
2	1

1. Bird droppings
2. Cloudy or discolored

YES	NO
2	1
2	1

3. Soot/ash/dirt particles
4. Insects/animal matter

YES	NO
2	1
2	1

5. Leaves/twigs/pollen/plant matter
6. Handling contamination

6. BUCKET SAMPLE WEIGHT

*Weigh **all** sample buckets.*

Bucket + Lid + Sample

\- Bucket + Lid

= Sample Weight (grams) X 0.00058 inches/gram = Sample Depth (inches)

7. PRECIPITATION RECORD

← **Bucket On** R - Rain Only (Includes Hail) S - Snow Only M - Mixture U - Unknown **Bucket Off** →

	TUES	WED	THURS	FRI	SAT	SUN	MON	TUES
Type *circle one* →	R S M U	R S M U	R S M U	R S M U	R S M U	R S M U	R S M U	R S M U
Amount *Inches or circle one* →	Z T MM	Z T MM	Z T MM	Z T MM	Z T MM	Z T MM	Z T MM	Z T MM

Z - Zero T - Trace MM - Missing

Do these values agree within ± 5% ? YES ☐ NO ☐ *(If no, reweigh)* Total Raingage Depth (inches)

BOTTLE USE

Did you pour sample into the bottle? YES ☐ NO ☐

8. SAMPLE CHEMISTRY

Only for buckets with a sample weight of 70 grams or more.

MO	DAY	YR

Is the DI water conductance less than 5 µS/cm? YES ☐ NO ☐ *(If no, call CAL)*

Specific Conductance (µS/cm)

75.0 Standard Certified	÷	Standard Measured	=	Correction Factor
Correction Factor	x	Check Sample Measured	=	Check Sample Corrected
Correction Factor	x	Precipitation Sample Measured	=	Precipitation Sample Corrected

pH

Check Sample pH

Precipitation Sample pH

9. SUPPLIES

Circle if needed, until received.

Vials	Field Forms
pH Electrode	Sample Bottles
pH 4 Buffer	Gloves (S, M, L)
pH 7 Buffer	Raingage Charts
Check Sample	Raingage Ink
75 µS/cm Std	Dashpot Fluid
Electrode Filling Solution	Lid Seal Pad

10. REMARKS

For example: equipment malfunction, contamination, farming, burning, logging, leakage before weighing, etc.

Rev. 12/98

Figure 3-10. Field Observer Report Form.

- Complete the FORF using either a ballpoint pen or a sharp No. 2 pencil. Be certain that notations are legible on **all** copies and that the form is **completely** filled out.
- Do not fill out the FORF on top of other blank FORFs.
- Incomplete or illegible FORFs require additional time to process and usually require phone inquiries to the Site Operator or Site Supervisor from the CAL.
- Site Operators should use **two FORFs** each week. One contains the information gathered at the field site for the week just ending. The other is for the week just beginning. This will reduce date and time errors and help substitute Observers complete the forms without errors.

3.3.1 SITE, Block 1

1. SITE

Name _____ ID

Figure 3-11. Block 1.

Fill in the Site Name and ID as assigned (Figure 3-11). Site Names are chosen during the site selection and installation process. The Site ID is a four-character code.

3.3.2 OBSERVER, Block 2

2. OBSERVER

Print name _____ Initials

Figure 3-12. Block 2.

Print the name and initials of the person to whom the CAL should direct questions concerning the week's sample and site operations. Use three initials whenever possible (Figure 3-12).

3.3.3 BUCKET ON/OFF, Block 3

3. BUCKET

	Date			Time
	MO	DAY	YR	0001-2400
ON				
OFF				

Figure 3-13. Block 3.

Record the date (month/day/year) and local time when the field bucket was installed (ON) and removed (OFF). Figure 3-13 defines the sampling period. Use 24-hour time, which runs from 0001 to 2400 hours. Therefore 9:00 a.m. is 0900 hours and 5:00 p.m. is 1700 hours. Declarations of standard or daylight-savings time are not necessary.

3.3.4 SITE OPERATIONS, Block 4

Because the Site Operator is the only one who observes the condition of the equipment in the field, it is crucial to obtain the Operator's assessment of field equipment performance.

4. SITE OPERATIONS

Check yes or no for all samples. If no for Item 1 or 2, describe in Block 10 and call CAL.

YES	NO	
2	1	1. The **sensor heater** and **motor box** operated properly and the **event recorder** indicates the collector lid opened and closed promptly for each precipitation event.
2	1	2. Raingage operated properly during the week.
2	1	3. Collector opened and closed at least once during the week, **other than for testing**.

Figure 3-14. Block 4.

Check *Yes* or *No* for each question in Block 4 (Figure 3-14). Answers to these questions and the comments provided in Block 10 are used to decide whether the sample is valid. For questions 1 and 2, a *Yes* indicates correct site operations, while a *No* indicates problems that must be documented in Block 10. **Notify the CAL by telephone (1-800-952-7353) when responses to questions 1 or 2 are *No*.**

Question 1 addresses the collector. Answer *No* if the checks performed during the bucket change uncovered any malfunctions in the sensor heater, motor box switching, or event recorder mechanisms.

Question 2 addresses the raingage. Answer *No* if the clock did not perform accurately during the sampling period or the pens did not trace correctly on the chart.

Question 3 requires a response **only if the site is equipped with a properly working event recorder.** Check *Yes* if something other than a test triggered the sensor and caused the roof mechanism to uncover the wet-side bucket. If the event recorder is inoperative, leave this response box blank.

3.3.5 SAMPLE CONDITION, Block 5

- Complete Block 5 (Figure 3-15) for **all samples** even if the bucket is dry.
- **Never attempt to remove any contaminant, no matter how large, from a bucket.**
- In Block 10, describe all contaminants observed in the field bucket.

5. SAMPLE CONDITION

Check yes or no for all samples.
*Describe **all** contamination in Block 10, including any not listed here.*

YES	NO	
2	1	1. Bird droppings
2	1	2. Cloudy or discolored

YES	NO	
2	1	3. S
2	1	4. In

Figure 3-15. Block 5.

Block 5 provides important information about contaminants in the field bucket before the precipitation is transferred to the sample bottle. These become mixed during transit and may not be

visible when the sample bottle arrives at the CAL. This information cannot be obtained unless you record it.

Use information recorded in field notebooks and on the bag protecting the field bucket to fill out this block. Observations should have been made at the site before placing the lid on the field bucket, while it was still in the collector.

Check each box *Yes* or *No* and enter comments regarding the type, size, and amount of contaminants in Block 10. Some may not be identifiable as either animal or plant in origin. It is not necessary to know the exact source of a contaminant.

Note: The CAL does not automatically invalidate the sample because of the presence of contaminants.

3.3.6 BUCKET SAMPLE WEIGHT, Block 6

- In the laboratory remove the field bucket from the black mailer and plastic bag. Leave the bucket lid on during this step. Save the bag for use later.
- Do not spill or discard any water or snow that may be in the bag. Any sample that has leaked from the field bucket must be measured.

Weigh all buckets whether or not they contain precipitation and record information in Block 6 (Figure 3-16).

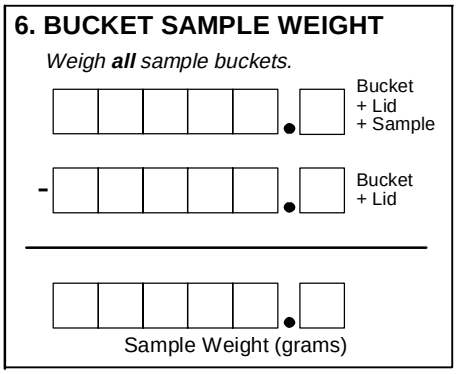


Figure 3-16. Block 6.

3.3.6.1 Measure Any Leakage

- If any sample leaked into the bag during transport, you must measure the leakage. First, weigh the bag containing the leakage, and then the bag alone. Obtain the weight of the leakage by subtracting the bag weight from the bag weight plus leakage. An alternative method is to pour the lost liquid into a graduated cylinder and measure its volume. Recall that 1 milliliter (mL) of water is equal to 1 gram (Figure 3-17).
- Note the occurrence of any leakage and its exact amount in Block 10 of the FORF. This amount will be added to the *Bucket + Lid + Sample* weight in the next step. Be as specific about the circumstances of the leakage as possible. For example, when and how did the field bucket leak, and could the sample have been contaminated?
- After weighing and recording any leakage, discard the lost water. **Do not return it to the sample bucket.**

Figure 3-17. Measure sample leakage.

3.3.6.2 Weigh the Sample

- Carefully dry any liquid and wipe any debris from the exterior of the bucket and lid. Weigh the sample, bucket, and lid to the nearest gram. Record this weight as *Bucket + Lid + Sample* in grams on the FORF (Block 6). Before recording this weight, add the weight of any leakage measured in the previous step.
- **Weigh all buckets and lids even if they contain no precipitation.** Weighing buckets that appear dry will confirm the absence of liquid and verify the correct operation of the balance.
- The CAL has recorded the weights on the bottom and side of the bucket, and on the top of the lid. Add these weights and record as *Bucket + Lid.*
- Subtract the *Bucket + Lid* from the *Bucket + Lid + Sample* weight to calculate *Sample Weight (grams)*. Record this value in Block 6 of the FORF.

Wet-side buckets that contain no water are valuable to the network. Handle them carefully and keep the snap-on lid in place. Such buckets may be used as field blank samples in which case they are checked for the same ions as normal samples. This allows the network to assess the impact of gases and particles in field buckets that do not collect wet deposition. See Section 6.5 for a description of the NTN Field Blank Program.

- Due to variances in balances, you may find small positive sample weights during periods with no precipitation and sample weights near or less than zero during periods with very light precipitation. Please note such cases in Block 10 on the FORF.

3.3.7 PRECIPITATION RECORD, Block 7

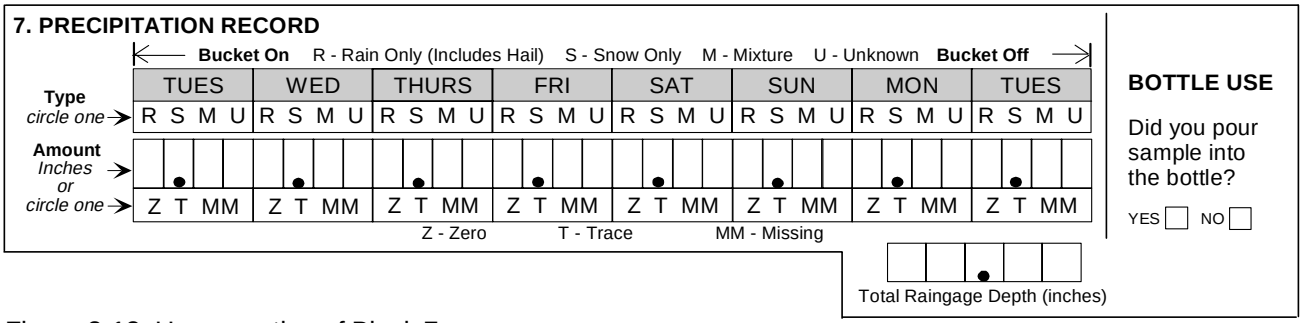


Figure 3-18. Upper portion of Block 7.

> The NTN uses either the raingage or collector sample volume to determine the precipitation amount. Normally the raingage determines the precipitation amount. The raingage amount and analyte concentrations from the collector are used to calculate chemical deposition. If raingage data are unavailable, the precipitation amount is determined by the collector sample volume. **Submit all samples for analysis.**

Complete the precipitation record (Figure 3-18) for all samples ensuring that this record matches the date on and date off of the sampling period. As evident in Block 7, the FORF is de-

signed to accommodate a standard Tuesday to Tuesday sampling period. If a nonstandard period needs to be reported, follow these general rules:

- If the sampling period exceeds 1 week, attach an additional FORF and carefully note the extra days. For example, with a Tuesday to Wednesday sample, fill out the first form for all 8 days (Tuesday to Tuesday) and add a form to report the second Wednesday. On this second form cross out all nonapplicable days (i.e., the first Tuesday and then Thursday through the second Tuesday).
- If the sampling period is less than 1 week, carefully note the correct starting day and cross out nonapplicable days. For example, for a Wednesday to Tuesday sample, cross out the first Tuesday in Block 7, and then fill out the rest of the week.

3.3.7.1 Precipitation Type

- Circle one *Type* of precipitation for each day with precipitation, even a trace.
- Circle *R* if only rain occurred, *S* if only snow occurred, and *M* for any combinations, including sleet and freezing rain. Record hail as *R* and document its occurrence in Block 10.
- Circle *U* (unknown) for those instances when you do not know the precipitation type.
- Fog, dew, and frost are not considered precipitation. Do not report them as trace amounts. Instead, note them in Block 10.

3.3.7.2 Precipitation Amounts

- Record the *Amount* of precipitation each day to the nearest 0.01 inch.
- On the first day of the sampling period (Tuesday), report only the precipitation that occurred after the bucket was installed (e.g., from 0900 to 2400 hours).
- On the last day of the sampling period, report only the precipitation that occurred before the bucket was taken off (e.g., from 0001 to 0900 hours).
- If no precipitation occurred, circle *Z* and do not record zeroes for the amount.
- Circle *T* in those instances where a trace amount of precipitation occurred (less than 0.01 inches).
- Circle *MM* to indicate that the information is missing. Describe the reason for the missing amounts in Block 10. Further, if the amount is missing because the raingage wasn't operating properly, you should have checked *No* for question 2 in Block 4.

In the lower right corner of Block 7 (Figure 3-18), record the *Total Raingage Depth (inches)*. This value should be the sum of all of the daily precipitation amounts from *Bucket On* to *Bucket Off*. Count trace amounts as zero in the addition unless the *Total Raingage Depth* is a trace, then write trace in this space. **If any daily values are missing, leave the *Total Raingage Depth* blank.**

3.3.7.3 Weight Recheck and Collection Efficiency

Compare the *Total Raingage Depth (inches)* to the *Sample Depth (inches)* in the lower portion of Block 7 (Figure 3-19). Obtain *Sample Depth (inches)* by multiplying the *Sample Weight (grams)* x 0.00058 inches/gram. Calculate the percent difference between the two numbers and answer the question, *Do these values agree within ± 5 percent?* Use the following equation.

$$\frac{\text{total raingage depth (inches) minus sample depth (inches)}}{\text{total raingage depth (inches)}} \times 100\% = \text{percent difference}$$

= [ ][ ][ ][ ][ ].[ ] X 0.00058 inches/gram = [ ][ ].[ ][ ] ← Do these values agree within ± 5% ? → [ ][ ].[ ][ ]
Sample Weight (grams) Sample Depth (inches) YES ☐ NO ☐ *(if no, reweigh)* Total Raingage Depth (inches)

Figure 3-19. Lower portion of Block 7, weight recheck.

If the values do not agree within ±5 percent, recheck all sample weights and calculations in Block 6. Record this recheck procedure in Block 10 and revise the weights as necessary.

> If the precipitation was in the form of rainfall, the balance is accurate, and more than 0.5 inches of precipitation occurred during the sampling period, the two values should agree within ±5 percent. In the event of snow or mixed precipitation, it is quite common for the collector to miss more than 5 percent of the precipitation.

The CAL has no way of correcting the error if the *Bucket + Lid + Sample* weight is wrong. It is up to you to double-check the weights. Notify the CAL immediately if you suspect equipment problems may account for the differences.

3.3.7.4 Detailed Interpretation of Precipitation and Event Recorder Traces

See Figure 3-20 for a sample raingage chart. Interpretation of the chart by the Site Operator provides the network with two important pieces of information: precipitation quantity and field bucket exposure.

- The lower line on the chart records the irregular pattern of weight addition to the gage corresponding to the accumulation of precipitation in the catch bucket. This record will be divided into daily precipitation amounts and then summed. As discussed in Section 3.3.7.3, this sum is recorded on the FORF as *Total Raingage Depth (inches)* and should agree within ±5 percent of the *Sample Depth (inches)*.
- The upper line on the chart reveals whether the collector lid opening and closing coincides with precipitation events through the tracings of the event recorder. This coincidence defines collection of a *wet-deposition only sample* as described in Section 2.3.2.1. Report large or persistent discrepancies between the opening and closing of the wet-side bucket and the occurrence of precipitation to the CAL as soon as possible and record them in Block 10.

3.3.7.4.1 Chart Features

Figure 3-21 is a raingage chart section. The chart covers daily periods along its horizontal axis. Vertical scaling of the chart is in inches printed along the major divisions of the chart: e.g., 1-11 and

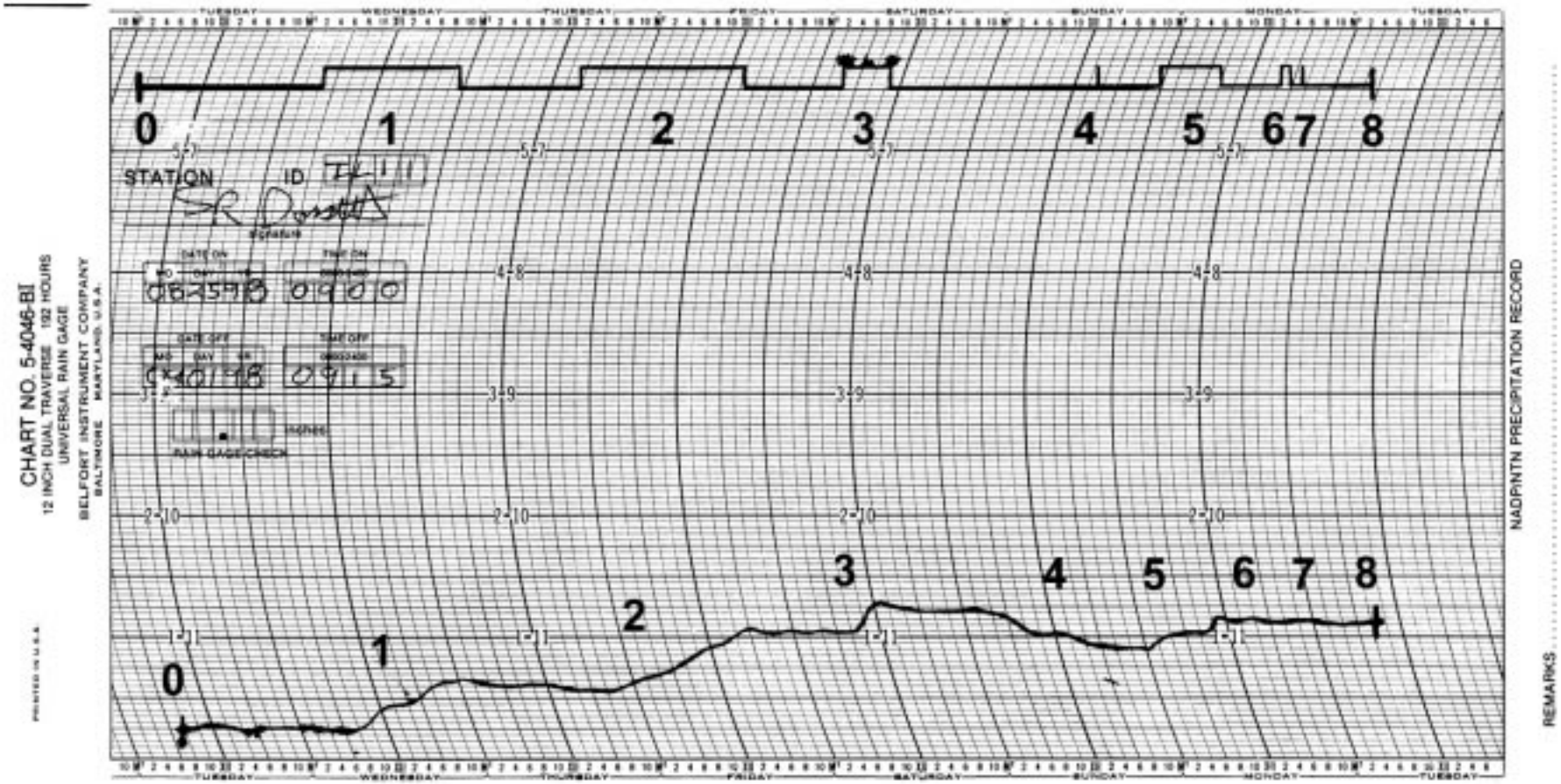


Figure 3-20. Sample raingage chart.

2-10. The chart is designed for a dual traverse raingage, and the number before the hyphen indicates the amount as the pen swings upward recording 0 to 6 inches of precipitation. The number after the hyphen indicates additional precipitation as the pen swings downward, recording 6 to 12 inches of precipitation. Record the Site ID and the chart's period of record in the spaces indicated at the top of the chart.

- Each vertical chart division represents 0.05 inches of precipitation. The maximum resolution of the chart is 0.01 inches and depends upon the Site Operator's ability to evaluate the traces. Ideally, a Site Operator can resolve each rainfall event to within approximately 0.02 inches.
- Each horizontal chart division represents 2 hours. The maximum resolution is about 15 minutes.

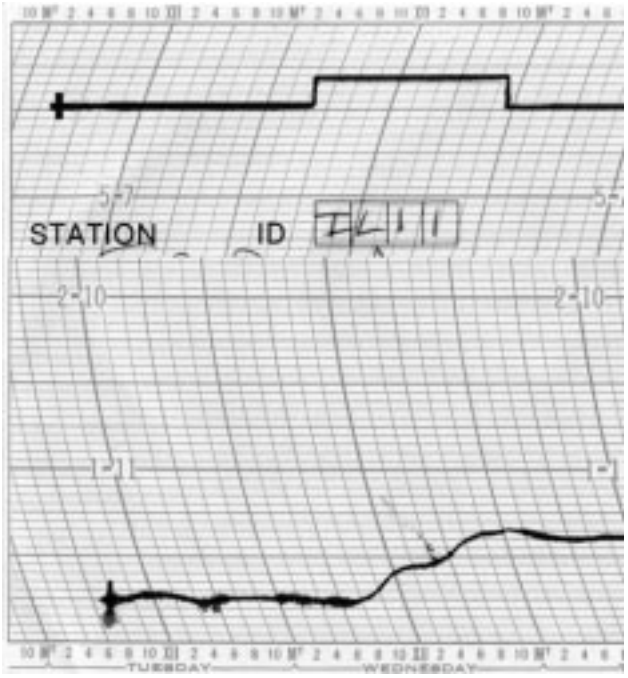


Figure 3-21. Raingage chart section.

3.3.7.4.2 Event Recorder Transcription

By design, the event recorder trace lags behind the precipitation record by 4 to 6 hours so that the two pens do not interfere with each other as the precipitation pen nears its upper limit. Because of this lag it is best to transcribe the event recorder trace onto the precipitation trace to check their agreement (Figure 3-22).

1. Lay the top left corner of the FORF against the left side of the event recorder trace, and use a pen or pencil to mark on the top edge of the FORF periods when the field bucket was open.

2. Slide the FORF down to the precipitation trace. Align the top left corner of the FORF with the beginning of the precipitation record. Now the two traces coincide in time.

3. Mark the precipitation record to show the open and closed periods of the collector. When transferring the event recorder trace, be certain to follow the curve of the time line; the FORF cannot simply be moved straight up. To do this, mark a time reference at Friday noon on the FORF, and when sliding the FORF up (to follow precipitation events as the trace climbs through the week), be certain to keep the time reference on Friday noon.

Figure 3-22. Transcribe event recorder trace.

Now that the event recorder trace is superimposed upon the precipitation line, you should be able to confirm that the opening period of the field bucket matches the incidence of precipitation. If this is not the case, check *No* for Block 4, Question 1 (see Section 3.3.4) and call the CAL.

3.3.7.4.3 Reading the Raingage Chart

Starting at Tuesday's 0 numbered event (Figure 3-23), note that the position of the lower trace moves up and down during the day. Up to 0.05 inches of drift on the chart is normal, a result of the heating and cooling of the metal components of the raingage. Chart paper may also expand and contract due to changes in humidity. If precipitation had occurred, the event recorder would have risen. Judgment must be exercised in these cases to know that the collector did not simply fail to open for precipitation. It is useful to note that this drift occurs most often with hot days and cool nights.

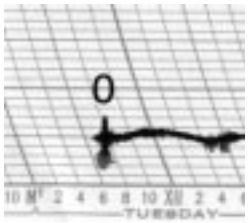


Figure 3-23. Chart point 0.

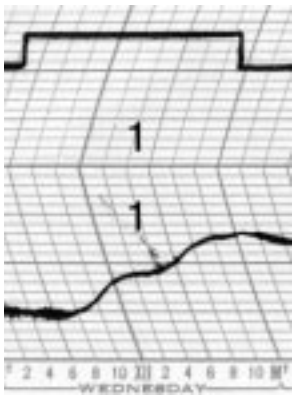


Figure 3-24. Chart point 1.

Event 1 (Figure 3-24) shows how the event recorder works when the field bucket is exposed. The event pen (top line) steps up as the collector opens at the start of a precipitation event and drops when the event is over. The precipitation amount is measured from the start of the rise in the raingage trace (bottom line) to the end of the rise. Event 1 started about 0800 hours Wednesday and lasted until midnight (2400 hours), leaving 0.42 inches of precipitation.

Precipitation during Event 2 (Figure 3-25) is also measured from the start to the end of the rising trace. It does not include the rise of Event 1 or the 0.08 inch drop between the end of Event 1 and the beginning of Event 2. This drop may be due to temperature drift or evaporation, but the cause is not important to the evaluation of the precipitation received. **What is important is to determine the magnitude of each precipitation event. Note that this "event" will be split between Thursday and Friday.**

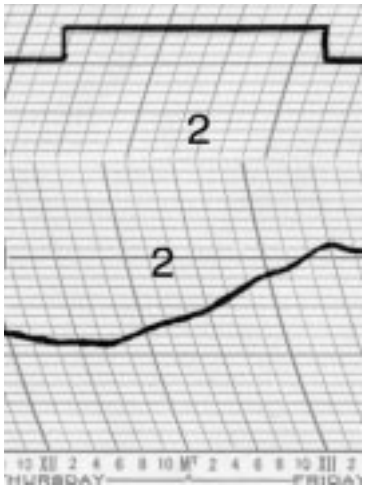


Figure 3-25. Chart point 2.

Event 3 is similar to Event 2. The event recorder confirms the operation of the collector on the top line.

To interpret Event 4 (Figure 3-26), you must understand exactly what the event recorder does. Its function is to record the time when the field bucket is uncovered and exposed to the atmosphere (the collector is open). It does not record the start and stop or duration of precipitation events. In this case, the event recorder indicates that the collector did open, but it is not clear that a measurable amount (0.01 inches or more) of precipitation occurred. It is possible that the collector sensor detected a small event that the raingage did not record. Unless you think otherwise, record precipitation during Event 4 as a trace amount.

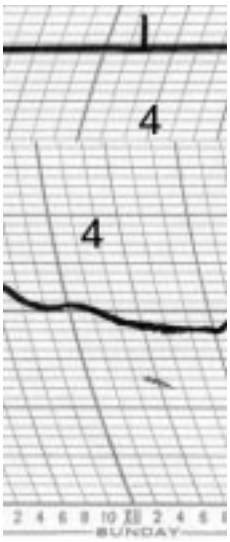


Figure 3-26.
Chart point 4.

Event 5 is similar to Events 2 and 3. This sequence illustrates the fall of the raingage trace due to evaporation. Remember that this drop must not be counted when determining the daily precipitation amount. During Event 5, 0.21 inches of precipitation occurred.

Events 6 and 7 are similar to Event 4 and reflect the type of trace expected during periods of intermittent drizzle or heavy fog. The collector opens frequently or stays open for a short time while no appreciable precipitation occurs.

Event 8 (Figure 3-27) is not a precipitation event, but a *test* event: the Site Operator activates the sensor, causing the collector to open in order to change field buckets. A *test* event should appear at both ends of the sampling period.

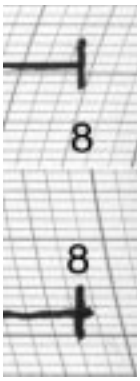


Figure 3-27.
Chart point 8.

3.3.7.4.4 Reporting Daily Precipitation Amounts: Arranging Events to Fit Field Form

Tables 3-1 and 3-2 list the amount of precipitation for each event and the total for the week. To complete Block 7, the precipitation event record must be arranged into daily precipitation amounts and summed.

To arrange daily values:

- Add events: Events 5 and 6 occurred on the same day.
- Split an event: Event 2 spanned 2 days.

To sum the total for the week:

- Simply add each daily value.
- Ignore traces.

Table 3-1. Chart Precipitation Record

Event No.	*Precipitation amount (inches)*
1	0.42 (all Wednesday)
2	0.07 (to Thursday) 0.42 (to Friday)
3	0.23 (all Saturday)
4	Trace
5	0.26 (to Monday)
6	0.02 (to Monday)
7	Trace
8	Test
Total	1.42

Table 3-2. Daily Precipitation Record

Day	*Precipitation amount (inches)*
Tuesday	0 (circle *Z*)
Wednesday	0.42
Thursday	0.07
Friday	0.42
Saturday	0.23
Sunday	Trace (circle *T*)
Monday	0.28
Tuesday	0 (circle *Z*)
Total	1.42

3.3.8 SAMPLE CHEMISTRY, Block 8

3.3.8.1 Transferring Liquid from Field Bucket

Transfer all samples of any volume, even a few drops, to the 1-liter sample bottle. There is no minimum amount for transfers. **The CAL does not analyze samples that are not poured into a sample bottle.**

Transferring the sample from the field bucket to the sample bottle requires that the sample be decanted. To decant a solution is to allow it to stand undisturbed so that debris settles out. The clean liquid is then poured from one container to another, allowing the debris to remain behind.

As with the field buckets and lids, use only CAL-cleaned sample bottles. If a bottle or cap becomes contaminated during sample transfer, replace it with a clean one. **Never attempt to rinse or otherwise reuse a bottle suspected of contamination.** Simply return the bottle to the CAL in a bag clearly marked “to be cleaned.”

- **Do not decant until the bucket contents are completely thawed.**
- **Do not agitate the field bucket.** Leave any settled debris behind and describe these in Blocks 5 and 10 of the FORF.

3.3.8.1.1 Decanting into Sample Bottle

1. Place a clean tray or other flat-bottomed pan on the laboratory bench or counter. Be sure the tray or pan is large enough to hold any spilled water.

2. Remove the 1-liter sample bottle from its bag and place it in the center of the tray or pan. Save the bag for use in shipping.

3. Put on a pair of the disposable gloves provided by the CAL. Keep the glove fingertips and palms clean.

4. Remove the bottle cap and set it aside **inside up** (top of the cap down) on a clean disposable lab wipe or tissue. Do not touch the inside surfaces of the bottle or cap or the rim of the bottle.

5. Remove the snap-on lid from the field bucket. Avoid contact with the bucket and lid rim.

6. Remove and discard your gloves.

7. Visually inspect the contents of the bucket for debris. This will be the last opportunity to identify contamination in the bucket. Note any contaminants in Blocks 5 and 10 of the FORF.

8. Grasp the bucket by the sides (not the handle or rim) and carefully decant the sample into the 1-liter bottle (Figure 3-28). Pour from the side opposite from which the lid was pried off the bucket. Keep the lip of the bucket above the sample bottle rim so that the bucket and bottle do not make contact. Be sure to hold the bucket handle against the bucket so that it does not swing down and overturn the sample bottle. Avoid leaning over the field bucket or sample bottle while decanting.

Figure 3-28. Decant the liquid.

9. Fill the sample bottle only up to the shoulder (about 1 inch below the top). If the bottle is filled further, the sample may freeze and break it during cold season shipment. Carefully screw the cap onto the bottle until it is snug.

10. Secure the snap-on lid to the field bucket and set it carefully aside. In the event of a spill from the sample bottle, any leftover sample in the field bucket may be used to fill another *new* sample bottle. Therefore, save the liquid in the bucket until you have completed the measurements and are preparing to ship the sample.

11. Discard any spilled sample. Do not pour it back into the sample bottle or field bucket. Note spillage on Block 10 of the FORF.

3.3.8.1.2 Sample Bottle Usage

- Answer the question on bottle use (Block 7 of the FORF, Figure 3-18). Answer *Yes* even if just a few drops were decanted.
- **Return a sample bottle each week whether or not one was used**. This will ensure that sites use only clean sample bottles and that the CAL can account for each sample from the site.

3.3.8.2 General Field Laboratory Analysis

> The sample is analyzed only when the sample weight measured in Block 6 is 70 grams or greater. For weights less than 70 grams, it is not necessary to fill out Block 8 (Figure 3-29), and you can proceed to Section 3.3.9, SUPPLIES, Block 9. It has been demonstrated that pH electrode performance improves with use. It is suggested that you calibrate the pH system and measure the Quality Control Check Sample each week, whether or not you have a precipitation sample to measure. If you do this, include the results on the FORF (Block 8) and include the date of the analysis.

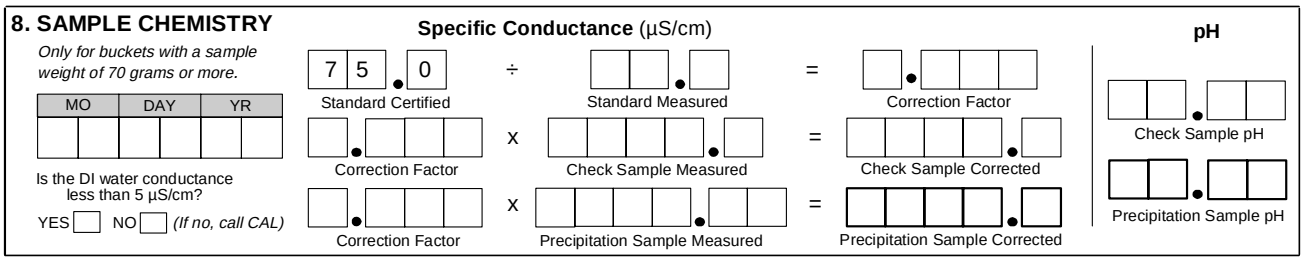


Figure 3-29. Block 8.

It is generally accepted that under certain conditions, changes in the chemical composition of precipitation occur between the time a sample is collected and its analysis at the CAL. Accurate measurements of both specific conductance and pH at the site are essential to demonstrate and document the occurrence of such changes. Before beginning the detailed procedures described below, it is important to keep in mind the following:

- It is imperative to ship samples to the CAL within 48 hours of their removal from the field.
- Store all solutions at room temperature in a dark place.
- The Quality Control (QC) Check Sample is formulated to approximate a typical precipitation sample. Use Check Sample pH and conductance values to indicate when measurement problems occur.
- If stored properly, all solutions should be usable for up to one year. If at any time you notice contamination or a sudden change in the solution measurements, ask the CAL for a replacement.

- Shake all solutions prior to use.
- Each Site Operator should be familiar with the manufacturer's instructions for all instruments. The following instructions should not conflict with the manufacturers' instructions for the calibration and operation of the equipment.
- Make sure the sample is thawed completely before decanting it into the sample bottle.
- Before making any measurements, allow all solutions, including the precipitation sample, to reach room temperature.
- If you cannot obtain acceptable values for the pH buffers, specific conductance standard, or QC Check Sample, do not make the field measurements on the actual sample. Instead, call the CAL for assistance.
- Always discard unused portions of any solution. Never return an unused solution to its original container.
- Always determine specific conductance first.
- Distilled water used for rinsing and cleaning should have a specific conductance of less than 2 microsiemens per centimeter (µS/cm). Conductance greater than 5 µS/cm may result in contamination.
- Space on the FORF is provided for one value of conductivity and one value of pH. If repeat measurements are made, record only one value.
- Appendix B provides additional information that may help in resolving pH and conductivity measurement problems. Indicate these problems on the FORF (Block 10). For further assistance, call the CAL.

3.3.8.2.1 Filling Vials for Field Chemistry Measurements

Rinse and fill four clear 4-mL vials (Figure 3-30) from the sample bottle: two for conductance measurements and two for pH measurements. If the laboratory equipment prevents the use of the 4-mL vials, call the CAL for site-specific instructions about how to proceed.

1. Remove the cap from the sample bottle and place it inside up (top of the cap down) on a clean, disposable laboratory wipe or tissue.

2. *Condition rinse* the vials by filling, discarding, and refilling each one with the sample. Carefully pour the sample avoiding spills and contact with the rim of the sample bottle or the vial.

3. After the vials are filled from the sample bottle, place them in the wooden vial holder provided by the CAL, tightly cap the sample bottle and set it aside.

Figure 3-30. Rinse and fill four vials.

4. Record the date of the field laboratory analysis on the FORF (Block 8).

5. Until you measure the vials, keep them isolated, protected by the CAL-supplied vial holder cover. Minimize the time between filling the vials and making the measurements.

Spilling a little sample during this process is normal. When the *Sample Weight (grams)* is less than 125 (from Block 6), take extra care to avoid losing liquid and do not replace spilled vials.

3.3.8.3 Conductance Measurement

If the conductance cell is not of the recommended low-volume type (see Appendix A), call the CAL for instructions.

3.3.8.3.1 Standardize Meter and Cell

1. Rinse the conductance cell at least three times with distilled water. Rinse once with the 75 µS/cm standard. Using another portion of standard, measure the specific conductance (Figure 3-31).

2. Record the value obtained in step 1 to the nearest 0.1 µS/cm in the *Standard Measured* space (see Figure 3-29).

3. Calculate the *Correction Factor* to the nearest 0.001 by dividing the *Standard Certified* (75 µS/cm) by the *Standard Measured* value. Record this value in the spaces provided on the FORF.

Figure 3-31. Measure the conductance standard.

3.3.8.3.2 Measure Conductance of Distilled Water

Rinse the cell three times with distilled water, discarding each rinse. Use a fourth portion to determine the specific conductance of your distilled water. Ideally, the value is less than 2 µS/cm. If the value is 5 µS/cm or less, check *Yes* in Block 8. If the value exceeds 5 µS/cm, check *No* in Block 8, continue making the conductance measurements, and call the CAL about acquiring a better water source.

3.3.8.3.3 Measure Quality Control Check Sample Conductance

1. Discard and shake off any distilled water from the conductance cell.

2. Next, rinse the cell with the QC Check Sample.

3. Using a second portion, determine the conductance of the Check Sample. Record this value to the nearest 0.1 µS/cm as *Check Sample Measured* in Block 8.

4. Multiply this value by the *Correction Factor* and record the result as *Check Sample Corrected.* This value should be 14.0 ± 2.0 µS/cm. If the corrected value falls outside these limits, repeat steps 2 and 3. If the corrected value still falls outside these limits, consult Appendix B for corrective action, contact the CAL, and stop the measurements. There is a problem that must be corrected before measurements can resume.

3.3.8.3.4 Measure Precipitation Sample Conductance

1. Rinse the cell three times with distilled water.

2. Rinse it with one of the 4-mL vials of precipitation sample.

3. Use a second 4-mL portion to determine the *Precipitation Sample Measured*. Record this value to the nearest 0.01 µS/cm and multiply by the *Correction Factor* to obtain the *Precipitation Sample Corrected.*

3.3.8.3.5 Store Conductance Cell

Rinse the cell three times and then fill it with distilled water. Cover the cell to prevent evaporation. Change the storage water weekly even if analyses are not performed. Most but not all cells are stored in distilled water. Always follow the manufacturer's recommendation for the cell.

3.3.8.4 pH Measurement

The CAL supplies all sites with a standard pH electrode. This should be the only electrode used for NTN field pH measurements, and it should be used **exclusively** for NTN samples. Note in Block 9, SUPPLIES, when a replacement electrode is required.

3.3.8.4.1 Prepare pH Meter and Electrode for Testing

1. Adjust the temperature control on the meter to room temperature. If there is no thermometer, set the temperature control to 25°C.

2. Remove the soaker bottle at the tip of the electrode (Figure 3-32). Use a squirt bottle to rinse the electrode tip several seconds in distilled water. Do not allow the squirt bottle tip to touch the electrode.

3. Examine the electrode to make sure any accumulated salts are dissolved from its tip; this build-up occurs during storage. If the accumulation is not dissolved, repeat step 2.

4. Gently blot the electrode tip with a clean lab wipe. Do not rub the electrode as this may build up a static charge and cause erroneous results.

Figure 3-32. Remove the soaker bottle.

5. Remove the black rubber sleeve or tape from the fill hole at the top of the electrode and replenish the filling solution. Use only the filling solution provided by the CAL for the specific electrode.

3.3.8.4.2 Calibrate pH Meter

1. Fill a 4-mL vial with pH 7 buffer.

2. Insert the electrode into the vial (Figure 3-33), and allow it to remain there for 30 seconds. This is called a conditioning rinse of the electrode and vial.

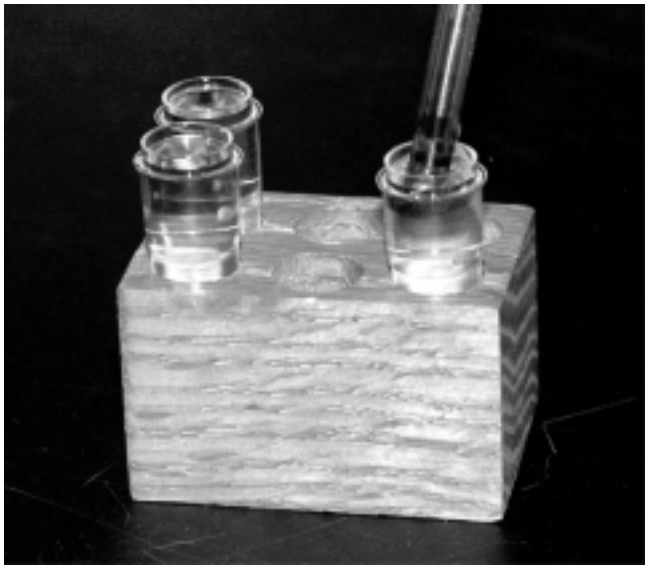


Figure 3-33. Insert the electrode into the vial.

3. Empty the vial and, without any other rinses, refill it with buffer. Insert the electrode tip directly into this condition-rinsed vial and briefly agitate. Allow sufficient time for the reading to stabilize (i.e., until the readings differ by no more than ±0.02 pH units within a 30-second period), but wait no more than 3 minutes. If the meter has an auto-read function, wait until it *locks on* (1-3 minutes). Adjust the calibration or standardize the control of the meter to read 7.00.

4. Rinse the electrode thoroughly with distilled water and blot the tip. Fill a clean vial with pH 4 buffer. Repeat the conditioning rinse as described in step 2 by inserting the electrode into the vial and allowing it to remain for 30 seconds. Remove the electrode, empty and refill the same vial with the pH 4 buffer, insert the electrode again, and briefly agitate. Allow sufficient time for the reading to stabilize, and then adjust the slope control of the pH meter to read 4.00 or allow the auto-read function to lock on.

5. Rinse the electrode thoroughly with distilled water and blot the tip. Then measure the pH 7 buffer as if it were any other sample. If it reads 7.00 ± 0.03 pH units, proceed with the measurements. If it does not, repeat steps 1 - 4. If you still cannot calibrate the meter, stop the analysis and check Appendix B for possible solutions, or call the CAL for assistance.

3.3.8.4.3 Purge pH Electrode Tip with Distilled Water

Fill a 4-mL vial with distilled water. Condition rinse the tip with distilled water as noted in the steps above. Measure the distilled water, values should be between pH 5.3 and 5.8. **Note:** This step is not meant as a check on the quality of the distilled water. The purpose is to dissolve any high-strength buffer ions from the bulb of the electrode and to get ready for the next measurements of low-strength solutions.

3.3.8.4.4 Measure Quality Control Check Sample pH

1. Gently blot the electrode tip to remove any excess distilled water.

2. Measure the Quality Control Check Sample using the conditioning rinse technique. Briefly agitate the probe and allow the system to stabilize for no more than 3 minutes and record the reading in the space *Check Sample pH* in Block 8. The Check Sample should read 4.90 ± 0.15 pH units.

3. If the measurement is outside this range, recalibrate the meter and try again. If the measurement fails again, consult Appendix B for corrective action, contact the CAL, and stop. This problem has to be corrected before measurements can resume.

3.3.8.4.5 Measure Precipitation Sample pH

1. Rinse the electrode thoroughly with distilled water. Blot the tip.

2. Condition the electrode by inserting it into one of the vials filled with precipitation sample and allow it to remain for 30 seconds.

3. Remove the electrode and reinsert it directly into the second vial containing precipitation. Briefly agitate the electrode and allow the system to stabilize. Record the measured pH value in the space marked *Precipitation Sample pH* in Block 8. **Note:** If you are using a pH meter that locks onto the reading, immediately repeat the measurement. If you obtain the same value, you can be certain the meter has stabilized.

3.3.8.4.6 Store pH Electrode

1. Rinse the electrode thoroughly with distilled water one last time. Blot the tip with a clean absorbent laboratory wipe and place the tip in the soaker bottle.

2. Replace the rubber sleeve or tape over the fill hole to prevent excessive crystal growth.

3.3.9 SUPPLIES, Block 9

The CAL will supply only those items listed in Block 9 of the FORF (Figure 3-34). Requested supplies are added to the returning black mailer from the CAL. **Continue to circle the desired item on each FORF you submit until the item is received**. If you are in danger of running out of a supply, please call your order into the CAL. A *supplies enclosed* sticker will appear on the mailer to alert you. Upon receipt, check each incoming mailer for requested supplies and important notices. Supplies not listed on the FORF, such as distilled water and lab wipes, are the responsibility of the individual site.

9. SUPPLIES
Circle if needed, until received.

Vials	Field Forms
pH Electrode	Sample Bottles
pH 4 Buffer	Gloves (S, M, L)
pH 7 Buffer	Raingage Charts
Check Sample	Raingage Ink
75 µS/cm Std	Dashpot Fluid
Electrode Filling Solution	Lid Seal Pad

Figure 3-34. Block 9.

Request new foam lid seals for the collector by telephone from the CAL. A damaged seal can severely affect sample quality.

3.3.10 REMARKS, Block 10

Block 10 (Figure 3-35) is used to record anything that might affect the representativeness of the weekly sample. This includes equipment failures, repairs, or calibrations; unusual events or weather conditions; contamination; and other occurrences at the field site or field laboratory.

The importance of the information provided in Block 10 cannot be overemphasized.

Careful observations of the sample and the surrounding environment can aid in evaluating sample validity and in data interpretation. Keep in mind that unusual problems or occurrences at or near the site may include plowing, harvesting, burning, increased atmospheric pollution or dust, power outages, etc. Use extra paper if necessary to document all such observations.

10. REMARKS *For example: equipment malfunction, contamination, farming, burning, logging, leakage before weighing, etc.*

Figure 3-35. Block 10.

Also carefully describe all contaminants in the bucket and listed in the notebook when the sample was removed from the field. Remember, this evaluation is especially important because the field bucket contents are not available for CAL personnel to examine.

Finally, note the specific time of the occurrence and circumstances of any leakage or spillage. In particular, note whether the sample leaked before weighing and if this leakage may have compromised the sample volume or quality.

3.4 Mailing Instructions

A large label inside each mailer lid lists the materials to be enclosed with each sample returned to the CAL.

3.4.1 Field Buckets

The following procedures apply to **all** buckets.

1. Remove the snap-on lid and discard any remaining precipitation.

2. Secure the snap-on lid to the bucket.

3. Return the field bucket to the bag used in the field, labeled with the Site ID, date off, etc.

4. Use a twist tie to secure the top of the bag.

5. Place the bagged field bucket into the mailer. Return all used buckets, lids, and bottles to the CAL for cleaning.

3.4.2 Sample Bottles

Always return a sample bottle in a labeled bag to the CAL each week. The following procedures apply to **all** bottles:

1. Check the bag labeling. Make sure all notes and comments are legible and can be understood. Write the Site ID, date and time off, and a brief description of any contamination on the bag.

2. Dry the outside of the sample bottle with a laboratory wipe.

3. Place the sample bottle into the bag, close the bag completely, and press out any trapped air.

4. Place the bagged sample bottle into one corner of the mailer.

3.4.3 Final Items

1. Enclose the white and yellow copies of the completed FORF and the original raingage chart in the black mailer. The pink copy of the FORF is for site records. Also keep a copy of the raingage chart.

2. Turn over the pre-addressed mailing card on the black mailer so that the CAL address shows (Figure 3-36).

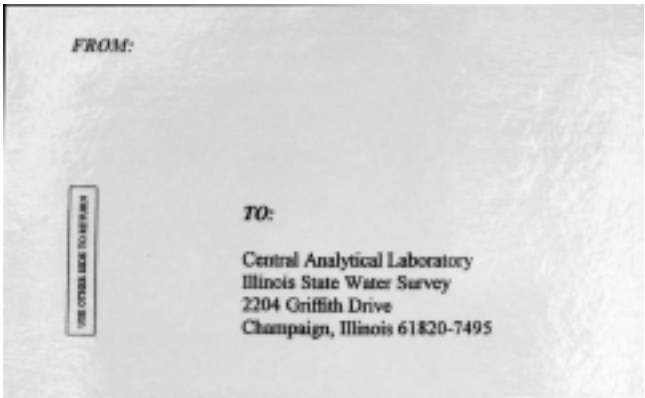


Figure 3-36. Make sure the CAL address shows.

3. Place the lid on the mailer and secure all four straps tightly.

4. Send the black mailer immediately by UPS regular delivery, Federal Express, or first class mail.

Send buckets and bottles no later than 48 hours after the sample has been removed from the field. Extended delays can invalidate samples.

3.5 Recordkeeping at the Site

It is suggested that Site Operators keep the pink copies of the FORF stapled to copies of the raingage charts and filed in chronological order. Questions will arise during the processing of the samples at the CAL and after receipt of the data reports from the CAL (See Section 4). Your data will help resolve questions and correct data errors.

Any notebooks taken to the field or used in the laboratory should be preserved for future use.

Retain site records for 2 years after submission of samples.

4 Preliminary Data Printouts

Each month the CAL sends Site Operators and Supervisors two reports that contain data from the FORFs and preliminary chemical analyses from the CAL. These reports contain messages that address potential errors or inconsistencies noted during the initial CAL data review.

> Site Operators and Supervisors are expected to review and respond to messages on printouts by forwarding corrections, explanations, or clarifications to the CAL. Data in these reports are preliminary and not for research. Final screened and verified data are available at the NADP Web site at http://nadp.sws.uiuc.edu or by contacting the Program Office.

4.1 Report Headings

The PRINTOUT DATE, SAMPLE ID, LAB TYPE and DATE/TIME are the same on the field (Figure 4-1) and preliminary (Figure 4-2) printouts.

PRINTOUT DATE: The date the report was generated appears in the upper left corner.

SAMPLE ID: A unique 12-character code assigned at the CAL identifies each sample. The first letter *N* identifies this as an NTN sample. Characters in positions 2-6 indicate a sequential number. Character 7 (normally an *S*) is used to identify a standard sample. Character 8, a *W*, denotes a wet-side sample. Characters in positions 9-12 identify the site ID.

LAB TYPE: A code assigned by the CAL indicates the type of laboratory processing the sample received. The first letter (i.e., *T*, *W*, or *D*) indicates the amount of liquid observed in the 1-liter sample bottle at the CAL. The second letter is *A,* which indicates 50 mL of dilution water was added to provide a complete chemical analysis, or *F*, which denotes a USGS field blank sample. Codes used are as follows:

- *T*: The sample bottle contained a trace of water possibly allowing a pH measurement, or pH and conductivity measurements. The volume was insufficient for additional chemical measurements.
- *W*: The sample bottle contained 35 mL or more of water. All chemical analyses were performed without any need for dilution.
- *WA*: The sample bottle contained less than 35 mL of water. After pH and conductivity were measured, 50 mL of dilution water was added to provide adequate sample for the 9 other analyses. All concentrations in the reports are corrected for dilution.
- *D*: No water was visible in the sample bottle or wet-side bucket upon arrival at the CAL. No chemical analysis was performed.
- *DF*: This Lab Type denotes a USGS *Field Blank* sample (See Section 6.5).

DATE ON/ TIME ON AND DATE OFF/TIME OFF: Local times identify the sampling period.

4.2 CAL Field Printout

The Field Printout (Figure 4-1) provides the site personnel with information from the FORF. It also lists the CAL pH and conductance values and evidence of sample leakage. Notes and error messages alert the Operator and Supervisor to potential data or operational problems. A key to the report headings, and list of the notes and error messages follows.

FIELD CHEM DATE: This date indicates when the Site Operator performed the field chemistry measurements.

PH/ LAB - FLD: These are the CAL (LAB) and the Site Operator (FLD) pH measurements.

CONDUCTIVITY/ LAB - FLD: These are the CAL (LAB) and the Site Operator (FLD) conductance measurements.

SAMPLE VOLUME (ML): This number indicates the water volume in the bucket when it was removed from the collector, as calculated in Block 6 of the FORF.

SAMPLE DEPTH (IN.): This is the SAMPLE VOLUME converted into inches of precipitation as in Block 7 of the FORF.

PRECIP. DEPTH (IN.): This number is the total sampling period precipitation from the raingage in inches.

LEAKAGE: This column describes the amount of water observed in the plastic bag enclosing the sample bottle when it was opened at the CAL.

Notes and Error Messages

Note and error messages are generated by computer programs that check for data errors, non-standard procedures, and potential field chemistry, collector, or raingage problems. Only those notes and error messages pertaining to field operations are listed here.

(→) AN ARROW PRECEDING A NOTE DENOTES A RESPONSE IS REQUIRED

```
            *
      ASAP**   ERROR 1 - TIME ON for sample ___ (SAMPLE ID ASSIGNED BY CAL) precedes the TIME OFF for
RESPOND***   SAMPLE ___ (SAMPLE ID ASSIGNED BY CAL). PLEASE NOTIFY CAL OF CORRECT TIMES BY
      ASAP**     SENDING A NOTE WITH YOUR NEXT BUCKET MAILING....THANKS.
            *

        *
        **    NOTE  2 - Time between sample ___ (SAMPLE ID ASSIGNED BY CAL) off and sample ___
**********    (SAMPLE ID ASSIGNED BY CAL) on is more than 59 minutes ___ (CALCULATED VALUE). POSSIBLE
        **    MISSING SAMPLE(S).
        *

   NOTE  3 - The sampling interval for ___ (SAMPLE ID ASSIGNED BY CAL) was nonstandard.
             The interval was ___ (CALCULATED VALUE) days.
```

NADP/NTN CENTRAL ANALYTICAL LABORATORY - ILLINOIS STATE WATER SURVEY

FIELD PRINTOUT
PRINTOUT DATE: 06/15/1999
QUESTIONS, CALL Scott Dossett (800-952-7353)

PLEASE NOTE - DATA WITH A SAMPLE ID LESS THAN NS6401SW (MARKED WITH AN ASTERISK) HAS BEEN REVIEWED BY THE CAL FOR THIS REPORT

SAMPLE ID	LAB TYPE	DATE ON	TIME ON	DATE OFF	TIME OFF	FIELD CHEM DATE	PH LAB	PH FLD	CONDUCTIVITY LAB	CONDUCTIVITY FLD	SAMPLE VOLUME (ML)	SAMPLE DEPTH (IN.)	PRECIP. DEPTH (IN.)	LEAKAGE
*NS6270SWIL11	W	033099	0930	040699	0930	040699	6.52	5.23	50.8	48.3	346.0	.20	.51	NONE
NS6517SWIL11	W	040699	0930	041399	0930	041399	4.77	4.61	18.8	22.2	1680.1	.97	1.02	NONE
NS6720SWIL11	W	041399	0930	042099	0930	042099	4.46	4.35	19.7	21.5	3170.3	1.84	2.10	NONE
NS6969SWIL11	W	042099	0930	042799	0935	042799	4.52	4.45	23.0	24.1	1351.9	.78	.76	NONE
NS7174SWIL11	W	042799	0935	050499	0930	050499	4.18	4.11	35.2	38.6	652.3	.38	.36	NONE

****

NOTE 6 - The LAB pH differed by more than 1.0 pH units from the FIELD pH for sample *NS6270SWIL11.

NOTE 9 - The SAMPLE DEPTH of *NS6270SWIL11 does not compare well with the PRECIPITATION DEPTH recorded for that period. If you have not yet done so, please send the CAL any information you have that might explain this difference...THANKS

****

PLEASE REVIEW THIS INFORMATION AND RESPOND TO NOTES AND ERRORS.

FIRST, CHECK YOUR PINK FIELD FORM COPIES.
THEN, WRITE A SHORT RESPONSE ON THIS PRINTOUT AND RETURN IT (OR A COPY) TO THE CAL WITH YOUR NEXT SAMPLE.

OUR DATA REPORTS OVERLAP AND SOME NOTES MAY BE REDUNDANT. PLEASE BE PATIENT.

CALL SCOTT DOSSETT AT 800-952-7353, FAX TO 217-333-0249 OR E-MAIL TO SDOSSETT@UIUC.EDU WITH QUESTIONS OR COMMENTS.

THANK YOU FOR YOUR CONTINUED COOPERATION.

THE 20 US/CM AND 1.0 PH UNIT CRITERIA USED TO TRIGGER PH AND CONDUCTIVITY NOTES ARE ARBITRARY CHOICES, AND MAY OR MAY NOT INDICATE MEASUREMENT PROBLEMS.

Figure 4-1. CAL field printout.

NOTE 4 - ___ (SAMPLE ID ASSIGNED BY CAL) did not have a standard TUE-TUE sampling period. Actual sampling period was ___(FROM FORF).

NOTE 5 - The FIELD pH for sample ___ (SAMPLE ID ASSIGNED BY CAL) ___ (FROM FORF) was outside the expected range for precipitation samples ___ (expected range is 3.0 to 9.0).

NOTE 6 - The LAB pH differed by more than 1.0 pH units from the FIELD pH for sample ___ (SAMPLE ID ASSIGNED BY CAL).

NOTE 7 - The FIELD CONDUCTIVITY for sample ___ (SAMPLE ID ASSIGNED BY CAL) ___ (FROM FORF) was outside the expected range for precipitation samples ___ (expected range is 1.0 to 300.0).

NOTE 8 - The LAB CONDUCTIVITY differed by more than 20 uS/CM from the FIELD CONDUCTIVITY for sample ___ (SAMPLE ID ASSIGNED BY CAL).

NOTE 9 - The SAMPLE DEPTH of (SAMPLE ID ASSIGNED BY CAL) does not compare well with the PRECIPITATION DEPTH recorded for that period. If you have not yet done so, please send the CAL any information you have that might explain this difference....THANKS.

NOTE 10 - Sample ___ (SAMPLE ID ASSIGNED BY CAL) had major LEAKAGE during shipment to the CAL.

```
          *
    ASAP**   ERROR 11 - A required DATE or TIME for sample ___ (SAMPLE ID ASSIGNED BY CAL) is
RESPOND***   missing. Please notify the CAL of missing info by sending a note with
    ASAP**   your next bucket mailing....THANKS.
          *
```

NOTE 12 - Sample ___ (SAMPLE ID ASSIGNED BY CAL) was not bagged. PLEASE BAG ALL BUCKETS BEFORE SHIPMENT TO THE CAL.

NOTE 15 - At the CAL it was noticed that the lid was not completely secured to the bucket for sample ___ (SAMPLE ID ASSIGNED BY CAL). PLEASE BE SURE TO SNAP THE LID ON ALL BUCKETS SENT TO THE CAL.

NOTE 16 - This sample ___ (SAMPLE ID ASSIGNED BY CAL) was compromised by problems during field handling or shipping. THE DATA WILL BE FLAGGED AS NONSTANDARD.

NOTE 19 - For sample ___ (SAMPLE ID ASSIGNED BY CAL) more than 16 days elapsed between the DATE OFF and the date the sample arrived at the CAL. Please ship all samples within 48 hours of collection....THANK YOU.

```
          *
    ASAP**   ERROR 20 - A pH or conductivity measurement was reported for sample ___
RESPOND***   (SAMPLE ID ASSIGNED BY CAL) but the FIELD CHEM DATE IS MISSING. Please notify the CAL
    ASAP**   of the missing info by sending a note with your next sample
          *  or calling Scott....THANKS.

          *
    ASAP**   ERROR 21 - For sample ___(SAMPLE ID ASSIGNED BY CAL) the DATE OFF, FIELD CHEM DATE, and
RESPOND***   CAL receipt dates are not in chronological order. Please re-check
    ASAP**   your DATE OFF and FIELD CHEM DATE and send corrected date(s) to the CAL.
          *
```

NOTE 25 - For over half of the samples in this report, the SAMPLE DEPTH ___ (from AEROCHEM COLLECTOR) is greater than the PRECIP DEPTH ___ (from RAINGAGE). Your recording raingage appears to be undercatching. Please refer to your INSTRUCTION MANUAL, Appendix D for calibration check procedures.

PLEASE REVIEW THIS INFORMATION AND RESPOND TO NOTES AND ERRORS.

FIRST, CHECK YOUR PINK FIELD FORM COPIES.
THEN, WRITE A SHORT RESPONSE ON THIS PRINTOUT AND RETURN IT (OR A COPY) TO THE CAL WITH YOUR NEXT SAMPLE.

OUR DATA REPORTS OVERLAP AND SOME NOTES MAY BE REDUNDANT. PLEASE BE PATIENT.

CALL SCOTT DOSSETT AT 800-952-7353, FAX TO 217-333-0249 OR E-MAIL TO SDOSSETT@UIUC.EDU WITH QUESTIONS OR COMMENTS.

THANK YOU FOR YOUR CONTINUED COOPERATION.

THE 20 μS/CM AND 1.0 PH UNIT CRITERIA USED TO TRIGGER PH AND CONDUCTIVITY NOTES ARE ARBITRARY CHOICES, AND MAY OR MAY NOT INDICATE MEASUREMENT PROBLEMS.

4.3 CAL Preliminary Printout

The preliminary printout (Figure 4-2) provides site personnel with data that are still undergoing verification. As part of this process, some samples are reanalysed. Additional screening of these data may result in their sequester from the final network database. A key to the report follows.

CONCENTRATIONS (MG/L): Preliminary analytical measurements are reported for each chemical in concentration units of milligrams per liter of solution. The chemicals measured include calcium (CA), magnesium (MG), potassium (K), sodium (NA), ammonium (NH4), nitrate (NO3), chloride (CL), sulfate (SO4), and orthophosphate (PO4). For samples with a LAB TYPE of W or WA, a full set of chemical concentrations is reported. For samples with a LAB TYPE of T, only pH and conductivity measurements are possible due to the small sample size. For samples with a LAB TYPE of D or DF, the ion concentrations will always be missing. All measured concentrations at or below the analytical method detection limit (very dilute solutions) are reported with a less than symbol (e.g., < .003 mg/L).

FIELD/LAB - COND.: These are Site Operator (FIELD) and CAL (LAB) conductance measurements.

FIELD/LAB - pH: These are Site Operator (FIELD) and CAL (LAB) pH measurements.

DEPOSITION (MILLIGRAMS/SQUARE METER): This lists the mass of each chemical deposited on a square meter by the precipitation in each sample. Chemical deposition is calculated from the product of the SAMPLE VOL and CONCENTRATION measurements divided by the cross-sectional area of the collection bucket, which is 0.0679 square meters. If the CONCENTRATION is below the analytical method detection limit, the calculation uses this value and the DEPOSITION is reported with the less than symbol.

SAMPLE VOL (ML): This is the water volume in the field bucket when it was removed from the collector, as calculated in Block 6 of the FORF.

MEAS ANIONS/ MEAS CATIONS (MICROEQUIV/L): The respective sums of the measured anion and cation concentrations are converted to charge units of microequivalents per liter. The conversion from milligram per liter (MG/L) to microequivalent per liter (MICROEQUIV/L) is done using these factors:.

Anions	*Factor*	*Cations*	*Factor*
SO4	20.83	NH4	55.44
NO3	16.13	CA	49.90
CL	28.21	MG	82.26
PO4	31.59	K	25.57
		NA	43.50
		H	($10^{6\text{-lab pH}}$) Example: lab pH = 4
			H =10^{2} or 100 MICROEQUIV/L

PRELIMINARY PRINTOUT NADP/NTN CENTRAL ANALYTICAL LABORATORY - ILLINOIS STATE WATER SURVEY
DATE: 06/15/99

PLEASE NOTE - DATA WITH A SAMPLE ID LESS THAN NS6401SW (MARKED WITH AN ASTERISK) HAS BEEN REVIEWED BY THE CAL FOR THIS REPORT

SAMPLE ID	LAB TYPE	DATE ON	TIME ON	DATE OFF	TIME OFF	CONCENTRATIONS (MG/L) CA	MG	K	NA	NH4	NO3	CL	SO4	PO4	FIELD COND. (MICROMHOS/CM)	LAB COND.	FIELD PH	LAB PH
*NS6270SWIL11	W	033099	0930	040699	0930	1.082	.152	1.060	.280	5.19	4.10	.57	7.48	3.302	48.3	50.8	5.23	6.52
NS6517SWIL11	W	040699	0930	041399	0930	.308	.085	.058	.217	.52	2.11	.22	2.74	<.003	22.2	18.8	4.61	4.77
NS6720SWIL11	W	041399	0930	042099	0930	.087	.012	.008	.009	.27	1.48	.04	1.66	<.003	21.5	19.7	4.35	4.46
NS6969SWIL11	W	042099	0930	042799	0935	.361	.045	.045	.108	.67	2.33	.16	2.40	<.003	24.1	23.0	4.45	4.52
NS7174SWIL11	W	042799	0935	050499	0930	.066	.013	.018	.011	.29	2.06	.07	2.93	<.003	38.6	35.2	4.11	4.18

SAMPLE ID	LAB TYPE	DEPOSITION(MILLIGRAMS/SQUARE METER) CA	MG	K	NA	NH4	NO3	CL	SO4	PO4	H	SAMPLE VOL(ML)	MEAS ANIONS (MICROEQUIV/L)	MEAS CATIONS (MICROEQUIV/L)
NS6270SWIL11	W	5.51	.77	5.40	1.43	26.45	20.90	2.91	38.12	16.83	.00	346.0	342.3	393.8
NS6517SWIL11	W	7.62	2.10	1.44	5.37	12.87	52.22	5.44	67.81	<.07	.42	1680.1	97.4	79.1
NS6720SWIL11	W	4.06	.56	.37	.42	12.61	69.12	1.87	77.52	<.14	1.63	3170.3	59.6	55.6
NS6969SWIL11	W	7.19	.90	.90	2.15	13.34	46.40	3.19	47.79	<.06	.61	1351.9	92.1	94.9
NS7174SWIL11	W	.63	.12	.17	.11	2.79	19.79	.67	28.15	<.03	.64	652.3	96.3	87.4

MONTHLY NEWS AND NOTES

Figure 4-2. CAL preliminary printout.

4.4 Monthly News and Notes

Each month news items or notes appear in the lower portion of the Preliminary Printout. Occasionally these include some “fill-in the blank” questions (e.g., to request updates to FAX numbers). Please complete these and return a copy to the CAL in these cases. Other news or notes do not require a response.

4.5 Usage Reminder

This report is for Site Supervisors and Operators use only. Remember, these preliminary data are subject to change. Final data are available on the NADP Web site at http://nadp.sws.uiuc.edu.

5 Field Site Maintenance

NTN sites are positioned and equipped according to site selection and installation rules that apply to the entire network. Occasionally you will need to perform maintenance tasks in order for the site to continue to meet these rules and collect high-quality data. These tasks are divided into two general categories:

- immediate site area maintenance
- field site equipment maintenance

Before making **any modifications** to the field site or equipment, or if you have questions about maintenance, PLEASE call the NADP Program Office at 1-800-952-7353.

5.1 Immediate Site Area Maintenance

Figure 5-1 is an idealized site diagram that serves as a handy reference regarding the rules for equipment spacing, vegetation height, and proximity of roads and buildings. Maintaining the height

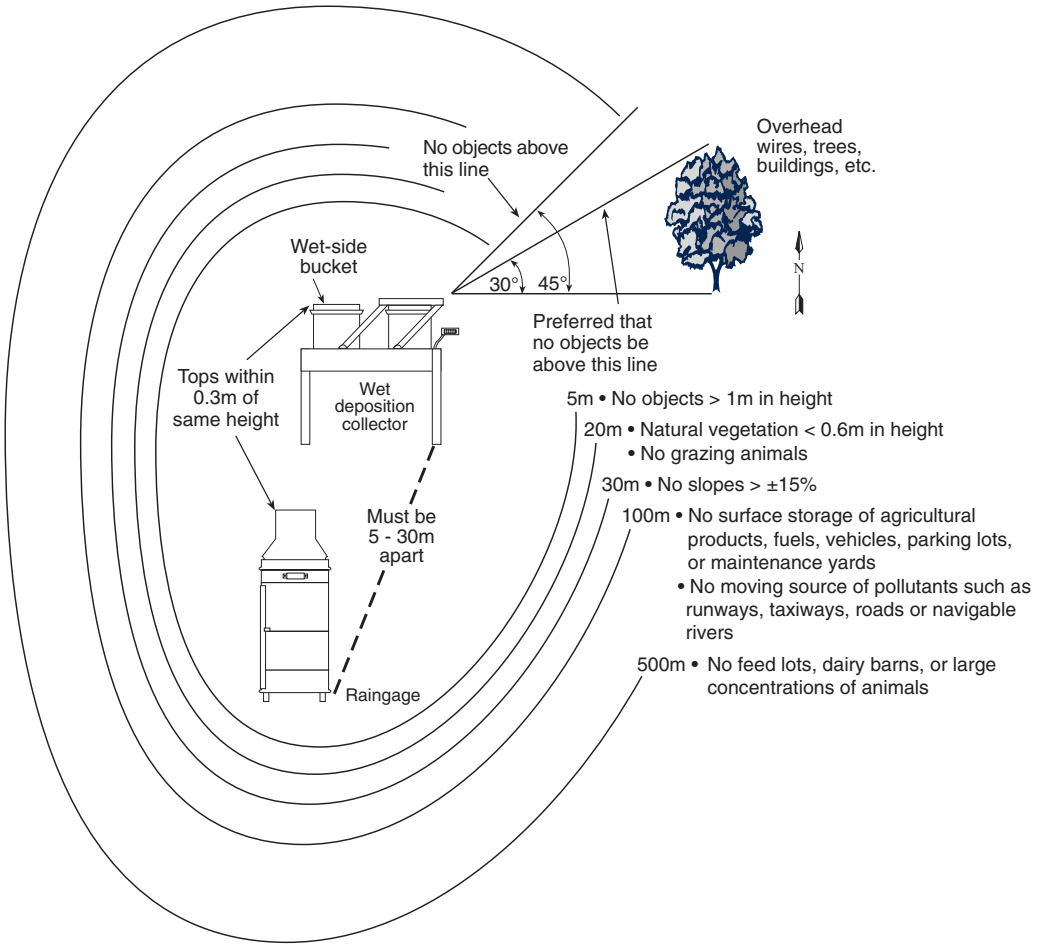


Figure 5-1. An idealized site.

of vegetation at the site is the responsibility of site personnel. The NADP Program Office should be informed of changes in the location, size, or character of other site attributes.

5.1.1 Vegetation Maintenance

For site maintenance, consider everything within 30 meters (m) of the collector and raingage. Leaves, grass seeds, or debris from nearby shrubs and trees can contaminate samples. The rules for maintaining vegetation are:

- Maintain annual vegetation on site at heights of less than 0.6 m. **Sites should not be mowed solely for aesthetics. Debris generated by frequent mowing may get into the sample bucket. Two or three mowings per year are adequate as long as the 0.6 m height requirement is met.**
- Ground cover should surround the collector and raingage for about 30 m. In areas where there are agricultural crops, a vegetated buffer strip **must** surround the collector for at least 30 m.

5.1.2 Obstructions in Wind Field

Immediate site area maintenance focuses on preventing contamination of the wet-side sample. These concerns for sample *quality* (i.e., the concentration of chemicals in samples) must be accompanied by concerns for sample *quantity* (i.e., representative precipitation amounts). To this end, criteria describing potential wind field obstructions apply. These obstructions may result in splash from one piece of equipment to another or cause one instrument's collection to be impeded by another. Relevant criteria are:

- No object over 1 m high with sufficient mass to deflect wind should be within 5 m of the collector or raingage.
- The height of any obstruction defines the minimum distance between the collector or raingage and the obstruction; doubling this distance is preferable. No object (such as equipment towers or trees) should project onto the collector or raingage with an angle greater than 45°; 30° is optimal.

> See the *Instruction Manual: NADP/NTN Site Selection and Installation* (NADP, 1984) for complete details regarding network siting criteria.

5.2 Field Site Equipment Maintenance

5.2.1 Aerochem Metrics 301 Precipitation Collector (see also Appendix C)

5.2.1.1 Sensor and Motor Box Checks

Each week, test the collector to confirm that a) the sensor heater is fully operational and b) it responds to precipitation and the motor box drives the lid to the correct position. These tests are made as follows:

1. Check the sensor temperature by touching the sensor plate. It should feel cool, unless the collector has been open within the last few minutes.

2. Activate the sensor grid by applying a few drops of water. **Do not use metal.**

3. The drive motor should immediately move the collector lid to cover the dry-side bucket. Observe this movement. The collector lid should operate freely with little motor noise and come to rest snugly on the dry-side bucket.

4. Check the motor box operation by inspecting the recording raingage while the collector is open (i.e., wet-side bucket exposed). Verify that the event recorder (upper) pen is in the up position.

5. After the collector has been open for 5-10 minutes, confirm that the sensor is hot to the touch.

6. Blow any remaining water off the sensor and observe the collector lid movement as it covers the wet-side bucket. It should move smoothly and complete its cycle in less than 15 seconds.

5.2.1.2 Sensor Head Cleaning

Periodically clean the sensor to remove any debris that could cause the collector to open and leave the wet-side bucket exposed during dry periods.

With the wet-side bucket removed and the collector plugged in:

1. Irrigate the sensor with distilled water or alcohol. (The collector will open. Just ignore this.)

2. Using a toothbrush, gently scrub the area between the sensor grid and plate. Avoid bending the grid and leave no brush residue trapped in the sensor.

3. Again, irrigate the sensor to rinse away any loosened residue.

4. Blow any remaining liquid off the sensor to allow the collector lid to return to the wet-side position.

5.2.1.3 Dry-Side Changes, Lid Seal Cleaning and Replacement

On the first Tuesday of every month, change the dry-side bucket and clean the underside of the lid seal. Use a clean, lint-free tissue dampened with distilled water. Wipe loose dirt from the lid surfaces. This limits any excess build-up of contaminants. Allow the lid seal to air dry (See Section 3.2.3 for detailed instructions).

Approximately every 12 months the CAL provides each site with a new foam lid seal and instructions for its installation (Figure 5-2). This replacement further limits contamination and helps ensure a tight lid-to-bucket seal. To change the lid seal, use a medium-sized straight blade screw-driver and follow these steps:

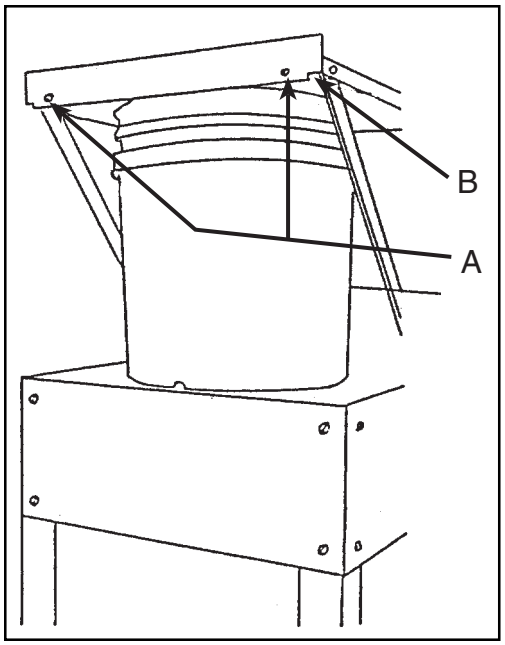


Figure 5-2. Removing the lid seal.

1. First, remove both buckets from the aluminum bucket holders. Position the lid mid-stride by unplugging the collector as the lid approaches the mid-point between the bucket holders.

2. Next, remove the two screws labeled A on Figure 5-2 and the L-retainers they hold in place. These retainers, labeled B, hold the foam lid seal in place. After removing the L-retainers, the old seal will simply drop out. Be careful not to lose the screws.

3. Insert the new foam lid seal and re-install the L-retainers and screws. This completes the lid seal change.

4. Plug the collector back into its power supply.

5. Record the lid seal change in Block 10 of the FORF.

5.2.1.4 Winter Operation

Depending on the site location, winter operation may pose a serious problem for collecting wet-deposition-only samples and may severely stress the operating components of the collector. Some of the more common problems encountered during winter operation are:

- The collector lid seal freezes to one of the buckets.
- The collector lid becomes immobilized due to accumulation of heavy snow or ice.
- The collector does not detect light blowing snow.
- Winds blow snow from an open wet-side bucket.

Typical symptoms of the above problems include:

- Total raingage depth indicates much more precipitation than the sample depth.
- Event recorder trace does not indicate the correct number or duration of events.
- Dry-side bucket contains snow and ice.
- Collector clutches are worn and motor units are burned out.

If any of these problems are regular occurrences, then the collector may need to be modified (although there is a limit to how much wintertime performance can be improved). Consider investments in optional equipment such as a peaked snow roof and/or heated lid seal pad, or an enclosed and heated collector base. **Consult the CAL prior to purchase or installation of any of these options.** Once installed, these devices remain on the collector through all seasons as a permanent modification. Under no circumstances should the foam lid seal be removed to alleviate problems.

The quality of samples affected by winter problems may be very difficult to assess. Note the condition of the equipment as you first saw it, the symptoms of any failure, and especially the extent to which the wet-side sample may have been affected in FORF Block 10, Remarks.

5.2.2 Belfort B5-780 Recording Raingage (see also Appendix D)

5.2.2.1 Winter Operation

The most common difficulties with the raingage during the winter are:

- Cold-induced clock problems
- Blowing snow-related problems

Chart clocks do not function well when the ambient temperature drops below 20° to 25°F. The wind-up raingage clock may not be able to run the full 7 days required. For sites at high altitudes or otherwise limited access or sites experiencing extremely cold conditions, a battery-powered clock (available from the manufacturer) is suggested. This type of clock operates on two C-cell batteries and is not as sensitive to cold temperatures as the wind-up clock.

Blowing snow poses a significant problem in the winter operation of the raingage. Besides the inaccurate measurement of precipitation caused by snow blowing out of the gage, the dashpot and internal mechanism of the raingage may be damaged if snow enters the housing. To prevent these problems, the network requires sites to winterize raingages.

Winterization Instructions

- Remove the funnel attached to the bottom of the top cap by rotating the funnel until its slots clear the beads in the collector tube (see Appendix D). Lift it off and store it in a safe place.
- Empty the catch bucket, replace it in the gage, and add 2 quarts of standard automotive ethylene glycol or propylene glycol antifreeze. This addition will cause the gage to read the equivalent of 2.75 inches of precipitation.
- **Do not make any zeroing adjustment to the gage baseline after adding antifreeze to the bucket**.
- Stir the antifreeze solution in the bucket each week after moving the recording pens away from the raingage chart drum.

Do not dump any antifreeze on the ground. It is toxic to plants and animals. Disposal of antifreeze should comply with proper disposal guidelines.

Table 5-1 gives the approximate freezing temperatures of the antifreeze solution when diluted by precipitation to the raingage reading indicated. Empty the catch bucket and recharge the antifreeze whenever the gage level and the prevailing temperatures indicate that freezing is probable.

Table 5-1. Catch Bucket Freezing Temperature

Gage Reading, inches	5	6.5	7.5	12
Freezing Temperature, °C	-37	-24	-18	-9

- Snow or mixed precipitation amounts are invalidated when the raingage is not properly winterized.
- The CAL notifies sites each winter about winterization procedures. The notice serves as a reminder of the importance of raingage winterization. Unfortunately, the notice may come too early for some sites and too late for others. Sites in northern regions should not wait for the memo. Each Site Operator is responsible for implementing the winterization procedure when temperatures begin to drop below freezing (32°F). For some high-elevation sites, year-round winterization is necessary, because snow, sleet, or freezing rain can occur at any time.

5.2.2.2 Calibration, Turnover, and Sensitivity Checks

5.2.2.2.1 Calibration

Check the raingage calibration at least twice a year and whenever inconsistencies between the Sample Depth and Total Raingage Depth become frequent. This comparison, made while filling out Block 7 (Precipitation Record) of the FORF, is very important (see Section 3.3.7.3 for detailed instructions). Of particular concern are periods when the Total Raingage Depth is less than the Sample Depth because this indicates the collector is catching more precipitation than the raingage. This is the reverse of the normal situation when the collector is expected to miss some precipitation before opening, thus resulting in smaller volumes than the raingage.

Please report the results of this check in FORF Block 10, Remarks, and call the CAL at 1-800-952-7353. When this check indicates a calibration problem, you may be advised to take corrective actions up to replacing your raingage with a rebuilt one from the CAL.

> Raingage calibration is based on the knowledge that 825 grams causes the precipitation pen to rise 1 inch on the raingage chart. Complete calibration instructions are available in Appendix D.

To check raingage calibration, follow these steps:

1. Place a test chart onto the chart drum and install it in the raingage. (see Section 3.2.5 for detailed instructions on changing the raingage chart.)

2. Start the pen inking by moving the pen up and down and then slightly rotating the drum.

3. Add six 825 gram objects one at a time to the bucket, each time turning the drum slightly so as to form a “stairstep” pattern on the test chart.

4. Repeat Step 3. This time **remove** the weights one by one.

5. Evaluate the calibration check by reading "rainfall amount" at each step of the weight additions and subtrations. Each step should be 1 inch up or down from the previous step. If all are within 0.10 inches of the target value, they are ok. If not, call the CAL.

6. Send a photocopy of the test chart to the CAL.

5.2.2.2.2 Turnover Check

This check affirms that the dual traverse gage will move to the 6-inch level, reverse its direction, and continue down the chart to measure a maximum of 12 inches of precipitation. In addition, this test confirms that the precipitation pen and the event recorder pen have adequate clearance.

The check entails gently pushing down on the catch bucket. The precipitation pen and the event marker pen should pass each other without touching at about the 5.5-inch level. Subsequently, the precipitation pen reverses direction. This reversal or turnover point should occur ± 0.10 inches from the top of the chart at the 6.0-inch line. If turnover is outside this range or is impeded by the event recorder pen, call the CAL.

5.2.2.2.3 Sensitivity Check

In order to accurately characterize the precipitation at your site, the raingage should respond or be sensitive to even very small additions, i.e., small amounts of precipitation. To check gage sensitivity, gently tap the inside of the catch bucket with one finger and observe the precipitation pen. A quick response from the pen should be observed. Call the CAL if the gage fails this simple test. It may be corroded or dirty.

5.3 Replacement of Field Equipment Components

The CAL provides all field replaceable components for both the Aerochem Metrics collector and the Belfort recording raingage. These components include the collector sensor, motor box, raingage clock, event recorder, and tower mechanism. All components are shipped via 2nd day delivery with detailed instructions regarding the tools required, component removal and installation, packing, and return shipping. Appendices C and D also detail component replacement procedures. Refer all equipment problems or questions to the CAL at 1-800-952-7353.

5.4 Power Requirements for Field Site Operation

The precipitation collector will operate from either 110V AC line current or 12V DC battery power. In addition, the collector can be set up to operate from 110V AC power; when this line voltage is lost, the 12V DC battery takes over. Note that the recording raingage does not require either power source. The collector motor box provides the power to operate the event recorder, and the raingage clock is powered by either wind-up or C-cell batteries.

5.4.1 110 Volt AC Line Power

This is the most reliable way to operate the site. The collector consumes very little power, a supply with a 15 amp rated duplex is adequate. If power outages are a problem, it is recommended that the site install a DC back-up battery. Call the CAL for battery specifics. The network recommends installation of a Ground Fault Interrupt (GFI) circuit breaker outlet. The GFI (which is commonly used around domestic water supplies) senses imbalances in the 110V AC line and shuts off the power very quickly, an excellent safety feature.

5.4.2 12 Volt DC Power

The collector can operate from either a DC/solar-assisted system or a DC battery. Because of problems encountered during winter, the hazards of transporting batteries, and the difficulty troubleshooting weak DC systems, it is recommended that the site not be operated solely off battery power. The requirements for solar panel sizing and battery storage capacity are discussed in the *Instruction Manual: NADP/NTN Site Selection and Installation*. Figure 5-3 is an idealized drawing of the typical DC/solar power system.

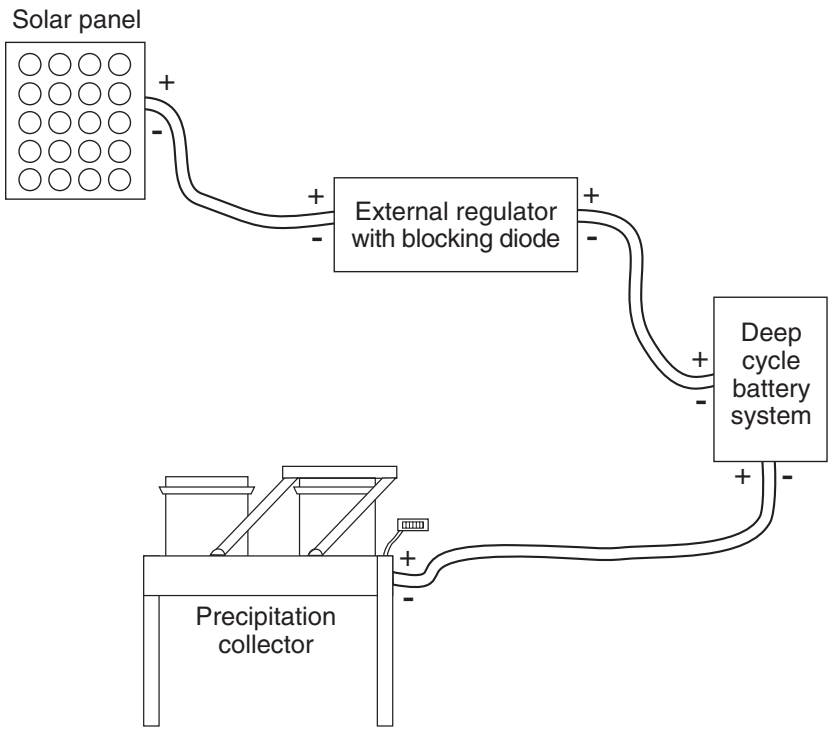


Figure 5-3. An idealized DC solar system.

5.5 References

NADP. 1984. *Instruction Manual: NADP/NTN Site Selection and Installation*, NADP Program Office, Champaign, IL.

NADP. 1990. *Quality Assurance Plan: NADP/NTN Deposition Monitoring*. NADP Program Office, Champaign, IL.

6 Quality Assurance Programs

Periodically, sites are required to participate in NTN quality assurance programs supported by the U.S. Geological Survey (USGS) and the U.S. Environmental Protection Agency (USEPA). This section presents an explanation of these programs. Results of these programs provide the NADP Program Office, funding agencies, and site personnel with information on whether siting criteria and equipment specifications are met, standard operational procedures are followed, and NTN bias and precision goals are achieved. Both agencies issue reports of their findings. Copies are available from the NADP Program Office (see Section 7.2 for contact information). In addition, results of these programs are reported at twice yearly NADP Subcommittee meetings.

6.1 NTN Site Systems and Performance Survey

In this quality assurance program, trained inspectors from ATS, Inc., under USEPA contract, conduct a systems and performance survey of each NTN site approximately every two years. The goals of this survey are to check for siting and equipment problems, ensure that standard NTN procedures are followed, and provide Site Operators with technical assistance in making adjustments in equipment or in correcting procedures.

During the survey the inspectors visit the field site where they make observations and perform various measurements of the ACM collector and Belfort gage. Both pieces of field equipment are tested to ensure they operate within network specifications. If specifications are not met, the inspectors may help the Site Operator to make necessary adjustments or recommend actions to correct the problem. The inspectors prepare a site sketch and record the location and orientation of NTN and other equipment, as well as the location, distance, and height of trees, bushes, or other obstructions that may interfere with sampling. The inspectors also take a set of photographs of the NTN equipment and site, and make notes about the surroundings. Of particular interest is the ground cover within 30 meters of the equipment and the location of roads, residences, storage structures, agricultural facilities, and other nearby sources of air pollutants that may affect the chemistry of wet deposition at the site. The inspectors record the distance from the field equipment to these sources, noting any deficiencies according to the criteria specified in the *NADP/NTN Instruction Manual: Site Selection and Installation* (NADP, 1984). As described in Section 2.2, these criteria are designed to ensure that NTN sites avoid unrepresentative influences from nearby sources.

The inspectors evaluate the performance of the Site Operators, who use their field laboratory equipment to measure a test solution. When equipment problems or deficient laboratory procedures are discovered, the inspectors offer advice on ways to improve procedures or correct problems. Other areas of performance reviewed by the inspectors include: collecting, handling, and measuring wet deposition samples; servicing the Belfort gage; recording data; and maintaining site documentation and data records. The goal is to ensure that standard NTN procedures are followed and offer improvements that can correct faulty procedures or equipment and prevent the loss of information or samples.

During every step of the survey, Site Operators are encouraged to ask questions and seek advice and assistance. These visits are intended to offer an opportunity for program representatives to visit with site personnel, answer questions, help with problems, and listen to concerns. Site Operators and

Supervisors are notified approximately a month in advance of planned visits. The visits occur during a mutually agreed upon time when both the Site Operator and Supervisor can meet with the inspectors. A site survey usually requires 4-5 hours. At the conclusion of the survey, a brief report is delivered to the Site Operator and Supervisor, and a complete report is sent to the NADP Program Office and CAL. Results of the site surveys are summarized in contract reports, which are available from the NADP Program Office (see Section 7.2 for contact information).

6.2 Blind-Audit Program

The blind-audit program is designed to assess the possible biases in NTN measurements resulting from the sample containers and from routine sample handling, shipping, and field measurements. Site Operators are required to submit a blind-audit sample approximately every 2 years. This program is called the blind-audit program because the sample identity is intentionally withheld from the CAL staff. Among the samples submitted each week, the CAL staff are not informed which ones are blind-audit samples, nor their chemical composition. These samples are synthetic solutions with a composition that simulates precipitation. The terminology quality assurance officers use to describe a sample that has an unknown identity *and* an unknown composition is "double blind." Blind-audit samples are a double-blind quality assurance audit of NTN measurements. The blind-audit program is administered by the USGS Branch of Quality Systems, and the USGS project officer identifies these samples only after the CAL analyses have been completed. Then the blind-audit samples are coded as quality assurance samples to prevent them from being confused with wet deposition samples.

The USGS project officer sets a schedule that specifies the sites and dates for submission of blind-audit samples. Samples are sent to the sites well before the scheduled date of submission. Each sample is accompanied by a detailed set of instructions that states when to send the sample, how to label it, how to handle it, and what information to record on the FORF that the Site Operator submits to the CAL with the sample. Information recorded on the FORF disguises the sample by making it appear to be a wet deposition sample from the site. To prevent any lapses in a site's wet deposition record, the Site Operator collects a real sample for the sampling period when the blind-audit sample is submitted. The identity of the real sample is disguised, but the sample is collected and sent to the CAL following standard procedures. Once the CAL is informed of the true identity of the blind-audit and real samples, the records and database are updated to reflect the actual data.

Site Operators receive the blind-audit sample in a clearly labeled bottle. Instructions accompanying the sample tell the Site Operator to pour ~75 percent of the blind-audit sample into a clean bucket, cover the bucket with a clean lid, and let it stand for ~24 hours. From this point, this portion of the sample is handled, measured, and shipped as if it were a wet deposition sample. The only departure from standard procedures is that the instructions specify what precipitation amounts to record on the FORF so that the precipitation data are consistent with the sample volume. Otherwise, a mismatch in the sample volume and precipitation amount may signal the CAL that this is a blind-audit sample. The portion of the blind-audit sample remaining in the original bottle is sent to the CAL separately for analysis. Analysis results from this portion of the sample are compared with those for the portion sent as a wet deposition sample. Differences indicate possible biases in NTN measurements from the sample containers and from routine sample handling, shipping, and field measurements.

Site Operators are contacted by telephone approximately a week before they are to submit the blind-audit samples to verify that they have received the samples and instructions, and to discuss any problems or questions they may have concerning the submission. Results from this program are reported in USGS reports (Gordon et al., 1997) and are available from the NADP Program Office (see Section 7.2 for contact information).

6.3 Intersite Comparison Program

Twice a year Site Operators are asked to measure the pH and conductivity of an intersite comparison sample supplied by the USGS Branch of Quality Systems. These samples are synthetic solutions that simulate precipitation. Different formulations are used for each set of tests. Site Operators are not told the target concentrations of the solutions. In other words, the intersite comparison samples are "single blind" to the Operators because they know they are being tested but not the expected results. Specific instructions for measuring the intersite comparison samples are sent with each sample. Site Operators report their measurements to the USGS Project Officer, who uses the results to assess the bias and precision of Site Operator pH and conductivity measurements.

A statistical summary of all of the measurements is reported to participating Site Operators, along with a graphical presentation of the target pH and conductivity values and acceptable ranges of measurements. Operators can see whether their measurements were acceptable, i.e., met the accuracy goals. Operators who do not meet the goals are asked to participate in a follow-up study conducted by the USGS. The purpose of the follow-up study is to resolve the cause of the measurement difficulties. They can also contact the CAL for assistance (see Section 7.1 for contact information) or consult Appendix B. Results from this program are reported in USGS reports (Gordon et al., 1997) and are available from the NADP Program Office (see Section 7.2 for contact information).

6.4 Collocated Sampler Program

The USGS Branch of Quality Systems sponsors this program to determine the overall precision of measuring precipitation amounts and chemistry, including the variability from sample collection through data validation and storage (See et al., 1990). Precision is calculated by comparing data for paired, collocated ACM collectors and Belfort gages operated at a site for 1 year. These paired instruments are the original site equipment and a second (collocated) set installed and operated according to standard procedures. Site Operators collect two samples and change two raingage charts each week. At the field laboratory, they handle and measure the samples independently, record data and observations on separate FORFs, and send both samples to the CAL. CAL technicians treat and analyze the samples as if from separate sites and screen, verify, and store the data independently in the database. After 1 year of collocated sampler operation, the second set of equipment moves to another site. Collocated sampling is performed at two or more sites each year.

The USGS Project Officer chooses sites where collocated sampling will occur after consulting and reaching agreement with site personnel. Three criteria govern site selection (See et al., 1990): (1) distribution among diverse regions; (2) distribution among low, medium, and high rainfall regions; and (3) site operational history. Once a site agrees to participate, the USGS ships the collocated field equipment to the site and is responsible for its proper installation. A schedule is set for starting the collocated sampling. When sampling ends, the USGS is responsible for equipment removal.

Differences in weekly chemical and precipitation measurements are calculated for valid collocated samples, and these differences are used to determine precision estimates for each chemical and for precipitation amounts. Results are reported in USGS reports (Gordon et al., 1997) and are available from the NADP Program Office (see Section 7.2 for contact information).

6.5 Field Blank Program

This program attempts to quantify biases from contamination that enters the wet-side bucket installed in the ACM collector for an entire sampling period plus contamination from routine sample handling, shipping, and field measurements. The possible contamination entering the bucket while it is installed in the ACM collector is a major difference between this program and the blind-audit program described in Section 6.2. Another difference is that there is no effort to disguise field blank samples from the CAL. Although the lid seal of the ACM collector is designed to protect the wet-side sample from dry deposition, dust can bypass this seal. Under windy and dusty conditions, this can be an important source of bias in NTN measurements. Contamination also can occur when the sample is handled and measured in the field laboratory and shipped to the CAL. By capturing all of these sources of contamination, field blank measurements include virtually all of the important sources of bias in NTN measurements caused by the equipment, containers, field procedures, and shipping.

To measure contamination from these sources, Site Operators add a synthetic solution to the wet-side bucket at the end of a sampling period when no precipitation occurred. This solution is provided by the USGS Branch of Quality Systems, which administers the program. The bucket is covered with a clean lid and left undisturbed for 24 hours. This waiting period allows the solution to remain in contact with the inside walls of the bucket, simulating the contact a rain sample has with the bucket surface. The Operator then handles the solution as a wet deposition sample, weighing it, transferring it to a sample bottle, measuring the pH and conductivity on a portion of the sample, and sending it to the CAL, along with a portion of the original solution. Analyses of this solution and the original solution are compared. Differences in these measurements are used to quantify the accumulated effects of these contamination sources. This program was initiated in October 1996. Results will be reported in future USGS reports.

6.6 References

Gordon, J., M. Nilles, D. Polacsek, and M. Ratcliff. 1997. *External Quality-Assurance Results for the National Atmospheric Deposition Program/National Trends Network during 1994*. U.S. Geological Survey, Water Resources Investigations Report 97-4201, Denver, CO.

NADP, 1984. *NADP/NTN Instruction Manual: Site Selection and Installation.* NADP Program Office, Champaign, IL.

See, R., T. Willoughby, M. Brooks, and J. Gordon. 1990. *Programs and Analytical Methods for the U.S. Geological Survey Acid Rain Quality-Assurance Project*. U.S. Geological Survey, Water Resources Investigations Report 90-4029, Denver, CO.

7 Directory

7.1 NADP - Central Analytical Laboratory

Illinois State Water Survey
2204 Griffith Drive
Champaign, IL 61820-7495

Web Address: http://nadp.sws.uiuc.edu/cal
E-Mail for site support: ntn@sws.uiuc.edu
E-Mail for general information: cal@sws.uiuc.edu

For Questions About	Contact
Selecting and Installing a Site ...how to install the NADP precipitation collector ...how to install the recording raingage ...power requirements, rules, equipment spacing ...application to enter network **Site Equipment** ...problems, troubleshooting, winter operations ...requirements, costs, calibrations, tests **Site Operations** ...standard procedures ...training video/CDROM, annual field operations course **Field Chemistry Measurements** ...equipment, cables, pH electrodes ...problems, check sample measurements ...pH meters, conductivity meters/cells **Monthly Site Preliminary Data Reports** ...explanations, error messages, notes	**Scotty R. Dossett, Site Liaison** **Phone: 1-800-952-7353** **Fax: 217-333-0249** **E-mail: sdossett@uiuc.edu**
Shipping/Supplies ...requirements, problems ...shipping vendors ...supplies not listed on field forms	**Jeff Pribble** **Phone: 217-244-0624** **Fax: 217-333-6540** **E-mail: pribble@sws.uiuc.edu**
Central Analytical Laboratory Operations ...administrative issues ...sample handling procedures, lab operations ...analytical methods, material safety data sheets (MSDS)	**Karen Harlin, CAL Director** **Phone: 217-244-6413** **Fax: 217-244-3054** **E-mail: k-harlin@uiuc.edu**
CAL Office ...contact other staff ...CAL web page ...miscellaneous information ...training course registration	**Pam Bedient, Administrative Assistant** **Phone: 217-244-0868** **Fax: 217-244-3054** **E-Mail: pbedient@sws.uiuc.edu**
Quality Assurance ...Central Analytical Laboratory QA/QC	**Jane Rothert, CAL QA Specialist** **Phone: 217-333-7942** **Fax: 217-333-6540** **E-mail: rothert@uiuc.edu**

7.2 NADP Program Office

Illinois State Water Survey
2204 Griffith Drive
Champaign, IL 61820-7459

Web Address: http://nadp.sws.uiuc.edu
E-Mail: nadp@sws.uiuc.edu

For Questions About	Contact
Program Participation ...general information, requirements ...National Research Support Project-3 ...costs, contracts and billings ...published reports and brochures **Atmospheric Integrated Research Monitoring Network (AIRMoN)** ...general information ...requirements, costs **Mercury Deposition Network (MDN)** ...general information ...requirements, costs	**Van Bowersox, NADP Coordinator** **Phone: 217-333-2213** **Fax: 217-244-0220** **E-mail: sox@sws.uiuc.edu**
NADP Data ...Web page ...color maps, tables, figures ...special data requests	**Bob Larson** **Phone: 217-333-9008** **Fax: 217-333-6540** **E-mail: blarson@sws.uiuc.edu**
Meeting Information ...annual Technical Committee meeting ...Subcommittee meetings	**Kathy Douglas** **Phone: 217-333-7871** **Fax: 217-333-0249** **E-mail: kathy@sws.uiuc.edu**
Quality Assurance ...QA/QC procedures ...bias...precision...blank levels ...network comparisons	**Chris Lehmann** **Phone: 217-265-8512** **FAX: 217-244-3054** **E-mail: clehmann@uiuc.edu**
Sample Archives ... inquiries, procedures, and requests for NTN and AIRMoN samples	**Karen Harlin, Assistant Coordinator** **Phone: 217-244-6413** **Fax: 217-333-6540** **E-mail: k-harlin@uiuc.edu**

7.3 External Quality Assurance Programs

For Questions About	Contact
USGS-NTN External Quality Assurance Project Data and Program Related Issues ...QA project planning ...data analysis and reports	**Gregory Wetherbee, Project Chief, Chemist** **USGS Water Resources Discipline, Branch of Quality Systems (USGS, WRD, BQS)** **Box 25046, MS 401, Bldg. 53** **Denver Federal Center** **Denver, Colorado 80225** **Phone: 303-236-1837** **Fax: 303-236-1880** **E-mail: wetherbe@usgs.gov** **http://bqs.usgs.gov/precip/project_overview/index.htm**
Field Logistics ... collocated samples ...sample handling evaluation program ...field blank/audit program ...inter-site comparison program ...inter-laboratory comparison program	**Natalie E. Latysh, Hydrologist** **USGS Water Resources Discipline, Branch of Quality Systems (USGS, WRD, BQS)** **Box 25046, MS 401, Bldg. 53** **Denver Federal Center** **Denver, Colorado 80225** **Phone: 303-236-1874** **Fax: 303-236-1880** **E-mail: nlatysh@usgs.gov** **http://bqs.usgs.gov/precip/project_overview/index.htm**
USEPA-NTN Site Systems and Performance Surveys ...on-site reviews and inspections ...site representativeness	**Michael J. Kolian** **U.S. Environmental Protection Agency** **Clean Air Markets Division** **6204N USEPA Headquarters** **Ariel Rios Building** **1200 Pennsylvania Avenue. N.W.** **Washington, DC 20460** **Phone: 202-564-2884** **Fax: 202-565-2140** **E-mail: kolian.michael@epa.gov**

7.4 Instrument Manufacturers

For Questions About	Contact
Wet Deposition Collector ...purchases ...optional features **Event Recorder** ...single pen ...dual pen	**Aerochem Metrics, Inc.** **4473 West Highway 476** **Bushnell, Florida 33513** **Phone: 352-793-8000** **Fax: 352-793-3954** **LODA Electronics Co.** **307 South Elm** **P.O. Box 207** **Loda, IL 60948-0207** **Phone: 217-386-2554** **Fax: 217-386-2439** **E-mail: loelco@prairienet.net** **http://www.lodaelectronics.com**
Recording Raingage ...purchases	**Belfort Instrument Company** **727 South Wolfe Street** **Baltimore, Maryland 21231** **Phone: 800-937-2353** **Fax: 410-342-7028** **E-mail: sales@belfortinstrument.com** **http://belfortinstrument.com**

Appendix A National Trends Network (NTN) Equipment Requirements

A.1 Field Site Equipment

Precipitation Collector: Two wet deposition collectors meet current NADP specifications: the Aerochem Metrics model 301 and the LODA model 2001 (see Sections 2.3 and 3.1). Section 7.4 lists contact information for the manufacturers.

Recording Raingage Equipped with Event Recorder: The Belfort model B5-780 recording raingage is the only raingage that meets NTN requirements (see Sections 2.3 and 3.1). This model is available only from the Belfort Instrument Company, while the NADP event recorder is available from either of the approved collector manufacturers listed in Section 7.4.

A.2 Field Laboratory Equipment

Equipment listed in this section meets NTN requirements. Examples may vary considerably in cost, serviceability, and expertise required for proper use. The NADP does not endorse any brand name.

Balance

Requirements
15 kg capacity, 1 g sensitivity/readability

Examples
Mettler model SB-16000 (top-loading electronic)
Ohaus model CHAMP CQ25R31 (top-loading electronic)
Ohaus model 1119-D0 (open beam mechanical)

pH Meter and Electrode

Meter Requirements
Read 0-14 pH units, digital display with readability to 0.01 pH units, microprocessor controlled with buffer recognition and auto-read capability

Meter Examples
Beckman model F250
Cole Parmer model A-59330-00
Corning model 430
Fisher model Accumet AB15
Oakton model pH 510
Orion model 250A or 410A
VWR model SB20 Symphony

Electrode Requirements : The CAL supplies a Broadley-James Combination pH Electrode model E1439-EC2-AO3. Sites are discouraged from providing their own electrode.

Specific Conductance Meter and Cell

Many conductance meters and cells have proprietary cabling. Make certain that the meter or cell you order will connect to your existing equipment, or purchase the meter and cell together.

Meter Requirements
0.1-1,000 µS/cm range and readability to 0.1m µS/cm

Meter Examples
Cole Parmer catalog number EW-19050-00
Oakton model CON 500
VWR model 2052
VWR catalog number 23226-501 (use only with VWR catalog number 23226-524 conductance cell)

Cell Requirements
Cell constant of 1.0 and a sample volume requirement < 10 mL

Cell Examples
VWR catalog number 23226-524 or 23198-020
YSI model 3403 or 3417

Suggested Labware

500 mL squeeze bottle
disposable laboratory wipes or lint free tissues
distilled or reagent water with conductivity below 5 µS/cm
electrode holder or ring stand
small flat bottomed dishpan

Note: The CAL provides other laboratory supplies, as well as a training video or CD-ROM. Contact the CAL at 1-800-952-7353 for additional information.

Appendices B, C, and D are not currently available in the online version of the National Trends Network Operators Manual. To obtain printed copies of any of these appendices, please contact:

Ms. Joyce Fringer
Illinois State Water Survey
2204 Griffith Drive
Champaign, IL 61820-7495
(217) 333-2213
jfringer@sws.uiuc.edu

ILLINOIS
DEPARTMENT OF
NATURAL
RESOURCES

Air Quality Monitoring Protocol for Denali National Park & Preserve, Alaska

Standard Operating Procedure (SOP) # 3

Version II IMPROVE Sampler Operating Procedures Manual for use in the IMPROVE Monitoring Network

Version v2.01.01 (January 2001)

Version II IMPROVE Sampler

Operating Procedures Manual for use in the

IMPROVE Monitoring Network

Crocker Nuclear Laboratory
One Shields Avenue
University of California
Davis, CA 95616-8569

(530) 752-1123
fieldops@crocker.ucdavis.edu

v2.01.01: January 2001

Standard Operating Procedures
Technical Information Document TI 201A

TABLE OF CONTENTS

page
TABLE OF CONTENTS 1
1. Introduction 3
1.1 IMPROVE Network 3
1.2 Changes from Version I to Version II 6
1.3 Weekly Sample Changes 7
2. Description of Version II IMPROVE Sampler 9
2.1 Shelters 9
2.2 $PM_{2.5}$ Filter Module 10
2.3 PM_{10} Filter Module 12
3. Controller 13
3.1 General Description 13
3.2 Current Status Screens 15
3.3 Main Menu 16
3.4 Changing the Date and Time 16
4. Procedures for Sample Changing in the Field 17
4.1 Preparation and Summary 17
4.2 Initiating the Sample Changing Sequence 18
4.3 Exposed Filter Readings (Final Readings on the Logsheet) 18
4.4 Removing and installing cassettes 19
4.5 Clean Filter Readings (Initial Readings on the Logsheet) 20
4.6 Field Logsheets 22
5. Troubleshooting Guide 23
6. Sampler Installation and Maintenance 25
6.1 Summary 25
6.2 Advanced Menu 25
6.3 Flow Rate Calibration 26
6.3.1 Calibration Equipment 26
6.3.2 Calibration Controller Commands 28
6.3.3 Adjusting the Nominal Flow Rate 28
6.3.4 Four Point Calibration 29
6.4 Sampler Configuration 30
Appendix I Flow Rate Equations 32
A-I.1 The Effect of Flow Rate on Cyclone Cut Point 32
A-I.2 Flow Control by a Critical Orifice 33
A-I.3 Flow Rate through a Orifice Meter 34
A-I.4 Pressure-Elevation Relationship 35
A-I.5 Calibration of Audit Devices 35
A-I.6 Nominal Flow Rate Equation 35
A-I.7 Flow Rate Equation for the System Vacuum Gauge 35
A-I.8 Calibration of the System Transducers 36
Appendix II. Dates of Sample Collection for Every Third Day 37

LIST OF FIGURES

page
Figure 1. Aerosol sites in the IMPROVE Network in early 2001 3
Figure 2. Typical sampler configuration. 9
Figure 3. $PM_{2.5}$ module. 10
Figure 4. PM_{10} module. 12
Figure 5. Controller module 13
Figure 6. Controller terminal 13
Figure 7. Current status screens. 15
Figure 8. Main menu screen. 16
Figure 9. Program version screen. 16
Figure 10. Change time screens. 16
Figure 11. Continue screen 1. 18
Figure 12. Exposed readings screens 18
Figure 13. Continue screen 2. 18
Figure 14. Exchange cassette screen. 19
Figure 15. Error, low flow through cyclone. 20
Figure 15. Error, cartridge upside down. 21
Figure 15. Clean filter readings screens. 21
Figure 16. Continue screen 3. 21
Figure 17. Three-filter field logsheet. 22
Figure 18. Advanced menu screen. 25
Figure 19. Insertion of calibration probe in $PM_{2.5}$ and PM_{10} modules. 26
Figure 20. Logsheet for nominal flow rate and four-point audit. 27
Figure 21. Flow calibration screens. 28
Figure 22. Sampler screens. 30
Figure 23. Protocol 2 screens. 31
Figure 24. Cyclone collection efficiency. 32

LIST OF TABLES

page
Table 1. IMPROVE and IMPROVE protocol sites in 2000. 4
Table 2: Types of cartridges for 1-day-in-3 sampling 8
Table 3. Elevation factors as a function of elevation in meters. 29
Table 4. Flow rate and 50% aerodynamic diameter *vs*. flow rate. 34
Table 5. Dates of sample collection for every third day. 37

1. Introduction

1.1 IMPROVE Network

IMPROVE (Interagency Monitoring of Protected Visual Environments) is a cooperative program of the National Park Service, Forest Service, Bureau of Land Management, Fish and Wildlife Service, Environmental Protection Agency, and state agencies, whose primary purposes are the protection of visibility in Class I areas and characterization of regional haze.

The Version I IMPROVE sampler has been used in this network since 1988. Between 1996 and 1999 there were approximately 80 sites, 30 were under the direct control of the IMPROVE steering committee, and the remainder under the control of one of the cooperating agencies.

In 2000, the number of sites will increase to approximately 145, with 110 will be under the direct control of the IMPROVE steering committee. All of the 110 sites are in or near Class I visibility areas. These sites represent all 156 Class I areas, except Bering Sea NWR. The remaining sites are referred to as "Protocol" sites, and are under the control of one of the committee agencies, states, or tribes. The operation of the Protocol sites is identical to that of the IMPROVE sites. Almost all of the Protocol sites are in remote areas. The locations of planned sites for early year 2001 are shown in Figure 1 and listed in Table 1. In 2000, the sampling protocol shifted from twice a week to every third day. To accommodate both the increase in size and sampling frequency, a new version of the sampler was needed.

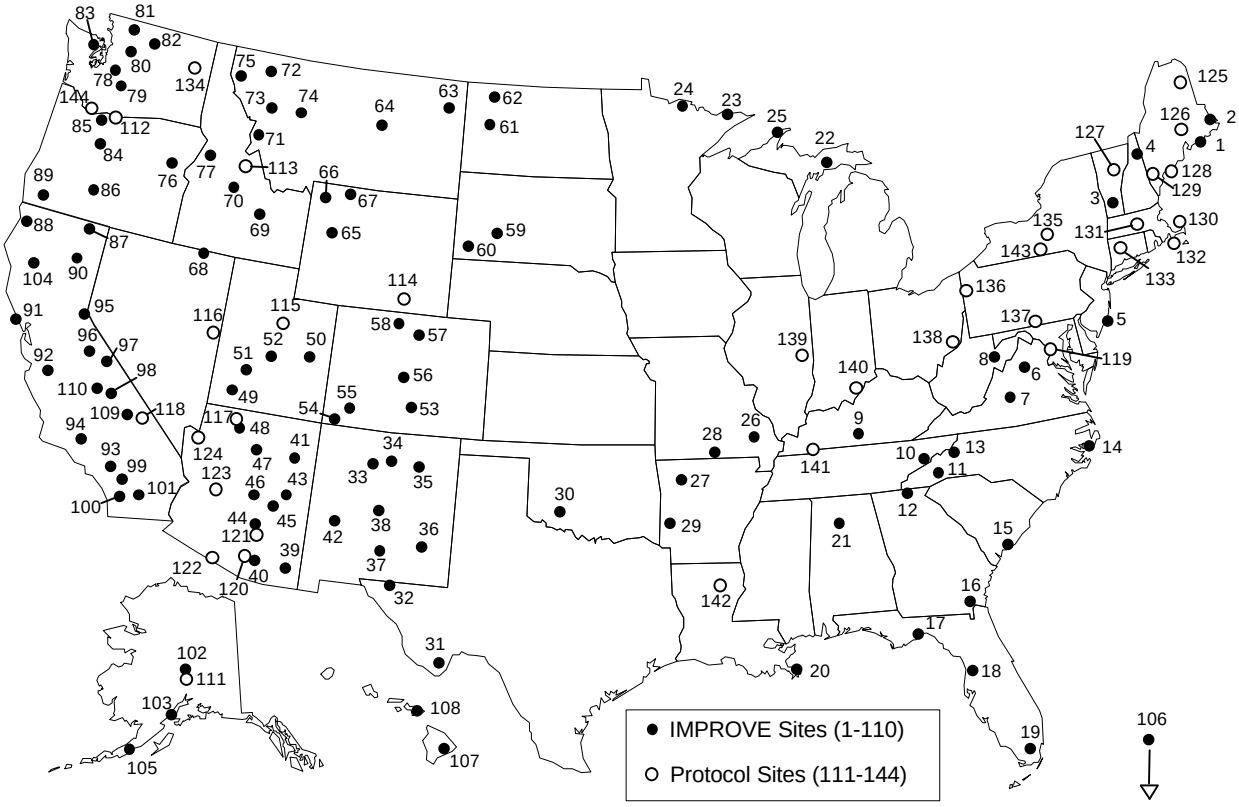


Figure 1. Aerosol sites in the IMPROVE Network in early 2001.

Table 1. IMPROVE and IMPROVE protocol sites in 2000.

n	*Represented Class I areas or Protocol Site*	*state*	*Agency*
1	Acadia	ME	IMPROVE
2	Moosehorn, Roosevelt Campobello	ME	IMPROVE
3	Lye Brook	VT	IMPROVE
4	Great Gulf, Presidential Range-Dry River	NH	IMPROVE
5	Brigantine	NJ	IMPROVE
6	Shenandoah	VA	IMPROVE
7	James River Face	VA	IMPROVE
8	Dolly Sods, Otter Creek	WV	IMPROVE
9	Mammoth Cave	KY	IMPROVE
10	Great Smoky Mtns, Joyce Kilmer-Slickrock	TN	IMPROVE
11	Shining Rock	NC	IMPROVE
12	Cohutta	GA	IMPROVE
13	Linville Gorge	NC	IMPROVE
14	Swanquarter	NC	IMPROVE
15	Cape Romain	SC	IMPROVE
16	Okefenokee, Wolf Island	GA	IMPROVE
17	Saint Marks	FL	IMPROVE
18	Chassahowitzka	FL	IMPROVE
19	Everglades	FL	IMPROVE
20	Breton	LA	IMPROVE
21	Sipsey	AL	IMPROVE
22	Seney	MI	IMPROVE
23	Boundary Waters	MN	IMPROVE
24	Voyageurs	MN	IMPROVE
25	Isle Royale	MI	IMPROVE
26	Mingo	MO	IMPROVE
27	Upper Buffalo	AR	IMPROVE
28	Hercules-Glades	MO	IMPROVE
29	Caney Creek	AR	IMPROVE
30	Wichita Mountain	OK	IMPROVE
31	Big Bend	TX	IMPROVE
32	Guadalupe Mountains, Carlsbad Caverns	TX	IMPROVE
33	Bandelier	NM	IMPROVE
34	San Pedro Parks	NM	IMPROVE
35	Wheeler Peak, Pecos	NM	IMPROVE
36	Salt Creek	NM	IMPROVE
37	White Mountain	NM	IMPROVE
38	Bosque del Apache	NM	IMPROVE
39	Chiricahua NM, Chiricahua W, Galiuro	AZ	IMPROVE
40	Saguaro	AZ	IMPROVE
41	Petrified Forest	AZ	IMPROVE
42	Gila	NM	IMPROVE
43	Mount Baldy	AZ	IMPROVE
44	Superstition	AZ	IMPROVE
45	Sierra Ancha	AZ	IMPROVE
46	Mazatzal, Pine Mountain	AZ	IMPROVE
47	Sycamore Canyon	AZ	IMPROVE
48	Grand Canyon (Hance site)	AZ	IMPROVE
49	Bryce Canyon	UT	IMPROVE
50	Canyonlands, Arches	UT	IMPROVE
51	Zion	UT	IMPROVE
52	Capitol Reef	UT	IMPROVE
53	Great Sand Dunes	CO	IMPROVE

n	***Represented Class I areas or Protocol Site***	***state***	***Agency***
54	Mesa Verde	CO	IMPROVE
55	Weminuche, La Garita, Black Canyon of Gunnison	CO	IMPROVE
56	Maroon Bells, West Elk, Eagles Nest, Flat Tops	CO	IMPROVE
57	Rocky Mountain	CO	IMPROVE
58	Mount Zirkel, Rawah	CO	IMPROVE
59	Badlands	SD	IMPROVE
60	Wind Cave	SD	IMPROVE
61	Theodore Roosevelt	ND	IMPROVE
62	Lostwood	ND	IMPROVE
63	Medicine Lake	MT	IMPROVE
64	UL Bend	MT	IMPROVE
65	Bridger, Fitzpatrick	WY	IMPROVE
66	Yellowstone, Grand Teton, Teton, Red Rock Lakes	WY	IMPROVE
67	North Absoraka, Washakie	WY	IMPROVE
68	Jarbidge	NV	IMPROVE
69	Craters of the Moon	ID	IMPROVE
70	Sawtooth	ID	IMPROVE
71	Anaconda-Pintler, Selway-Bitterroot	MT	IMPROVE
72	Glacier	MT	IMPROVE
73	Bob Marshall, Mission Mountains, Scapegoat	MT	IMPROVE
74	Gates of the Mountains	MT	IMPROVE
75	Cabinet Mountains	MT	IMPROVE
76	Eagle Cap, Strawberry Mountain	OR	IMPROVE
77	Hells Canyon	ID	IMPROVE
78	Mount Rainier	WA	IMPROVE
79	Goat Rock, Mt Adams	WA	IMPROVE
80	Alpine Lakes	WA	IMPROVE
81	North Cascades, Glacier Peak	WA	IMPROVE
82	Pasayten	WA	IMPROVE
83	Olympic	WA	IMPROVE
84	Three Sisters, Mount Jefferson, Mount Washington	OR	IMPROVE
85	Mount Hood	OR	IMPROVE
86	Crater Lake, Diamond Peak, Mountain Lakes, Gearhart Mountain	OR	IMPROVE
87	Lava Beds, South Warner	CA	IMPROVE
88	Redwood	CA	IMPROVE
89	Kalmiopsis	OR	IMPROVE
90	Lassen Volcanic, Caribou, Thousand Lakes	CA	IMPROVE
91	Point Reyes	CA	IMPROVE
92	Pinnacles, Ventana	CA	IMPROVE
93	San Gabriel, Cucamonga	CA	IMPROVE
94	San Rafael	CA	IMPROVE
95	Desolation, Mokelumne	CA	IMPROVE
96	Yosemite, Emigrant	CA	IMPROVE
97	Hoover	CA	IMPROVE
98	Sequoia, Kings Canyon	CA	IMPROVE
99	San Gorgonio, San Jacinto	CA	IMPROVE
100	Agua Tibia	CA	IMPROVE
101	Joshua Tree	CA	IMPROVE
102	Denali	AK	IMPROVE
103	Tuxedni	AK	IMPROVE
104	Marble Mountain, Yolla Bolly Middle Eel	CA	IMPROVE
105	Simeonof	AK	IMPROVE
106	Virgin Islands	VI	IMPROVE
107	Hawaii Volcanoes	HI	IMPROVE
n	***Represented Class I areas or Protocol Site***	***state***	***Agency***
108	Haleakala	HI	IMPROVE
109	Dome Land	CA	IMPROVE

110	Kaiser, Ansel Adams, John Muir	CA	IMPROVE
111	Trapper Creek-Denali	AK	NPS
112	Columbia River Gorge	WA	USFS
113	Salmon	ID	USFS
114	Brooklyn Lakes	WY	USFS
115	Lone Peak	UT	USFS
116	Great Basin	NV	NPS
117	Indian Gardens	AZ	NPS
118	Death Valley	CA	NPS
119	Washington DC	DC	NPS
120	Saguaro west	AZ	Arizona
121	Queen Valley	AZ	Arizona
122	Organ Pipe	AZ	Arizona
123	Hillside	AZ	Arizona
124	Meadview	AZ	Arizona
125	Presque Isle	ME	Micmac Tribe
126	Old Town	ME	Penobscot Tribe
127	Proctor Research	VT	Vermont
128	Casco Bay	ME	Maine
129	Bridgton	ME	Maine
130	Cape Cod	MA	Massachusetts
131	Quabbin Reservoir	MA	Massachusetts
132	Martha's Vineyard	MA	Wampanoags Tribe
133	Mohawk Mountain	CT	Connecticut
134	Spokane Reservation	WA	Spokane Tribe
135	Connecticut Hill	NY	EPA/CASTNet
136	M.K. Goddard	PA	EPA/CASTNet
137	Arendtsville	PA	EPA/CASTNet
138	Quaker City	OH	EPA/CASTNet
139	Bondville	IL	EPA/CASTNet
140	Livonia	IN	EPA/CASTNet
141	Cadiz	KY	EPA/CASTNet
142	Sikes	LA	EPA/CASTNet
143	Addison Pinnacle	NY	New York
145	Columbia Gorge	WA	USFS

1.2 Changes from Version I to Version II

The Version II sampler is not significantly different than the Version I sampler. Both consist of independent filter modules connected to a common controller module. Each filter module has independent air streams with separate sizing devices, critical orifice flow controllers, and pumps. Each module has solenoids for exposing up to four filters between changes. No change has been made in the sampling trains from the inlet to the filter. The same cyclones define the $PM_{2.5}$ cut point. Collocated tests show no differences in particulate concentrations. Other key components have not changed. Flow control continues to be obtained by a critical orifice between the filter and pump. In both versions, the flow rate for $PM_{2.5}$ particles is measured independently at two locations, ahead of the filter and between the filter and critical orifice.

The Version I sampler operated very reliably, with minimal downtime, but several factors led to the modifications. First, the change to a 1-day-in-3 protocol required replacement of the weekday-oriented clock. Microprocessor technology is much different in 1999 than in 1987, so we moved in this direction. Second, the samplers at existing sites were due for replacement, having been in the field for up to a decade. By shifting all samplers to Version II at this point, we could maintain a

uniform network. Third, the cassettes we have used now for twenty years have been discontinued by the manufacturer. Having new cassettes made to our design opened up avenues for improving the way we handle filters in the laboratory and in the field.

The controller is the most significant change from Version I and II. Version I uses a programmable clock that is oriented to days of the week, while Version II uses a microprocessor. Other components of the sampler were modified to take advantage of the microprocessor.

- The dial flow rate gauges were replaced by transducers that can be read by the controller. All readings are displayed digitally on the controller screen.
- The mechanical elapsed timers were eliminated.

The shift to microprocessors and transducers changed the way we record the flow rates. The Version I sampler used flow rates measured at the time of sample change, both before and after sampling. The Version II microprocessor monitors the flow rate and temperature every minute and logs this information in magnetic memory. The data are downloaded onto a magnetic card transported with the cassettes. The operator still records the flow rates at the time of sample change for quality control, but this is now simplified and improved. In the Version I sampler, the operator had to read dials on flow rate gauges. In the Version II sampler, all information to be recorded on the logsheet is displayed digitally on the controller screen. The controller display follows the logsheets exactly. The operator is still expected to check the values recorded for reasonableness.

The second major change in the Version II sampler is in the filter cassettes. The new cassettes have the same dimensions of the old, but have a much superior design. The top and bottom of the new cassette are held together by O-rings instead of a screw fitting, which has eliminated leaks. Built-in stainless steel screens produce a more uniform particle distribution. The materials are the same as those used in the cassettes in the FRM sampler. The cassettes are currently available for 25mm filters with a 2.2 cm^2 collection area, 25mm filters with a 4 cm^2 collection area, and 37mm filters with a 6.4 cm^2 collection area. The cassettes can be stacked for a secondary filter. Collocated comparisons between the old and new cassettes show no differences in collection.

The installation of the cassettes in the sampler has also been improved. In the Version I sampler, the cassettes were loaded individually and attached to hoses from the solenoids. In the Version II sampler, the cassettes are installed in a cartridge in the central laboratory. Each cartridge holds four cassettes, with either ambient filters, field blanks, or no filter. The site operator exchanges the entire cartridge. Guide pins ensure that the cassettes are correctly oriented, eliminating the possibility that a given filter could run on the wrong date. The hoses between the cassettes and the solenoids have been replaced by a direct connection using a manifold that drops onto the cassettes. This eliminates leaks in the hoses and leaks around the cassettes from incorrect installation during sample changing.

Finally, many parts have been redesigned to make the sampler easier to maintain. The fiberglass enclosure has been replaced by steel enclosure of one-half the volume. Some components have been redesigned to allow any defective parts to be replaced quickly, minimizing down-time. For example, the electronics components for each filter module are enclosed in a removable box. If a component fails, a new box is expressed to the site and snapped in place.

1.3 Weekly Sample Changes

The filters are loaded into cassettes and cartridges at the central laboratory at Davis. All cassettes have caps to protect sample integrity. All the cartridges and the logsheet for a given change are enclosed in a resealable bag with the date of the sample change. Three bags will be shipped to and from the site in a "Blue Box" shipping container, labeled with all the sample changing dates.

The IMPROVE network will operate in the one-day-in-three protocol, with sample changing always on Tuesday. With this protocol, the arrangement of ambient filters will vary slightly for each week, with the pattern repeating every third week. Each Blue Box will have three bags, three logsheets, a one memory card and will be shipped every three weeks. The three types of cartridges are listed in Table 2. All cartridges will be labeled by the Tuesday sample-changing date.

Table 2: Types of cartridges for 1-day-in-3 sampling.

cartridge type	position 1	position 2	position 3	position 4
Type 1	Thursday	Sunday	unused	unused or field blank
Type 2	Wednesday	Saturday	Tuesday	unused or field blank
Type 3	Friday	Monday	empty hole	unused or field blank

For two of the three weeks, the sampler will be not be operating on the sample-changing day. For these sample changes, the operator records the final readings, replaces the old cartridges with new cartridges, and records the initial readings. The only difference is that there will be initial or final readings for the filter in position 3 on two of the three weeks. The logsheet and display will indicate when the values for position 3 are to be recorded.

The procedures are different every third week, when the sampler will be operating when the operator arrives. When the operator presses the buttons to start the sample change, the controller will suspend sampling, read the flow rates for all the filters and display the information to be recorded. For this change, the operator will have to transfer the cassette in position 3 from the old cartridge to the new. The key information for the operator is that the new cartridges will not have any cassette in position 3. The cassette in position 3 has a black O-ring attaching it and is the only one that can be removed without a special tool. After the cassette is transferred, the new cartridge in installed. After the initial readings are taken, the sampler will resume collection on the filters in position 3.

The field blanks in position 4 are completely transparent to the site operator and to the sampler controller. Flow rate measurements are not taken for field blanks. Selected sites will have secondary quartz filters for Module C. Two cartridges will stacked together in the sample handling laboratory and inserted by the site operator as a single unit. The module must be slightly modified to accommodate this. No special procedures are required for the site operator.

2. Description of Version II IMPROVE Sampler

2.1 Shelters

The sampler will be protected from direct sunlight by a shelter. The shelter will also protect the filters during sample-changing in rain or snow. This will vary from an outdoor stand with a sunshield to a fully enclosed but well-ventilated shelter. The shelters at IMPROVE sites will not be heated or air-conditioned. The length of the inlet stacks will be 1.83m at all sites.

The standard configuration is shown in Figure 2. Most sites will have four modules plus a controller. Selected sites will also have a quality assurance module. Each module will have its own pump requiring 3.3 amperes (A) at 120 volts (V).

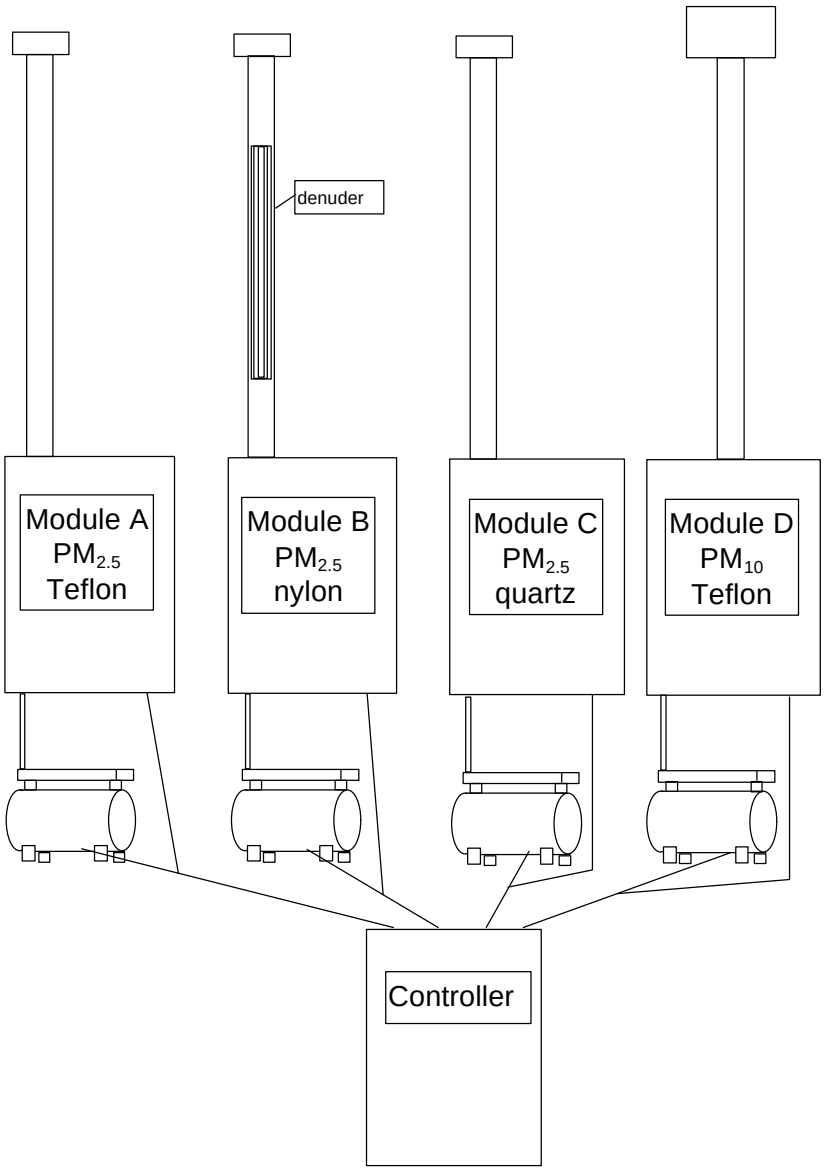


Figure 2. Typical sampler configuration.

2.2 $PM_{2.5}$ Filter Module

A Version II $PM_{2.5}$ module is shown in Figure 3.

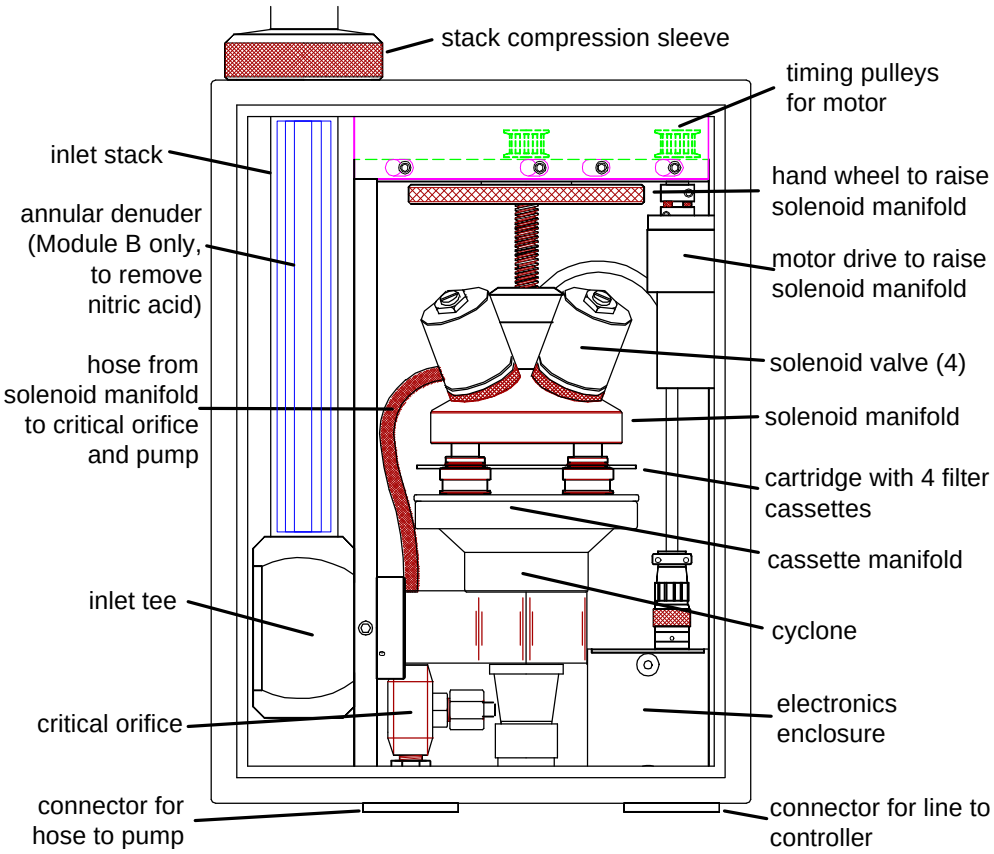


Figure 3. $PM_{2.5}$ module.

Inlet and Cyclone The ambient air enters through a screened inlet on top of the stack. This removes bugs, rain, and particles larger than 15 µm. The air stream then passes through a cyclone that removes particles larger than 2.5 µm. The cyclone has a 50 percent efficiency for 2.5 µm aerodynamic diameter particles at a flow rate of 22.8 L/min. A 5% decrease in flow rate, from 22.8 to 21.7 L/min, would increase the cut point from 2.5 to 2.9 µm.

Module B (nylon) has a carbonate-coated annular denuder to remove nitric acid. The denuder consists of four concentric 61-cm aluminum tubes. The calculated efficiency for removing HNO_3 is greater than 99.7%. The denuder is inserted in the inlet tube and held by O-rings.

The temperature of the air just before it reaches the cyclone is measured by a temperature probe in the base of one inlet stack. The temperature is measured every minute and the average recorded on the memory card every 15 minutes.

Critical Orifice Flow Control The flow rate at the cyclone is controlled by a critical orifice between the solenoids and the vacuum pump. Critical flow will be maintained as long as the vacuum behind the orifice is 53% of the atmospheric pressure or less. The primary reason for maintaining a

constant volume flow rate of 22.8 L/min is to maintain a constant 2.5 µm cut point. There are two factors that cause the flow rate to vary from the nominal: the change in pressure drop across the filter and the change in ambient temperature. (The system is calibrated with a typical filter, so only the change from normal has an effect.) This is discussed in Appendix Section I.2. The diameter of the orifice can be adjusted by authorized technicians to give the desired nominal flow rate.

Flow Rate Measurement The flow rate is monitored by two pressure transducers. The flow rate ahead of the filter is determined from a transducer monitoring the pressure drop of air as it passes through the cyclone. The cyclone approximates a standard measuring orifice. The flow rate after the filter is determined from a transducer measuring the pressure relative to atmospheric just ahead of the critical orifice. This pressure drop is produced by the filter. Since the flow rate is determined before and after the filter, any leaks in the system can be identified at the time of filter installation. Both transducers are calibrated using a measuring orifice audit device that has been calibrated to a primary flow standard at the UC Davis laboratory. The controller will read and record both transducers every minute and record the averages every 15 minutes.

The flow rate equations for both transducers are expressed in parameterized form using parameters determined during the flow rate calibration at the site. There is also a pressure function based on the elevation of the site, F(elev), and a temperature function. The elevation factor is 1.00 for sites near sea level and increases to 1.20 at 10,000 feet, as listed in Table 3 on page 29. The temperature function varies from 0.95 at -9°C (17°F) to 1.05 at 50°C (122°F). The equation for the first transducer (across the cyclone) is:

$$Q_m = 10^a M^b F(elev) \sqrt{\frac{T + 273}{293}},$$

where M is the "Mag" reading on the controller screen), F(elev) is the pressure function based on the elevation of the site, and a and b are calibration parameters normalized to 20°C and sea level.
The flow rate equation for the second transducer (before the critical orifice) is:

$$Q_v = (c - d * V) F(elev) \sqrt{\frac{T + 273}{293}},$$

where V is the "Vac" reading on the controller screen, and c and d are calibration parameters.

Filter Cassettes and Cartridges The filter cassettes are manufactured specifically for the IMPROVE sampler. They are made of acetal homopolymer, with stainless steel screens. The two halves of the cassette are held together by an O-ring seal. A special tool is required to separate and assemble the two halves. This process is only done at the UC Davis central laboratory when the filters are unloaded and reloaded. The O-ring design has eliminated the leaks occasionally found with the threaded design of the old cassettes. The cassettes are always installed in cartridges, with four cassettes per cartridge. Most cassettes are held in the cartridges by a snap ring and cannot be removed easily. Some cassettes are to be moved from one cartridge and to a second cartridge in the field; these cassettes are held in by an O-ring and can be removed and inserted relatively easily. Each cartridge has a center hole and a small alignment hole. When the cartridge is placed on the cyclone manifold, alignment pins on the manifold prevent the cartridge from being rotated a quarter or half turn. For the $PM_{2.5}$ module, the labels and red/yellow/green dots on the cartridges will always be up.

All cassettes are labeled by site, module, and the date of sample collection. All cartridges are labeled by site, module, and the date of sample change.

2.3 PM_{10} Filter Module

A Version II PM_{10} module is shown in Figure 4. The particle size cut is determined by a standard commercial PM_{10} inlet.

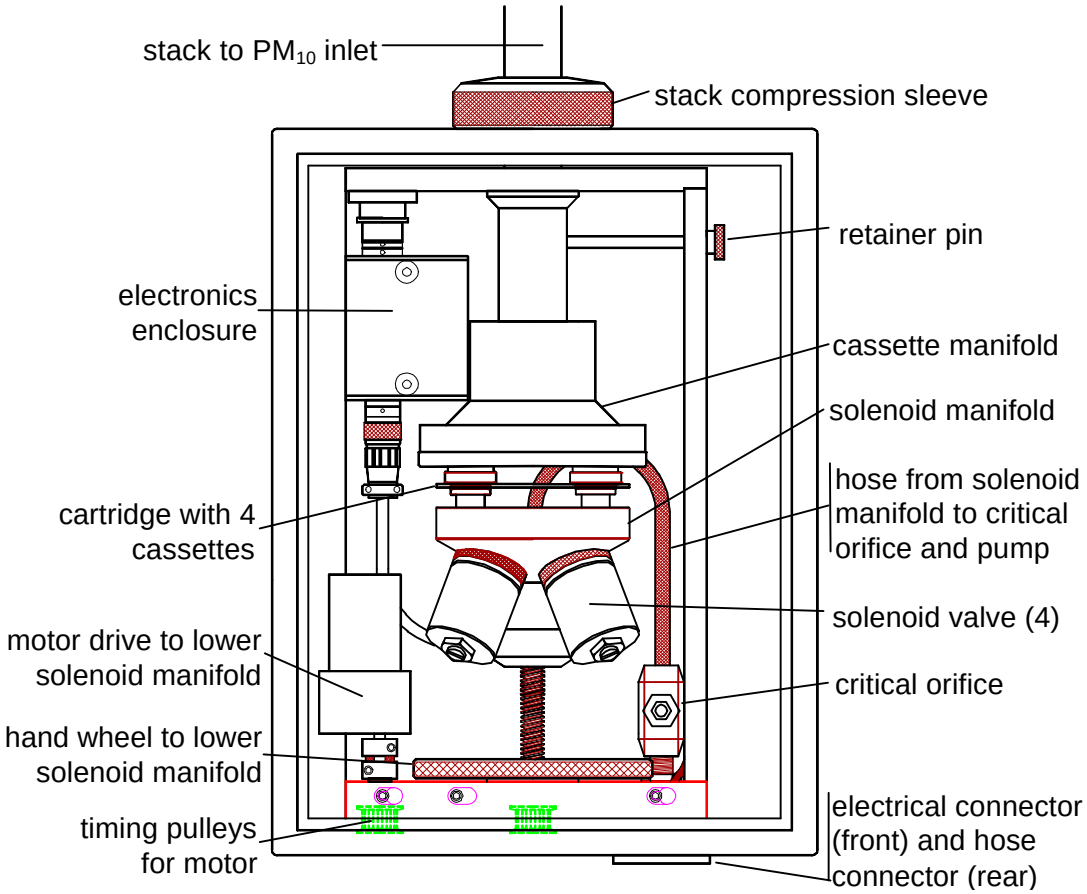


Figure 4. PM_{10} module.

Flow Rate Measurement The flow rate is monitored by a single pressure transducer between the filter and critical orifice. This transducer is calibrated using a measuring orifice audit device that has been calibrated to a spirometer at the UC Davis laboratory. The controller reads the transducer every minute and records the average every 15 minutes.

Filter Cassettes and Cartridges The same cassettes and cartridges are used in the PM_{10} module. The only difference is that they are inserted upside down compared to those for the $PM_{2.5}$. For the PM_{10} module (D), the labels and blue dot on the cartridge will be <u>down</u>.

3. Controller

3.1 General Description

The Version II controller consists of a TERN 16-bit controller, a Two Technologies terminal with LCD screen and a twenty button keypad, plus appropriate electric components. The controller is shown in Figure 5. The lower portion shows the connectors on the bottom of the module. The terminal can be removed from the controller to be closer to the sampler modules. This is useful during sampler calibration but not recommended during the weekly sample change. When left in the controller, the cord is contained in the storage pocket.

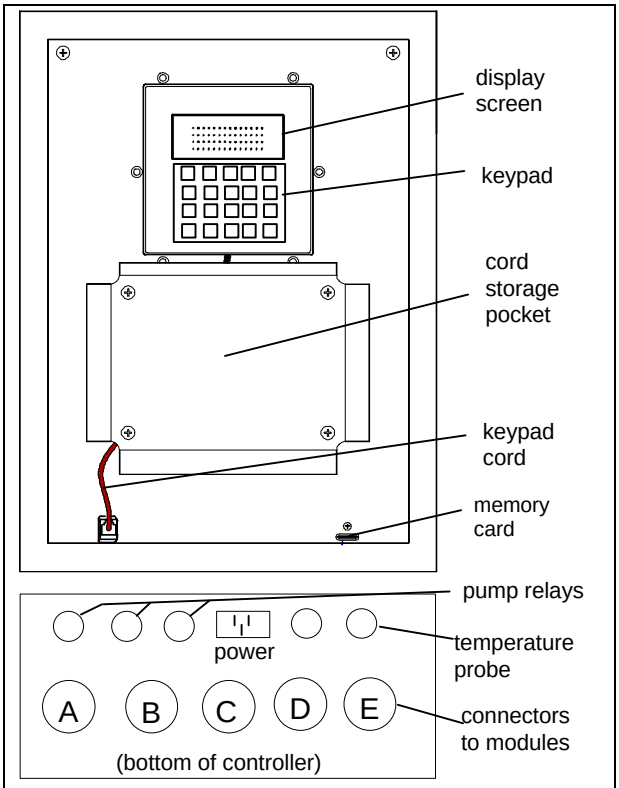


Figure 5. Controller module

The control programs are written in C/C++ on a computer and downloaded into the microprocessor.

Fifteen-minute averages of flow rate and temperature are downloaded into a removable ISSI Serial Flash Module (memory card) that is shipped between the site and the central laboratory with the filters. The memory card is 1 MB and will hold the information of about one year of sampling. This is normally changed every third week.

The controller can currently accommodate up to five filter modules.

The terminal is shown in greater detail in Figure 6. The LCD display has 4 lines of 20 characters. When the sampler is in the AUTO MODE, the LCD will display the current status of the sampler modules, as discussed in Section 3.2. All functions of the sampler are set up using menus and sub menus, as discussed in Section 3.3. The six keys to activate the menu are shown in the figure.

The **ENTER** key is generally used to jump to the next main step. The →**F4** or ←**F3** keys to move to the next or previous screens. In almost all cases, the screen will indicate the options.

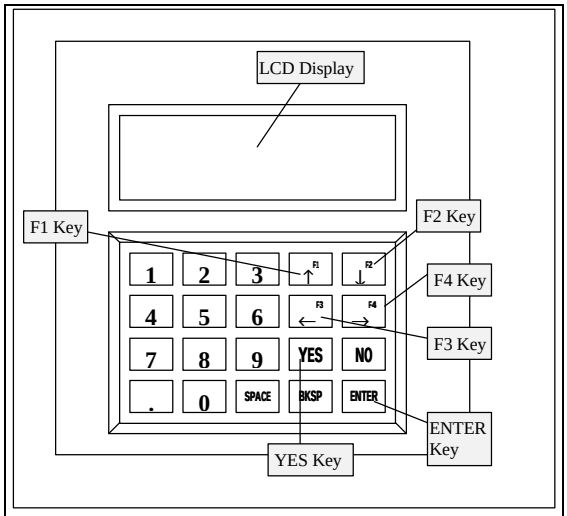


Figure 6. Controller terminal

The programmed controller is responsible for the following aspects of the sampler.

- Provide the site operator a status of current sampler operations.
- Provide the site operator an interface for recording initial and final measurements of the filters during sample change, using the LCD screen.
- Provide options for selecting sampling protocols and filter types. This is normally performed by the UC Davis technician at the time of installation.
- Set the date and time.
- Switch the filter solenoids and pump relays on and off.
- Measure and record the pressure transducers and temperature probe. A standard configuration has 7 transducers. Measurement is done once a minute and averages are recorded on the memory card every 15 minutes. The averages are also recorded whenever there is a power outage or the operator starts the sample change.
- Measure and record ambient temperature. This is on the same schedule as that of the pressure transducers.
- Download the measurements to a removable ISSI Serial Flash Module (memory card).

The controller program has two modes: an AUTO MODE and a MENU MODE. The program normally is in the AUTO MODE whether the sampler is on or off. During this AUTO MODE, there are several possible current status screens.

To move from the AUTO MODE to the MENU MODE, press the **ENTER** key. This will switch the display from a current status screen to a menu screen. The MENU MODE has a main menu and several sub-menus. After using a menu, make certain that the controller has returned to the AUTO MODE. After completing the standard filter change, the program will automatically return to the AUTO MODE. For other menus, press the **ENTER** key to return to the AUTO MODE.

3.2 Current Status Screens

When the sampler is in the AUTO MODE, it will show one of the three current status screens in Figure 7. In all current status screens, the top line shows the current date, time, and day of the week. The final digit indicates the sampling protocol: 1 for Wednesday/Saturday and 2 for one-day-in-three. For 5 seconds every minute, the bottom line of the screen will indicate that it is recording the flow rate and temperature sensors.

If samples are being collected, the controller will show screen 1. This screen will be showing on the sample changing day every third week. The temperature is expressed in volts from the probe and will be converted in the laboratory to the correct temperature.

If the sampler is off and if there are remaining sampling days, the controller will show screen 2. This screen should never be showing on the sample changing day.

If the sampler is off and if all the sampling periods are complete and the filters can be changed, the controller will show screen 3. This screen will be showing on two out of three sample changing days.

Screen 1. Sample collection is in process. The second line shows which filter is on and the voltage of the temperature probe. The bottom two lines show the elapsed time for all ambient filters.	**01/04/00 08:01 TUE 2** **Fil 3 ON, Temp= 98V** **Fil 1 |Fil 2 |Fil 3** **24hrs |24hrs | 8hrs**
Screen 2. The sampler is off and is waiting for the next period. The last two lines indicate that everything is off.	**01/03/00 08:02 Mon 2** **A B C D** **OFF OFF OFF OFF**
Screen 3. All sampling with the current set of filters is completed. <u>The filters can now be changed</u>. Sampling will not resume unless the filters are changed.	**01/11/00 08:00 TUE 2** **SAMPLING** **COMPLETED**

Figure 7. Current status screens.

3.3 Main Menu

The MENU MODE can be accessed by pressing the **ENTER** key when the sampler is the AUTO MODE. When the **ENTER** button is pushed the main menu shown in Figure 8 will appear. If the program is "recording sensors" (5 seconds every minute), there will be a delay of up to 5 seconds.

```
F1=Filter Readings
F2=Change Date&Time
F3=Advanced Menu
ENTER=AUTO MODE
```

Figure 8. Main menu screen.

The screen indicates four options.

1. Pressing the ↑**F1** key will bring up the filter reading menu for the standard weekly filter change. Press this key to begin the sample changing procedures, as described in Section 4, Sample Changing Procedures.

2. Pressing the ↓**F2** key will bring up the menu to change the current date and time, as described in Section 3.4 Changing the Date and Time.

3. Pressing the ←**F3** key will bring up the advanced menu. The menu will allow the user to calibrate the flow rate and change the sampler protocols. This menu requires an access code. This menu is described in Section 6.2, Advanced Menu.

4. Pressing the **ENTER** key will return the sampler to AUTO MODE. The sampler must be in the AUTO MODE to collect samples. If the sampler is left in the MENU MODE without any input for longer than 15 minutes, the program should automatically revert to the AUTO MODE. However, to be safe, do not leave the sampler in the MENU MODE.

A fifth option allows you to check the version of the operating system. This information might be requested by UCD when trying to fix a software problem. Pressing the decimal point (.) will yield Figure 9. After five seconds, the program will automatically return to the main menu.

```
UCD Sampler  nnnn
Avgs every 15 min
Software Ver. 00.04
July 2000 PHW
```

Figure 9. Program version screen.

3.4 Changing the Date and Time

From the AUTO MODE, press **ENTER** to reach the main menu. From the main menu, press the ↓**F2** key to enter the change time menu, shown in Figure 10. The item to be changed is underlined. By pressing the ←**F3** and →**F4** keys, you can move the underline left or right to the desired category (month, day, year, hour, minute). To increase or decrease the value of the category, use the ↑**F1** or ↓**F2** key. The day of the week will automatically change with the date.

```
12/01/00 08:00 SAT 3
F1&F2 adjusts values
F3&F4 to move cursor
Press ENTER to write
```

Figure 10. Change time screens.

When finished, press the **ENTER** key to record this information and return to the main menu.
Press the **ENTER** key a second time to return to the AUTO MODE.

4. Procedures for Sample Changing in the Field

4.1 Preparation and Summary

The operator will receive a "Blue Box' shipping container from Davis every three weeks. Inside will be three resealable bags each containing the filters for one week and the corresponding logsheet. The bag will be labeled with the date that the filters are to be installed. The Blue Box will be labeled with all three dates. The Blue Box will also have a memory card in a pouch on the inside of the top cover. In each bag there will be cartridges, with four cassettes per cartridge. The cartridges will be color-coded for each module: A=red, B=yellow, C=green, D=blue.

Most sites will have two Blue Boxes, one being used at the site, and the other in transport or waiting at the site. The Blue Box should be received 10 days before the first sample-change day. At sites with possible delays in mail, there will be more than two Blue Boxes in the system. If the appropriate box is not present by the change date, the operator should contact the UCD laboratory (530-752-1123).

Before going to the site, the operator must check the dates on the Blue Box(es). If the first date on the new Blue Box is today's date, the operator should bring both this Blue Box and the previous Blue Box. If

For all sample changes, the procedures are:

1. Initiate the changing sequence by pressing the **ENTER** and ↑**F1** keys.
2. Record the general data shown on the controller display, then press the **ENTER** key.
3. Record the Final Readings for each exposed filter, using the →**F4** key to move to the next filter. When finished check that all blanks in the log sheet are filled in and the numbers are reasonable. If okay, press the →**F4** key. To redo the readings, press the ←**F3** key.

4a. If this is not a sampling day. (Two out every three weeks. The sampler is not running when you got there.) Remove the cartridge of exposed cassettes from each module and replace it with a cartridge of clean cassettes. Do not remove any cassettes from their cartridges. When finished press the **ENTER** key.

4b. If this is a sampling day. (Every third week. The sampler is running when you got there.) The old cartridges will have a black O-ring in position 3 and the new cartridges have holes in position 3. Remove the old cartridge from the sampler. Move the cassette in position 3 of the old cartridge to the hole in the new cartridge. This cassette is held in with a black O-ring and is the only cassette that can be easily removed. Install the new cartridge. When finished check that all blanks on the right side of the log sheet are filled in and the numbers are reasonable. If okay, press the **ENTER** key.

5. If today's bag is the first in a new blue box, remove the memory card from the controller and place it in the pouch of the old blue box. Remove the memory card from the new box and place in the controller. If there is no memory card in the new box, leave the old one in the controller.
6. Record the Initial Readings for each clean filter, using the →**F4** key to move to the next filter. When finished check that all blanks in the log sheet are filled in and the numbers are reasonable. If okay, press the →**F4** key. To redo the readings, press the ←**F3** key. The sampler will automatically return to the current status (operational) mode.

4.2 Initiating the Sample Changing Sequence

Begin sample changing by pressing the **ENTER** key (to go to the main menu) and the ↑**F1** key (to initiate the changing sequence).

The program asks whether to proceed with the readings. The terminal screen is shown in Figure 11. Press **YES** to proceed. (A **NO** response returns the program to the AUTO MODE. Use this if you accidentally pressed the ↑**F1** key.)

```
   Filter Reading
        PRESS
YES to Continue
 NO to Cancel
```

Figure 11. Continue screen 1.

In the sample-changing procedures, there are two types of screens. The first are temporary informational screens with the top line being "One moment please." These screens are to inform you that the controller is performing some task, such as turning on pumps or recording information on the memory card. No interaction is required. The remaining screens all require some response. In many cases, you will record a displayed value on the logsheet. For this type of screen, you will press the indicated key to proceed to the next screen. In the following figures, only those screens requiring an interaction are shown.

4.3 Exposed Filter Readings (Final Readings on the Logsheet)

There will be a series of informational screens with the upper lines showing "One moment please." These will indicate when the pumps are being turned on and when the readings are being recorded on the memory card. The program will automatically switch to the screens of Figure 12.

The displays for the final reading of the exposed filters requiring a response are shown in Figure 12.

Screen 1: Record on the logsheet the voltage of the temperature probe shown in this screen. (This will be converted to degrees in the laboratory.) When recorded, press the **ENTER** key to proceed.

```
Logsheet Entry
01/01/00 08:00 SAT 2
CurTemp  98V
Hit ENTER when ready
```

↓

Screen 2: Record on the final reading (right) side of the logsheet the information for each filter shown in this screen. The module designation (ABCDE) and the position number (FIL 2, FIL 2) are displayed. Record pressure readings (**Vac** & **Mag**) and the elapsed time in minutes (**ET**). When the information for the filter is recorded, press the →**F4** key to go to the next filter. To return to a previous display use the ←**F3** key. A standard sampler will have 8 or 12 filters.

```
Mod(A)
 Cass    Vac Mag  ET
(FIL 1)  12  32 1440
    F3-Bkwd  F4-Fwd
```

Figure 12. Exposed readings screens.

When all filters have been examined, , the screen shown in Figure 13 will appear. Check the logsheet for completeness. To retake the final readings press the ←**F3** key. If complete, proceed with the initial readings for the clean filters by pressing the **F4** key.

```
F3-GO BACK to take
   Exposed readings
F4-Replace EXPOSED
   filters w/ CLEAN
```

Figure 13. Continue screen 2.

4.4 Removing and installing cassettes

After the **F4** key is pressed, the screen shown in Figure 14 will appear.

Change the cartridges before pressing the **ENTER** key.

```
Remove EXPOSED
cassettes and
insert CLEAN ones.
Hit ENTER when done.
```

Figure 14. Exchange cassette screen.

To remove the cassettes, either activate the motor switch or use the hand wheel to raise the upper manifold. The cartridge will automatically separate from both manifolds.

There are two different procedures for changing filters, depending on whether the sampling day falls on Tuesday. The dates when the sampling date is on Tuesday are given in Table 5 of Appendix III. You will know this if the sampler was operating immediately before the sample change.

<u>If this is not a sampling day</u>. Remove the exposed cartridge for each module, put caps on all the cassettes, and place the exposed cartridge in the resealable bag with last week's date. Stack the cartridges to achieve the most compact shape, offsetting each one by 1/8 turn. Remove the appropriate cartridge from the bag with the current date. The cartridges will be color-coded: A=red, B=yellow, C=green, D=blue. Remove the caps and place them in the bag. Place the new cartridge in the lower manifold with the alignment pins through the holes in the cartridges. For the $PM_{2.5}$ modules (ABC), the stickers and the red, yellow, or green dot will be up. For the PM_{10} module (D), the stickers and the blue dot will be <u>down</u>. The alignment pins allow only one orientation. The cartridge will float on the pins. Lower the upper manifold using the motor switch or hand wheel.

<u>If this is a sampling day</u>. Remove the old cartridge from the sampler and get the new cartridge for the same module from the bag with the current date. This will have a hole in position 3. Move the cassette in position 3 from the old cartridge to the hole in the new cartridge. (The cassette in position 3 is held in by an O-ring and is the only cassette that can be easily removed.) Put caps on the three remaining cassettes in the exposed cartridge and place it in the resealable bag with last week's date. Remove the caps on the other three cassettes in the new cartridge and place them in the bag. Place the new cartridge in the lower manifold. The alignment pins will not allow it to be rotated. Lower the upper manifold using the motor switch or hand wheel.

> Care must be taken during this process of moving the cassette from the old to the new cartridge to protect the filter from contamination by rain or snow. If the roof does not adequately protect this process, you should remove all four of the exposed cartridges, move to a protected location, switch the position 3 cassettes from the old cartridges to the new and then return to the sampler to install the new cartridges.

Check that the caps are on all of the exposed cassettes. Arrange the four cartridges for the most compact shape by offsetting each one by 1/8 turn. Reseal the resealable bag when all cartridges are changed. If this is the last week of filters for the Blue Box, return it to Davis as soon as possible using the reversible mailing label.
If the bag of new cassettes is the first in the new box, the operator should replaced the memory card in the controller. Remove the memory card from the controller and place it in the pouch on the

inside of the lid of the old box. Remove the memory card from the pouch in the new box and insert in the controller. If there is no memory card in the new box, leave the old memory card in the controller and make a note on the logsheet.

After all modules are changed, press **ENTER** to continue to the initial readings of clean cassettes.

4.5 Clean Filter Readings (Initial Readings on the Logsheet)

A series of temporary informational screens will appear ("One moment please.") while the pumps are being turned on and the sensors are read. The display will automatically switch to the next screen.

If the filter was improperly installed, one of two error messages may appear on the screen. In both cases it will alternate between the message and what to do.

```
      WARNING
LOW FLOW DETECTED
check Module (A) for
proper installation
```

```
Press:
F3-To re-check
   installed filters
F4-Ignore warning
```

Figure 15. Error, low flow through cyclone.

If the flow rate through the cyclone is much less than the nominal flow rate then the messages of Figure 15 will appear. There are two normal reasons for the condition. First, you may have failed to lower the cassette manifold. Second, you may have a missing cassette in the cartridge. Every third week, when the change day coincides with the sampling day, it is necessary to move the current filter from the old cartridge to the new. This message will occur if you forgot to transfer the cassette. In either case, correct the problem and press the **←F3** key. If you have corrected the problem, it will proceed to Figure 17. If this does not work, and the installation appears to be correct, it is possible to override this check and proceed with the sample change. In this case, press the **→F4** key. The program proceed to Figure 17. Note that you will probably get the low flow message for all two or three filters in the cartridge.

Note that this message will not appear for the PM_{10} D module because there is no cyclone. If the mistake was made for A, B, or C, check that D is properly installed.

If the cartridge was installed upside down, then the messages of Figure 16 will appear. Install the cartridge the correct direction shown on the diagram on the module door and press the ←**F3** key. If you have corrected the problem, it will proceed normally to Figure 17. If this does not work, and the installation appears to be correct, it is possible to override this check and proceed with the sample change. In this case, press the →**F4** key. The program proceed to Figure 17. Note that you will probably get the upside down message for all two or three filters in the cartridge.

```
WARNING: Cartridge
may be UPSIDE DOWN
check Module (A) for
proper installation
```

```
Press:
F3-To re-check
   installed filters
F4-Ignore warning
```

Figure 16. Error, cartridge upside down.

The displays for the initial reading of the clean filters requiring a response are shown in Figure 17. The information is to be recorded on the left side of the logsheet.

Record the pressure readings (**MxVac**, **Vac** & **Mag**) for each clean filter. There is a space for only one **MxVac** reading on the logsheet. The values for all filters in a given module will be the same. Therefore record this value only once for each module. When the information for the filter is recorded, press the →**F4** key to go to the next filter. To return to a previous display use the ←**F3** key. As with the exposed filter readings, cycle through each of the filters pressing the **F4** key.

```
Mod(A)
 Cass  MxVac Vac Mag
(FIL 1)  40   12  32
    F3-Bkwd  F4-Fwd
```

Figure 17. Clean filter readings screens.

When all filters have been examined, Figure 18 will appear. Check the left side of the logsheet for completeness. If not complete, or if it was necessary to redo the readings, press ←**F3**. If okay, press →**F4** to continue. This ends the recording of readings.

```
F3-GO BACK to take
   CLEAN filter
   readings
F4-FINISH
```

Figure 18. Continue screen 3.

The information for the clean filter will now be remeasured and the values recorded on the memory card. A series of temporary informational screens ("One moment please.") will indicate the status. The sampler will automatically exit from the MENU MODE and return to the AUTO MODE.

Every third week the sampler will resume sampling on Filter 3. The informational screens will say that the pumps are being started and the sensors are being recorded. The first current status screen of Figure 7 will automatically appear (Fil 3 ON).

For the other two weeks, the sampler remains off. The sensors will be read and the second current status screen of Figure 7 will automatically appear (everything OFF). In either case, you could make certain that a current status is showing on the screen before you leave.

4.6 Field Logsheets

Each shipping box will contain three resealable bags, each containing all the cartridges for the change, plus a logsheet. Two of the three logsheets will be exactly as shown in Figure 19. The third logsheet will not have any entries for position 3.

IMPROVE Network Field Log

Preweighed by:ABC
12/25/1999

INSTALL ON --> **ACAD1 01/18/2000**

CurTemp_____C

INITIAL READINGS							FINAL READINGS		
Operator's Initials_____			**Date:____/____/1999** **Time:_____**				**Init____**	**Date:____/____/1999** **Time:_____**	
SamDate	**StrTim**		**MxVac**	**Cass**	**Vac**	**Mag**	**Vac**	**Mag**	**ET**
**********	**********	**********	**********	**********	**********	**********	**********	**********	**********
01/19/2000	**0000**			**1**	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __ __
		Mod A	__ __ __						
01/22/2000	**0000**			**2**	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __ __
01/25/2000	**0000**			**3**	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __ __
**********	**********	**********	**********	**********	**********	**********	**********	**********	**********
01/19/2000	**0000**			**1**	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __ __
		Mod B	__ __ __						
01/22/2000	**0000**			**2**	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __ __
01/25/2000	**0000**			**3**	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __ __
**********	**********	**********	**********	**********	**********	**********	**********	**********	**********
01/19/2000	**0000**			**1**	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __ __
		Mod C	__ __ __						
01/22/2000	**0000**			**2**	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __ __
01/25/2000	**0000**			**3**	__ __ __	__ __ __	__ __ __	__ __ __	__ __ __ __
**********	**********	**********	**********	**********	**********	**********	**********	**********	**********
01/19/2000	**0000**			**1**	__ __ __		__ __ __		__ __ __ __
		Mod D	__ __ __						
01/22/2000	**0000**			**2**	__ __ __		__ __ __		__ __ __ __
01/25/2000	**0000**			**3**	__ __ __		__ __ __		__ __ __ __

Lab Use Only
TFF M11681
10.911
10.822
10.302

comments:

For Help Call (530) 752-1123

Figure 19. Three-filter field logsheet.

5. Troubleshooting Guide

If time and weather conditions permit, please try the steps listed below for common sampler problems before calling the UC Davis sample handing laboratory: Phone (530) 752-1123, FAX (530) 752-4107, e-mail fieldops@crocker.ucdavis.edu .

1) Missed change day.

   a) If there are remaining sampling days in the week:
   remove the exposed filters as would normally be done and put in the clean filters that were to have been installed on the last change day. Make a note on the logsheet.

   b) If the week is completely missed:
   remove the exposed filters as would normally be done but do not put in the filters for the missed change day. Keep these in the shipping box and send them back to Davis when both weeks in that box have passed. Install the appropriate filters for the current week. Make a note on the logsheet of the filters that were not installed.

2) The display is blank.

   a) Power may be out.

      i) Check main circuit breaker, cycle it off and on if you are unsure if it has blown.

      ii) Check power strip that sampler and pumps are plugged in to (this may be located inside the pump enclosure). There should be a switch on the power strip. If it is not lit, turn it off and then on again.

      iii) Check the power cord for the sampler. This black cord runs from the base of the control module to the power strip. If it is unplugged, reconnect it.

      iv) If you are still not sure if power is on:
      (a) Unplug one of the pumps from its outlet box.
      (b) Disconnect the silver vacuum hose connecter from the top of the pump.
      (c) Plug the pump cord directly into the power strip. It should start if there is power.
      (d) Reconnect the vacuum hose and plug the pump back into the duplex outlet box.

   b) Sometimes the display gets too cold. If this is a possible problem, remove the keypad by disconnecting the phone jack on the back and allow it to warm up.

3) The elapsed time reads zero.
   Check the following to determine why sampling did not occur on the scheduled day. Indicate problem on logsheet. If you cannot determine cause of problem call UC Davis at 530-752-1123 as soon as possible.

   (a) Check that the date and time on the controller screen are correct. Adjust if necessary using menu option F2.

   (b) If possible, check whether there was a power outage for the entire day.

   (c) Look at the Module A filter—can any sample be seen? Even if clean, do not reuse the filter.

4) Pump will not start.

   i) Check that the pumps are all plugged in (the outlet box that the pump is plugged into may have a switch on it but this does not control the pump power).

   ii) Test the pump that is not starting by doing the following:

      (a) unplug one of the pumps from its outlet box.

      (b) Disconnect the silver vacuum hose connecter from the top of the pump.

      (c) Plug it the pump cord directly into the power strip. It should start if there is power.

      (d) Reconnect the vacuum hose and plug the pump back into the duplex outlet box.

   iii) Extreme cold may prevent pumps from starting. Remove pump to warm location (or come back when the weather is warmer) and test. If cold may be a problem:

      (a) Run pumps continuously by plugging into unswitched outlets (power strip or wall outlet).

      (b) Keep pumps warm by placing an automotive electric blanket or other heat source under the pumps.

5) The motor drive is not working.
   You can raise and lower the cassette assembly using the hand wheel. Before this can be done, it is necessary to disengage the motor drive. The motor drive is shown in Figure 3 and Figure 4. For the $PM_{2.5}$ module, push down on the top of the drive while pulling the bottom toward yourself. Then swing the motor to the left to lock it in the disengaged position. The hand wheel may now be used to raise or lower the solenoid manifold. The procedure is the same for the PM_{10} module (D), except the motor is upside down compared to the $PM_{2.5}$ modules. Notify UC Davis by calling or making a note on the logsheet.

6) The temperature probes give incorrect readings.
   Use an external thermometer and write the readings of both the internal probe and the external thermometer on the logsheet. Please note whether readings are in Farenheit or Centigrade.

6. Sampler Installation and Maintenance

6.1 Summary

Prior to the installation of the sampler, the site will be prepared by the local site operator for power and a shelter. The sampler will be shipped to the site.

Sampler installation will normally be done by a field technician from UC Davis. This consists of the following elements:

- Placing the controller and filter modules on a wall of the shelter and cutting a hole in the ceiling for the stacks.
- Connecting the cables between the controller, filter modules, and pumps and the vacuum hoses between the modules and the pumps.
- Using the advanced menu, selecting the sampling parameters.
- Using the advanced menu, calibrating the flow rates of the filter modules.
- Attaching the sample changing instructions, on the inside of the controller door.
- Training the site operators and jointly installing the initial set of filters.

Approximately six months after installation or annual maintenance, the site operator will be requested to check the flow rate calibration. Detailed instructions and the appropriate equipment will be sent from Davis. This check will be done more frequently if some problem is detected in the flow rate values.

Sampler maintenance will be done annual by a field technician from Davis. This will consist in the following elements:

- Calibrating the flow rates of the filter modules.
- Cleaning and refurbishing the sampler, include replacing parts where needed.
- Making scheduled modifications to the sampler and controller program.
- Calibrating the flow rates of the filter modules a second time.
- Discussing procedures with the site operator, and providing any necessary training for new site operators.

6.2 Advanced Menu

From the operational/current status mode, press **ENTER** to reach the main menu. From the main menu, press the ←**F3** key to enter the advanced menu. You will be asked to provide an authorization code. This will be provided to the site operators when needed. After the correct code is entered, the display of Figure 20 is shown.

```
F1=Calib  ENTER=Exit
F2=Site Config.
F3=Select Change Day
F4=Select Start Time
```

Figure 20. Advanced menu screen.

There are two menus for the IMPROVE network. The select change day and start time menus are used only for Special Studies.

• Perform flow rate calibration.	↑**F1** key	Section 6.3 Flow Rate Calibration
• Select sampling protocol.	↓**F2** key	Section 6.4 Site Configuration

6.3 Flow Rate Calibration

6.3.1 Calibration Equipment

The equipment needed for calibration are:

- a cartridge with four calibration cassettes for each filter type
- an audit device for the $PM_{2.5}$ and PM_{10} modules (Figure 21)
- a calculator
- calibration logsheets (Figure 22)

The audit device consists of a probe with a calibrated orifice and a magnehelic gauge. The probe is shortened for the PM_{10} module by removing the two extreme sections. The magnehelic has a magnetic backing; use this to attach the calibration magnehelic to the module door in the vertical position. Record the 'zero' reading on the logsheet. Insert the probe in the base of the $PM_{2.5}$ inlet or in the top of the PM_{10} inlet manifold , as shown in Figure 21.

The calibration cassette in position 1 contains a standard filter for the module. The other positions have different pressure drops to vary the flow rate through the module in the same way that a loaded filter would decrease the flow rate.

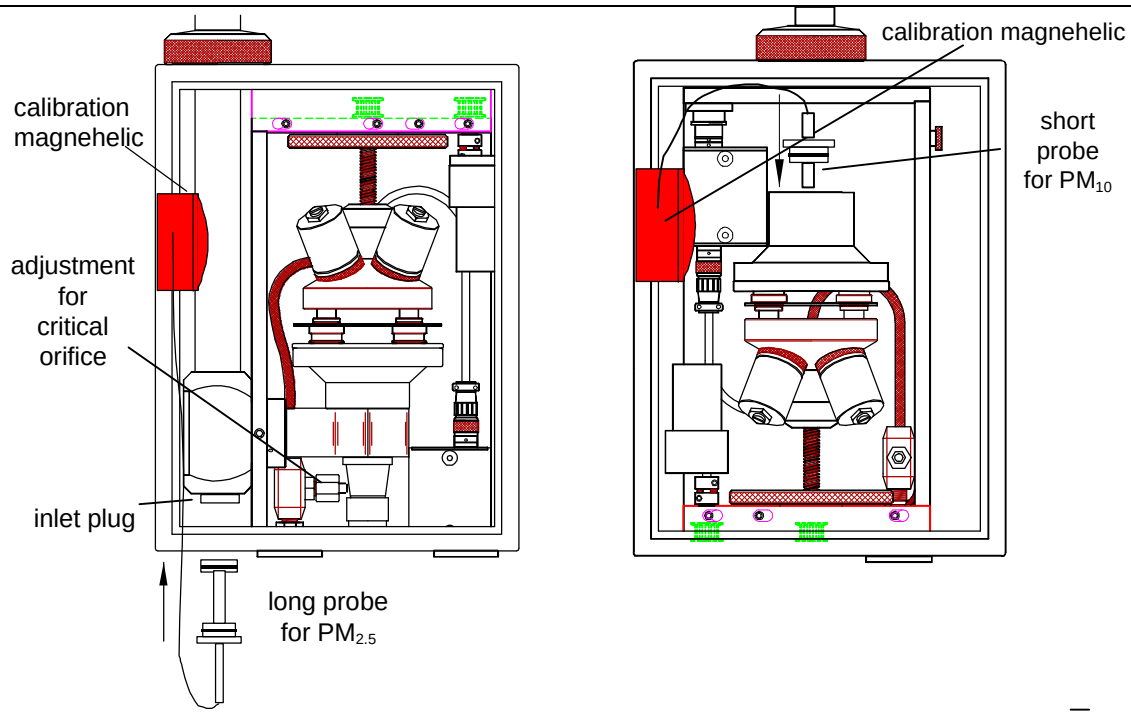


Figure 21. Insertion of calibration probe in $PM_{2.5}$ and PM_{10} modules.

Sampler Field Audit Form

Site Name: _____ Site Elevation Factor: _____
Audited by: _____ Date of Field Audit: _____/_____/_____
Audit Device Number: _____ Audit Constants: a_o=_____ b_o=_____
Temperature: _____°C (reference only, not used)

Module Description: _____

Nominal Flow Rate

desired calibration magnehelic reading: $\Delta P_o = \left(\frac{23}{F(elev)} \frac{1}{10^{a_0}} \right)^{1/b_0}$ = _____

actual reading: ΔP_o = _____ flow rate at 20°C: $Q = F(elev) 10^{a_o} \left(\Delta P_o \right)^{b_o}$ = _____

Four-Point Calibration

Calibration Cassette	Calibration Magnehelic ("H_2O)	Calibration Flow Rate (L/min)	System Vac Transducer	System Mag Transducer
# 1 nominal				
# 2				
# 3				
# 4				

flow rates relative to sea level and 20°C

System Mag $Q = 10^a M^b$ a=_____ b=_____ r^2=_____

System Vac $Q = c - d*V$ c=_____ d=_____ r^2=_____

Figure 22. Logsheet for nominal flow rate and four-point audit.

6.3.2 Calibration Controller Commands

From the operational/current status mode, press **ENTER** to reach the main menu. From the main menu, press the **←F3** key to enter the advanced menu. From the advanced menu, press the **↓F2** key to enter the calibration menu. Figure 23 shows the displays. Pressing the **←F3** and **→F4** key will move backward or forward between filters. When the calibration is completed, press the **ENTER** key to return to the main menu and **ENTER** to return to the current status mode.

```
Starting pumps


Pump 1 Started
```

↓

```
Mod(A) ENTER to exit
Cass MxVac  Vac  Mag
(F1)  40.1 12.2 32.1
    F3-Bkwd  F4-Fwd
```

Figure 23. Flow calibration screens.

The controller will keep the solenoid for this filter open until the next solenoid is requested.

6.3.3 Adjusting the Nominal Flow Rate

Warning: Once sampling has begun, do not adjust the critical orifice until after you have made a full four-point calibration of the current settings.

The nominal flow rate is adjusted by varying the diameter of the critical orifice. This is done using the filter in the first position. After adjustment a full calibration must be done.

The appropriate nominal flow rate would be one that gave a flow rate of 22.8 L/min at the mean temperature of the network, which is approximately 15°C. The nominal flow rate will be set to give a flow rate of 23 L/min at 20°C. This corresponds to 22.8 L/min at 15°C. The desired reading on the on the calibration magnehelic should be:

$$M_o = \left(\frac{23}{F(elev)} \frac{1}{10^{a_0}} \right)^{1/b_0} ,$$

where a_o and b_o are the constants for the calibration magnehelic. Record the reading for the nominal flow rate on the logsheet shown in Figure 9. The elevation factors as a function of elevation are listed in Table 3. The elevations of the IMPROVE sites are listed in Appendix II.

Rotate the black knob on the critical orifice until the calibration magnehelic has the desired reading. Record the final measurements on the logsheet.

Table 3. Elevation factors as a function of elevation in meters.

meters	feet	F(elev)	P	meters	feet	F(elev)	P	meters	feet	F(elev)	P
0	0	1.000	29.90	1200	3,936	1.075	25.88	2400	7,872	1.158	22.32
50	164	1.003	29.72	1250	4,100	1.078	25.73	2450	8,036	1.161	22.18
100	328	1.006	29.55	1300	4,264	1.081	25.57	2500	8,200	1.165	22.04
150	492	1.009	29.37	1350	4,428	1.085	25.41	2550	8,364	1.168	21.90
200	656	1.012	29.20	1400	4,592	1.088	25.26	2600	8,528	1.172	21.76
250	820	1.015	29.02	1450	4,756	1.091	25.10	2650	8,692	1.176	21.63
300	984	1.018	28.85	1500	4,920	1.095	24.95	2700	8,856	1.180	21.49
350	1,148	1.021	28.68	1550	5,084	1.098	24.80	2750	9,020	1.183	21.35
400	1,312	1.024	28.51	1600	5,248	1.101	24.65	2800	9,184	1.187	21.22
450	1,476	1.027	28.34	1650	5,412	1.105	24.49	2850	9,348	1.191	21.09
500	1,640	1.030	28.17	1700	5,576	1.108	24.34	2900	9,512	1.195	20.95
550	1,804	1.033	28.00	1750	5,740	1.112	24.19	2950	9,676	1.198	20.82
600	1,968	1.036	27.83	1800	5,904	1.115	24.05	3000	9,840	1.202	20.69
650	2,132	1.040	27.67	1850	6,068	1.119	23.90	3050	10,004	1.206	20.56
700	2,296	1.043	27.50	1900	6,232	1.122	23.75	3100	10,168	1.210	20.43
750	2,460	1.046	27.34	1950	6,396	1.126	23.60	3150	10,332	1.214	20.30
800	2,624	1.049	27.17	2000	6,560	1.129	23.46	3200	10,496	1.218	20.17
850	2,788	1.052	27.01	2050	6,724	1.133	23.31	3250	10,660	1.221	20.04
900	2,952	1.055	26.84	2100	6,888	1.136	23.17	3300	10,824	1.225	19.91
950	3,116	1.059	26.68	2150	7,052	1.140	23.02	3350	10,988	1.229	19.79
1000	3,280	1.062	26.52	2200	7,216	1.143	22.88	3400	11,152	1.233	19.66
1050	3,444	1.065	26.36	2250	7,380	1.147	22.74	3450	11,316	1.237	19.53
1100	3,608	1.068	26.20	2300	7,544	1.150	22.60	3500	11,480	1.241	19.41
1150	3,772	1.072	26.04	2350	7,708	1.154	22.46	3550	11,644	1.245	19.28
1200	3,936	1.075	25.88	2400	7,872	1.158	22.32	3600	11,808	1.249	19.16

6.3.4 Four Point Calibration

1. Record on the calibration logsheet the calibration magnehelic readings and the system readings from the terminal display. Calculate the flow rates corrected to 20°C and sea level using the equation:

$$Q = 10^{a_o} \left(\Delta P_o\right)^{b_o} \quad ,$$

   using the readings from the *Calibration Magnehelic ("H_2O)* column and the constants for the calibration magnehelic. Write these in the second column, *Calibration Flow Rate (L/min)*.

2. Repeat for the other three filters, using the YES button to shift between solenoids.
3. Perform a regression of the <u>log</u> of the calibration flow rate (y) as a function of the <u>log</u> of the sampler magnehelic reading (x). A reasonable fit yields a correlation coefficient (r^2) of 0.999. The constant a for the sampler magnehelic is the intercept, while the constant b is the slope. Record on logsheet.

4. Perform a regression of the calibration flow rate (y) as a function of the small gauge reading (x). Do not use logs. A reasonable fit yields a correlation coefficient (r^2) of 0.999. The constant c for the small gauge is the intercept, while the constant d is the slope.
5. If the calibration is unacceptable you will have to cycle through all the modules to get back to this module
6. When satisfied with the calibration, replace the calibration cassettes with the regular sampling cassettes.

6.4 Sampler Configuration

Every controller needs to be assigned a configuration. There are currently 2 protocols pre loaded in the processor for the IMPROVE network, Wed/Sat and 1-in-3. The current screen displays the protocol in the upper right corner, with 1=Wed/Sat and 2=1-in-3. (See Figure 7.)

To enter the configuration menu, press the ↓**F2** key in the advanced menu. (From the current status mode, press **ENTER** to reach the main menu. From the main menu press the ←**F3** key to enter the advanced menu.) Press the **ENTER** key to return to the main menu and **ENTER** a second time to return to the current status mode.

Sampler Code and Averaging Time

Each sampler will have a code equal to the last four digits of the UCD Inventory number on the tag inside Module A near the inlet stack. The first screen is shown in Figure 24. When a digit is entered it will appear on line 3. When four digits are entered a fourth line will say "Site Code Accepted"). If an incorrect digit is entered, you may erase it using the backspace key.

The second screen will then appear asking for the averaging time for the flow rate and temperature sensors. Enter 15 minutes. The numbers will appear on the fourth line.

```
Please enter 4 digit
 SITE CODE (eg 0001)
```

↓

```
Enter Data avg(mins)
  Then press enter
   Max: 1440 min
```

Figure 24. Sampler screens.

Protocol 2: IMPROVE: One day in Three Schedule

Selecting this program will set the sampler to sample every third day for 24 hours. The start time will always be 00:00 (midnight). The sampler will be changed every Tuesday. As shown in Figure 25, select the following options for the IMPROVE: One day in three protocol.

Select **IMPROVE**. Press **ENTER** to save and continue.

```
Select Study
*IMPROVE  SPECIAL
F3&F4 to change
Press ENTER to save
```

↓

Select **1/3**. Press the **ENTER** key to save and continue.

```
Select PROTOCOL
 W/S *1/3
F3&F4 to change
Press ENTER to save
```

↓

Select **Module Types**. Use the ←**F3** and →**F4** keys to move left or right, and the ↑**F1** and ↓**F2** keys to increase or decrease to letter designation (A, B, C, D, E, S, or nothing). Press the **ENTER** key to save and return to the advanced menu.

```
Select Module Types
MOD 1 2 3 4 5
    A B C D
```

Figure 25. Protocol 2 screens.

If any number was entered incorrectly, press the ↓**F2** key to rerun the site configuration program.

Press the **ENTER** key to return to the main menu and **ENTER** a second time to return to the current status mode.

Appendix I Flow Rate Equations

A-I.1 The Effect of Flow Rate on Cyclone Cut Point

The collection efficiency of the IMPROVE cyclone was characterized at the Health Sciences Instrumentation Facility at the University of California at Davis. The efficiency was measured as a function of particle size and flow rate using two separate methods: PSL and SPART. The PSL method uses microspheres of fluorescent polystyrene latex particles (PSL) produced by a Lovelace nebulizer and a vibrating stream generator and analyzed by electron micrographs. The SPART method uses a mixture of PSL particles produced by a Lovelace nebulizer and analyzed by a Single Particle Aerodynamic Relaxation Time (SPART) analyzer. The aerodynamic diameter for 50% collection, d_{50}, was determined for each flow rate. The relationship between diameter and flow rate is shown in Figure 26.

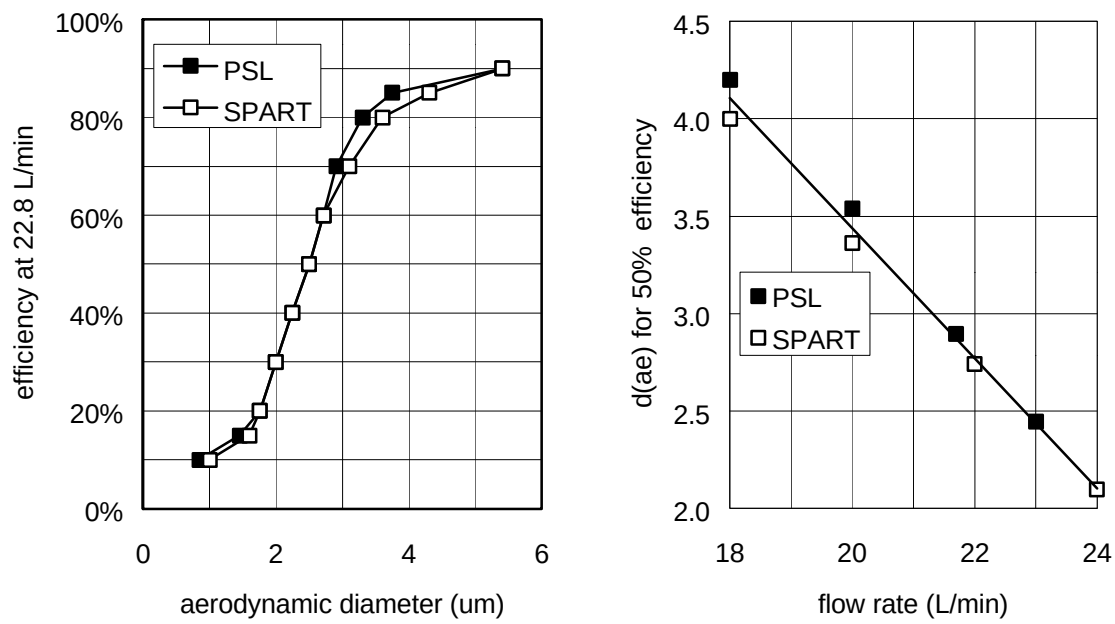


Figure 26. Cyclone collection efficiency.
The left plot shows the efficiency as a function of particle diameter at a flow rate of 22.8 L/min. The right plot shows the 50% cut point as a function of flow rate. The solid symbols are from PSL and the open symbols from SPART.

The best-fitting straight line in Figure 12 is based on measurements for both methods for flow rates between 18 and 24 L/min. The equation is:

$$d_{50} = 2.5 - 0.334 * (Q - 22.75) \qquad (1)$$

with a correlation coefficient of $r^2 = 0.991$. In order to maintain a constant cut point of 2.5 µm, it is necessary to maintain a constant volume flow rate of 22.8 L/min.

A-I.2 Flow Control by a Critical Orifice

The flow rate through each module of the IMPROVE sampler is maintained by a critical orifice, located between the filter and pump. The diameter is adjustable. As long as the pressure after the orifice is less than 52% of the pressure in front of the orifice, the air flow will be critical, that is, limited by the speed of sound and will not be affected by small changes in pump performance.

The volume flow rate is used in IMPROVE because the ambient concentration is important for visibility studies and the particle size cut varies with volume, not mass, flow rate. The volume flow rate increases as the pressure of the air decreases when the air passes through different stages. Since there is negligible pressure drop across the inlet, the volume flow rate does not change between the inlet and the cyclone. The pressure will decrease across the cyclone and filter. If this pressure drop is ΔP, then the inlet/cyclone flow rate is (1- ΔP) times the flow rate at the front of the critical orifice.

The flow rate through a critical orifice depends on the diameter of the orifice and the absolute temperature of the air at the front of the orifice. We will assume that this temperature is the same as the temperature at the cyclone measured by the probe. We have chosen to express all calibrations relative to 20°C. The equation for the inlet flow rate is

$$Q = Q_O * \left(1 - \frac{\Delta P}{P}\right) * \sqrt{\frac{T + 273}{293}} \ , \qquad (2)$$

where Q_0 is a constant and $\Delta P/P$ is the relative decrease in pressure across the filter. The pressure drop ΔP is produced either by the pressure drop of a clean filter or by filter loading. To remove the effect of the clean filter, each critical orifice is adjusted during calibration to give the desired flow rate with a typical clean filter appropriate for the module. The important pressure quantity is then the variation, δP, about the nominal pressure drop of the clean filter used in calibration, ΔP_{nom}:

$$\delta P = \Delta P - \Delta P_{nom} \qquad (3)$$

The δP associated with variations of clean filters can be negative or positive, and will affect all measurements for a sample period equally. The δP associated with filter loading will be positive and will increase over the sampling period.

The mean annual temperature for the network is about 15°C. In order to have the mean annual flow rate at 22.8 L/min, the critical orifices are adjusted to provide a flow rate of 23 L/min at 20°C with a typical filter in the cassette. The constant Q_0 in Equation 2 is then given by

$$Q_O = 23 * \left(1 - \frac{\Delta P_{nom}}{P}\right)^{-1} \ , \qquad (4)$$

Substituting Equation 4 into Equation 2, and assuming there is no variation in atmospheric pressure at the site, the flow rate is given by

$$Q = 23 * \left(1 - \frac{dP}{P - \Delta P_{nom}}\right) * \sqrt{\frac{T + 273}{293}} \ , \qquad (5)$$

Effect of Temperature and Pressure Drop on Cyclone Efficiency

Variations in temperature with site, month, and time of day affect the collection cut point but not the volume calculation. Table 4 shows the change in flow rate using the calibration procedures.

Table 4. Flow rate and 50% aerodynamic diameter *vs*. flow rate.

Table A1-1. Flow rate and 50% aerodynamic diameter *vs*. flow rate.

T (°C)	-20	-10	0	10	20	30	40	50
Q (L/min)	21.4	21.8	22.2	22.6	23.0	23.4	23.8	24.1
d_{50} (µm)	3.0	2.9	2.7	2.6	2.4	2.3	2.2	2.1

Because the flow rate is measured throughout the sampling period, variations in ΔP also affect the collection cut point but not than the volume calculation. For a typical western site, Canyonlands, the flow rate decreased 1% during the sampling period, which is much less than the precision of the measurements. For a heavily loaded eastern site, Shenandoah, the decrease was 3%.

A-I.3 Flow Rate through a Orifice Meter

An orifice meter consists of a restriction in the air path and a device to measure the pressure drop across the restriction. The audit devices and the cyclone are both used as orifice meters.

The flow rate through an orifice meter depends on the pressure drop across the restriction and the square root of the density of the air. Because the density is proportional to the pressure and absolute temperature, the flow rate can be written:

$$Q = Q_1 \left(dP\right)^b \sqrt{\frac{P_o}{P}} \sqrt{\frac{T + 273}{293}} \qquad (6)$$

where Q_1, β, and P_O are constants. For laminar flow, β= 0.5. We express Equation 6 in parameterized form using the magnehelic reading, M, for the pressure drop:

$$Q = 10^a M^b \sqrt{\frac{P(\text{sea level})}{P(site)}} \sqrt{\frac{T + 273}{293}} \ . \qquad (7)$$

We have arbitrarily defined all pressures relative to the standard pressure at sea level and all temperatures relative to 20°C. Thus, the parameters, a and b, are always calculated relative to 20°C and Davis. The value of b should be similar to that of β, around 0.5. The advantage in expressing the parameters relative to sea level is that all modules should have parameters with similar values independent of the site elevation.

Because of the difficulties in measuring the ambient pressure, we have chosen to use an average pressure based on the elevation of the site. The pressure-elevation function is discussed in Section A-I.4. We will write the pressure and temperature functions as F(elev) and f(T):

$$\text{F(elev)} = \sqrt{\frac{P(\text{sea level})}{P(site)}} \qquad \text{f(T)} = \sqrt{\frac{T + 273}{293}} \ .$$

Thus, the flow rate Q in terms of the magnehelic transducer from Equation 7 is

$$Q = 10^a M^b \ F(elev) \ f(T) \qquad (8)$$

A-I.4 Pressure-Elevation Relationship

The ambient pressure enters into the equations for UCD audit devices and the system magnehelic as the square root of the pressure. Because of the difficulties of measuring the ambient pressure at each sample change, we have chosen to use an average pressure based on the elevation of the site. The actual pressure is used only in calibrating the audit devices at Davis.

Based on the 1954 tables of Treworth, the pressure at an elevation of Z meters is:

$$P = P(\text{sea level}) * \exp\left[-\left\{\frac{Z}{8437} + \left(\frac{Z}{26621}\right)^2\right\}\right], \tag{9}$$

It is convenient to define an elevation factor that is the square root of the pressure at sea level divided by the pressure at the site. This factor is expressed as

$$F(elev) = \sqrt{\frac{\text{P(sea level)}}{P(site)}} = \exp\left[\frac{Z}{16874} + \left(\frac{Z}{37648}\right)^2\right] \tag{10}$$

The values of nominal P and F(elev) as a function of elevation are given in Table 3 (page 29).

A-I.5 Calibration of Audit Devices

The reference flow rate is provided by a spirometer located in the sampler laboratory at UCD. The spirometer measurements are verified by a dry gas meter monitoring the exhaust to the calibration pump. Taking the logs of Equation 7A, the flow rate equation for the audit device is

$$\log(Q) = a_o + \log\sqrt{\left(\frac{29.92}{P}\right)\left(\frac{T+273}{293}\right)} + b_o * \log(M_o) \ . \tag{11}$$

The log of the meter reading, M_O, is regressed against the log of the flow rate for a set of four flow rates covering the normal range of the device. The constants relative to the nominal sea level pressure (29.92) and 20°C are calculated using

$$a_0 = \text{intercept} - \log\sqrt{\left(\frac{29.92}{P}\right)\left(\frac{T+273}{293}\right)} \qquad b_0 = slope \ . \tag{12}$$

A-I.6 Nominal Flow Rate Equation

In order to have a mean flow rate of 22.8 L/min at 15°C, the critical orifices are adjusted to provide a flow rate of 23 L/min at 20°C with a typical filter in the cassette. Using Equation 7b, the audit device flow rate at the site and 20°C is given by

$$Q_O = 10^{a_0} M_O^{b_0} F(\text{elev}) = 23.0 \text{ L / min} \tag{13}$$

The desired reading on the audit device is

$$M_o = \left(\frac{23}{F(elev)}\frac{1}{10^{a_0}}\right)^{1/b_0} \ . \tag{14}$$

A-I.7 Flow Rate Equation for the System Vacuum Gauge

The measurement by the vacuum transducer is based on the equation for the critical orifice, Equation 2:

$$Q = Q_O * \left(1 - \frac{\Delta P}{P}\right) * f(T) .$$

We can redefine the Q_0 constant to include the elevation factor:

$$Q = Q_3 * \left(1 - \frac{\Delta P}{P}\right) * f(T)\ F(elev) , \qquad (15)$$

where Q_3 is another constant. For a reading on the vacuum transducer of V, we can write this in terms of the positive parameters c and d as

$$Q = [c - d*V\ ]*f(T)\ F(elev). \qquad (16)$$

The parameters will be independent of temperature, but not independent of pressure. That is, they would change if the sampler were moved to a new location. The form of this equation was chosen to keep it parallel to that of the system orifice meter.

A-I.8 Calibration of the System Transducers

A four point calibration is made of the system orifice meter and the vacuum gauge at the site using an audit device to determine the flow rate at the inlet. The equations for the flow rate from the audit device (Q_o), the system orifice meter (Q_m), and the vacuum transducer (Q_v), all relative to sea level and 20°C are:

$$Q_o = 10^{a_0} M_o^{\ b_0} \qquad (17)$$

$$Q_m = 10^a M^b \qquad (18)$$

$$Q_v = c + d * V \qquad (19)$$

For each of the four points, Q_0 is calculated using Equation 17. For the system orifice meter, the log of Q_0 is regressed against the log of M: a is the intercept and b is the slope. For the vacuum transducer Q_0 is linearly regressed with V: c is the intercept and d is the slope.

Appendix II. Dates of Sample Collection for Every Third Day

The dates of sample collection for every third day are listed in Table 5.

Table 5. Dates of sample collection for every third day.
Dates where the sample collection is on a Tuesday are underlined.

2000			2001			2002			2003			2004		
1/1	5/3	9/3	1/1	5/1	9/1	1/2	5/2	9/2	1/3	5/3	9/3	1/1	5/3	9/3
1/4	5/6	9/6	1/4	5/4	9/4	1/5	5/5	9/5	1/6	5/6	9/6	1/4	5/6	9/6
1/7	5/9	9/9	1/7	5/7	9/7	1/8	5/8	9/8	1/9	5/9	9/9	1/7	5/9	9/9
1/10	5/12	9/12	1/10	5/10	9/10	1/11	5/11	9/11	1/12	5/12	9/12	1/10	5/12	9/12
1/13	5/15	9/15	1/13	5/13	9/13	1/14	5/14	9/14	1/15	5/15	9/15	1/13	5/15	9/15
1/16	5/18	9/18	1/16	5/16	9/16	1/17	5/17	9/17	1/18	5/18	9/18	1/16	5/18	9/18
1/19	5/21	9/21	1/19	5/19	9/19	1/20	5/20	9/20	1/21	5/21	9/21	1/19	5/21	9/21
1/22	5/24	9/24	1/22	5/22	9/22	1/23	5/23	9/23	1/24	5/24	9/24	1/22	5/24	9/24
1/25	5/27	9/27	1/25	5/25	9/25	1/26	5/26	9/26	1/27	5/27	9/27	1/25	5/27	9/27
1/28	5/30	9/30	1/28	5/28	9/28	1/29	5/29	9/29	1/30	5/30	9/30	1/28	5/30	9/30
1/31	6/2	10/3	1/31	5/31	10/1	2/1	6/1	10/2	2/2	6/2	10/3	1/31	6/2	10/3
2/3	6/5	10/6	2/3	6/3	10/4	2/4	6/4	10/5	2/5	6/5	10/6	2/3	6/5	10/6
2/6	6/8	10/9	2/6	6/6	10/7	2/7	6/7	10/8	2/8	6/8	10/9	2/6	6/8	10/9
2/9	6/11	10/12	2/9	6/9	10/10	2/10	6/10	10/11	2/11	6/11	10/12	2/9	6/11	10/12
2/12	6/14	10/15	2/12	6/12	10/13	2/13	6/13	10/14	2/14	6/14	10/15	2/12	6/14	10/15
2/15	6/17	10/18	2/15	6/15	10/16	2/16	6/16	10/17	2/17	6/17	10/18	2/15	6/17	10/18
2/18	6/20	10/21	2/18	6/18	10/19	2/19	6/19	10/20	2/20	6/20	10/21	2/18	6/20	10/21
2/21	6/23	10/24	2/21	6/21	10/22	2/22	6/22	10/23	2/23	6/23	10/24	2/21	6/23	10/24
2/24	6/26	10/27	2/24	6/24	10/25	2/25	6/25	10/26	2/26	6/26	10/27	2/24	6/26	10/27
2/27	6/29	10/30	2/27	6/27	10/28	2/28	6/28	10/29	3/1	6/29	10/30	2/27	6/29	10/30
3/1	7/2	11/2	3/2	6/30	10/31	3/3	7/1	11/1	3/4	7/2	11/2	3/1	7/2	11/2
3/4	7/5	11/5	3/5	7/3	11/3	3/6	7/4	11/4	3/7	7/5	11/5	3/4	7/5	11/5
3/7	7/8	11/8	3/8	7/6	11/6	3/9	7/7	11/7	3/10	7/8	11/8	3/7	7/8	11/8
3/10	7/11	11/11	3/11	7/9	11/9	3/12	7/10	11/10	3/13	7/11	11/11	3/10	7/11	11/11
3/13	7/14	11/14	3/14	7/12	11/12	3/15	7/13	11/13	3/16	7/14	11/14	3/13	7/14	11/14
3/16	7/17	11/17	3/17	7/15	11/15	3/18	7/16	11/16	3/19	7/17	11/17	3/16	7/17	11/17
3/19	7/20	11/20	3/20	7/18	11/18	3/21	7/19	11/19	3/22	7/20	11/20	3/19	7/20	11/20
3/22	7/23	11/23	3/23	7/21	11/21	3/24	7/22	11/22	3/25	7/23	11/23	3/22	7/23	11/23
3/25	7/26	11/26	3/26	7/24	11/24	3/27	7/25	11/25	3/28	7/26	11/26	3/25	7/26	11/26
3/28	7/29	11/29	3/29	7/27	11/27	3/30	7/28	11/28	3/31	7/29	11/29	3/28	7/29	11/29
3/31	8/1	12/2	4/1	7/30	11/30	4/2	7/31	12/1	4/3	8/1	12/2	3/31	8/1	12/2
4/3	8/4	12/5	4/4	8/2	12/3	4/5	8/3	12/4	4/6	8/4	12/5	4/3	8/4	12/5
4/6	8/7	12/8	4/7	8/5	12/6	4/8	8/6	12/7	4/9	8/7	12/8	4/6	8/7	12/8
4/9	8/10	12/11	4/10	8/8	12/9	4/11	8/9	12/10	4/12	8/10	12/11	4/9	8/10	12/11
4/12	8/13	12/14	4/13	8/11	12/12	4/14	8/12	12/13	4/15	8/13	12/14	4/12	8/13	12/14
4/15	8/16	12/17	4/16	8/14	12/15	4/17	8/15	12/16	4/18	8/16	12/17	4/15	8/16	12/17
4/18	8/19	12/20	4/19	8/17	12/18	4/20	8/18	12/19	4/21	8/19	12/20	4/18	8/19	12/20
4/21	8/22	12/23	4/22	8/20	12/21	4/23	8/21	12/22	4/24	8/22	12/23	4/21	8/22	12/23
4/24	8/25	12/26	4/25	8/23	12/24	4/26	8/24	12/25	4/27	8/25	12/26	4/24	8/25	12/26
4/27	8/28	12/29	4/28	8/26	12/27	4/29	8/27	12/28	4/30	8/28	12/29	4/27	8/28	12/29
4/30	8/31			8/29	12/30		8/30	12/31		8/31		4/30	8/31	

Air Quality Monitoring Protocol for Denali National Park & Preserve, Alaska

Standard Operating Procedure (SOP) # 4

Site Operator Standard Operating Procedures for Ozone, Clean Air Status and Trends Network (CASTNet), and Meteorological Instruments

Version: various instrument-specific revisions (January 2001)

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

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	2
2.1	Project Manager	2
2.2	Field Specialist	2
2.3	Station Operator	3
3.0	REQUIRED EQUIPMENT AND MATERIALS	3
4.0	METHODS	3
4.1	Weekly Visits	3
4.2	Troubleshooting, Maintenance, and Instrument Replacement	4
4.3	Documentation	5

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 3176-3105 *Weekly Station Visit Temperature (Climatronics)*

- CI 3176-3107 *Weekly Station Visit Relative Humidity (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 3176-3120 *Weekly Station Visit Relative Humidity Sensor (Rotronics)*
- CI 3176-3130 *Weekly Station Visit Solar Radiation Sensor (Climatronics)*
- CI 3176-3131 *Weekly Station Visit Solar Radiation Sensor (R.M. Young)*
- CI 3176-3140 *Weekly Station Visit Wetness Sensor (R.M. Young)*
- CI 3176-3150 *Weekly Station Visit Precipitation Sensor (Climatronics)*

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.

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)**

National Park Service Air Quality Monitoring

Checklist Instruction Number: **3176-3100**

Revision Number / Date: **0 / March 2000**

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 (1-800-344-5423).

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 8816 datalogger, press <**D**> for Real-Time Display Menu.

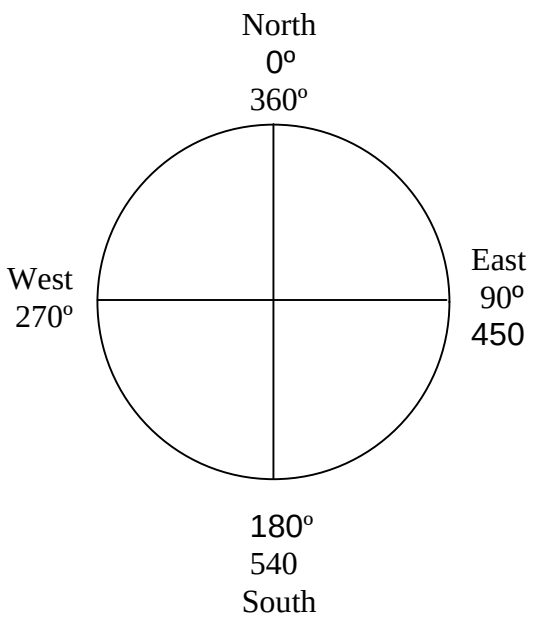
```
ESC 8816 v5.31  ID:BL      Real-Time Display Menu       08/06/97  14:59:27

    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 8816 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 (1-800-344-5423) to report the discrepancy.

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 8816 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 8816 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 8816 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 8816 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 8816 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. 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 (1-800-344-5423) 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 (1-800-344-5423) 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 8816 datalogger. Remember that pressing <**Esc**> several times will return you eventually to the Home Menu.

```
ESC 8816 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 8816 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 8816 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 8816 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 8816 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. 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

- **Relative Humidity (Climatronics)**

National Park Service Air Quality Monitoring

Checklist Instruction Number: **3176-3107**

Revision Number / Date: **0 / MARCH 2000**

Objective: Weekly checks of the relative humidity system are performed to verify the operational integrity of the sensor, aspirator, sampling system, and to verify that collected data are reasonable.

---

1. Verify that the relative humidity sensor housing aspirator fan is operational.

The relative humidity sensor housing is positioned on the meteorological tower and houses both the relative humidity and temperature sensors. The relative humidity sensor housing is fan aspirated. Listen for the sound of the fan. If it has failed, call the Operation Support Center (1-800-344-5423).

2. Note the current relative humidity measurement and compare it to your observations of ambient conditions.

From the Home Menu on the ESE 8816 datalogger, press <**D**> for Real-Time Display Menu:

```
ESC 8816 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 8816 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     )
      SOL    = 100.3     (WMS     )
      RNF    = 0         (MM      )
      RH     = 66.83     (%       )
      STP    = 21.48     (DGC     )
```

Watch the RH reading for several updates to identify any current trends. Call the Operation Support Center (1-800-344-5423) if the RH is out of range.

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.

Note: With experience you will develop a feel for judging whether the RH reading is representative of the ambient observation.

Report conditions that affect validity (e.g., aspirator fan failure) in the logbook.

3. Take the RH offline in preparation to check the translator calibration response.

To ensure that only relative humidity is recorded in the hourly average, it is necessary to mark the RH channel offline. Relative humidity 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 8816 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 8816 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 8816 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 8816 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]
    SOL    [10]
    RNF    [11]
    STP    [14]
```

Use the ↑ and ↓ keys to navigate and the spacebar to select the RH channel for offline status. The RH channel should be marked with a ">" indicating imminent offline status. Press <**Enter**> to take the marked channel offline.

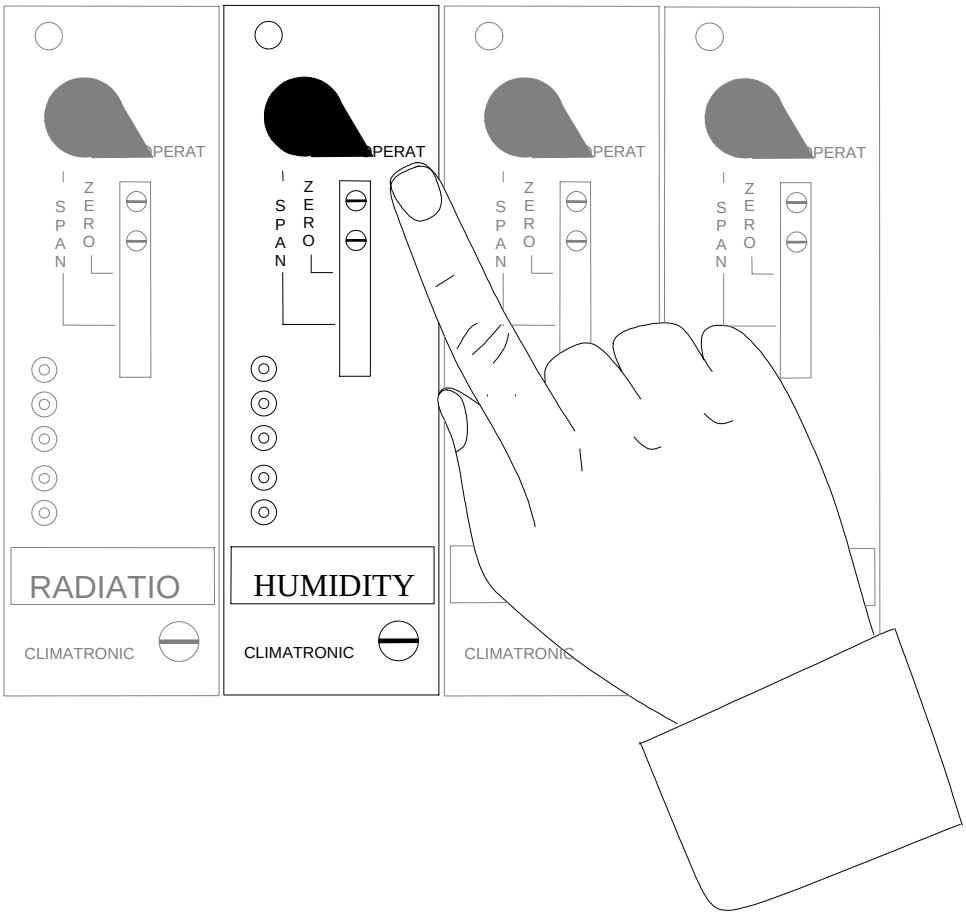
```
ESC 8816 v5.31  ID:BL    Choose(Space Toggle/Enter Select)     08/06/97  14:59:27

    O3        [01]
    O3CAL     [02]
    O3R8      [03]
    VWD       [04]
    SIG       [05]
    VWS       [06]
    SWS       [07]
    TMP       [08]
    SOL       [10]
    RNF       [11]
   >RH        [12]
    STP       [14]
```

Check the status of the RH 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. RH 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 humidity translator from OPER. to ZERO. Verify that the RH zero response are between -2 and 2.

The mode selector switch on the relative humidity translator is normally in the OPER. 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 found below:

Zero	-2	to	2
Span	98	to	102



Set the humidity mode selector switch to ZERO. Observe the RH until it has stabilized. Compare the observation to the limits. The ranges are indicated on the sticker affixed to the front of the translator card. Call the Operation Support Center (1-800-344-5423) if the response is out of tolerance.

5. Set the mode switch on the HUMIDITY translator from ZERO to SPAN. Verify that the RH span response is within the range indicated on the calibration sticker affixed to the translator.

Set the humidity mode selector switch to SPAN. Observe the RH until it has stabilized. Compare the observation to the limits in the table. Call the Operation Support Center (1-800-344-5423) if the response is out of tolerance.

6. Set the mode switch to OPER.

7. Bring the RH channel back online.

Bring the RH channel online by beginning at the Home Menu of the ESC 8816 datalogger. Remember that pressing <**Esc**> several times will eventually return you to the Home Menu.

```
ESC 8816 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 8816 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 8816 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. RH should be the only channel displayed.

```
ESC 8816 v5.31  ID:BL    Choose(Space Toggle/Enter Select)     08/06/97  14:59:27

    RH      [12]
```

Use the ↑ and ↓ keys to navigate and the spacebar to select a channel. Press the <**Spacebar**> to select RH for online status. Press <**Enter**> to put the channel online.

```
ESC 8816 v5.31  ID:BL    Choose(Space Toggle/Enter Select)     08/06/97  14:59:27

   > RH      [12]
```

Check the status of the RH 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. RH will no longer by marked with a flag indicating online status; 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 is automatically recorded in the logbook when this step is completed.

Checklist Instruction - Weekly Station Visit

- **Temperature/Delta Temperature Sensor (Climatronics)**

National Park Service Air Quality Monitoring

Checklist Instruction Number: **3176-3110**

Revision Number / Date: **0 / March 2000**

Objective: Weekly checks of the temperature and delta temperature system are performed to verify the operational integrity of the temperature sensors, aspirators, and to verify that collected data are 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 (1-800-344-5423).

2. Note the current temperature and delta temperature measurements and compare to your observation of ambient conditions.

From the Home Menu on the ESE 8816 datalogger, press <**D**> for Real-Time Display Menu.

```
ESC 8816 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 8816 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 any current trends. 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 (1-800-344-5423) 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 8816 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 8816 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 8816 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 8816 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]
```

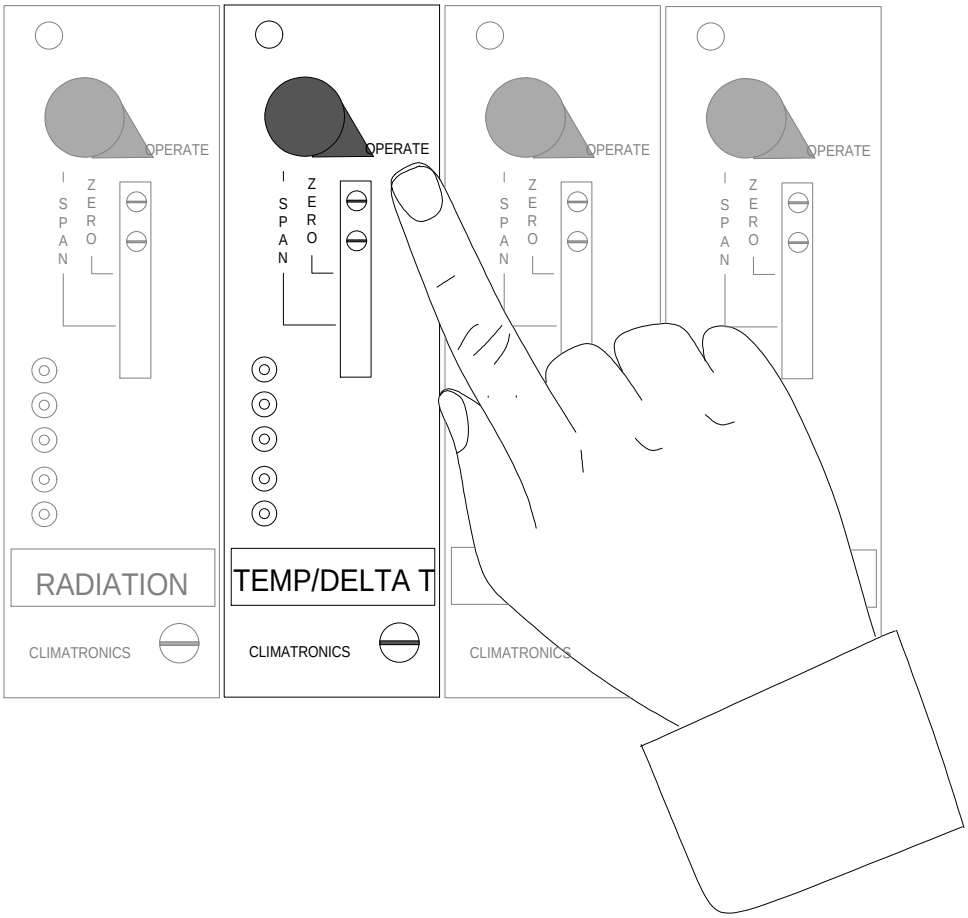
Use the ↑ and ↓ keys to navigate and the spacebar to select the TMP and DTP channels for offline status. The TMP and DTP channels should be marked with a ">" indicating imminent offline status. Press <**Enter**> to take the marked channel offline.

```
ESC 8816 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. 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 tempΔtemp 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 (1-800-344-5423) 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 tempΔtemp 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 (1-800-344-5423) 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 8816 datalogger. Remember that pressing <**Esc**> several times you will eventually return to the Home Menu.

```
ESC 8816 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 8816 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 8816 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 8816 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 8816 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. 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

- **Solar Radiation Sensor (Climatronics)**

National Park Service Air Quality Monitoring

Checklist Instruction Number: **3176-3130**

Revision Number / Date: **0 / March 2000**

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 are 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 NPS 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 ESE 8816 datalogger, press <**D**> for Real-Time Display Menu:

```
ESC 8816 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 8816 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 (1-800-344-5423) 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 8816 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 8816 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 8816 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 8816 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 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 8816 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 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. 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.

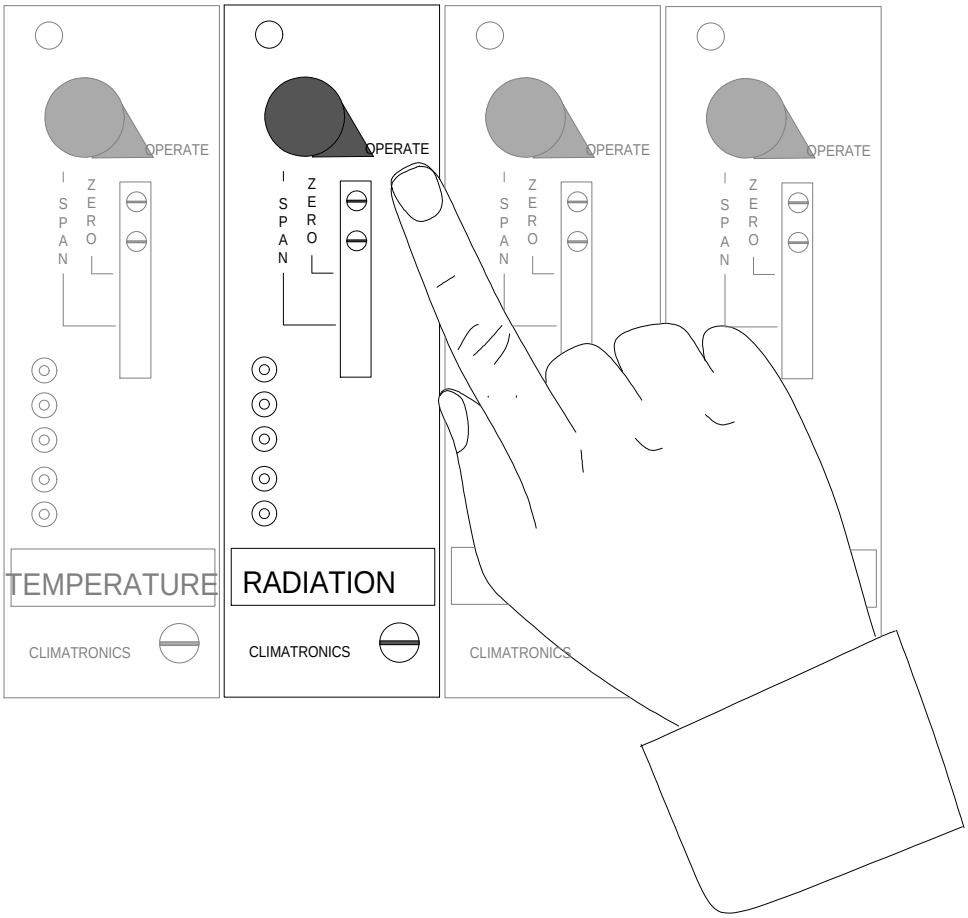
4. Set the mode selector switch on the RADIATION translator from OPER. to ZERO. Verify that the SOL zero response is between –5 and +5.

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 (1-800-344-5423) 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 8816 datalogger. Remember that pressing <**Esc**> several times you will return eventually to the Home Menu.

```
ESC 8816 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 8816 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 8816 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 8816 v5.31  ID:BL    Choose(Space Toggle/Enter Select)     08/06/97  14:59:27

 >    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. 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

- **Wetness Sensor (R.M. Young)**

National Park Service Air Quality Monitoring

Checklist Instruction Number: **3176-3140**

Revision Number / Date: **0 / March 2000**

Objective: Weekly check of the wetness sensor are performed to verify the operational integrity of the wetness system including verifying the sensor's response to wet and dry conditions. The wetness sensor response is 0 (zero) when it is dry and 100 when it is wet. The intent of the sensor design and placement is to mimick a ground-level leaf on a plant. When a leaf is dry it exchanges gases with the ambient air. When a leaf is wet, it suspends gas exchange. Modelers use the gaseous pollutant data and wetness data together to estimate the level of air pollution exposure to plants.

---

1. Take the WET channel offline to test the sensor.

Since the operational checks on the wetness sensor will generate false data, the WET channel must be taken offline. Data taken while the WET channel is offline will not be included in the hourly averages.

From the Home Menu press <**C**> for Configuration Menu:

```
ESC 8816 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 8816 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 8816 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 and the spacebar, to select the WET channel for offline status. The WET channel should be marked with a ">" indicating imminent offline status. Press <**Enter**> to take the marked channel offline.

```
ESC 8816 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 WET channel by pressing <**Esc**> key 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. WET should be marked with a *D* flag to the

right to indicate offline status. The offline time will automatically be recorded as a DataView log entry.

2. Wet test the sensor with water except during the following conditions: snow, freezing temperatures, rain, or if the sensor is wet.

If dry, the WET channel should be 0.0 ±1.0. Wet the sensor "leaf" with clean water. The WET channel should now read 100.0 (±1.0). Dry the sensor "leaf" with a Kimwipe and check the logger WET display again. The WET channel should read 0.0 (±1.0) again. If the conditions above were not met, call the Operation Support Center (1-800-344-5423) for assistance.

3. Bring the WET channel back online.

Bring the WET online by beginning at the Home Menu of the ESC 8816 datalogger. Remember that pressing <**Esc**> several times will eventually return you to the Home Menu.

```
ESC 8816 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 8816 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**> Configure (Data) Channels:

```
ESC 8816 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. WET should be the only channel displayed.

```
ESC 8816 v5.31  ID:BL    Choose(Space Toggle/Enter Select)     08/06/97  14:59:27

    WET     [12]
```

Use the ↑ and ↓ keys and the spacebar, and select the WET channel for online status. The WET channel should be marked with a ">" indicating imminent online status. Press <**Enter**> to take the marked channel online.

```
ESC 8816 v5.31  ID:BL    Choose(Space Toggle/Enter Select)     08/06/97  14:59:27

    > WET     [12]
```

Check the status of the WET 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. WET will no longer be marked with a flag that indicates offline status; a *P* will be in the flag column for each channel indicating that a purge period is 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 automatically recorded when this step is completed.

Checklist Instruction - Weekly Station Visit

- **Precipitation Sensor (Climatronics)**

National Park Service Air Quality Monitoring

Checklist Instruction Number: **3176-3150**

Revision Number / Date: **0 / March 2000**

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 verify that collected data are 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 ESE 8816 datalogger, press <**C**> for Configuration Menu:

```
ESC 8816 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 8816 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 8816 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]
```

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 8816 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. 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 (i.e., leaves, bugs, etc.) call the Operation Support Center (1-800-344-5423) if there is unmelted snow in the funnel. This indicates a failure of the heating system. Record significant findings in the logbook.

3. Tip the tipping mechanism 10 times at a rate of one tip per second.

From the Home Menu select <**D**> for Real-Time Display Menu:

```
ESC 8816 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 8816 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, tip the mechanism 10 times, and return to the shelter to read the resulting "precipitation."

To access the tipping mechanism, remove the collection funnel from the precipitation gauge body.

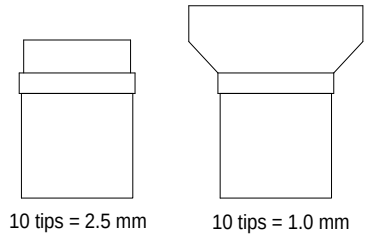
Caution: The gauge heater is supplied with 115 VAC.

Holding the collection funnel with one hand, tip the tipping mechanism 10 times waiting one second between tips. Use caution to avoid the heater wires attached to the inside of the funnel. Replace the funnel making sure to guide the wires back into the gauge so they don't interfere with the tipping mechanism motion.

Back in the shelter, the ESC 8816 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 2.5mm for gauges with vertical side funnels and 1.0mm for gauges with funnels larger than the gauge housing. Call the Operation Support Center (1-800-344-5423) if the results are different than above.



4. Bring the RNF back online and record the value.

From the Home Menu press <**C**> for Configuration Menu:

```
ESC 8816 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 8816 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 8816 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.

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	**STATION OPERATOR MAINTENANCE PROCEDURES FOR GASEOUS MONITORING SITES USING THE DATAVIEW SYSTEM**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3178**
DATE	**JANUARY 2001**

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

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	3
2.1	Project Manager	3
2.2	Field Specialist	3
2.3	Station Operator	3
3.0	REQUIRED EQUIPMENT AND MATERIALS	3
4.0	METHODS	4
4.1	Weekly Visits	4
4.2	Troubleshooting, Maintenance, and Instrument Replacement	4
4.3	Documentation	5

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) or sulfur dioxide (SO_2).

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 3178-3101 *Weekly Station Visit Ozone Analyzer (Monitor Labs ML8810) Ozone Calibrator (Dasibi 1003-PC) CASTNet Dry Deposition*
- CI 3178-3102 *Weekly Station Visit Ozone Analyzer (Monitor Labs ML8810) Ozone Calibrator (Dasibi 1008-PC)*
- CI 3178-3105 *Weekly Station Visit Ozone Analyzer (Dasibi 1003-AH) Ozone Calibrator (Dasibi 1003-PC)*
- CI 3178-3106 *Weekly Station Visit Ozone Analyzer (Dasibi 1003-AH) Ozone Calibrator (Dasibi 1003-PC) CASTNet Dry Deposition*
- CI 3178-3110 *Weekly Station Visit Ozone Analyzer (TEI 49) Ozone Calibrator (Dasibi 1003-PC) CASTNet Dry Deposition*
- CI 3178-3111 *Weekly Station Visit Ozone Analyzer (TEI 49) Ozone Calibrator (Dasibi 1003-PC)*
- CI 3178-3113 *Weekly Station Visit Ozone Analyzer (TEI 49) Ozone Calibrator (TEI 49) CASTNet Dry Deposition*

- 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 TL) Gas Dilution Calibrator (TEI 146)*
- CI 3178-3121 *Weekly Station Visit Ozone Analyzer (API 400) Ozone Calibrator (Dasibi 1003-PC) CASTNet Dry Deposition*
- CI 3178-3122 *Weekly Station Visit Ozone Analyzer (APR 400) Ozone Calibrator (Dasibi 1003-PC)*
- CI 3178-3126 *Weekly Station Visit Ozone Analyzer (CSI OA 325-2) Ozone Calibrator (Dasibi 1003-PC) CASTNet Dry Deposition*
- CI 3178-3300 *Multipoint Calibration Ozone Analyzer (ML 8810) Ozone Calibrator (Dasibi 1003-PC)*
- CI 3178-3303 *Multipoint Calibration Ozone Analyzer (ML 8810) Ozone Calibrator (Dasibi 1008-PC)*
- CI 3178-3305 *Multipoint Calibration Ozone Analyzer (Dasibi 1003-AH) Ozone Calibrator (Dasibi 1003-PC)*
- CI 3178-3310 *Multipoint Calibration Ozone Analyzer (TEI 49) Ozone Calibrator (Dasibi 1003-PC)*
- CI 3178-3312 *Multipoint Calibration Ozone Analyzer (TEI 49) Ozone Calibrator (TEI 49)*
- CI 3178-3315 *Multipoint Calibration Ozone Analyzer (TEI 49C) Ozone Calibrator (TEI 49C)*
- CI 3178-3317 *Multipoint Calibration Sulfur Dioxide Analyzer (TEI 43C TL) Sulfur Dioxide Calibrator (TEI 146)*
- CI 3178-3320 *Multipoint Calibration Ozone Analyzer (API 400) Ozone Calibrator (Dasibi 1003-PC)*
- CI 3178-3325 *Multipoint Calibration Ozone Analyzer (CSI OA 325-2) Ozone Calibrator (Dasibi 1003-PC)*
- CI 3178-3350 *Multipoint Calibration Sulfur Dioxide Analyzer (TEI 43C) Dynamic Gas Calibrator (TEI 146C)*
- CI 3178-3352 *Multipoint Calibration Sulfur Dioxide Analyzer (TEI 43C) (360ppb-440ppb) Dynamic Gas Calibrator (TEI 146)*

- CI 3178-3354 *Multipoint Calibration Sulfur Dioxide Analyzer (TEI 43C) Dynamic Gas Calibrator (TEI 146)*
- CI 3178-3356 *Multipoint Calibration Sulfur Dioxide Analyzer (TEI 43C) (760ppb - 840ppb) 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 primary filter weekly and change if necessary (at least every two weeks). Change the ozone secondary filter monthly. 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.

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.

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 49C)**
- **Ozone Calibrator (TEI 49C)**
- **CASTNet Dry Deposition**

National Park Service Air Quality Monitoring

Checklist Instruction Number: **3178-3116**

Revision Number / Date: **0 / March 2000**

Objective: The objectives of the weekly station visit related to ozone instrumentation and the CASTNet dry deposition filter pack are to:

- Verify that the ozone analyzer is functioning properly.
- Check the ozone primary filter (green filter holder) weekly and change if necessary. The filter must be changed no less than every two weeks.
- Change the ozone secondary filter (orange filter holder) monthly.
- 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 (1-800-344-5423) 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 offline.

To ensure that only ambient ozone concentrations are recorded in the hourly average, it is necessary to mark the O3 channel offline. Ozone data marked in this manner are automatically excluded from the hourly average.

To access the Login Screen of the ESC 8816 datalogger press <**Esc**> on the keyboard a couple of times until the Home Menu is displayed:

```
ESC 8816 V5.31  ID:BL        Home Menu        08/06/97  14:59:27

    H  Help Screen
    L  Login/Set User Level


    O  Log Out/Exit
```

Press <**L**> for Login/Set User Level:

```
ESC 8816 v5.31  ID:BL         Login Screen          08/06/97  14:59:27

   Enter Password                  **************
```

Login by typing **NPSAIR** on the keyboard then press <**Enter**>. The datalogger display will look similar to:

```
ESC 8816 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 8816 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 8816 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 8816 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 O3 channel for offline status. The O3 channel should be marked with a ">" indicating imminent offline status. Press <**Enter**> to take the marked channel offline.

Check the status of the O3 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. O3 and O3R8 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.

3. Replace the secondary ozone filter in the orange holder monthly.

Two particulate filters are in your ozone sample inlet system. The primary ozone sample line filter is in the "pothead" at the top of the dry deposition tower, and the secondary ozone sample line filter is in the shelter behind the ozone analyzer. The table below lists the characteristics of each:

FILTER CHARACTERISTICS	PRIMARY FILTER	SECONDARY FILTER
Holder Color	Green	Orange
Min. Particle Collection Size	20 µm	5 µm
Location	10 meters on Dry Deposition Tower	In shelter behind O3 analyzer
Teflon tube size	3/8" Diameter	1/4" Diameter
Replacement Interval	2 weeks	1 month
New filter conditioning required	No	Yes

Both filters protect the sample inlet system from particulate that could contaminate and subsequently reduce the ambient ozone concentrations. Proper filter inspection and replacement is key to maintaining accurate readings of ambient ozone concentrations.

To open the secondary filter holder, loosen the orange tightening ring from the filter housing using the dark green filter wrenches supplied by the Operation Support Contractor (1-800-344-5423). Change the secondary filter, using clean tweezers to

remove and discard the exposed filter. Using tweezers, select a new 5µm Teflon filter from the envelope and install it into the filter holder. 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 secondary ozone filter (orange holder) was installed, condition it by starting a DIAGSZ

Following a secondary filter change, a DIAGSZ check is required to verify the integrity of the sampling system and to condition the new filter. From the ESC 8816 datalogger Home Menu, press <**C**> for Configuration Menu:

```
ESC 8816 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 8816 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 8816 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 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. First, pump noise in the shelter increases dramatically as the ozone calibrator (O3CAL) and the zero air pumps switch to on. Second, the ozone analyzer display changes from the Run screen shown below:

```
O3 PPB                          60.0

SAMPLE          10:25        REMOTE
```

To the LEVEL2 screen shown here:

```
O3 PPB                          410

LEVEL2          10:25        REMOTE
```

After 15 minutes the span phase will conclude and the zero phase will commence. The ozone analyzer screen will change to the ZERO screen shown below.

```
O3 PPB                          0.0

ZERO            10:25        REMOTE
```

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. Finish last week's SSRF for CASTNet dry deposition.

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 Environmental Science and Engineering (ESE), 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 (1-800-344-5423) for exceptions.

Begin this week's filter change by completing the SSRF from last week. 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 datalogger LAST BASE AVERAGE for FLW and record it in the FILTER OFF DAS FLOW (LPM) entry cell on the SSRF. Obtain the Last Base Average

for flow by starting at the Home Menu for the datalogger. Press <**D**> for Real-Time Display Menu. Press <**B**> for Display Last Base Average.

```
ESC 8816 v5.31  ID:BL    Display Last Base Avg.     08/06/97  14:59:27

    O3    = 60.24        (        )
    O3CAL = 0.132        (        )
    O3R8  = 67.31        (        )
    VWD   = 289.3        (        )
    SIG   = 32.44        (        )
    VWS   = 3.544        (        )
    SWS   = 3.761        (        )
    TMP   = 29.81        (        )
    DTP   = 0.113        (        )
    SOL   = 678          (        )
    RNF   = 0            (        )
    WET   = 0.127        (        )
    FLW   = 3.010        (        )
    STP   = 23.12        (        )
```

6. Take the FLW channel offline.

Since the 10-meter dry deposition sampling tower must be tipped to change the CASTNet dry deposition filter and inspect the primary filter in the green holder, the FLW channel must be taken offline. Once offline, the data are not included in the hourly average. Note: The O3 channel was taken offline in Step 2.

Take the FLW offline as before by accessing the Home Menu on the ESC 8816 datalogger. Press <**Esc**> on the keyboard a couple of times until the Home Menu is displayed.

Press <**C**> for Configuration Menu.

Press <**D**> for Configure (Data) Channels.

Press <**M**> for Disable/Mark Channel Offline.

Use the ↑ and ↓ keys and the spacebar to select the FLW channel. The FLW channel should be marked with a ">" indicating imminent offline status. Press <**Enter**> to take the marked channel offline.

Check the status of the O3 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**> to display the data channels with flags. O3, O3R8, and FLW should be marked with a *D* flag to the right to indicated offline status. O3, O3CAL, and O3R8 may be additionally flagged with a *C* indicating a calibration is occurring. The offline time is automatically recorded in the logbook when this step is completed. Turn off or unplug the dry deposition pump and the hour-meter.

7. Tip the dry deposition tower and check the primary ozone filter in the green holder for visible degradation.

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 primary ozone filter reside in the "pothead" at the top of the tower. The ozone filter is in a Teflon housing with a green tightening ring. The housing is open on the bottom and the filter can be viewed and inspected through this opening. Look 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 two weeks, whichever comes first.

8. Replace the primary ozone filter in the green holder if required.

To change the ozone particulate filter, loosen the green tightening ring from the filter housing using the dark green filter wrenches supplied by the Operation Support Center (1-800-344-5423). Remove the exposed filter. Using clean tweezers, remove one 20µ Teflon filter from the envelope and install it in the filter housing. Ensure that the filter remains clean during this process since contamination reduces the ambient ozone concentration in the sample stream. Reassemble the filter housing and tighten the green ring securely using the filter wrenches. If the filter was replaced, type the date in the space provided on the checklist.

9. Replace the CASTNet dry deposition filter and complete the SSRFs.

A) Wearing clean vinyl gloves (provided by the Operation Support Contractor (1-800-344-5423), 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. Make a note of the value.

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 zero value is ± 0.03 different now than before the pump was turned on. Turn off the pump.

H) 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 ESE. The pink copy remains in your station logbook.

Inspect the plumbing for signs of obvious deterioration or moisture. If either is discovered, report your finding to the OSC.

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 of the filter change, followed by the day of the week. 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 on the Chain of Custody label, 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 elapsed timer to zero. Turn the flow pump and the elapsed timer on.

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.

10. Bring the O3 and FLW channels back online.

Bring the O3 and FLW channels online by beginning at the Home Menu of the ESC 8816 datalogger. Remember that pressing <**Esc**> several times will eventually return you to the Home Menu.

```
ESC 8816 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 8816 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 8816 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. O3 and FLW should be the only channels displayed.

```
ESC 8816 v5.31  ID:BL    Choose(Space Toggle/Enter Select)     08/06/97  14:59:27

  >  O3      [01]
     FLW     [13]
```

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 8816 v5.31  ID:BL    Choose(Space Toggle/Enter Select)     08/06/97  14:59:27

   > O3      [01]
   > FLW     [13]
```

Check the status of the O3 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, O3R8, and FLW will no longer by marked with a flag that indicates offline status; a *P* will be in the flag column for each indicating that a purge period is 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 be recorded in the logbook when this step is completed.

Note: If the calibration sequence, **DIAGSZ**, is still active, O3, O3CAL, and O3R8 will be flagged with a *C*.

11. If a new secondary filter (orange holder) is installed, enter the DIAGSZ filter conditioning results for O3.

From the Home Menu press <**R**> for Report Generation Menu:

```
ESC 8816 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 zero and span results from the ACTUAL column on to 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.

12. If a new secondary filter (orange holder) was installed, enter the DIAGSZ filter conditioning results for O3CAL.

Following the same procedures as the previous step, enter the values for O3CAL.

The checklist will prompt you to call the OSC if the results were not in tolerance.

13. Enter the O3 manifold flow rate. Call the OSC if out of range.

A Thomas pump continuously draws ambient air from 10 meters through the glass manifold found behind the instrument rack. The O_3 analyzer draws ambient air from this glass manifold. Maintaining the proper flow rate through the glass manifold is critical.

The manifold flow rotameter is an indicator of the ambient air flow rate through the intake manifold. The site-specific flow rate required for proper manifold air flow is specified on a calibration sticker applied to the manifold flow rotameter. Finding the ball within one minor division of the specified flow rate is acceptable and is sufficient confirmation of proper air flow through the intake manifold. Call the Operation Support Contractor (1-800-344-5423) if the flow rate is out of this range.

Checklist Instruction - Multipoint Calibration

- **Ozone Analyzer (TEI 49C)**
- **Ozone Calibrator (TEI 49C)**

National Park Service Air Quality Monitoring

Checklist Instruction Number: **3178-3315**

Revision Number / Date: **0 / March 2000**

Objective: The objective of a monthly multipoint calibration is to perform 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 8816 datalogger.

From the ESC 8816 datalogger Home Menu, press <**C**> for Configuration Menu:

```
ESC 8816 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 8816 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 8816 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 (1-800-344-5423) 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 8816 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 8816 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 met. 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 (1-800-344-5423).

4. Observe the continuous average report for several minutes. When five or more one-minute updates indicate a stable zero response, +5ppb to –5ppb, record the last one-minute averages for O3 and O3CAL.

After several minutes the Continuous Average Report will display the arrays of one-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 three one-minute averages of O3 are in the range of +5ppb to –5ppb.
2. The last three one-minute averages of O3CAL are in the range of +5ppb to –5ppb.

Record the last one-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 8816 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 8816 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 8816 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 8816 datalogger Home Menu, press <**C**> for Configuration Menu:

```
ESC 8816 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 8816 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 8816 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 one-minute updates indicate a stable span response, 360ppb to 440ppb, record the last one-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 8816 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 one-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 three one-minute averages of O3 are within the range of 360ppb to 440ppb.
2. The difference between O3 and O3CAL for each of the last three averages is less than 25ppb.

Record the last one-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 (1-800-344-5423) 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 three or more one-minute updates indicate a stable response, record the last one-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 three or more one-minute updates indicate a stable response, record the last one-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 8816 datalogger Home Menu, press <**C**> for Configuration Menu.

```
ESC 8816 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 8816 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 8816 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 (1-800-344-5423) 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 (1-800-344-5423) to discuss the results of the multipoint check.

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	**INFORMATION MANAGEMENT CENTER (IMC) CONCEPT AND CONFIGURATION**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3340**
DATE	**MARCH 1999**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Betsy Davis-Noland	
PROJECT MANAGER	Robert Deemer	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
NPS COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Update respon./equipment, add CASTNet.	January 2001	

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
2.1	Program Manager	1
2.2	IMC Data Processing Staff	1
2.2.1	IMC Manager	4
2.2.2	Data Analyst	5
2.2.3	Data Technician	6
2.3	Database Manager and Systems Support Staff	6
2.4	Field Specialist	7
2.5	Technical Assistant	7
2.6	Site Operator	8
2.7	NPS ARD Staff	8
3.0	REQUIRED EQUIPMENT AND MATERIALS	8
3.1	Monitoring Site Data Collection Hardware	9
3.2	IMC Computer Hardware	9
3.2.1	Servers	9
3.2.2	Workstations	9
3.2.3	Computer Support Hardware	9
3.3	IMC Software	12
3.3.1	Oracle Relational Database Management System	12
3.3.2	AQDBMS Custom Software	12
3.3.3	Network Operating System and Support Software	12
3.4	Additional Support Equipment	12
4.0	METHODS	14
4.1	IMC Concept and Overview	14
4.2	Data Quantity and Quality Objectives	14
4.3	AQDBMS Design Concept	14
4.4	Data Collection	14

TABLE OF CONTENTS (CONTINUED)

Section **Page**

4.5 Data Validation 18

4.5.1 Level 0 Data Validation 18
4.5.2 Preliminary Validation 18
4.5.3 Final Validation 19

4.6 Data Reporting 19

LIST OF FIGURES

Figure **Page**

2-1 IMC Staff Organization 3

3-1 IMC Computer Hardware Configuration 11

4-1 NPS Gaseous Air Pollution and Meteorological Monitoring Network Data Collection, Validation, and Reporting Flow Diagram 15

LIST OF TABLES

Table **Page**

1-1 IMC-Related Standard Operating Procedures (SOP), Technical Instructions (TIs), and Reference Documents (REF) 2

3-1 Current IMC Computer Hardware Configuration 10

3-2 Current IMC AQDBMS Software 13

4-1 Performance Measures and Goals for the NPS Ambient Air Quality Network 16

4-2 Current AQDBMS Design Specifications Summary 17

4-3 Current IMC Standard Report Products and Tasks 20

1.0 PURPOSE AND APPLICABILITY

The Gaseous Pollutant and Meteorological Monitoring Network 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 ozone, sulfur dioxide, and meteorological parameters. More recently, dry deposition monitoring systems, operated under Clean Air Status and Trends Network (CASTNet) protocol, have been added to selected sites. Data collected from the network consist of over 40 million hourly averages collected from over 60 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.

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 each staff position. Figure 2-1 is an organizational chart of IMC staff.

2.1 PROGRAM MANAGER

The program manger has the overall responsibility, accountability, and authority for the IMC. The program manager shall:

- Meet all project objectives on schedule, including reporting and other products and technical requirements.
- Assign duties to the IMC manager and technical staff, and review the 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.

2.2 IMC DATA PROCESSING STAFF

The IMC data processing staff consists of the IMC manager, data analyst(s) and data technician(s). Descriptions and specific duties of each position are provided in the following subsections. In general, the data processing staff is responsible for performing day-to-day data collection, validation, reporting, and other tasks directed by the IMC manager. The data processing staff shall:

- Verify automatic daily datalogger and DataView polling and perform manual or auxiliary polling as required.
- Coordinate with site operators to ensure that all field documentation is complete and available on time.

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 AIRS 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	Air Quality Data Base Management System (AQDBMS) EPA AIRS Reference
REF	ARS	Stackplot User's Guide

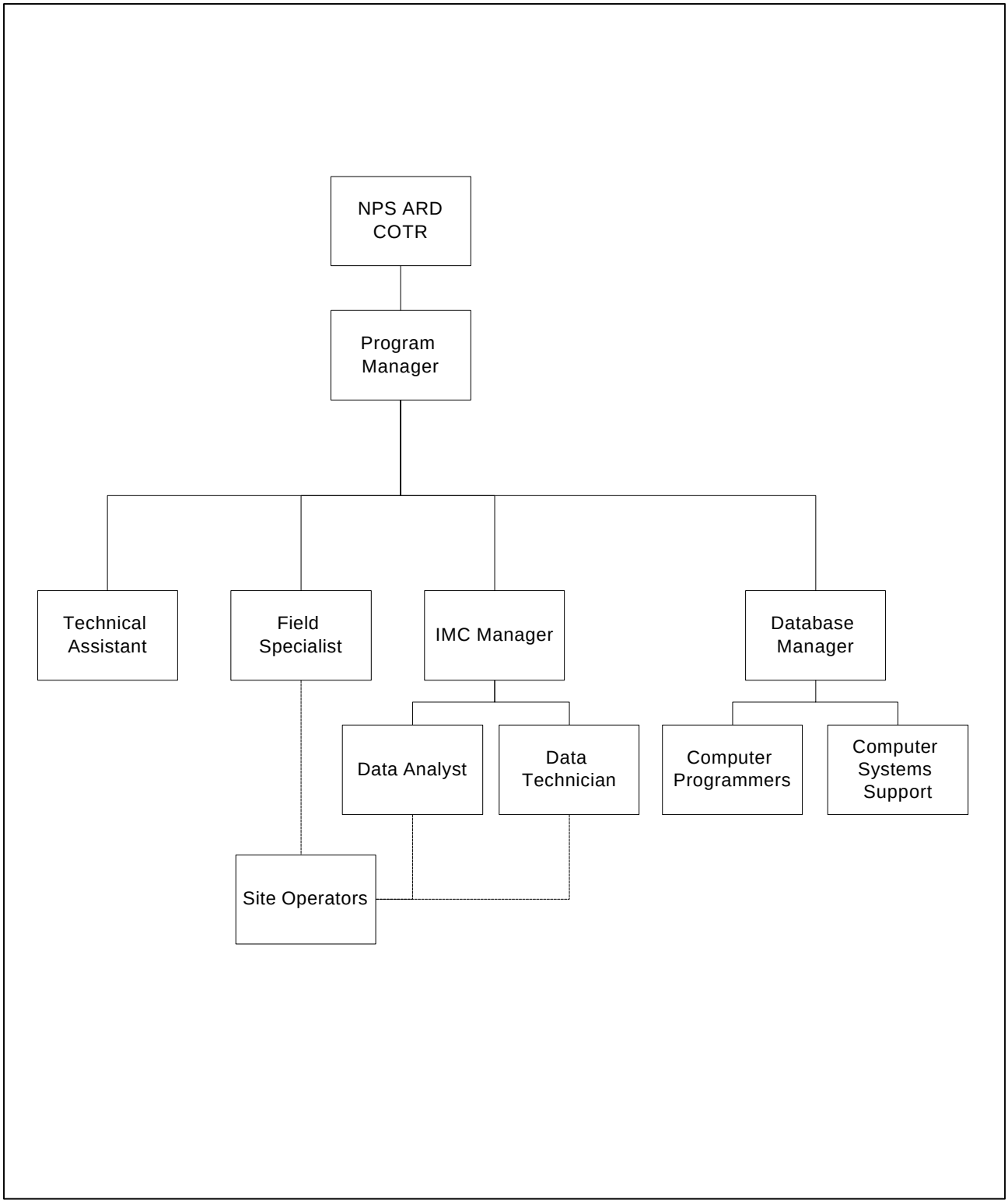


Figure 2-1. IMC Staff Organization.

- Provide telephone support to site operators to resolve data communications and documentation problems.
- Complete Electronic Status Board entries and inform field operations staff of noted inconsistencies.
- Validate all data according to established protocols.
- Participate in weekly program reviews among ARS personnel and in monthly plot reviews with the COTR, NPS ARD personnel, and ARS personnel.
- Generate and assemble all data reports.
- File all field documentation, data reports, and supplemental information.
- Fulfill all data requests as assigned.
- Participate in weekly CASTNet conference calls.
- Submit all CASTNet-related data to the CASTNet contractor.
- Submit all validated data and precision check and audit data to the Environmental Protection Agency's (EPA) Aerometric Information Retrieval System (AIRS) database.
- Update database files to account for system configuration or site changes.
- Test all advanced and evolving software and database applications.

Specific duties of the IMC manager, data analyst(s), and data technician(s) are presented below.

2.2.1 IMC Manager

The IMC manager supervises the IMC data analysts and data technicians and coordinates the day-to-day tasks as listed above to ensure timely, quality data collection, validation, reporting, and archiving. The IMC manager shall:

- Set up and maintain the automatic data collection programs and support information.
- Provide technical support to the site operator via telephone.
- Update information in the AQDBMS site configuration tables and stackplot configuration files.
- Review stackplots including annotations made by the data analyst and data technician.
- Review AQDBMS entries (i.e., validation codes or hand-entered values) made by the data analyst and data technician.
- Update and/or verify the Data Validation Log.

- Participate in weekly program reviews and monthly plot reviews, and verify that all questions are addressed.
- Respond to site operator comments on data reports.
- Coordinate and/or perform all data reports, CASTNet data submittals, and AIRS uploads.
- Coordinate the servicing of data requests and scheduled data deliveries.
- Create and update IMC-related SOPs and TIs.
- Coordinate all hardcopy and digital archives.
- Test all software changes or enhancements.
- Inform the network operations staff of any observed, site-related data or communications inconsistencies.
- Summarize IMC-related progress and forward items to the technical assistant for inclusion in monthly progress reports.

2.2.2 Data Analyst

The data analyst shall:

- Review and annotate stackplots.
- Hand enter or enter reduced data from other sources (strip charts, printouts, or digital data) as required.
- Update the Data Validation Log in the AQDBMS.
- Enter validation codes in the AQDBMS based on stackplot annotations.
- Enter data retrieved from other data sources.
- Review annotated stackplots with the field specialist.
- Participate in weekly program reviews and monthly plot reviews. Respond to questions posed during the plot review.
- Assist with data report preparation.
- Assist with data requests.

2.2.3 Data Technician

The data technician shall:

- 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) to verify complete, error-free data collection and to evaluate the integrity of the monitoring system.
- Perform required daily retries.
- Review collected data files.
- Identify collection or monitoring system problems and initiate corrective actions.
- Run anomaly screening program.
- Blank-fill missing data as necessary.
- Collect, review, and log DataView and manual site documentation.
- Print, review, and annotate stackplots.
- Update the Data Validation Logs in the AQDBMS.
- Enter validation codes in the AQDBMS based on stackplot annotations.
- Post annotated stackplots for the plot reviews.
- Participate in weekly program reviews and monthly plot reviews and respond to questions posed during the plot reviews.
- Assist with data report preparation.
- Assist with data requests.

2.3 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, network administrators, and data communications specialists. The systems support staff shall:

- Design, develop, implement, and test database, data acquisition, data communications, 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.

2.4 FIELD SPECIALIST

The field specialist shall:

- 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.
- 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 before the monthly plot review.
- Participate in the monthly plot review.

2.5 TECHNICAL ASSISTANT

The technical assistant shall:

- Enter appropriate information in the Site Status Log.
- Printout trip reports and give them to the IMC.
- Compile and mail data reports.
- Assist with IMC correspondence.
- File all hardcopy documentation and maintain hardcopy site files.
- Mail any corrections made to reports to the report recipients.

2.6 SITE OPERATOR

The site operator shall:

- Enter all required site documentation on DataView.
- Telephone the IMC or field specialist if data collection or calibration problems are noted on site.
- Review monthly draft data reports and forward comments to the IMC.
- Perform regular site maintenance and troubleshooting as directed by the field operations staff.

2.7 NPS ARD STAFF

NPS ARD staff shall:

- Participate in monthly plot reviews.
- 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.

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 and DataView station logs daily via telephone 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 modem and a laptop computer with an internal modem. The datalogger stores data via analog 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. Monitoring site hardware currently used in the network is presented in Table 3-1.

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. 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 services:

1) File services for storing and retrieving program executables, ASCII data files, word processing documents, etc.

2) Database services for managing a relational database management system (RDBMS) such as Oracle.

3) Internet communications services for transferring data to and from the EPA AIRS database and other sources.

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.

Table 3-1

Current IMC Computer Hardware Configuration

Monitoring Site Data Collection Hardware

Component	Manufacturer	Model	Communications Settings		Number of inputs	
			Baud Rate	Error Checking	Analog	Serial
Datalogger	ESC	8816	19.2K	Yes	16	2
Datalogger Telephone Modem	various	N/A	variable up to 19.2K	Yes	-	-
DataView Laptop	Gateway	solo 5300	variable up to 56K	Yes	-	-

Hardware Specifications for IMC Servers

Name	Manufacturer	Model	Processor(s)	RAM	Disk Space	Ethernet Speed	Services
ARS_NET3	Compaq	Prolient 1600R	Pentium III 500mhz	635MB	25GB	100mbs	File
ARS_IMC	Compaq	Prolient 2500	Pentium 180 mhz	380MB	25GB	100mbs	File, Database

Hardware Specifications for Workstations

User	Processor(s)	RAM	Disk Space	Network Card	Modem Baud Rate	Floppy Drive	CD Drive Speed
Database Manager	Pentium III 600	128MB	9.5GB	3Com Ethernet 100Mb	33.6K	3.25	12x
IMC Data Processing Staff	Pentium®	32MB	1GB	3Com Ethernet 10Mb	56K	3.25	12x

IMC Computer Support Hardware

Component	Manufacturer	Model	Function
Draft printer	Epson	LQ1500	Draft quality reports
High-quality laserjet printer	Hewlett-Packard	LaserJet 4050TN	Report tables and plots
Color printer	Epson	Stylus 1500	Color report tables and plots
Write capable CD Drive	Pinnacle Micro	2x/6x	Data distribution and archive
T-1 Internet data connection			Internet access
Scanner	Hewlett-Packard	ScanJet 5P	Scanning images (i.e., photographs and maps) for reports

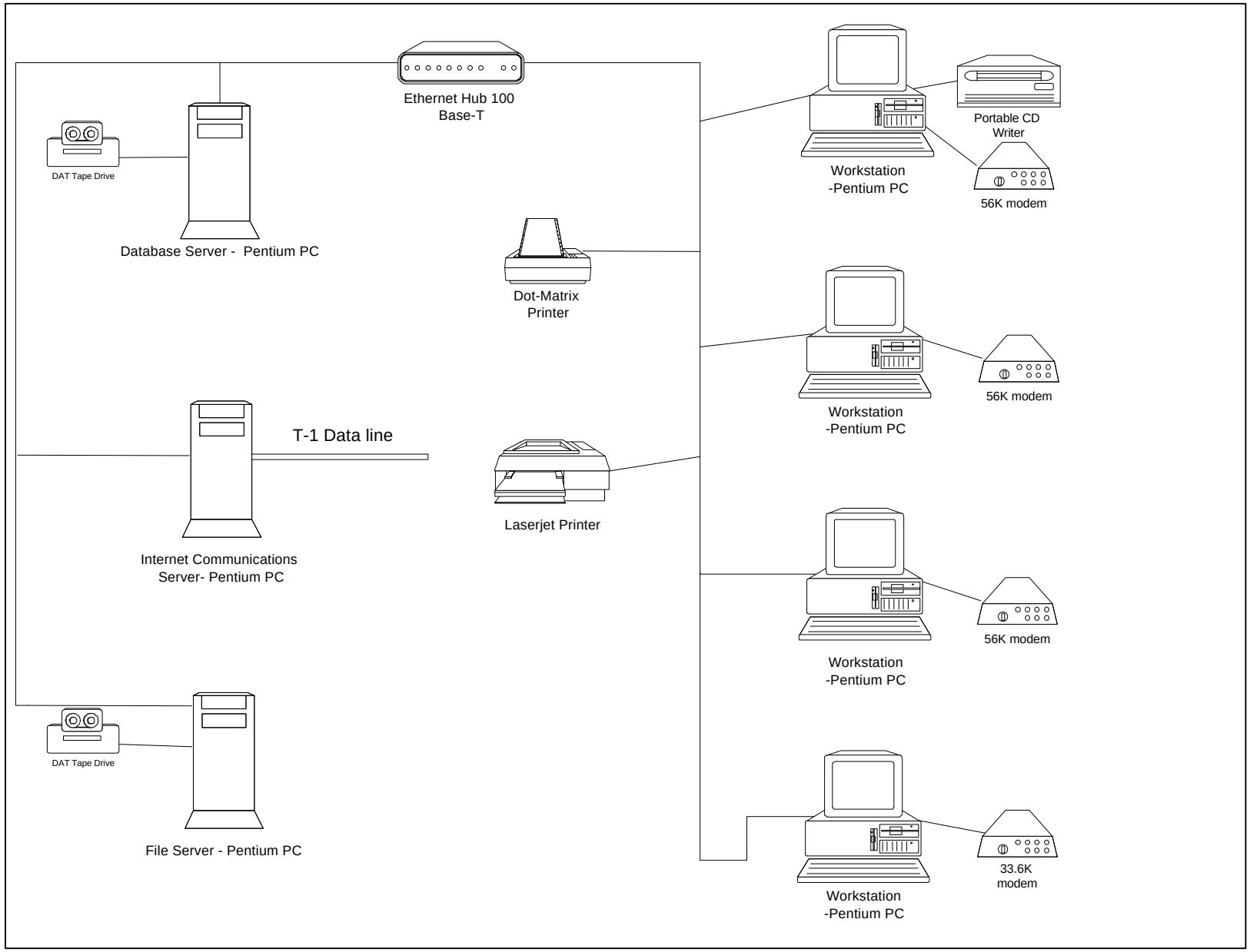


Figure 3-1. IMC Computer Hardware Configuration.

3.3 IMC 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 (RDBMS).

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 below.

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 (RDBMS) 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, strip charts, 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.

Table 3-2

Current IMC AQDBMS Software

Oracle Database System				
Program	Manufacturer	Version	Installed on	Function
Oracle Workgroup Server for Netware	Oracle Corporation	8.1	Database Server	Relational Database Management System
SQL Net8 TCP/IP	Oracle Corporation	8.1	Database Server	Database Networking
SQL*Net8 Listener	Oracle Corporation	8.1	Database Server	Database Networking
SQL*Net8 Client	Oracle Corporation	8.1	Client	Database Networking
Oracle DBA Tools	Oracle Corporation	2.2	Client	Database Administration and Special processing

AQDBMS Custom Software				
Program	Manufacturer	Source Code Language and Version	Installed on	Function
DATA COLLECTION				
Crosstalk	DCA	Crosstalk Mk.4	Client	Required to run Crosstalk script
DATA VALIDATION AND REPORTING				
IMC Application	ARS	PowerBuilder 7	Server	User interface for data collection, validation, and reporting
PowerBuilder Deployment Kit	Powersoft	PowerBuilder 7	Client	Required to run PB application
Stackplot Diurnal Plot Three-Year Summary Plot Roseplot	ARS ARS ARS ARS	Visual Basic 6 Visual Basic 6 Visual Basic 6 Visual Basic 6	Server Server Server Server	User interface for producing data plots
Visual Basic deployment dlls	Microsoft	Visual Basic 6	Client	Required to run VB programs

Network Operating System and Support Software				
Component	Manufacturer	Version	Installed on	Function
Novell Netware TCP/IP Protocol	Novell	5.1	Servers	Network operating system
Novell Netware Client	Novell	3.2	Clients	Network operating system
Arcserve	Cheyenne	7	Servers	Server backup
HP Laserjet 4050TN Printer Driver	Hewlett-Packard		Clients	Printer communications
Epson Stylus 1500 Printer Driver	Epson		Clients	Printer communications
MS-Windows 98SE	Microsoft		Clients	PC operating system
MS-Word 97	Microsoft	97	Clients	Word processing reports
MapViewer	Golden Software	2.13	Clients	Report map production
Deskscan II	Hewlett-Packard	2.17	Clients	Report site photo production
WS-FTP PRO	Ipswitch	6.51	Clients	AIRS data transmission
MS-System Agent	Microsoft	98	Clients	Automatic data collection
WINZIP	NicoMac Computing	8	Clients	Data archive

4.0 METHODS

This section presents an overview of the IMC, NPS Ambient Air Quality Network data quantity and quality objectives, and the methods used in the IMC to meet the data objectives.

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 Ambient Air Quality Network. 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 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 Ambient Air Quality Network. 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, validation 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.

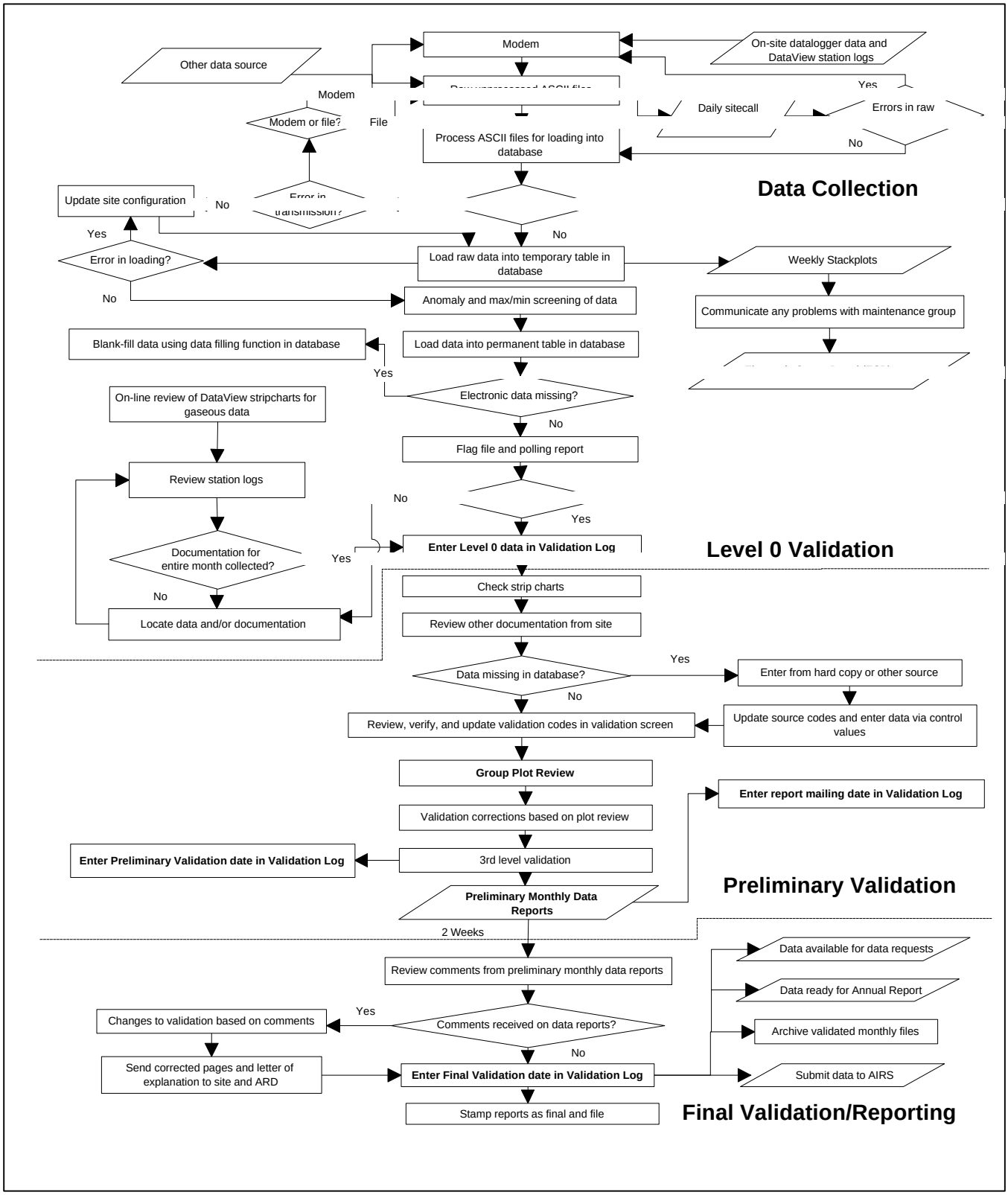


Figure 4-1. NPS Gaseous Air Pollution and Meteorological Monitoring Network Data Collection, Validation, and Reporting Flow Diagram.

Table 4-1

Performance Measures and Goals for the NPS Ambient Air Quality Network

Performance Measure	Performance Goal
1. Performance of Monthly Calibrations for Pollutant Analyzers	**Number of Calibrations:** Ozone: 100% 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 10 calibrations per year **Calibration Results:** Absolute percent difference for 80% of all calibrations at each site are within 5%, 90% 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 daily 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 ≤ 10 days. Status Board Entries: 100% entered within 1 working day. Site Visits: All problems identified during semiannual visits are resolved within 7 days.
4. Data Communications Problems	100% of problems corrected within 6 calendar days. 100% of sites polled at least weekly.
5. Precision Checks	100% of sites, at least once every 14 days.
6. Zero/Span Checks	100% 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 monthly progress reports.
8. 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 **Monthly Criteria:** 100% of sites, ≥ 60% valid data capture 90% of sites, ≥ 75% valid data capture 80% of sites, ≥ 85% valid data capture
9. Data Requests	100% of all requests handled satisfactorily within 10 days. All requests completed within 20 days.
10. Quality Assurance Performance Checks	80% of all audits (on a site-parameter basis) will have an average absolute percent difference of ≤ 7.5% All audits (on a site-parameter basis) will have an average absolute percent difference of ≤ 10%. Absolute percent difference of all audit points is ≤ 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.*
11. AIRS/PARS Submittals	Data from 100% of sites submitted within 90 days.
12. Preliminary Data Reports	All preliminary data reports submitted within 45 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

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, AIRS codes, location information
   - Datalogger configuration for current sites
   - Site Status Log

5. Parameter information:
   - Name, abbreviation, AIRS 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 AIRS 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 AIRS national database.

4.5.1 Level 0 Data 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 and Site Status Log entries 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 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.

- Preliminary data reports are generated and delivered to the NPS ARD and to each site operator.

- Preliminary validation is considered complete on the date the preliminary reports are mailed.

4.5.3 Final Validation

Final validation is performed on monthly data sets two weeks after preliminary reports are mailed. The following steps occur during the Final validation process:

- Responses from site operators, ARD staff, and other related parties are reviewed.

- Validation code changes are made if appropriate.

- Updates to pages effected by changes are printed, replaced in preliminary reports, filed, and mailed (with cover letter) explaining changes to the NPS ARD and site operators.

- A Final validation date is entered in the Data Validation Log.

- Preliminary data reports are stamped "FINAL" and filed in the appropriate site file.

Upon completion of this final step, the data are considered final. The validated data are ready to be formatted for submittal to the EPA AIRS 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 AIRS database, (submission of CASTNet-related data to the CASNet 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.

Table 4-3

Current IMC Standard Report Products and Tasks

Deliverable Product/Task	Distribution List	Schedule
Ozone "hit list"	NPS ARD	Monthly during the ozone season, generated from raw data at the end of each month.
Monthly Progress Report	NPS ARD	Monthly, by the 10th of the month following the period of record.
Monthly Data Reports (one for each site)	NPS ARD, site operators	Monthly, within 45 days of receipt of all site documentation.
Annual Data Reports (one for each site)	NPS ARD, site operators	Yearly, by July 31st of the year following.
Annual Digital Data in ASCII files	NPS ARD	Yearly, by July 31st of the year following.
CASTNet-related data	CASTNet contractor	Quarterly, within 60 days of the end of the quarter.
EPA AIRS data submittal	EPA AIRS	Quarterly, within 90 days after the end of the quarter.
Data requests	To requesting party	As approved by the NPS ARD

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	**DAY TO DAY NETWORK OPERATIONS TECHNICAL SUPPORT FOR THE NATIONAL PARK SERVICE GASEOUS AND METEOROLOGICAL MONITORING PROGRAM**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3345**
DATE	**SEPTEMBER 2000**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	David L. Dietrich	
PROJECT MANAGER	Robert Deemer	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
0.1	Change site document review procedures	January 2001	

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
2.1	IMC Staff	1
2.1.1	IMC Manager	1
2.1.2	Data Analyst	1
2.1.3	Data Technician	2
2.2	Network Operations Staff	2
2.2.1	Section Manager	2
2.2.2	Field Specialists and Technician of the Week (TOW)	3
2.2.3	Technical Assistant	3
3.0	REQUIRED EQUIPMENT AND MATERIALS	3
4.0	METHODS	3
4.1	Telephone Support - Scheduled and Unscheduled	4
4.2	Routine Data and Operational Systems Review	5
4.2.1	Data Products	5
4.2.2	Daily Data Review	11
4.2.3	Weekly Review	12
4.2.4	Site Document Review	13
4.2.5	Monthly Review	15
4.3	Operational Network Documentation	15
4.3.1	Site Status Report	15
4.3.2	Site Status Log	15
4.4	Corrective Actions	18
4.5	Coordination, Tracking, and Inventory Control of Government-Owned Equipment to and from Monitoring Sites or Other Repair Facilities	18
4.6	Maintenance and Distribution of Expendable Site Supplies	19
4.7	Maintenance and Distribution of Capital Equipment and Instrumentation	19

LIST OF FIGURES

Figure		Page
4-1	Example Daily Datalogger Report	6

LIST OF FIGURES (Continued)

Figure		Page
4-2	Example Daily Flag File	7
4-3	Example Primary Data Stackplot	8
4-4	Example Calibration Results Summary Stackplot	9
4-5	Example Daily Summary	10
4-6	Example Weekly IMC - Network Operations Notes	14
4-7	Example Site Status Report	16
4-8	Example Electronic Site Status Log Display	17
4-9	Example Listing of Replacement and Consumable Parts	20

1.0 PURPOSE AND APPLICABILITY

Maintaining the continuous operation of the National Park Service (NPS) Gaseous and Meteorological 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 Manager

The IMC manager's responsibilities include:

- Supervise the data analyst and data technician.
- Participate in weekly and monthly data reviews.
- Perform daily, weekly, or monthly duties in the absence of the data analyst and data technician.

2.1.2 Data Analyst

The data analyst shall:

- Participate in weekly and monthly data reviews.
- Follow through from problems noted during monthly plot review and data validation.
- Perform daily, weekly, or monthly duties in the absence of the data technician.

2.1.3 Data Technician

The data technician shall:

- Print and review the daily datalogger report and flag file.
- Print and file daily site summaries.
- Review daily stackplots.
- Review daily calibration plots.
- Print, circulate, and file weekly stack plots.
- 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.
- Keep current notebook with any problems.
- Enter trip report pre-calibration results.
- Enter any audit results.

2.2 NETWORK OPERATIONS STAFF

2.2.1 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 section manager. TOW responsibilities are detailed in Section 4.0 and generally include:

- Review of network data daily.
- Review results of automated calibrations daily.
- Initiate contact with station operators when problems are recognized .
- Consult with station operators when they telephone.
- Document communication with station operators.
- Regularly interact with the IMC staff .

2.2.3 Technical Assistant

The technical assistant shall:

- Enter Site Status Report information into the Site Status Log.
- Print Site Status Logs and place in Site Status Log Notebook.
- Track status of shipped 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. Telephone support will include the following:

- 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.

- During the last week of each month, every site operator will be contacted by ARS network operations staff to discuss the status of site operations and review any procedures or problems critical to site operations. Sites where repeated contacts have been made throughout the month to resolve specific problems will generally not be contacted during the scheduled period.

- 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). 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.

- Daily Flag File lists any datalogger parameter flag with a < sign or any flag generated by the anomaly screening program Figure 4-2 is an example of the Daily Flag File.

- 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, hard copy stackplots are generated each Sunday, and archived by site for convenient and immediate access by network operations and IMC staff. An example Primary Data Stackplot is provided as Figure 4-3.

- Calibration Results Summary Stackplots of zero, span, and precision data for the previous 30 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 4-4.

- 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 and keyboard-entered messages entered by the site operator. An example Daily Summary is provided as Figure 4-5.

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.

```
Logging 08/20/2000 00:05
CANY-IS Logger# 1 08/19/2000 23:00 08/19/2000 23:00 SDWD-2    <N
CANY-IS Logger# 1 08/19/2000 23:00 08/19/2000 23:00 VWS-2     <N
CANY-IS Logger# 1 08/19/2000 23:00 08/19/2000 23:00 WET-1     <N

LAST STATION LOG ENTRY FOR JOYV IS 08/08/00 14

Logging 08/20/2000 03:09
BIBE-KB Logger# 1 08/19/2000 01:00 08/19/2000 01:00 O3-10     <C
BIBE-KB Logger# 1 08/19/2000 20:00 08/19/2000 23:00 SOL-1     VZ

Logging 08/20/2000 03:15
CHIR-ES Logger# 1 08/19/2000 14:00 08/19/2000 14:00 FLOW-1    <P
CHIR-ES Logger# 1 08/19/2000 21:00 08/19/2000 22:00 O3CAL-2   <C
CHIR-ES Logger# 1 08/19/2000 14:00 08/19/2000 14:00 RNF-2     P

Logging 08/20/2000 03:20
CRMO-VC Logger# 1 08/19/2000 02:00 08/19/2000 02:00 O3-12     <C XV XR
CRMO-VC Logger# 1 08/19/2000 10:00 08/19/2000 11:00 SDWD-2    NV
CRMO-VC Logger# 1 08/19/2000 19:00 08/19/2000 19:00 SDWD-2    NV

LAST STATION LOG ENTRY FOR DENA IS 08/08/00 15

Logging 08/20/2000 03:31
DEVA-PV Logger# 1 08/19/2000 21:00 08/19/2000 21:00 O3-11     <C XV XR
DEVA-PV Logger# 1 08/19/2000 00:00 08/19/2000 20:00 O3CAL-2   VZ
DEVA-PV Logger# 1 08/19/2000 21:00 08/19/2000 21:00 O3CAL-2   <C

Logging 08/20/2000 03:37
EVER-BC Logger# 1 08/19/2000 02:00 08/19/2000 02:00 DTP-1     NR
EVER-BC Logger# 1 08/19/2000 07:00 08/19/2000 07:00 VWS-2     NR

Logging 08/20/2000 03:43
GLAC-WG Logger# 1 08/19/2000 21:00 08/19/2000 21:00 O3-3      <C XV XR
GLAC-WG Logger# 1 08/19/2000 03:00 08/19/2000 05:00 VWS-2     NR
GLAC-WG Logger# 1 08/19/2000 23:00 08/19/2000 23:00 VWS-2     NR

LAST STATION LOG ENTRY FOR GLAC IS 08/09/00 11
Logging 08/20/2000 03:48
GRBA-MY Logger# 1 08/19/2000 21:00 08/19/2000 21:00 O3-11     <C XV XR
GRBA-MY Logger# 1 08/19/2000 00:00 08/19/2000 01:00 SDWD-2    NV
GRBA-MY Logger# 1 08/19/2000 20:00 08/19/2000 20:00 SDWD-2    NV

Logging 08/20/2000 03:54
GRSM-CC Logger# 1 08/19/2000 22:00 08/19/2000 22:00 SWS-1     NR
GRSM-CC Logger# 1 08/19/2000 02:00 08/19/2000 02:00 VWS-2     NR
GRSM-CC Logger# 1 08/19/2000 22:00 08/19/2000 22:00 VWS-2     NR

Logging 08/20/2000 03:59
GRSM-CD Logger# 1 08/19/2000 00:00 08/19/2000 01:00 O3CAL-2   VZ
GRSM-CD Logger# 1 08/19/2000 22:00 08/19/2000 23:00 SDWD-1    NV
GRSM-CD Logger# 1 08/19/2000 05:00 08/19/2000 05:00 SWS-1     NR
```

Figure 4-2. Example Daily Flag File.

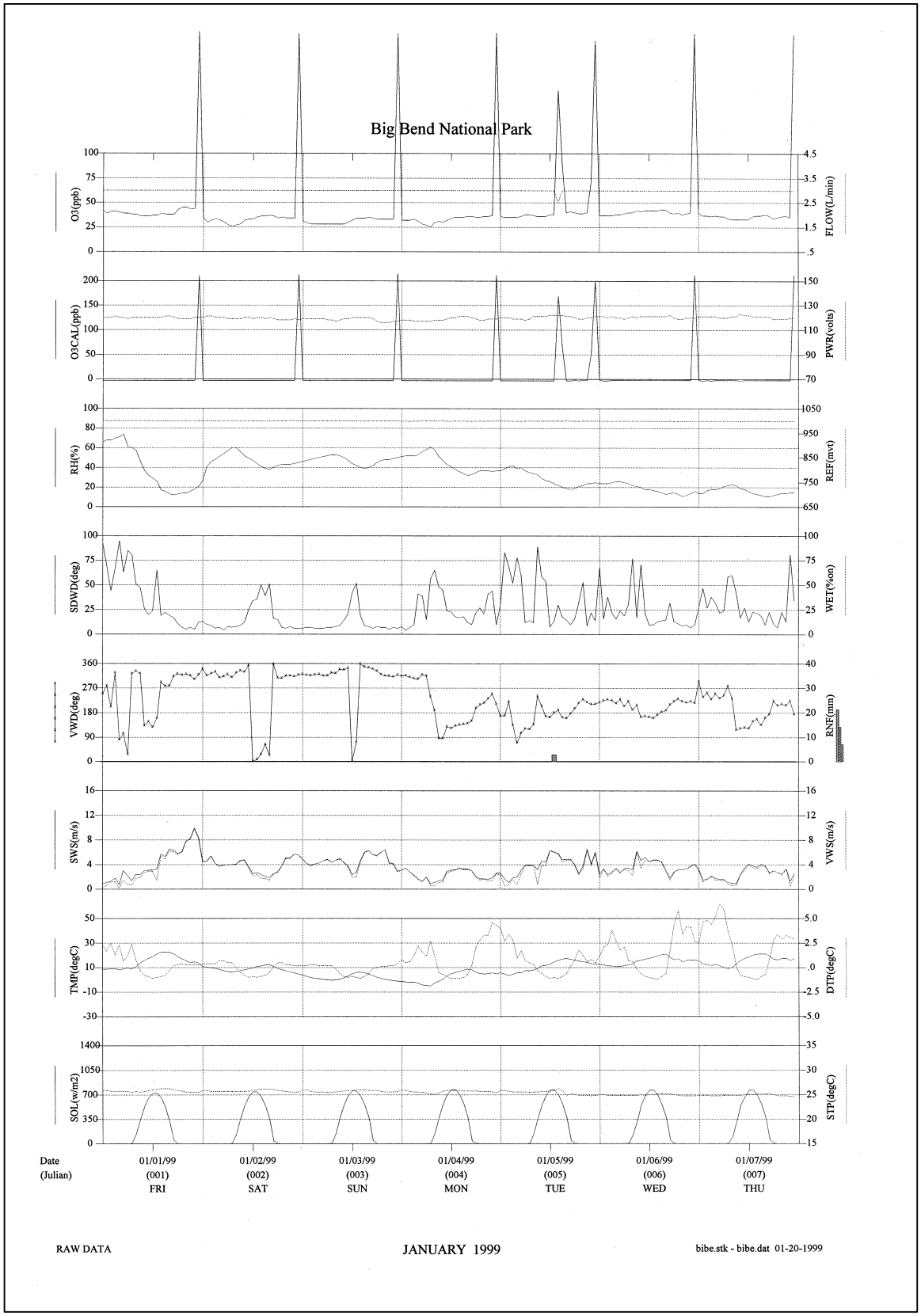


Figure 4-3. Example Primary Data Stackplot.

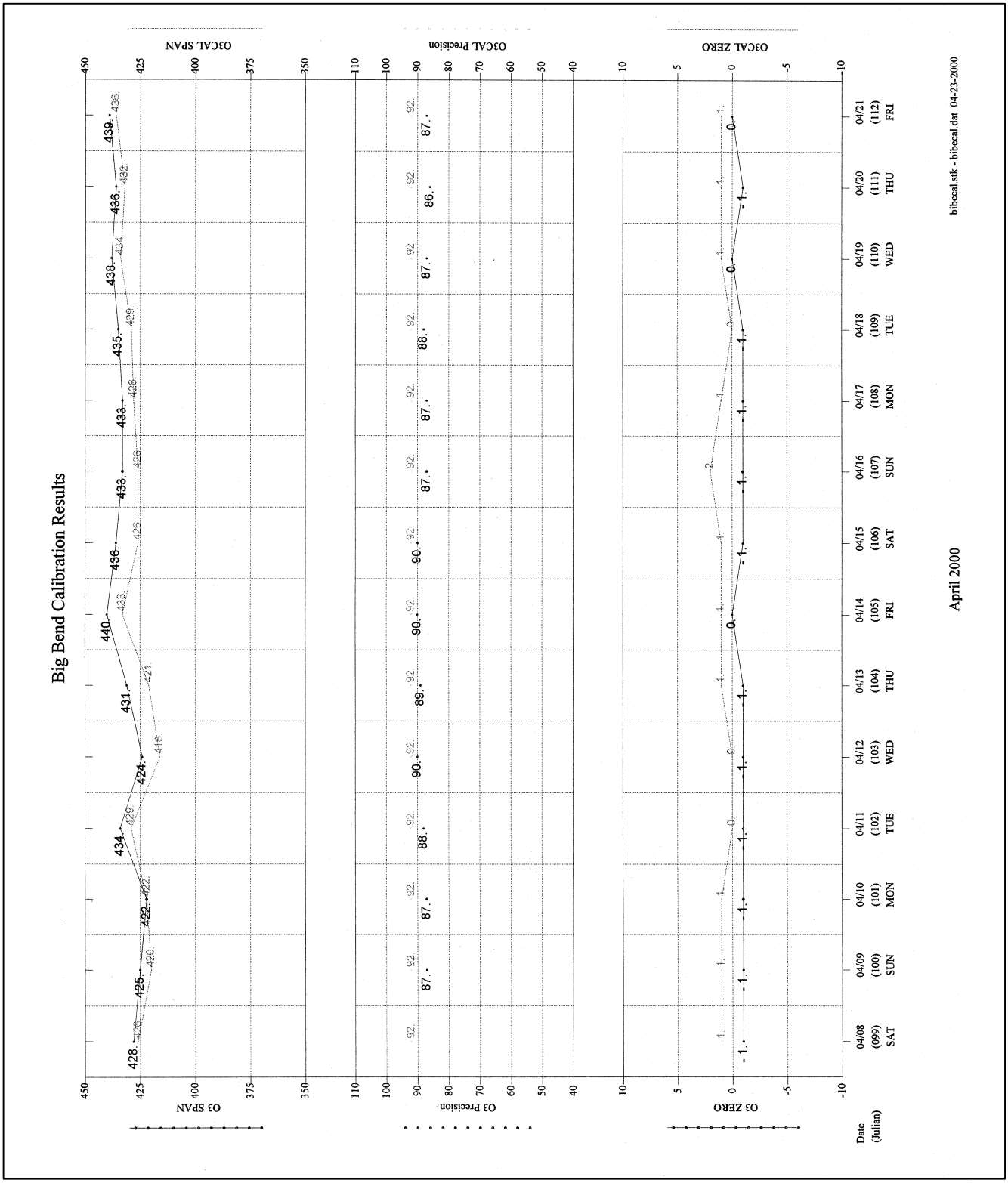


Figure 4-4. Example Calibration Results Summary Stackplot.

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 4-5. 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 technician reviews data daily and informs the network operations staff immediately of any noted anomalies. Notification of network operations is initially performed verbally. The data technician compiles a daily list of all problems reported to network operations and provides a copy of the list to network operations. 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 data technician 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 1-minute of NIST time will be reported to network operations for correction.

- Primary Data Stackplot - The stackplot for each site is reviewed on screen with the flag file. 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 - Dark values $\geq$ 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 technician reviews the plots for value consistency. Any noted anomalies are reported to network operations.

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 two weeks. 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. Site Status Reports will be prepared for any confirmed anomaly or inconsistency. The Site Status Reports are forwarded to the technical assistant who enters the information into the Site Status Log within two business days. Copies of Site Status Logs are printed by the technical assistant and placed in the Site Status Log Notebook. A reference to all noted problems are also entered on the Site Status white-board in the network operations work area.

- Daily Datalogger Report - These daily printouts are reviewed each morning. The accuracy of the logger time is verified and any time drift beyond one minute 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 on-line.

4.2.3 Weekly Review

Every Tuesday, IMC staff (IMC manager, data analyst, and data technician) 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 Site Status Log Notebook 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

  - Site documentation packets
  - Supplemental data summary plots and listings
  - National Performance Audit Program (NPAP) audit results or state audit results when available

- Network Operations
  - Site Statue Log Notebook
  - Trip reports (calibration results are entered by the data technician 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.

A summary of the week's resolved and unresolved issues will be compiled by the IMC and posted on the network operations bulletin board. An example of this summary is provided as Figure 4-6.

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 network operations 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 analyst and TOW 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 on a Site Status Report and will prompt immediate corrective actions.

IMC-Maintenance Notes as of 12/23/99:

RESOLVED? (X)	SITE	ISSUE
	CANY	rh is out until further notice
	CHIR	occasionally ramps up on analyzer and calibrator
x	CRMO	temp unit dropped out sent ne wunit
	DENA	dasabled channel for sws vws vwd; wd frozen 12/30/99
	GSCM	Barameter, sol, and rnf are having problem12/21/99; o3, so2, & cal disabled channel 12/30/99
	GSLR	flow fluctuates
x	HATH	flow is down, turn thermostat getting TL flags
	LAVO	rh is overrranging 108
	HAVO	RH Max still too low = 92%. Valid? Stp was reaching lower limits
	JOTR	Cal precision is off 12/23/99
	MAHM	analyzer dropped out for a few hours on Christmas Day
x	MEVE	O3 span quit 12/16/99
	MORA	new rh sensor in next month; dtp is wrong
x	NOCA	sol flipped out gave readings of -1468 for several hours 12/19/99
	OLYM	12/29 o3 reached 0
x	PINN	WET overranging > 100%.
x	ROMO	TMP, DTP looks questionable as of 11/22/99.
	SHEN	so2 is giving neg readings
	VOYA	wd vane senton 12/28/99; invalidate vws, sws, vwd, and sdwd from 12\21 station visit to present; wd is frozen 12/30/99
	YELW	turn up the heater

Figure 4-6. Example Weekly IMC - Network Operations Notes.

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 focussed 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. The day prior to the plot review, the IMC data analyst reviews the commented stackplots with the TOW who will support plot review. 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 Report

Any inconsistency in the data or any other information pertinent to data validity noted and by the field specialists (or TOW), IMC, or site operator will be manually documented in a Site Status Report. An example Site Status Report is provided as Figure 4-7. It is the TOW's (or other field specialist's) responsibility to complete a Site Status Report 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. The TOW also enters a brief reference to each problem on the network operations white-board.

Written Site Status Reports are forwarded daily to the technical assistant who enters the information on the reports into the electronic Site Status Log within two business days. All original Site Status Reports are filed chronologically by site in the network operations work area.

4.3.2 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 noted by network operations or IMC staff, as noted on Site Status Reports (Figure 4-7), are entered or updated daily. Communication links between the IMC and NPS ARD will allow for the NPS ARD staff to access, review, initiate, or update a current record.

SITE STATUS REPORT

All unshaded sections (#1-8) MUST be completed.

Site: 1)	Site/Ref. #:	Problem? 2) Y or N	Date Started: 3)	Date Closed: 4)

Actions Resulting from Problem:

Date	ARS Visit	Operator Visit	Audit	Multipoint Cal.	Prec. Check.

Data Lost? 5)

Affected Parameters: 6)

Abbreviated Description: 7)

SITE STATUS DETAILS

Date	Your Initials	Notes
8)		
		Continued? [ ]

Page 1 of _____ (Only necessary if there is more than one page.)

Figure 4-7. Example Site Status Report.

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 4-8.

Copies of the Site Status Log unresolved problems by site are printed immediately following data entry and filed by site in the Site Status Log Notebook in the network operations area. This notebook serves as a quick reference to all issues regarding action by the TOW and all field specialists.

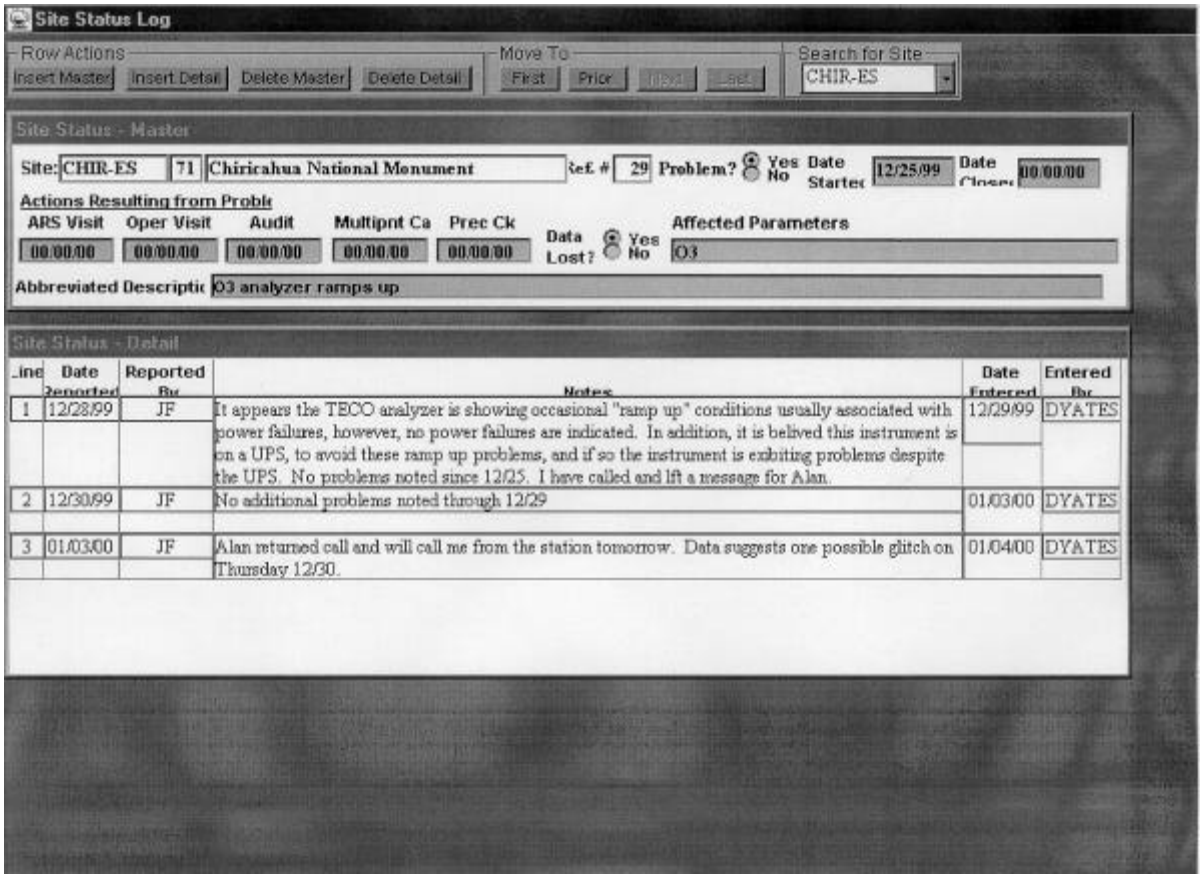


Figure 4-8 . Example Electronic Site Status Log Display.

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 its 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 contact 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 station. 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 hard copy documents and are entered into the NPS Equipment Inventory Database. 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 hard copy 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 4-9.

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 Monitor Labs	8 9	
Lamps - Photometer	Dasibi Monitor Labs	10 12	**10***
Logsheets	3-Part Pre-carboned	1500	
Met Gear - Climatronics	Bearings (WS/WD) Cups Vanes Potentiometers Photo Chopper Assemblies Dew Point Sensors	120 7 5 10 5 13	
Met Gear - Qualimetrics	Bearings (WS) Bearings (WD) Cups Vanes Potentiometers Photo Chopper Assemblies Dew Point Sensors	16 20 6 5 3 7 5	
Pumps	Monitor Labs Dasibi - 5 liter Dasibi - 3 liter Thomas Pump & Mounts Dasibi Pump Feet (Sets of 4)	3 4 6 7 8	
Recorder Supplies	Pens Chessell Chart Paper	145 40	 **1000***
Ribbons	Panasonic KX-P150 Panasonic KX-P115	 2 6	10
Scrubbers	Dasibi Monitor Labs	15 12	
Silica Gel		6	
Solenoid Valves	Monitor Labs - 115 V Dasibi - 24 V Dasibi 115 V	7 9 12	
Tubing/Fittings	Tubing 1/8" Tubing 1/4" Assorted Fittings	225' 75' ~50	 **200***
Teflon Filters (10 packs)	2 micron (47 mm) 20 micron (50 mm)	25 0	**50*** **100***

*** Please order ASAP.**

Figure 4-9. Example Listing of Replacement and Consumable Parts.

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	**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	
PROJECT MANAGER	Robert Deemer	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
NPS COTR		

REVISION HISTORY			
	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change flowchart / add site documentation TI	January 2001	

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
3.0	REQUIRED EQUIPMENT AND MATERIALS	1
4.0	METHODS	3

LIST OF FIGURES

Figure		Page
1-1	NPS Ambient Air Quality and Meteorological Monitoring Network Data Collection, Validation, and Reporting Flow Diagram	2

1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) outlines the steps taken by the National Park Service (NPS) Air Resources Division's (ARD) Information Management Center (IMC) to collect ambient air quality and meteorological data from network dataloggers and station logs from network DataView computers. This information includes:

- Criteria pollutant parameters
- Meteorological parameters
- Diagnostic parameters and calibration results
- DataView 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 Telephone Modem*
- TI 3350-4005 *Collection of DataView Files via Telephone Modem*

2.0 RESPONSIBILITIES

Staff positions that have data collection responsibilities are:

- IMC manager
- Data technician
- 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*. The hardware and software used to perform specific data collection functions are referenced in the TI that supports this SOP (see previous Section 1.0).

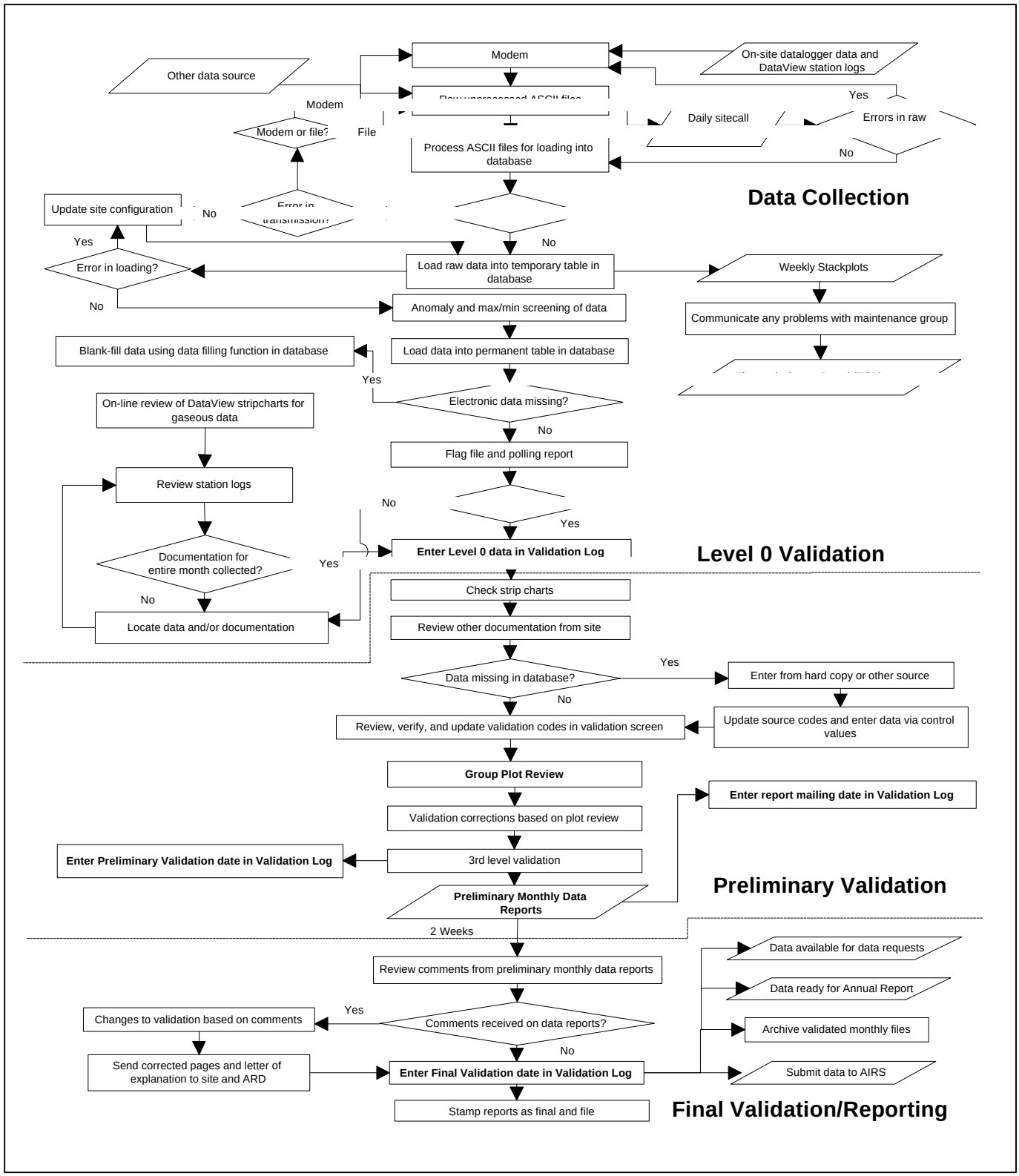


Figure 1-1. NPS Ambient Air Quality and Meteorological Monitoring Network Data Collection, Validation, and Reporting Flow Diagram.

4.0 METHODS

To assure complete, error-free data collection, data are usually logged on-site by a ESC 8816 datalogger and collected daily via telephone 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 daily 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 strip chart plots, printed data tables, or DataView digital data files. As a last resort, suitable data from third parties may be used. In the event of DataView communication failure, station logs can be manually copied to diskette or printed by the site operator and mailed to the IMC.

To summarize, the IMC collects data by one of these methods:

- From a datalogger via telephone modem
- Reduced from DataView strip chart plots, printed data tables, or DataView digital data files
- 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.

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	**COLLECTION OF AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA VIA TELEPHONE MODEM**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3350-4000**
DATE	**MARCH 1999**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Betsy Davis-Noland	
PROJECT MANAGER	Robert Deemer	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
NPS COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change all procedures for the DataView system	January 2001	

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
2.1	IMC Manager	1
2.2	Data Technician	1
2.3	Field Specialist	2
2.4	Site Operator	2
3.0	REQUIRED EQUIPMENT AND MATERIALS	2
4.0	METHODS	3
4.1	Automatic Data Collection	3
4.1.1	Starting the Auto Poll Process	3
4.1.1.1	Polling Order	6
4.1.1.2	Manual Data Polling	6
4.1.1.3	Reviewing the Log and Err Files	7
4.1.1.4	Daily Output	8
4.1.2	Daily Preparation For Automatic Execution of the AQDBMS	8
4.1.3	IMC Daily AQDBMS Summary Reports	9
4.1.4	Data Reformat	9
4.1.5	Data Error Checking	9
4.2	Retry of Failed Data Collection Sites	9
4.3	Data Files Generated by the AQDBMS	11
4.4	Manual Data Collection Via Telephone Modem From Datalogger	12
4.4.1	Manual Data Processing	12
4.5	Daily Review of Data Directory Contents	13
4.6	Monthly Archival of Final Raw Data Files	13
5.0	REFERENCES	13

LIST OF FIGURES

Figure		Page
4-1	AQDBMS Data Acquisition and Processing Via Telephone Modem Detailed Flowchart	4
4-2	The Polling Interface Shows Last Successful Poll	5
4-3	A Sample Data Collection Log	7
4-4	A Sample Data Collection Error File	8
4-5	Example Daily Site Information File	10
4-6	Example ESC Datalogger Format Data File	11

LIST OF TABLES

Table		Page
4-1	File Name and Directory Organization of Files Generated by AQDBMS Routines	5

1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the steps taken by the National Park Service (NPS) Air Resources Division's (ARD) Information Management Center (IMC) to collect ambient air quality and meteorological data via telephone 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 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 telephone modems.

2.0 RESPONSIBILITIES

2.1 IMC MANAGER

The IMC manager shall on a daily basis:

- Set up and maintain the automatic data collection programs and support information.
- Provide technical support to the site operator via telephone.
- Ensure proper archive and storage of final raw data files.

2.2 DATA TECHNICIAN

The data technician shall:

- 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.
- Archive final raw data files.

2.3 FIELD SPECIALIST

The field specialist shall:

- Inform IMC staff of any changes in site configurations resulting from maintenance visits.
- Inform IMC staff of any equipment or data acquisition systems malfunction, replacements, additions, or inconsistencies.
- Inform IMC staff of any data acquisition system program changes.
- 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.

2.4 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.* The IMC requires the following hardware and software to collect data from dataloggers via telephone modems:

- Monitoring site data collection hardware
- IMC hardware:
  - Hardware specifications for IMC servers
  - Hardware specifications for workstations
  - Support hardware:
    - Draft printer
    - 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 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 4-2 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. To open the Polling window, select **Polling** from the Configuration frame.

4.1.1 <u>Starting the Auto Poll Process</u>

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.”

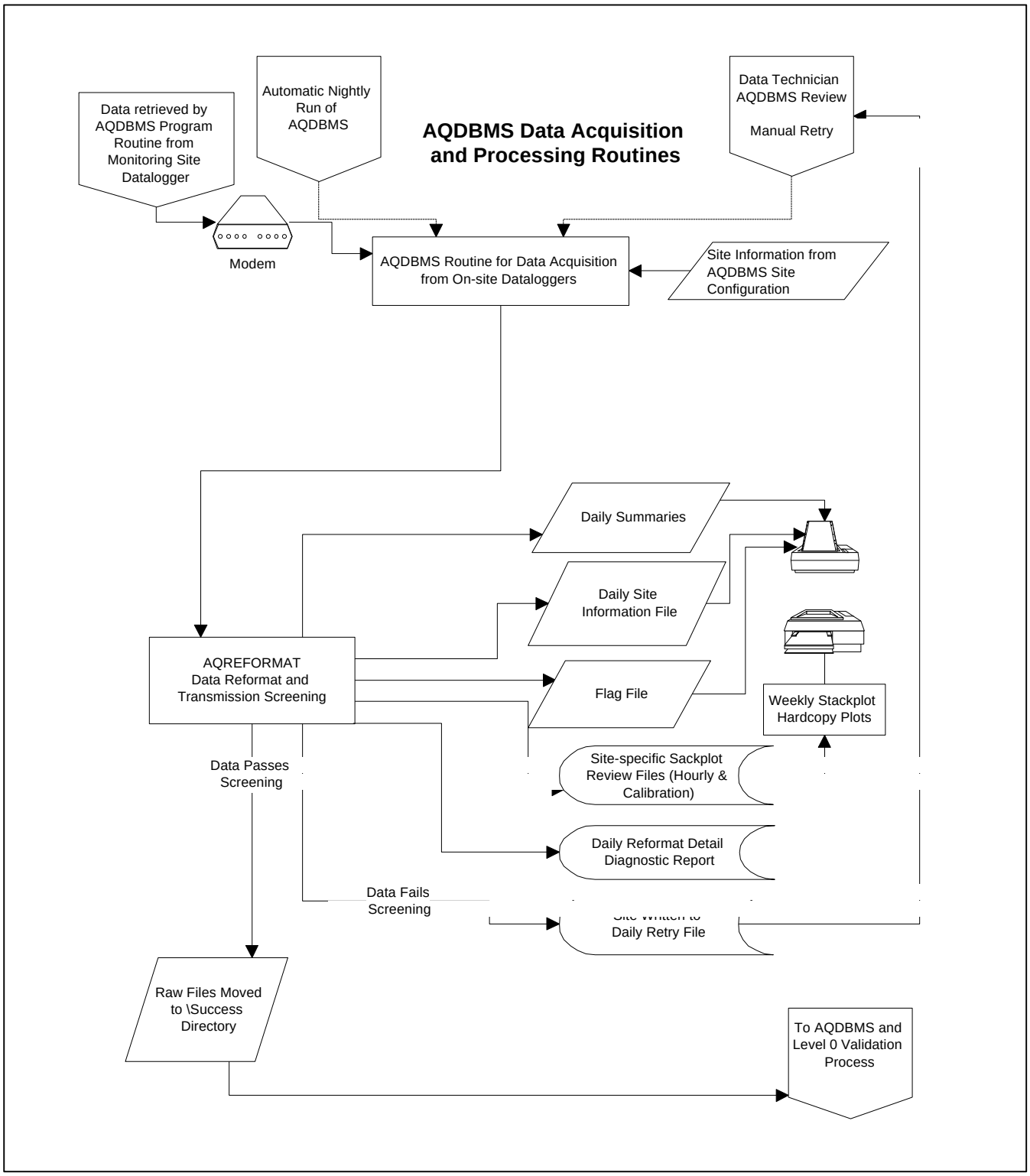


Figure 4-1. AQDBMS Data Acquisition and Processing Via Telephone Modem Detailed Flowchart.

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	LOGS	LaserJet
Flag File	All flags on all data	AQDBMS	yyyymmdd.FLG	LOGS	LaserJet
Data Files	Raw ESC datalogger output	AQDBMS	ssssmmdd.yyyyR	ESC_SITECALL\ SUCCESS	Archived and Printed on Epson
Plot Files	Daily raw stackplot configuration and data files	AQDBMS	site.STK site.DAT	SITECALL\REVIEW SITECALL\REVIEW	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
yy = 2-digit year
ERR = error report
MES = detailed message report
SUM = summary report
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\NPSAIR\.

[4] Data Collection Summary, Logger Time Accuracy Summary, and Span File are used by the field specialist.

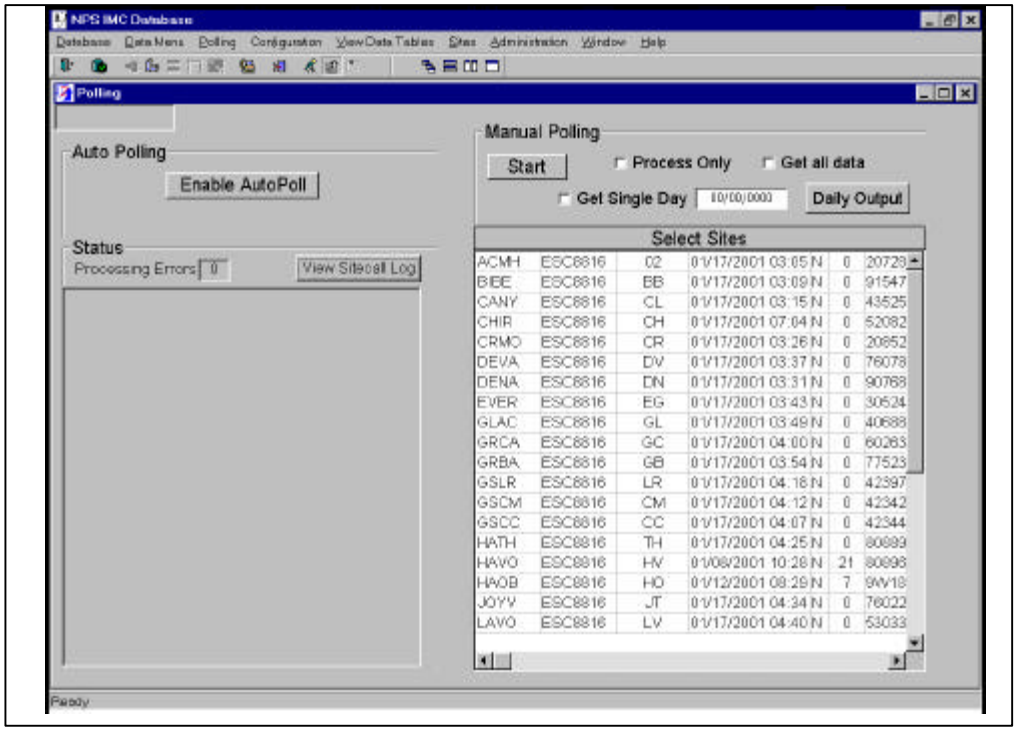


Figure 4-2. The Polling Interface Shows Last Successful Poll.

4.1.1.1 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

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 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.

- 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\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.

```
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.

4.1.1.4 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)

Results of the AQDBMS program run are shown on the AQDBMS polling screen. The data technician 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.

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).

4.1.2 <u>Daily Preparation for Automatic Execution of the AQDBMS</u>

Software for automatically running the AQDBMS is installed on the data collection workstation. The data technician prepares the workstation at the end of each day by:

- Shutting down and restarting the workstation.
- Launching the AQDBMS software.

When the data collection workstation is unattended for extended periods such as weekends and holidays, data collection is handled without data technician 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 Reports

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 technician each working day, to determine the success or failure of the automatic data collection routines. The *Flag File* report generated daily; it is used to help explain data inconsistencies. Examples of these reports are shown in Figures 4-5 and 4-6 respectively. These reports are intended to summarize the diagnostic information only. Detailed troubleshooting must be performed by the data technician 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 technician examines the DSI file to determine which sites failed to poll correctly. The AQDBMS tracks the last successful poll date for each site. The data technician 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.
- 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

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 technician 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 VIA TELEPHONE MODEM FROM DATALOGGER

If the AQDBMS automatic data collection system is unable to correctly retrieve error-free data, the data technician 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*.
  - Click **start**.
- Manual entry from strip charts.
- Third party data report.

Procedures for manual data retrieval using communications software and manual datalogger commands are outlined in the following subsection. 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 and strip charts.

In the past, the Information Management Center (IMC) has also collected ambient air quality and meteorological data from remote monitoring sites where telephone lines were not directly available. At these sites, data stored daily onto a portable data storage module (RAMPack) were either mailed to the IMC or taken to a nearby location where a RAMPack Reader, telephone, and modem were available and downloaded to ARS. The data were downloaded at one-week intervals. Following download, the data were processed the same way as data collected manually via telephone modem from datalogger. As of December 1998, these dataloggers and RAMPacks are no longer used and therefore are not discussed in detail here.

4.4.1 <u>Manual Data Processing</u>

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**.

4.5 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 technician 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 quarter, 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 technician 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 NPS ARD, 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
Fort Collins, CO 80525
Phone: 970-484-7941
Fax: 970-484-3423

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	Don Mussard	
PROJECT MANAGER	Robert Deemer	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
NPS COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS

TABLE OF CONTENTS

Section **Page**

1.0 PURPOSE AND APPLICABILITY 1

2.0 RESPONSIBILITIES 1

2.1 IMC Manager 1
2.2 Data Technician 1
2.3 Field Specialist 2
2.4 Site Operator 2

3.0 REQUIRED EQUIPMENT AND MATERIALS 2

4.0 METHODS 3

4.1 Automatic Station Log Collection 3

4.1.1 Starting the Automatic Station Log Software 3
4.1.2 Polling Order 3
4.1.3 Reviewing the Station Log Acquisition Status 3
4.2 Manual Station Log Collection 6

4.2.1 Manually Retrieving Digital Station Logs 6
4.2.2 Manually Retrieving Hardcopy Station Logs 6

4.3 Automatic Import of Station Logs to the AQDBMS 6
4.4 Monthly Archive of Raw Station Log Files 6

5.0 REFERENCES 6

LIST OF FIGURES

Figure **Page**

4-1 AQDBMS Station Log Acquisition and Processing Via Telephone Modem Flowchart 4

4-2 Example DataView Status Report 5

LIST OF TABLES

Table **Page**

4-1 File Name and Directory Organization of Files Generated by Station Log Collection Routines 5

1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the steps taken by the National Park Service (NPS) Air Resources Division's (ARD) 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 IMC MANAGER

The IMC manager shall on a daily basis:

- Set up and maintain the automatic station log collection programs and support information.
- Provide technical support to the site operator via telephone.
- Ensure proper archive and storage of station log data files.

2.2 DATA TECHNICIAN

The data technician shall:

- 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 morning 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.

- Archive station log files.

2.3 FIELD SPECIALIST

The field specialist shall:

- Inform IMC staff of any changes in site configurations resulting from maintenance visits.

- Inform IMC staff of any equipment or DataView system malfunction, replacements, additions, or inconsistencies.

- Inform IMC staff of any DataView system program changes.

- Provide assistance to the IMC for troubleshooting DataView problems.

2.4 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 technician 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 12:01 a.m. each workday. 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 technician should review the last three columns of the report daily and take action to recover station logs older than 7 days.

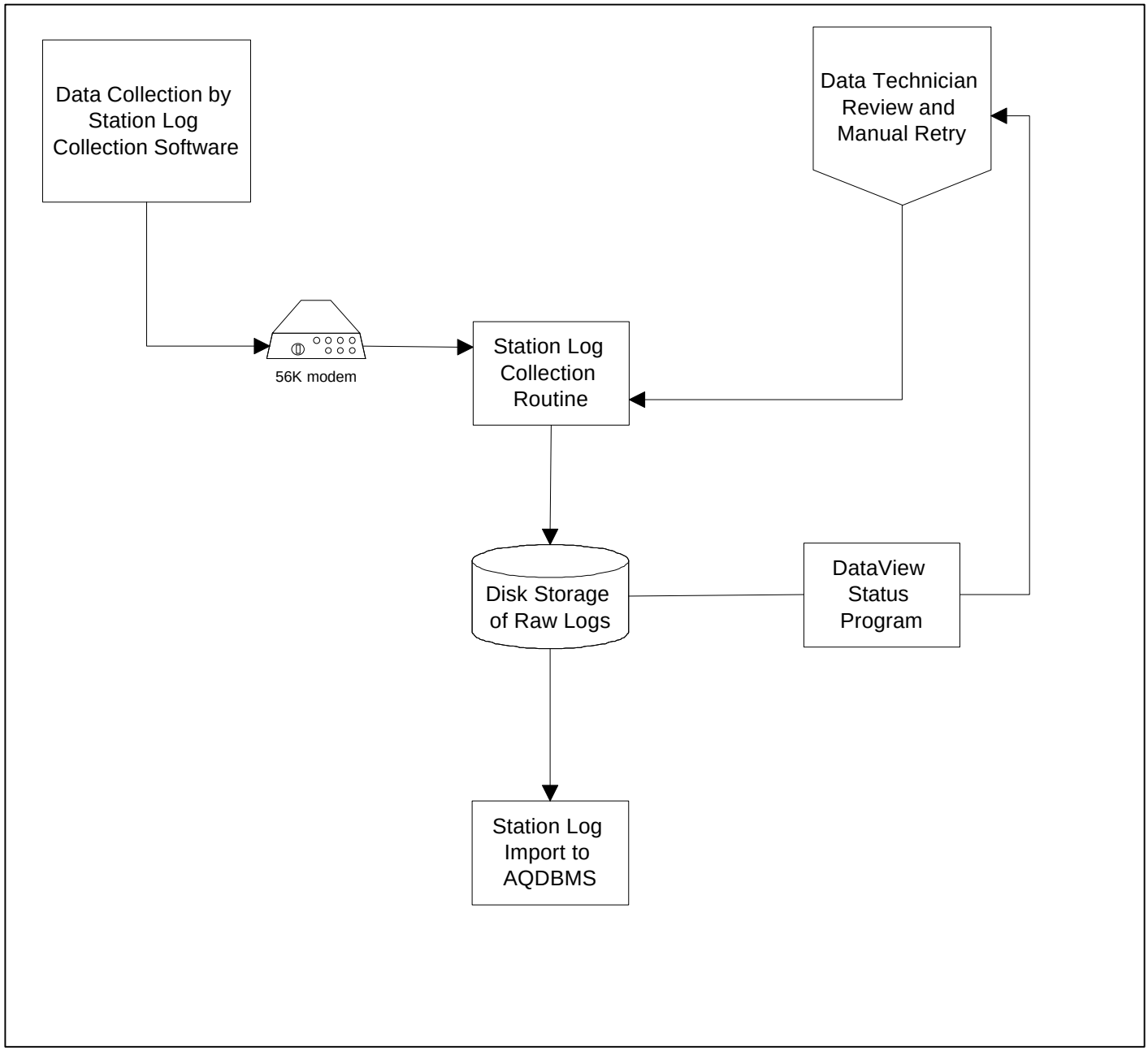


Figure 4-1. AQDBMS Station Log Acquisition and Processing via Telephone Modem Flowchart.

Table 4-1

File Name and Directory Organization of Files Generated by Station Log Collection Routines

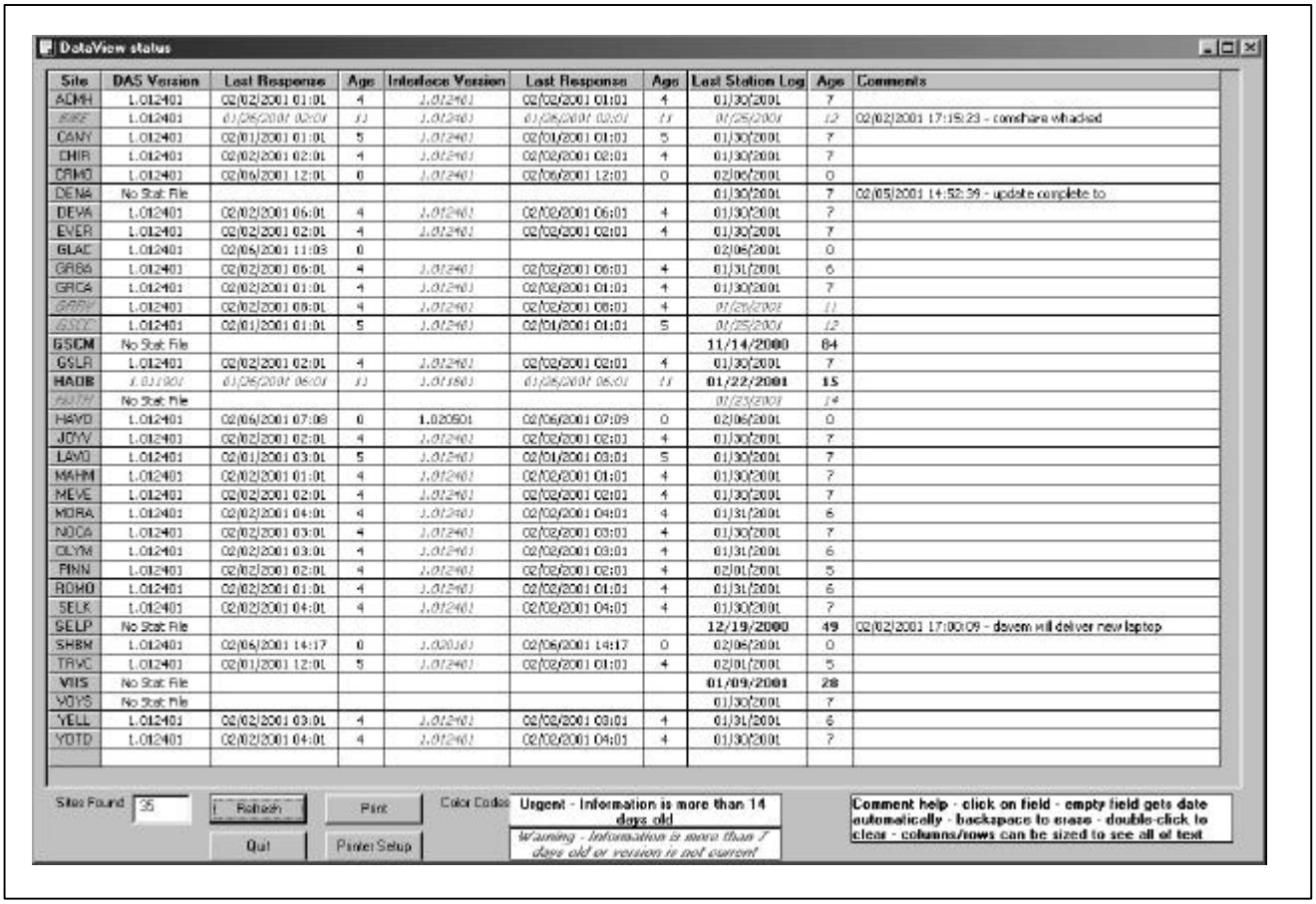
File Type	File Description	Source(s)[1]	File Name(s)[2]	Directory Location[3]	Destination
Station Logs	Comma-delimited ASCII text files	Station log collection software	sitemmddyyyylog .csv	DATAVIEW\POLL_ DATA	Archived and imported to AQDBMS

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
yy = 2-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\.



DataView status

Site	DAS Version	Last Response	Age	Interface Version	Last Response	Age	Last Station Log	Age	Comments
ACMH	L.012401	02/02/2001 01:01	4	1.012401	02/02/2001 01:01	4	01/30/2001	7	
BIRF	L.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	L.012401	02/01/2001 01:01	5	1.012401	02/01/2001 01:01	5	01/30/2001	7	
CHIR	L.012401	02/02/2001 02:01	4	1.012401	02/02/2001 02:01	4	01/30/2001	7	
CRMO	L.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	L.012401	02/02/2001 06:01	4	1.012401	02/02/2001 06:01	4	01/30/2001	7	
EVER	L.012401	02/02/2001 02:01	4	1.012401	02/02/2001 02:01	4	01/30/2001	7	
GLAC	L.012401	02/06/2001 11:03	0				02/06/2001	0	
GRBA	L.012401	02/02/2001 06:01	4	1.012401	02/02/2001 06:01	4	01/31/2001	6	
GRCA	L.012401	02/02/2001 01:01	4	1.012401	02/02/2001 01:01	4	01/30/2001	7	
GRBR	L.012401	02/02/2001 06:01	4	1.012401	02/02/2001 06:01	4	01/26/2001	11	
GSCC	L.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	L.012401	02/02/2001 02:01	4	1.012401	02/02/2001 02:01	4	01/30/2001	7	
HADE	1.011901	01/26/2001 06:01	11	1.011801	01/26/2001 06:01	11	01/22/2001	15	
HAUN	No Stat File						01/23/2001	14	
HAYD	L.012401	02/06/2001 07:09	0	1.020501	02/06/2001 07:09	0	02/06/2001	0	
JOYV	L.012401	02/02/2001 02:01	4	1.012401	02/02/2001 02:01	4	01/30/2001	7	
LAVO	L.012401	02/01/2001 03:01	5	1.012401	02/01/2001 03:01	5	01/30/2001	7	
MAHM	L.012401	02/02/2001 01:01	4	1.012401	02/02/2001 01:01	4	01/30/2001	7	
MEVE	L.012401	02/02/2001 02:01	4	1.012401	02/02/2001 02:01	4	01/30/2001	7	
MORA	L.012401	02/02/2001 04:01	4	1.012401	02/02/2001 04:01	4	01/31/2001	6	
NOCA	L.012401	02/02/2001 03:01	4	1.012401	02/02/2001 03:01	4	01/30/2001	7	
OLYM	L.012401	02/02/2001 03:01	4	1.012401	02/02/2001 03:01	4	01/31/2001	6	
PINN	L.012401	02/02/2001 02:01	4	1.012401	02/02/2001 02:01	4	02/01/2001	5	
ROMO	L.012401	02/02/2001 01:01	4	1.012401	02/02/2001 01:01	4	01/31/2001	6	
SELK	L.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 - dovem will deliver new laptop
SHEN	L.012401	02/06/2001 14:17	0	1.020101	02/06/2001 14:17	0	02/06/2001	0	
TRVC	L.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	L.012401	02/02/2001 03:01	4	1.012401	02/02/2001 03:01	4	01/31/2001	6	
YOTD	L.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 technician should attempt to manually retrieve the file by running the station log collection software. After the program begins, the technician 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 technician 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 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 technician ensures that a complete month of station logs have been collected and resides in the *\success* directory.

- Create three (3) copies of the CD and distribute to the NPS ARD, 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
Fort Collins, CO 80525
Phone: 970-484-7941
Fax: 970-484-3423

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		
TITLE	NAME	SIGNATURE
ORIGINATOR	Betsy Davis-Noland	
PROJECT MANAGER	Robert Deemer	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
NPS COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change all procedures for the DataView system	January 2001	

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
3.0	REQUIRED EQUIPMENT AND MATERIALS	3
4.0	METHODS	3
4.1	Level 0 Validation Procedures	3
4.1.1	Daily Data Review and Anomaly Screening	3
4.1.2	Review of Raw Data Stackplots	5
4.1.3	Site Documentation	5
4.2	Preliminary Validation Procedures	5
4.2.1	Validation Acceptance Criteria	6
4.2.2	Entering Validation Codes and Other Values into the AQDBMS Database	8
4.3	Final Validation Procedures	10
4.4	Post-Final Validation Procedures	12

LIST OF FIGURES

Figure		Page
1-1	NPS Ambient Air Quality and Meteorological Monitoring Network Data Collection, Validation, and Reporting Flow Diagram	2
4-1	The Preliminary Validation Checklist	7
4-2	Example of a Commented Stackplot	9
4-3	The Final Validation Checklist	11

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) and National Park Service (NPS) guidelines for successful submission to the EPA AIRS (Aerometric Information Retrieval 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 AIRS 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.
- Accomodate 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*

2.0 RESPONSIBILITIES

Staff positions that have data validation responsibilities are:

- IMC Manager
- Data analyst
- Data technician

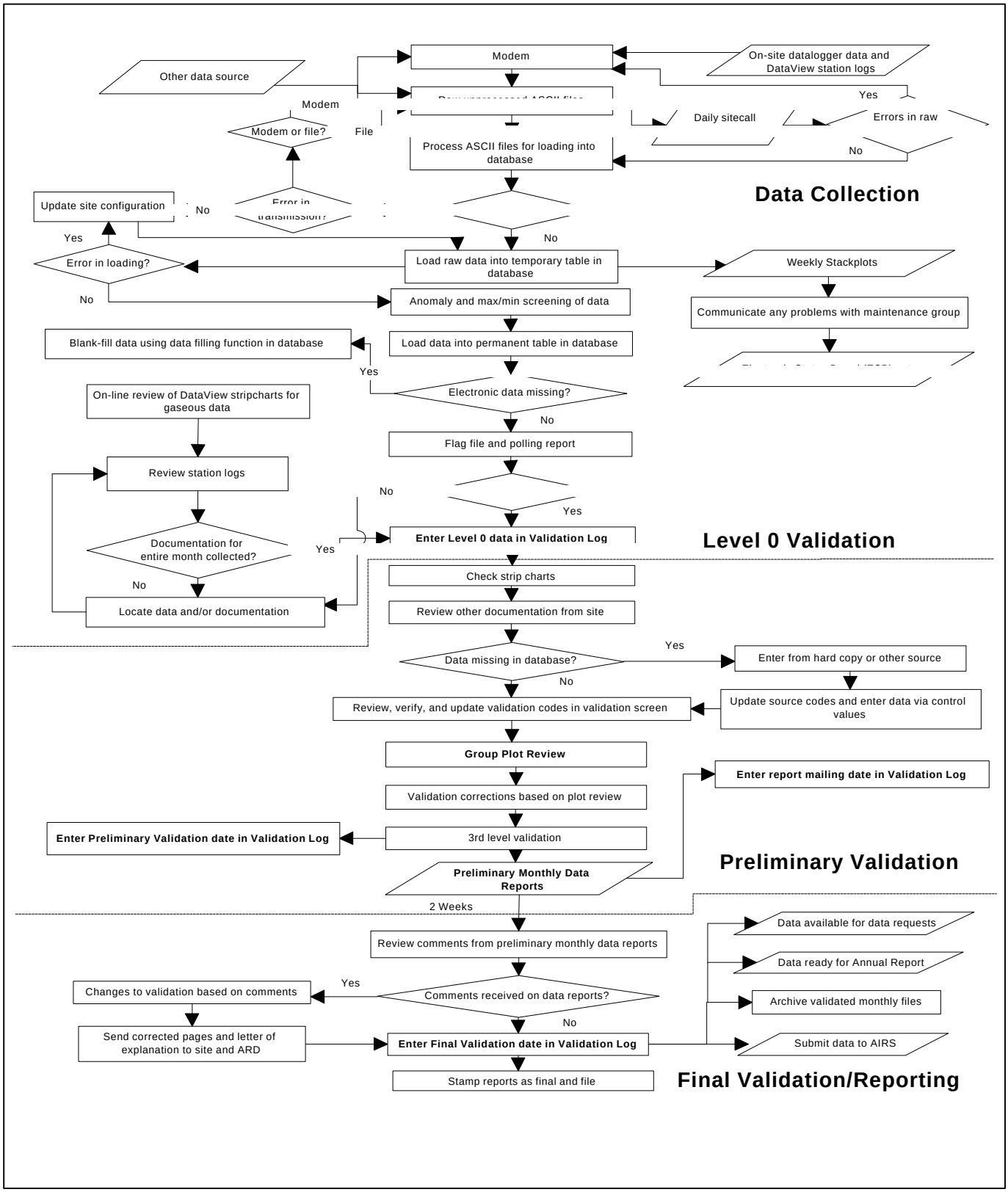


Figure 1-1. NPS Ambient Air Quality and Meteorological Monitoring Network Data Collection, Validation, and Reporting Flow Diagram.

- Field specialist
- Site operator
- NPS ARD 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.* 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.
- Initially screening the daily data for anomalies.
- Visually reviewing graphed raw data on stackplots on a weekly basis (in conjunction with the flag file).
- Verifying the receipt of DataView station logs.

4.1.1 <u>Daily Data Review and Anomaly Screening</u>

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 visually reviewed by the data technician. Data for one site, one day, all parameters, are displayed on the computer screen at a time. The data technician reviews the data and verifies the following:

- All sites and parameters that should be collected are collected.
- The data set for each site is complete by scrolling to the end of the day to be sure that all data are present.
- Parameter codes at the left of the screen match the data assigned to them. This includes checking for proper units, precision, accuracy, and scaling.
- 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 strip chart, 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 technician 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 ± 10% and span values within ± 15% 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 (such as datalogger flags, anomaly screening flags, or flags resulting from visual data review).

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 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 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. 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.

4.1.3 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.

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.

4.2 PRELIMINARY VALIDATION PROCEDURES

Data for a site/month must be at Level 0 validation before beginning Preliminary validation. The Preliminary 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:

- 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.
  - Reviewing and perhaps entering precision check and calibration data into the AQDBMS database.

- Entering and reviewing any audit report data received for the site/month into the AQDBMS database.

- Entering validation codes into and perhaps adjusting values in the AQDBMS database.
- Updating the AQDBMS Data Validation Log.
- Reviewing validated data stackplots.

4.2.1 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:

- 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 (normally 19.5˚C to 30.5˚C for O_3 and SO_2 analyzers, 4.5˚C to 40.5˚C for API ozone analyzers, and site-specific for research grade measurements).
- 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.

Validation Checklist – Preliminary

Month/Year _____ Site _____

		Date	Initials
1.	Checked O3 Trace via PC Anywhere in DataView.	_____	_____
2.	Checked Daily Summaries (all printed).	_____	_____
3.	Hand Entered/reduced Data? Y____ N____	_____	_____
	Dates and Hours: _____		
4.	Reviewed Previously Commented Stackplots.	_____	_____
5.	Checked Power Failure Log on Last Daily Summary. (>15 minutes in any monitoring hour).	_____	_____
6.	Reviewed Trip Reports & Checked RH Cal Results (Maintenance blue card binder)	_____	_____
7.	Printed and Reviewed Station Logs	_____	_____
8.	Checked Station Temperature to be 19.5°C to 30.5° C (API analyzers: 4.5°C to 40.5°C).	_____	_____
9.	Checked Site Status Log.	_____	_____
10.	Checked SSRF Forms for Leak Check	_____	_____
11.	Recorded Comments on Plots.	_____	_____
12.	Entered Validation Codes/Values into Database	_____	_____
13.	Entered Multipoint Calibration Results into database. (Results appear on Station Logs).	_____	_____
14.	Verified that any Pre-Maintenance Calibrations (Considered ARS Audit) and Other Audits are Received and Entered.	_____	_____
15.	Validation Log Updated.	_____	_____
16.	Group Plot Review.	_____	_____

Figure 4-1. The Preliminary Validation Checklist.

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, 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 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.
- 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.

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, in the log record for the site/month.

4.2.2 Entering Validation Codes and Other Values into the AQDBMS Database

After commenting stackplots, validation codes for each hourly average value for each parameter are entered into the database. The codes entered come directly from the commented stackplots and are also guided by the datalogger and anomaly flags that are already in the database. Validation codes are entered in place of the anomaly screening and datalogger flags although sometimes an anomaly screening flag is also a validation code. All flags are tracked by date and source.

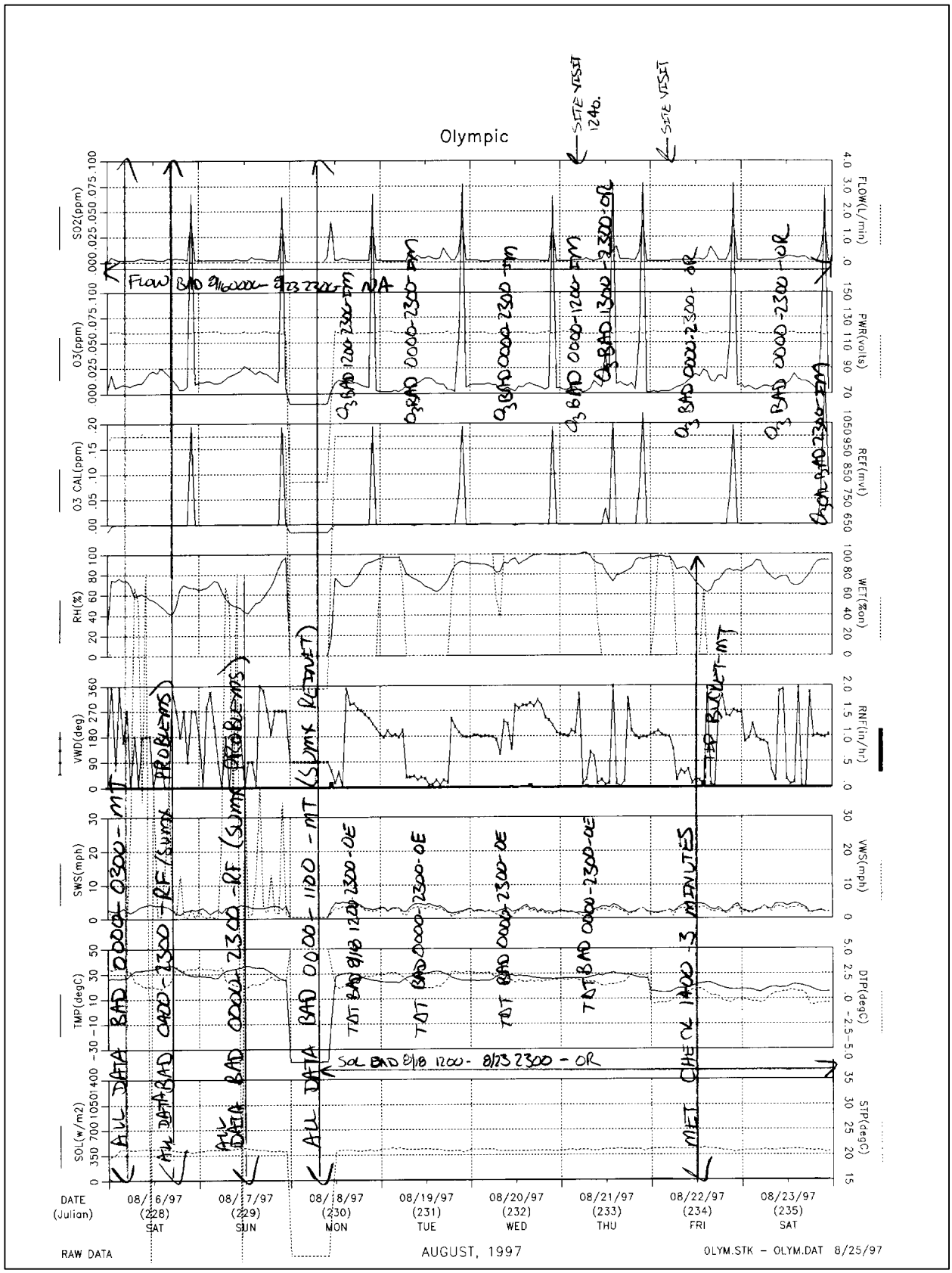


Figure 4-2. Example of a Commented Stackplot.

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 entering validation codes for a site/month and reviewing the validated data output. 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. The Final Validation Checklist, shown in Figure 4-3, 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. Final validation is accomplished by the following:

- A group plot review that includes input from air quality specialists, field specialists, and site operators, to resolve all questionable validation issues

- Making necessary validation code changes in the AQDBMS database based on the group plot review discussion

- Generating and reviewing monthly data reports

Validation Checklist - Final

Month/Year_____ **Site**_____

Date of Validation_____ **Initials**_____

		Date	**Initials**
1.	Checked Preliminary Validation Checklist.	_____	_____
2.	Review plots with comments	_____	_____
3.	Verify preliminary edits.	_____	_____
4.	Verify preliminary invalid data codes.	_____	_____
5.	Run validated data plots for monthly report.	_____	_____
6.	Data Validation Log updated.	_____	_____
7.	Comments:_____		
	_____		
	_____		
	_____		
	_____		
8.	Review comments from Monthly Report	_____	_____
9.	Data Validation Log updated.	_____	_____
10.	Create updated plots.	_____	_____

Figure 4-3. The Final Validation Checklist.

The monthly reports are mailed to the site operators who then have two weeks to review the reports and submit commits. If comments are received, the data remains at Preliminary validation until all questions/problems are resolved. If no comments are received or once all questions/problems are resolved, the data are considered final. 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. The monthly data reports are stamped with the Final validation stamp in the upper right-hand corner of the cover page and filed. At the Final validation level, the data can be uploaded to AIRS (see TI 3550-5300, *Submitting Ambient Air Quality and Meteorological Data to the EPA AIRS 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 Final validation date in the Data Validation Log for the site/month is deleted.
- The necessary changes are made in the AQDBMS database.
- A detail log record explaining the changes made is added to the Data Validation Log for the site/month.
- A new Final validation date is entered in the Data Validation Log for the site/month.
- The changes are explained in the comments section of the Final Validation Checklist for the site/month.
- The monthly report pages that were affected by the change are regenerated and replaced in the report on file. A copy of each changed page is also sent to the recipients of the monthly report with a cover letter explaining the need to replace the page(s) in their copy of the report.
- A note with the date and analyst's initials is attached to the cover of the monthly data report explaining the changes made.
- If the affected data has been submitted to the EPA AIRS database, it must be resubmitted.

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	**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	
PROJECT MANAGER	Robert Deemer	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
NPS COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change all procedures for the DataView system	January 2001	

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
2.1	IMC Manager	1
2.2	Data Analyst	1
2.3	Data Technician	1
2.4	Field Specialist	2
2.5	Technical Assistant	2
3.0	REQUIRED EQUIPMENT AND MATERIALS	2
4.0	METHODS	3
4.1	The Data Validation Log	3
4.2	The Site Status Log	3
4.3	Loading and Entering Data into the AQDBMS Database	3
4.3.1	Polling Configuration	5
4.3.2	Raw Data Formats Configuration	5
4.3.3	Using Process Data	8
4.3.4	Correcting Data Loading Errors	8
4.3.5	Blank-Filling Data	9
4.4	Data Review	10
4.5	Anomaly Screening	12
4.6	Review of Raw Data Stackplots	14
4.7	Site Documentation	14
4.8	Loading Data From Other Sources	14
5.0	REFERENCES	15

LIST OF FIGURES

Figure		Page
4-1	NPS Ambient Air Quality and Meteorological Monitoring Network Data Collection, Validation, and Reporting Flow Diagram	4
4-2	Polling Configuration	6
4-3	Example Raw Data Format for Hourly Data	6
4-4	Example Raw Data Format for ESC Calibration Sequence	7

LIST OF FIGURES (CONTINUED)

Figure		Page
4-5	Example View Tables Monthly Data Window	11
4-6	Example Records in the Screening Ranges Table	13

LIST OF TABLES

Table		Page
4-1	ESC 88616 Datalogger Data Flags	10
4-2	Anomaly Screening Flags	13

1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the steps taken by the National Park Service (NPS) Air Resources Division's (ARD) 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 IMC MANAGER

The IMC manager 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.

2.2 DATA ANALYST

The data analyst shall:

- Review stackplots of raw data.
- Update the Data Validation Log in the AQDBMS.

2.3 DATA TECHNICIAN

The data technician shall on a near daily basis:

- Collect digital data and load it into the database.
- Run the anomaly screening program.

- Blank-fill missing data as necessary.
- Print and review stackplots of raw data.
- Collect and log field documentation.
- File all hardcopy documentation and maintain hardcopy site files.
- Identify collection or monitoring system problems and initiate corrective actions.
- Update the Data Validation Log in the AQDBMS with the Level 0 validation date.

2.4 FIELD SPECIALIST

The field specialist shall review stackplots and troubleshoot inconsistencies observed on the stackplots or identified by IMC staff.

2.5 TECHNICAL ASSISTANT

The technical assistant shall:

- Enter appropriate information into the Site Status Log.
- Print out trip reports and give them to the IMC.

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:
    - Draft printer
    - 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

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 technician 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. The log entry for a particular site/month must exist before data can be edited in the Data Validation Window. 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 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 Telephone 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.

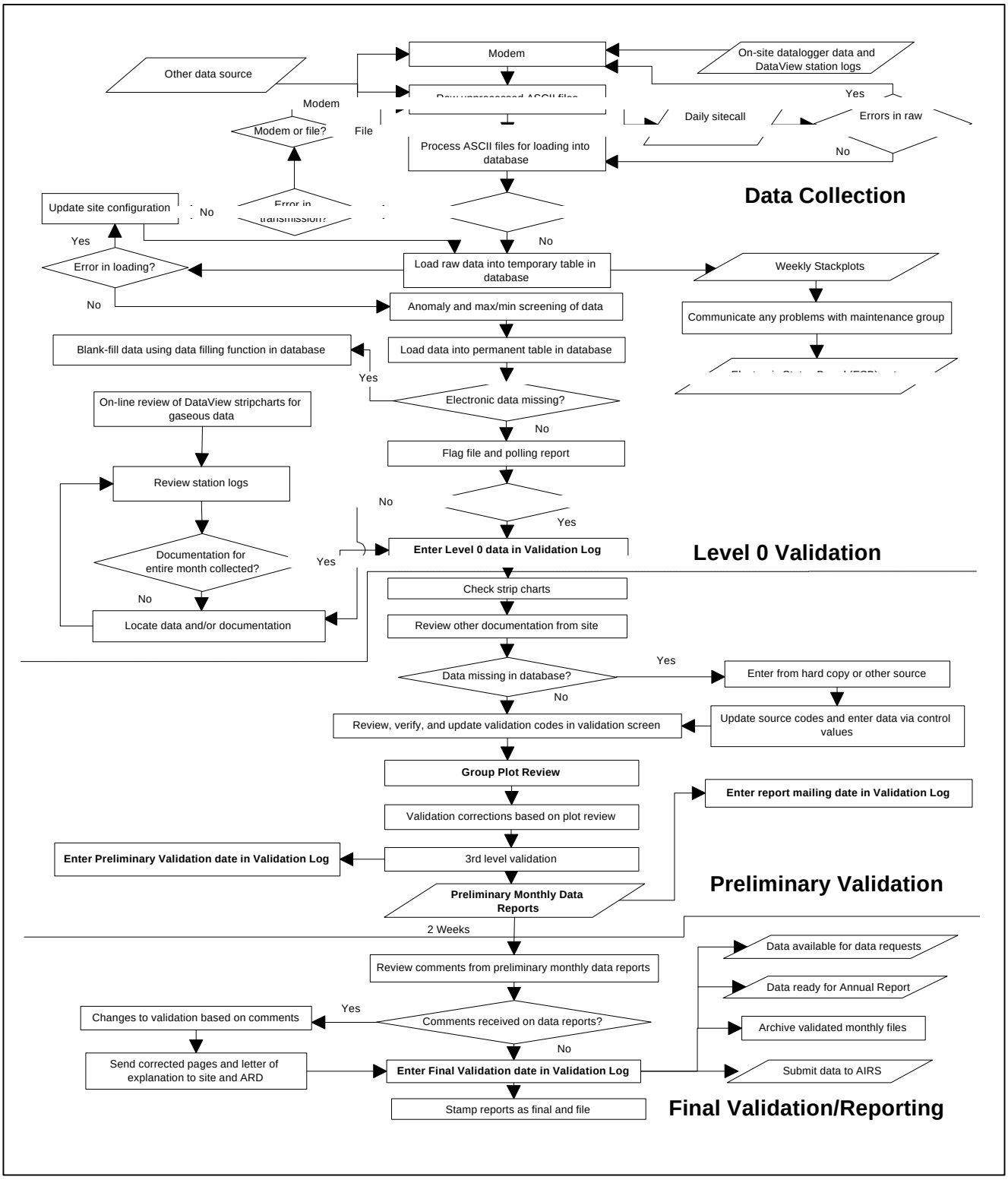


Figure 4-1. NPS Ambient Air Quality and Meteorological Monitoring Network Data Collection, Validation, and Reporting Flow Diagram.

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 "Process Data" command. Sometimes, data cannot be acquired electronically and must be hand-entered from daily printouts or strip charts. 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:

- 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.

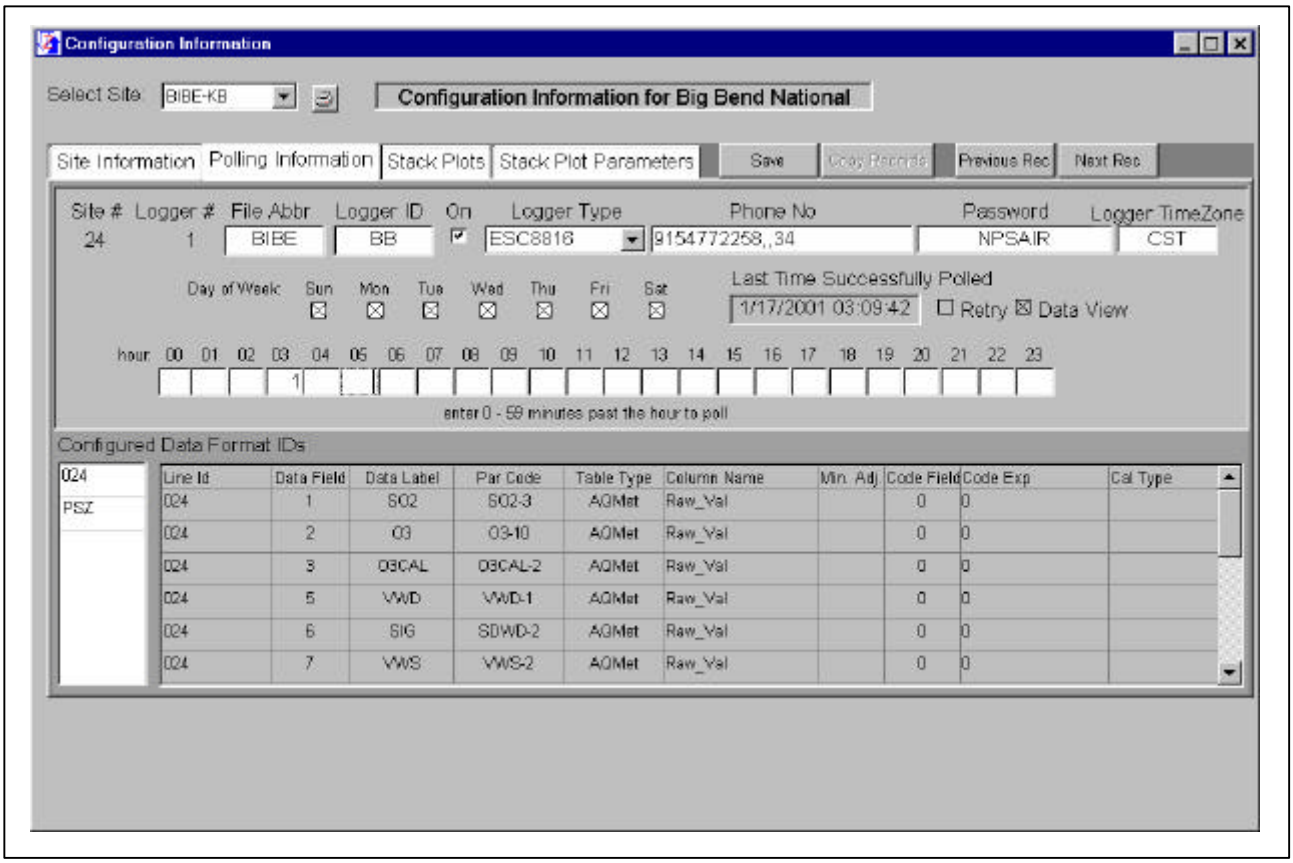


Figure 4-2. Polling Configuration.

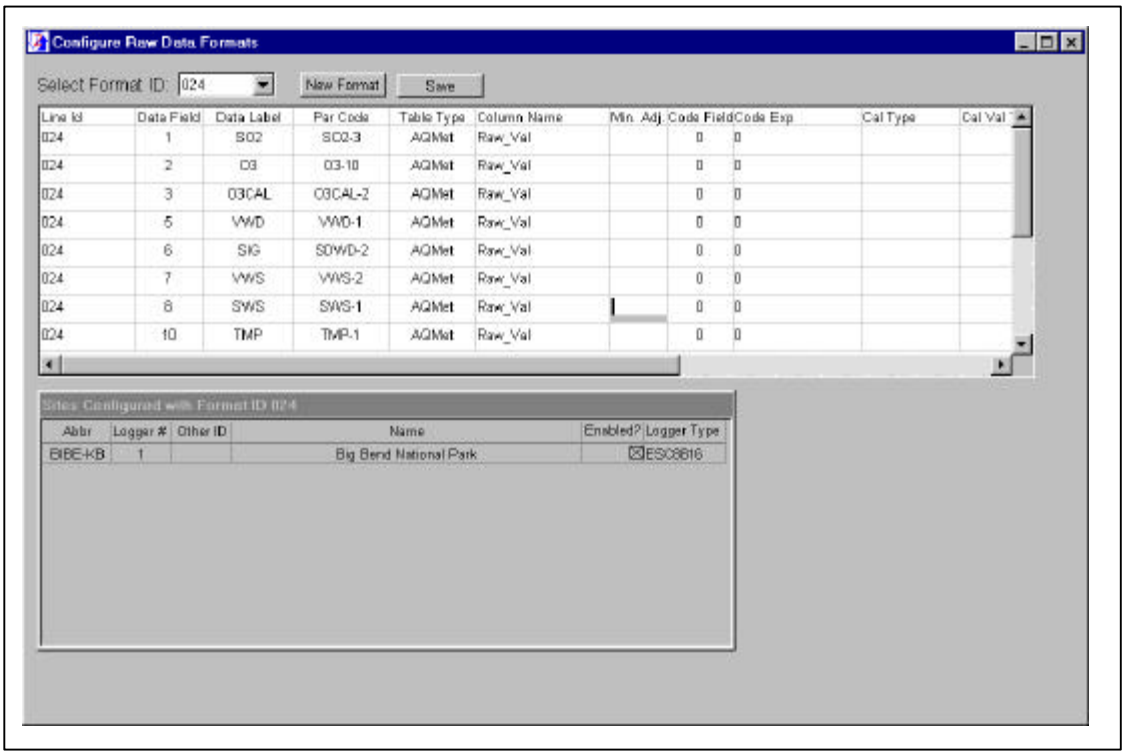


Figure 4-3. Example Raw Data Format for Hourly Data.

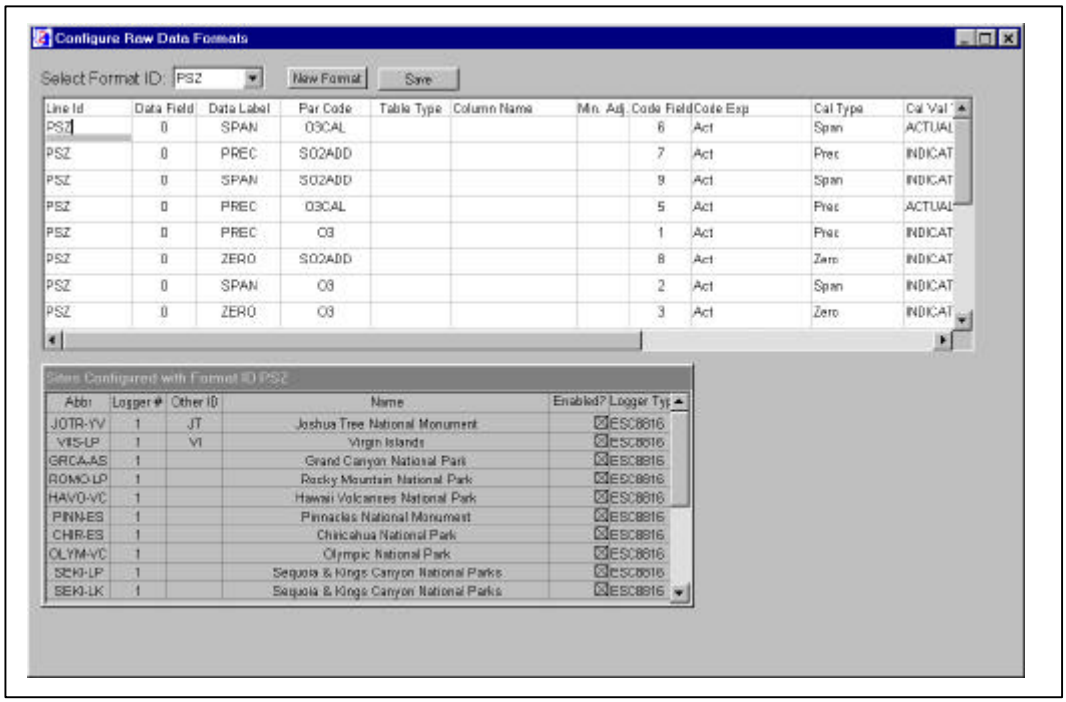


Figure 4-4. Example Raw Data Format for ESC Calibration Sequence.

When configuring raw data formats, follow these guidelines:

- For hourly data collected on 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.

4.3.3 Using Process Data

The "Process Data" command loads hourly data for a given day for currently monitored sites from ASCII files (such as BIBE0601.2000R 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 *\\ars\net3\vol2\projects\IMC\ESC_sitecall\final* directory. The program also writes to a message file in this directory that can be viewed in any text editor.

To run Process Data:

- Copy the ASCII files to the *\\ars_net3\vol2\projects\IMC\ESC_sitecall* directory.

- From the Polling menu, click **Process Data**.

- 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 file indicating the successes and failures of the processes. The file is called "AQ*yymmdd*.ORC", where *yy* are the last two digits of the year, *mm* is the month number, and *dd* is the day number. (For example, the file AQ970601.ORC holds messages for June 1, 1997). This file is written to the *\\ars_net3\vol2\projects\IMC\ESC_sitecall\final* directory and can be viewed in any text editor. 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.

- 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 Telephone 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 technician. 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 validation code field. As the data proceed through the data validation process, however, all original datalogger flags are replaced by permanent validation codes.

Table 4-1

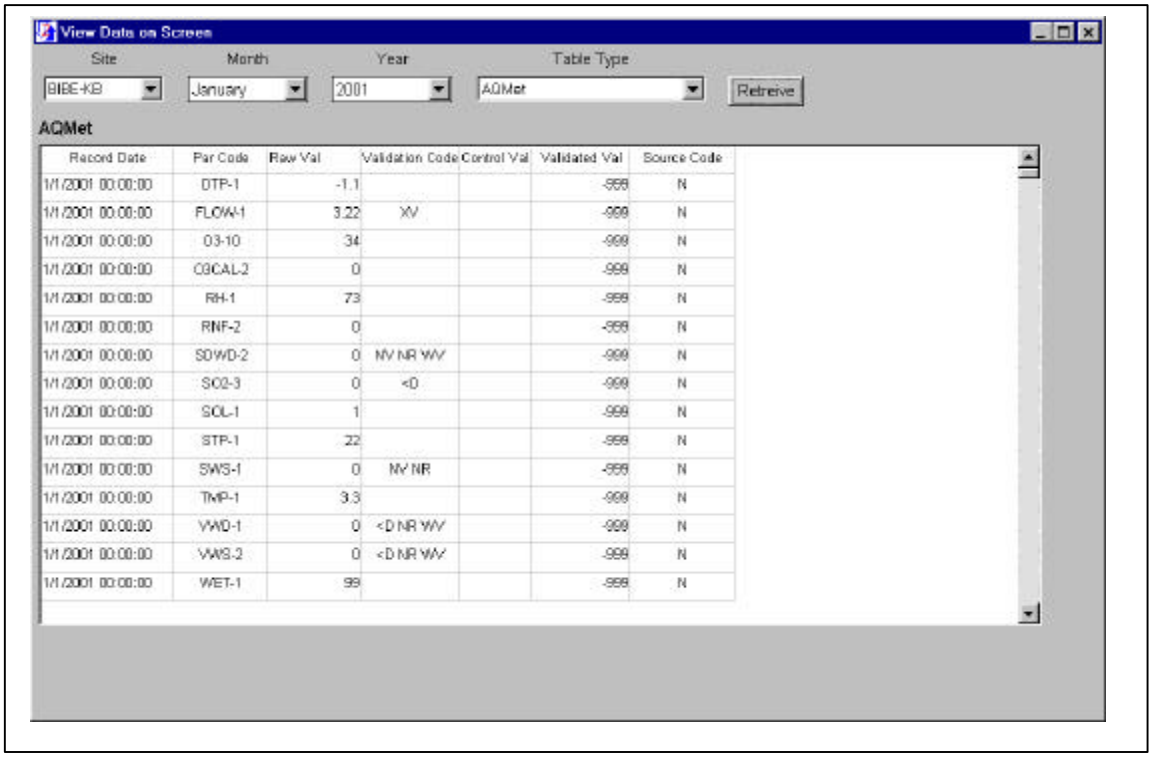
ESC 8816 Datalogger Data Flags[1]

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.

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.



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	<0		-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 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

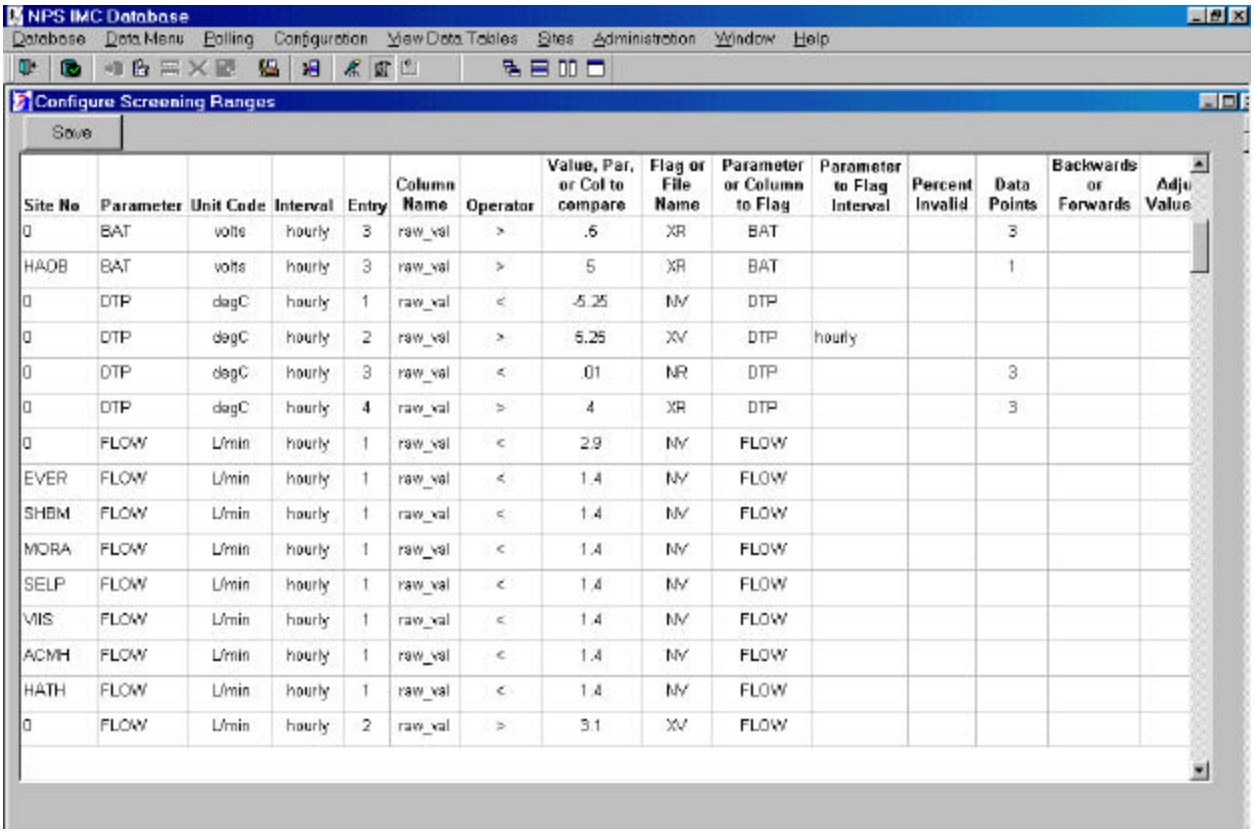
After data for a site/day are verified, they are screened for anomalies by an AQDBMS program. This program applies anomaly flags (Level 0 validation codes). These flags are added to any datalogger flags that were loaded with the raw data from the datalogger. The screening program uses values stored in 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 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 IMC manager 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 IMC manager makes the changes, run the screening program again.

After screening, the data technician 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 25% 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.



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	>	.6	XR	BAT			3		
HADB	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.

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 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. 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.

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 strip chart output received from the site. Typically, ambient air quality parameters are backed up with a strip chart recording. Meteorological parameters are not always recorded on strip charts. If a valid strip chart 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 strip chart:

- 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**, or **U**).
- 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 IMC manager 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.

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	**AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA – PRELIMINARY VALIDATION**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3450-5010**
DATE	**MARCH 1999**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Betsy Davis-Noland	
PROJECT MANAGER	Robert Deemer	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
NPS COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change all procedures for the DataView system	January 2001	

TABLE OF CONTENTS

Section **Page**

1.0 PURPOSE AND APPLICABILITY 1

2.0 RESPONSIBILITIES 1

2.1 IMC Manager 1
2.2 Data Analyst 2
2.3 Data Technician 2
2.4 Field Specialist 2

3.0 REQUIRED EQUIPMENT AND MATERIALS 2

4.0 METHODS 3

4.1 The Data Validation Log 3
4.2 The Site Status Log 3
4.3 Validation Acceptance Criteria 6
4.4 Entering Validation Codes and Other Values into the AQDBMS Database 8

4.4.1 The Initial Data Validation Window 11
4.4.2 The Data Validation Data Window 13
4.4.3 Entering Control Values 14
4.4.4 Replacing Raw Values 15
4.4.5 Screening Data in the Data Validation Window 16
4.4.6 The Data Validation Log 16

4.5 Reviewing Validated Data Stackplots and Other Output 16

5.0 REFERENCES 17

LIST OF FIGURES

Figure **Page**

4-1 NPS Ambient Air Quality and Meteorological Monitoring Network Data Collection, Validation, and Reporting Flow Diagram 4

4-2 The Preliminary Validation Checklist 5

4-3 Example of a Commented Stackplot 7

4-4 The Initial Validation Window 11

4-5 The Data Validation Data Window 13

LIST OF TABLES

Table **Page**

4-1 Analyst’s Actions Based on Datalogger and Anomaly Screening Flags 9

4-2 Validation Codes 10

1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the steps taken by the National Park Service (NPS) Air Resources Division's (ARD) 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 Preliminary 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, trend-graphs, and edit logs.
  - Reviewing the AQDBMS Site Status Log.
  - Recording and reviewing comments on the raw data stackplots.
  - Reviewing and perhaps entering precision check and calibration data into the AQDBMS database.
  - Entering and reviewing any audit report data received for the site/month into the AQDBMS database.
- Entering validation codes and perhaps adjusted values into the AQDBMS database.
- Updating the AQDBMS Data Validation Log.
- Reviewing validated data stackplots and other output.

2.0 RESPONSIBILITIES

2.1 IMC MANAGER

The IMC manager shall:

- Review stackplots including annotations made by the data analyst and data technician.
- Review AQDBMS entries (i.e., validation codes or hand-entered values) made by the data analyst and data technician.

- Verify hand-entered data values.
- Update the Data Validation Log in the AQDBMS with the Preliminary validation date.

2.2 DATA ANALYST

The data analyst shall:

- Review and annotate stackplots using field documentation.
- Update the Data Validation Log in the AQDBMS with the stackplots commented date.
- Enter validation codes into the AQDBMS based on the stackplot annotations.
- Review annotated stackplots with the field specialist.

2.3 DATA TECHNICIAN

The data technician shall:

- Review and annotate stackplots using field documentation.
- Update the Data Validation Log in the AQDBMS with the stackplots commented date.
- Enter validation codes into the AQDBMS based on the stackplot annotations.
- Review annotated stackplots with the field specialist.
- Post annotated stackplots on the bulletin board.

2.4 FIELD SPECIALIST

The field specialist shall review annotated stackplots with the IMC staff before the plot review.

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:
  - Draft printer
  - 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 Preliminary 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 five (5) major subsections:

4.1 The Data Validation Log
4.2 The Site Status Log
4.3 Validation Acceptance Criteria
4.4 Entering Validation Codes and Other Values into the AQDBMS Database
4.5 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 technician 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. The log entry for a particular site/month must exist before data can be edited in the Data Validation window. 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 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, 2001) for detailed instructions.

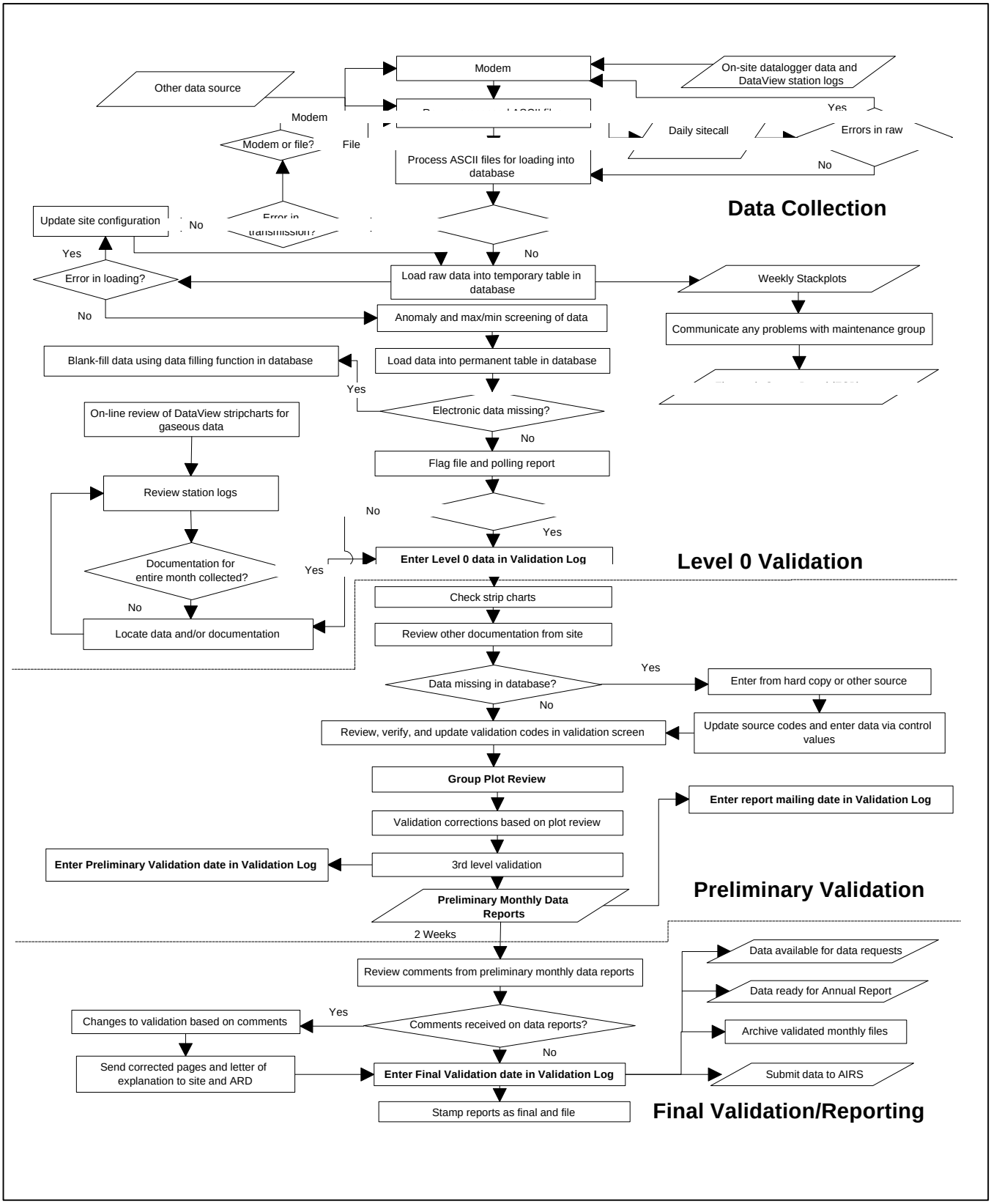


Figure 4-1. NPS Ambient Air Quality and Meteorological Monitoring Network Data Collection, Validation, and Reporting Flow Diagram.

Validation Checklist – Preliminary

Month/Year _____ Site _____

		Date	Initials
1.	Checked O3 Trace via PC Anywhere in DataView.	_____	_____
2.	Checked Daily Summaries (all printed).	_____	_____
3.	Hand Entered/reduced Data? Y____ N____	_____	_____
	Dates and Hours: _____		
4.	Reviewed Previously Commented Stackplots.	_____	_____
5.	Checked Power Failure Log on Last Daily Summary. (>15 minutes in any monitoring hour).	_____	_____
6.	Reviewed Trip Reports & Checked RH Cal Results (Maintenance blue card binder)	_____	_____
7.	Printed and Reviewed Station Logs	_____	_____
8.	Checked Station Temperature to be 19.5°C to 30.5° C (API analyzers: 4.5°C to 40.5°C).	_____	_____
9.	Checked Site Status Log.	_____	_____
10.	Checked SSRF Forms for Leak Check	_____	_____
11.	Recorded Comments on Plots.	_____	_____
12.	Entered Validation Codes/Values into Database	_____	_____
13.	Entered Multipoint Calibration Results into database. (Results appear on Station Logs).	_____	_____
14.	Verified that any Pre-Maintenance Calibrations (Considered ARS Audit) and Other Audits are Received and Entered.	_____	_____
15.	Validation Log Updated.	_____	_____
16.	Group Plot Review.	_____	_____

Figure 4-2. The Preliminary 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:

- 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.

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. A commented plot is shown in Figure 4-3. 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.
- Explanations of valid but unusual data are also included.

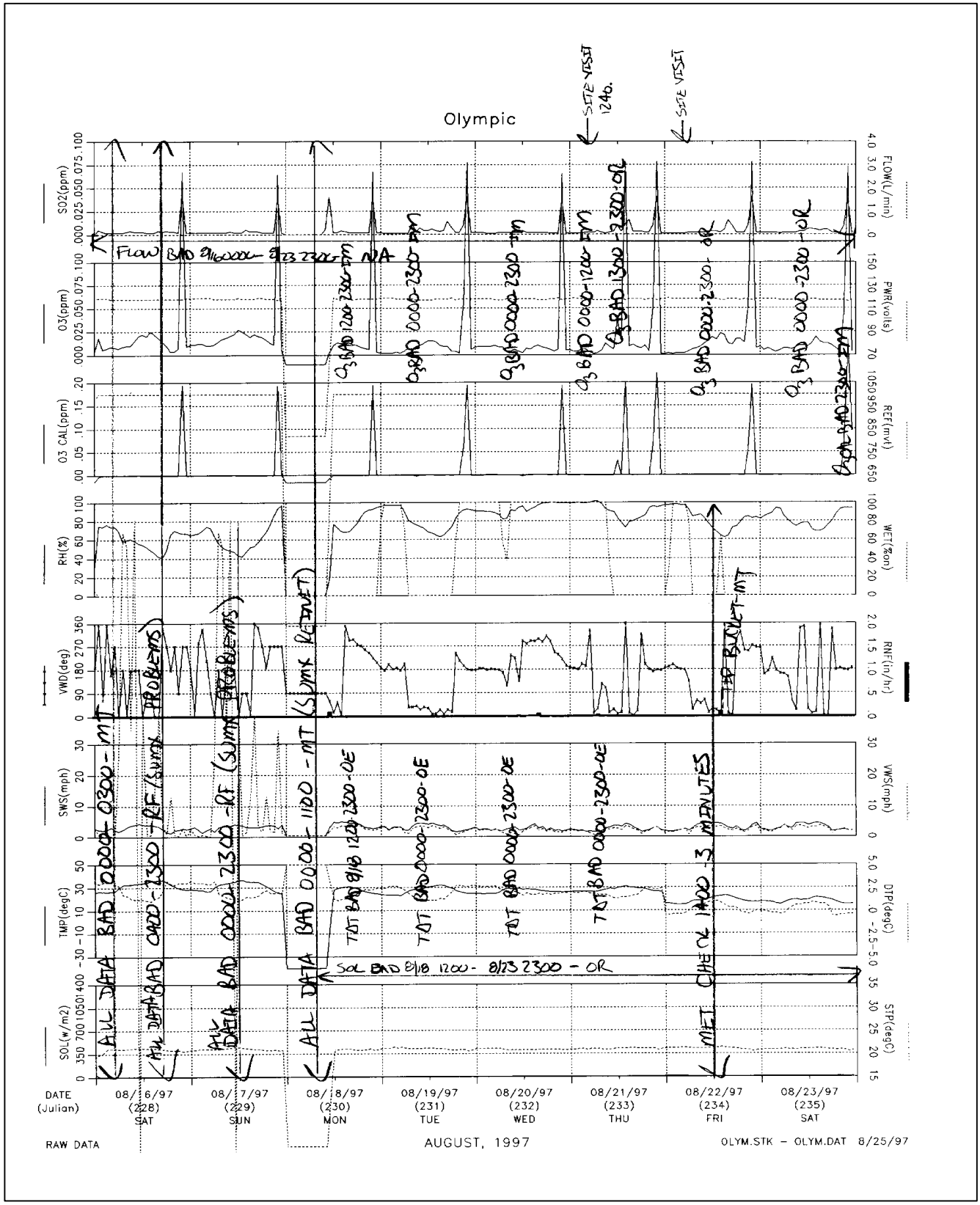


Figure 4-3. Example of a Commented Stackplot.

- Data points flagged by the anomaly-screening program 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 and entered if necessary 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.

4.4 ENTERING VALIDATION CODES AND OTHER VALUES INTO THE AQDBMS DATABASE

After commenting stackplots, validation codes are entered in to the database. The codes entered come directly from the commented stackplots and are also guided by the datalogger and anomaly flags that are already in the database. A validation code is entered for each data point and replaces any datalogger and anomaly screening flags, although sometimes an anomaly screening flag is also a validation code. Table 4-1 is a list of datalogger and anomaly screening flags and most common analyst actions taken based on the flags. Table 4-2 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 <u>all</u> 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 4-1

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.	None
B	Datalogger	Bad input status.	Investigate
C	Datalogger	Calibration.	Invalidate with ZS, PC, CA, SC, PA, or MT
D	Datalogger	Parameter marked down.	Investigate; can be valid or invalid
F	Datalogger	Power failure.	Investigate; may be erroneous or true power failure
P	Datalogger	Purge.	Investigate
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	Data invalid for ozone when station temp is > 30.5˚C.	Invalidate O_3, O_3CAL, SO_2 keeping TH
TL	Screening	Data invalid for ozone when station temperature < 19.5˚C.	Invalidate O_3, O_3CAL, SO_2 keeping TL
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 RF
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 4-2

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.
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 warmup. 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 (for example RH).
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.
PC	Precision Check. Normally once per week, not more than 1 per day (all others should be listed as ZS or MT).
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 (not used much).
SC	Use when both a precision check and a zero/span check are done within the same hour. Not to be used with a PC in the same day.
TH	Data invalid for ozone when station temp is > 30.5° C.
TL	Data invalid for ozone when station temperature < 19.5° 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 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.
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

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 4-4.

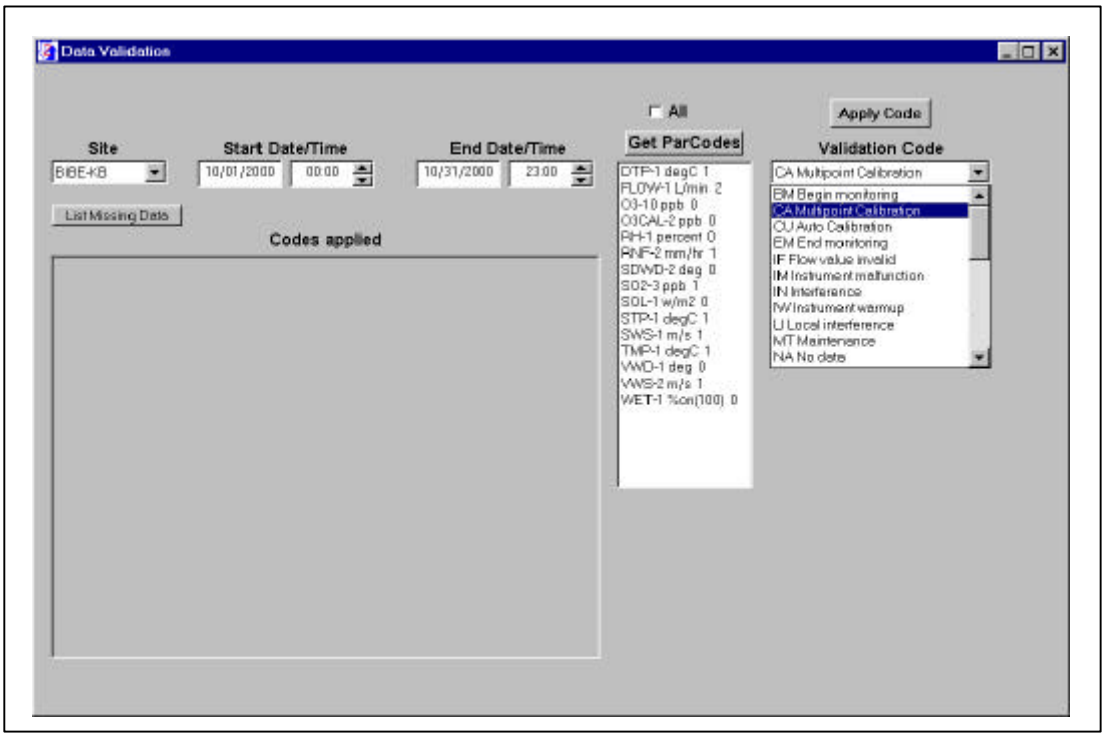


Figure 4-4. The Initial Validation Window.

To apply validation codes:

- 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.

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.

- 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.

4.4.2 <u>The Data Validation Data Window</u>

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 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.

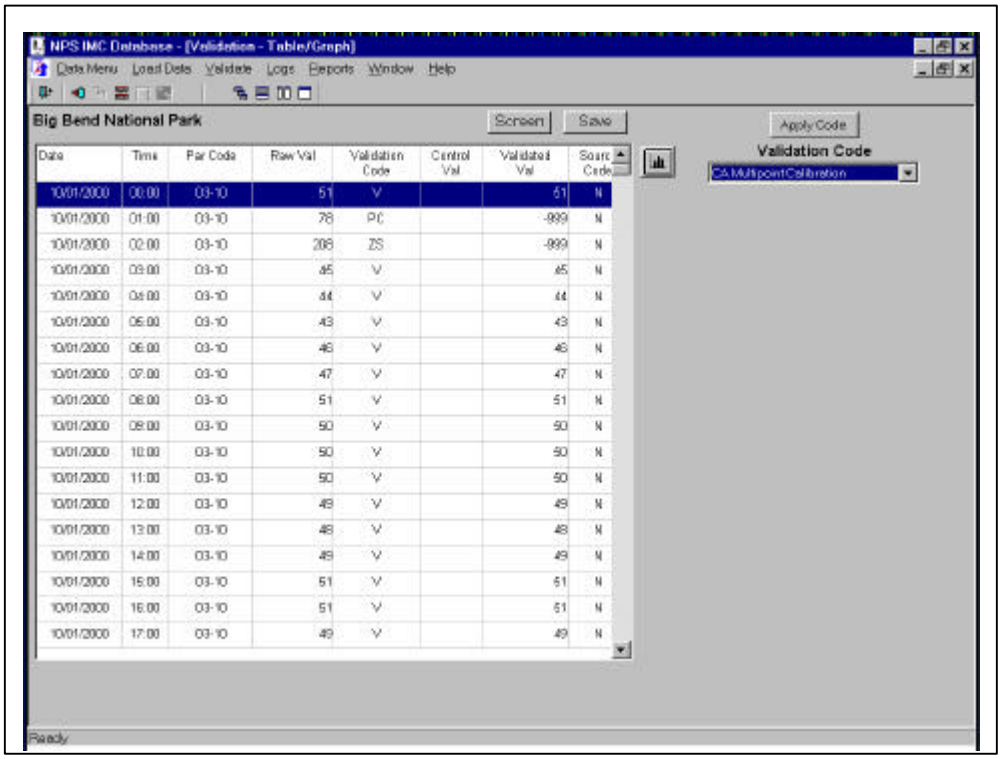


Figure 4-5. The Data Validation Data Window.

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.
- 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. 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:

- 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**, or **U**).
- 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.

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 outpu8t 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.

4.5 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.
- Reviews validated data stackplots to further verify that no points were missed.
- Reviews daily summaries and station logs.

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 Monthly Reporting*, for detailed instructions.

Preliminary data validation is complete after entering validation codes for a site/month and reviewing the validated data output. 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), 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	**AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA – FINAL VALIDATION**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3450-5020**
DATE	**MARCH 1999**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Betsy Davis-Noland	
PROJECT MANAGER	Robert Deemer	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
NPS COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change all procedures for the DataView system	January 2001	

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
2.1	IMC Manager	1
2.2	Data Technician	1
2.3	Data Analyst	2
2.4	Site Operator	2
2.5	Technical Assistant	2
3.0	REQUIRED EQUIPMENT AND MATERIALS	2
4.0	METHODS	2
4.1	The Data Validation Log	5
4.2	The Site Status Log	5
4.3	Group Plot Review	5
4.4	Making Validation Code Corrections and Completing Final Validation	5
4.4.1	The Data Validation Data Window	5
4.4.2	Entering Control Values	7
4.4.3	The Data Validation Log	8
4.4.4	Completing Final Validation	8
4.5	Post-Final Validation Procedures	9
5.0	REFERENCES	9

LIST OF FIGURES

Figure		Page
4-1	NPS Ambient Air Quality and Meteorological Monitoring Network Data Collection, Validation, and Reporting Flow Diagram	3
4-2	The Final Validation Checklist	4
4-3	The Data Validation Data Window	6

1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the steps taken by the National Park Service (NPS) Air Resources Division's (ARD) 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 Final Validation Checklist 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. Final data validation is accomplished by the following:

- A group plot review that includes input from NPS staff, air quality specialists, field specialists, and site operators to resolve all questionable validation issues.
- Making necessary validation code changes in the AQDBMS based on the group plot review discussion.
- Generating, mailing, and reviewing 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 IMC MANAGER

The IMC manager shall:

- Participate in the monthly plot review and respond to questions posed during the plot review.
- Respond to site operator comments on preliminary data reports.
- Update the Data Validation Log in the AQDBMS with the Final validation date.

2.2 DATA TECHNICIAN

The data technician shall:

- Participate in the monthly plot review and respond to questions posed during the plot review

.

- File data reports when final.

2.3 DATA ANALYST

The data analyst shall participate in the monthly plot review and respond to questions posed during the plot review.

2.4 SITE OPERATOR

The site operator shall review monthly reports and forward comments to the IMC.

2.5 TECHNICAL ASSISTANT

The technical assistant shall mail any corrections made to reports to the NPS ARD and site operators.

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:
  - Draft printer
  - 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 Final 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 five (5) major subsections:

4.1 The Data Validation Log
4.2 The Site Status Log
4.3 Group Plot Review
4.4 Making Validation Code Corrections and Completing Final Validation
4.5 Post-Final Validation Procedures

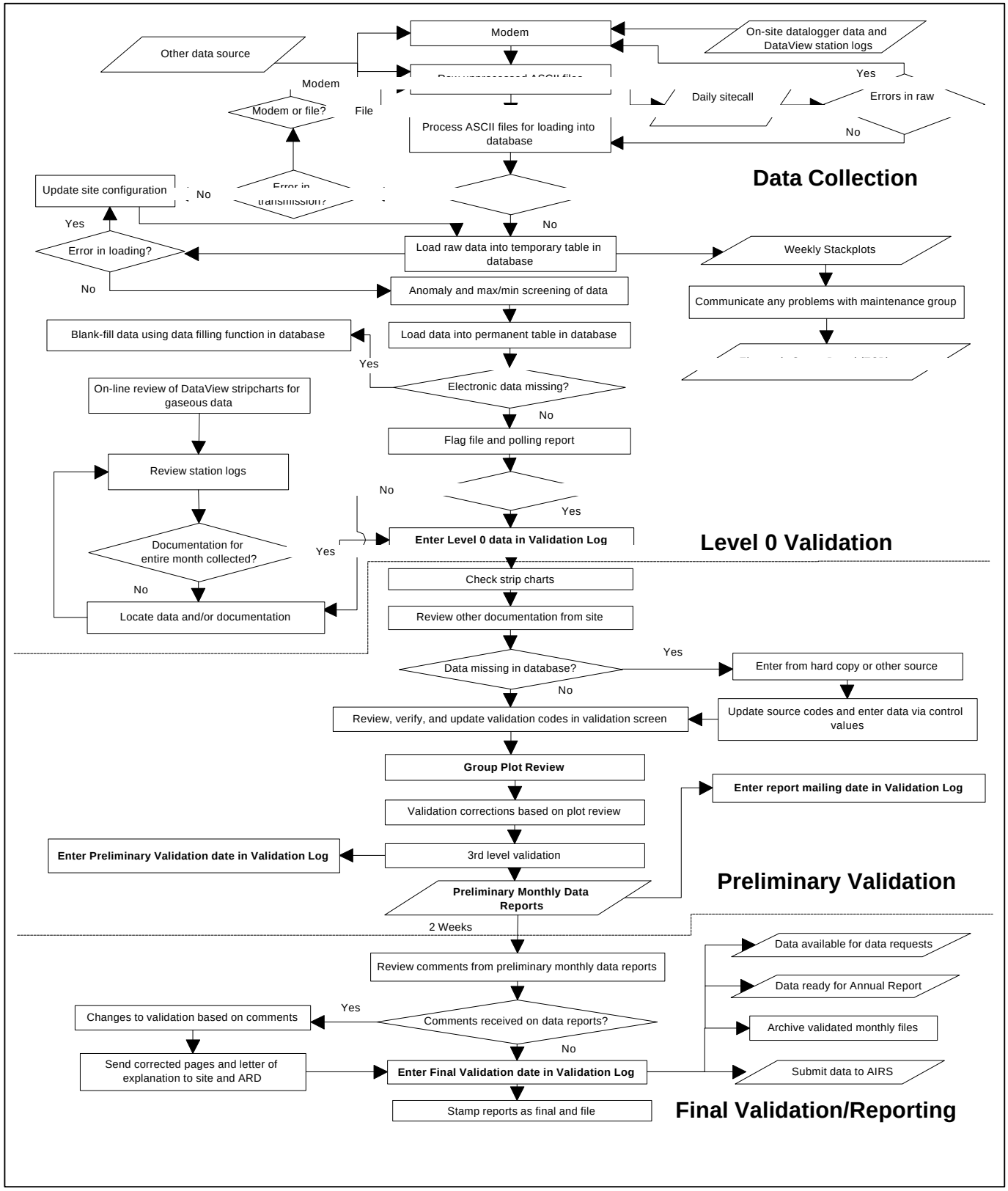


Figure 4-1. NPS Ambient Air Quality and Meteorological Monitoring Network Data Collection, Validation, and Reporting Flow Diagram.

Validation Checklist - Final

Month/Year_____ **Site_____**

Date of Validation_____ **Initials_____**

		Date	**Initials**
1.	Checked Preliminary Validation Checklist.	_____	_____
2.	Review plots with comments	_____	_____
3.	Verify preliminary edits.	_____	_____
4.	Verify preliminary invalid data codes.	_____	_____
5.	Run validated data plots for monthly report.	_____	_____
6.	Data Validation Log updated.	_____	_____
7.	Comments:_____		
	_____		
	_____		
	_____		
	_____		
8.	Review comments from Monthly Report	_____	_____
9.	Data Validation Log updated.	_____	_____
10.	Create updated plots.	_____	_____

Figure 4-2. Final Validation Checklist.

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 technician 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. The log entry for a particular site/month must exist before data can be edited in the Data Validation window. 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 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 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 GROUP PLOT REVIEW

A plot review is held to review all data collected for a month. Included in the group are data analysts, field specialists, and NPS 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.

4.4 MAKING VALIDATION CODE CORRECTIONS AND COMPLETING FINAL VALIDATION

After the plot review 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.

4.4.1 <u>The Data Validation Data Window</u>

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.

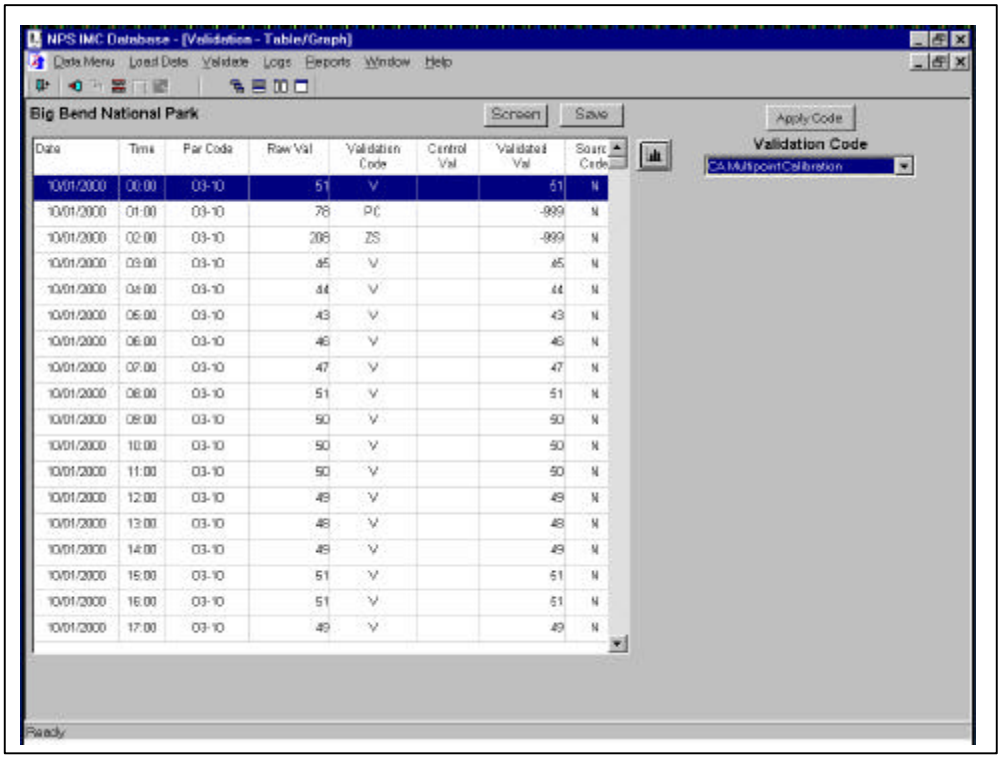


Figure 4-3. The Data Validation Data Window.

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.
- 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.

4.4.2 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.

4.4.3 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 outpu8t 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.

4.4.4 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.
- Monthly reports are generated (see TI 3550-5000, *Ambient Air Quality and Meteorological Monitoring Data Monthly Reporting*).
- The data analysts and technicians review the reports for any missed data validation points. If additional errors are found, repeat the validation code changes above and replace the affected stackplots and affected report pages.
- Monthly report pages affected by the changes are regenerated.
- Reports are mailed; one copy to NPS ARD and one copy to the site operator. One copy remains in the file in the IMC.
- Recipients of the reports are given two weeks to review the reports and submit comments on the reports.
- If no comments have been received within two weeks of mailing the report, the Final validation is complete. If comments are received requiring additional validation code changes, the changes are made, and monthly report pages affected by the change are regenerated and mailed to the report recipients.
- The monthly data reports are stamped with the Final validation stamp in the upper right-hand corner of the cover page and filed.

- The Data Validation Log entry for the site/month is updated with the Final validation date and initials of the responsible analyst.

After completing these steps, Final validation is complete and data are ready to be uploaded to AIRS, included in data requests, and annual data summary reports.

4.5 POST-FINAL VALIDATION PROCEDURES

If a validation error is found after the data are labeled as final, the following steps are taken:

- The Final validation date in the validation log for the site/month is deleted.
- The necessary changes are made in the AQDBMS database.
- A detailed log record explaining the changes made is added to the Data Validation Log for the site/month.
- A new Final validation date is entered in the Data Validation Log for the site/month.
- The changes are explained in the comments section of the Final validation checklist for the site/month.
- The monthly report pages that were affected by the change are regenerated and replaced in the report on file. A copy of each changed page is also sent to the recipients of the monthly report with a cover letter explaining the changes and the need to replace the page(s) in their copy of the report.
- A note with the date and analyst's initials is attached to the cover of the monthly data report explaining the changes made.
- If the affected data have been submitted to the Environmental Protection Agency's (EPA) Aerometric Information Retrieval System (AIRS) database, they must be resubmitted

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	**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	
PROJECT MANAGER	Robert Deemer	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
NPS COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change all procedures for the DataView system	January 2001	

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	3
3.0	REQUIRED EQUIPMENT AND MATERIALS	3
4.0	METHODS	3
4.1	Monthly Progress Report	4
4.2	Monthly Data Report	5
4.3	Annual Data Report	6
4.4	Ozone Hit List	7
4.5	Data Requests	7
4.6	Distribution	8
4.6.1	Distribution of Monthly Progress Reports	8
4.6.2	Distribution of Monthly Preliminary Data Reports	8
4.6.3	Distribution of Annual Data Reports	8
4.6.4	Distribution of Monthly Ozone Hit Lists	9
4.6.5	Distribution of Data Requests	9
4.7	Submitting Data to the EPA AIRS Database	9
4.8	Submitting Data to the CASTNet Contractor	9

LIST OF FIGURES

Figure		Page
1-1	NPS Ambient Air Quality and Meteorological Monitoring Network Data Collection, Validation, and Reporting Flow Diagram	2

LIST OF TABLES

Table		Page
4-1	Report Product Distribution	8

1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) outlines the steps of producing ambient air quality and meteorological data reports. Reporting of Ambient Air Quality and Meteorological Monitoring by the National Park Service (NPS) Air Resources Division's (ARD) Information Management Center (IMC) includes preparation and distribution of the following report products:

- Monthly progress reports
- Monthly preliminary data reports
- Annual data reports
- Monthly ozone "hit list" during the summer ozone season

In addition, the IMC reports criteria pollutant, meteorological, and precision and accuracy data to the Environmental Protection Agency's Aerometric Information Retrieval System (AIRS) database on a monthly basis, and handles 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.

Monthly progress reports summarize the technical aspects of the National Park Service Ambient Air Monitoring Assistance Contract performed during the reported month. These reports include the technical progress of both network operations and information management tasks, along with project-related milestones and maintenance schedules.

Monthly preliminary data reports provide NPS ARD personnel, individual station operators, and other project-related personnel, the opportunity to review and comment on preliminary ambient ozone (O_3) and/or sulfur dioxide (SO_2) data, and associated meteorological data collected at individual monitoring sites. A separate report is prepared for each monitoring site operating during the reported month.

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 May through September) of site-specific ozone hourly averages > 100 and ≥ 124 ppb, and 8-hour averages > 84 ppb. The monthly hit list, based on Level 0 data, is forwarded to the NPS contracting officer's technical representative (COTR) as a preliminary indication of which sites recorded high ozone values during the month.

The EPA AIRS database is a repository of air quality-related data from a multitude of federal, state, and city agencies. Data from the NPS Ambient Air Quality Network are submitted to allow retrieval of the data by other government agencies and researchers from a common source.

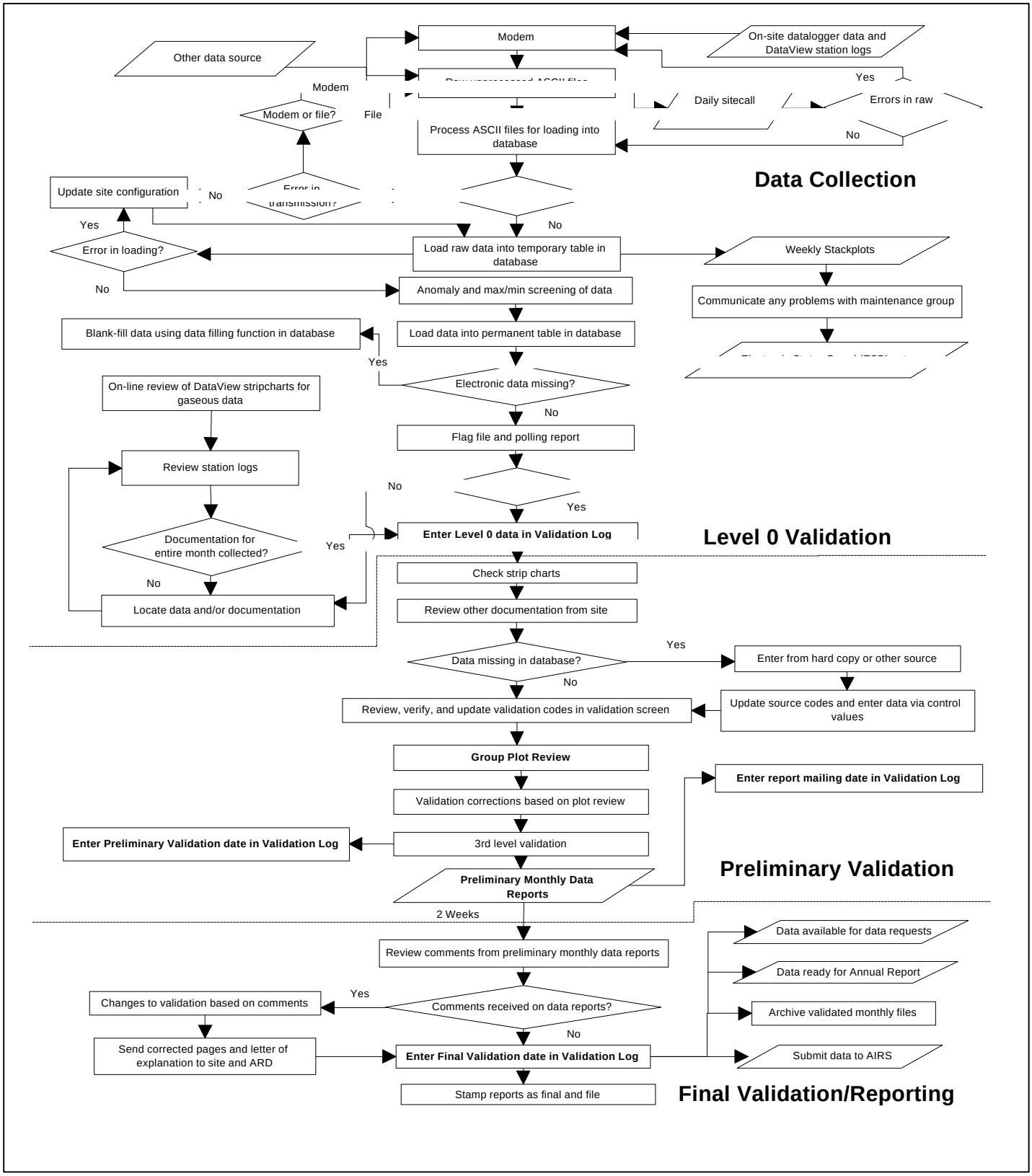


Figure 1-1. NPS Ambient Air Quality and Meteorological Monitoring Network Data Collection, Validation, and Reporting Flow Diagram.

Data requests are handled on an individual basis. Each request is authorized by the ARD before being filled by 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:

- 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 AIRS Database*

2.0 RESPONSIBILITIES

Staff positions that have data reporting responsibilities are:

- IMC manager
- Data analyst
- Data technician
- 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.* 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

A monthly progress report for the network is generated each month. Separate monthly and annual data reports are produced for each site collecting data during the monitoring period. In addition, annual data reports are generated for selected sites that are not part of the NPS Ambient Air Quality Network, but are in or very near a National Park Service unit. At these sites, data were collected, validated, and submitted to the EPA AIRS database by another agency. The data are downloaded from AIRS and are loaded into the Air Quality Data Base Management System (AQDBMS) database.

The ozone "hit list" is generated from Level 0 data in the AQDBMS database. Data requests are typically filled from finalized data in the AQDBMS database. Final data are submitted to the EPA AIRS database on at least a quarterly basis.

This section includes eight (8) major subsections:

4.1 Monthly Progress Report
4.2 Monthly Data Report
4.3 Annual Data Report
4.4 Ozone Hit List
4.5 Data Requests
4.6 Distribution
4.7 Submitting Data to the EPA AIRS Database
4.8 CASTNet Distribution

4.1 MONTHLY PROGRESS REPORT

Monthly progress reports summarize the progress of network-related tasks during the report month. Three copies of this report are completed and forwarded to the COTR by the 10th of the month following the reported month. Specific content of the progress report varies from month to month, however, each report generally includes the following:

- Section 1.0 Introduction – including current monitoring site map

- Section 2.0 Operational Monitoring Support:

  - Semiannual site visit schedule and findings
  - Equipment acceptance testing and modification
  - Site operations and operator training
  - Coordination with the National Dry Deposition Network (NDDN)
  - Capital equipment purchases and capital equipment and parts inventories
  - Standard operating procedures updates
  - Passive, enhanced, and special study monitoring support
  - PRIMENet support

- Section 3.0 Information Management Center Support:

  - Summary of data review meetings
  - Data polling, validation, reporting, and archive status
  - List of data requests

- Section 4.0 Contract Administration:

  - Supporting appendices including maintenance and calibration reports

4.2 MONTHLY DATA REPORT

Monthly data reporting involves generating a preliminary data report for each site in the NPS Ambient Air Quality Network where data were collected during the reported period. Monthly preliminary reports are completed and distributed within 60 days after the end of the reported month as the culmination of data validation. Each preliminary data report contains the following sections and products:

- Introduction
- Data Summaries and Statistics
- Data Collection Statistics Table
- Stackplots for all parameters, one plot for each 7 or 8 days
- Meteorological Parameter Summary Table
- Wind Rose Plot
- Gaseous Parameter Summary plots and tables for ozone and/or sulfur dioxide depending on the site configuration, including:
  - Gaseous pollutant versus National Ambient Air Quality Standards
  - Diurnal plot
  - Data summary by month for the past year
  - Pollutant rose plot
  - Hourly average tables

The steps taken to produce each monthly preliminary data report are:

- Verify completion of preliminary data validation of the reported data.
- Print report tables.
- Create stackplot data files.
- Print report plots.
- Print the cover page and text pages.
- Print review checklists.
- Review reports.
- Make corrections.
- Copy and mail the reports, and file the original.
- Replace pages affected by changes resulting from comments.
- Stamp original report “final.”

Refer to TI 3550-5000, *Ambient Air Quality and Meteorological Monitoring Data Monthly Reporting*, for details on the report content and each report preparation step.

4.3 ANNUAL DATA REPORT

Annual data reporting involves generating an annual data summary report for each site in the NPS Ambient Air Quality Network (and additional selected sites that are not in the network but are in or view near a park service unit) where data were collected during the reported period. Annual data summary reports are completed and distributed by August 31st following the reported year. Each annual data summary report contains the following sections and products:

- Section 1.0 Introduction:
  - A description of the monitoring network including a site map
  - A detailed description of the individual monitoring site including a site specifications map
- Section 2.0 Data Summary:
  - Overview
  - Ozone Data Summary
  - Sulfur Dioxide Summary
  - Meteorological Data Summary
  - Dry Deposition Data Summary
- Section 3.0 National Park Service Air Resources Division Data Sources:
  - Guide to the attached data diskettes
  - NPS IMC and AIRS Invalid Data Codes
  - Other Sources for Retrieving NPS Gaseous Pollutant Data
- Section 4.0 Glossary:
  - Definitions and Computational Procedures for NPS Quick Look Annual Summary Statistics Table
  - Air Quality Glossary

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.
- Print report tables.
- Create stackplot data files.
- Create monthly columnar data files.
- Print report plots.

- Print the cover page, text pages, and map pages.
- Print review checklists.
- Review reports.
- Make corrections and update Data Validation Log records.
- Copy and mail the reports, and file the originals.

Refer to TI 3550-5100, *Ambient Air Quality and Meteorological Monitoring Data Annual Reporting,* for details on report contents and each report preparation step.

4.4 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 > 84 ppb. The ozone hit list is generated from Level 0 data at the end of every month during the ozone season, which is May through September. Since the data have not yet been validated, the IMC manager reviews the list and excludes values recorded during obvious non-ozone events such as daily zero/span calibrations. Refer to TI 3550-5000, *Ambient Air Quality and Meteorological Monitoring Data Monthly Reporting*, for details on each step.

4.5 DATA REQUESTS

Data requests are received by the ARD or IMC and forwarded to the IMC IMC manager. The IMC manager takes the following steps:

- Completes the Data Request Form.
- Determines the amount of time and materials needed to fill the request.
- Forwards the request information to the ARD 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.
- Files the completed Data Request Form with copies of related documentation.
- Reports a list of fulfilled data requests in the next monthly progress report.

These steps are detailed in TI 3550-5200, *Handling Requests for Ambient Air Quality and Meteorological Monitoring Data.*

4.6 DISTRIBUTION

4.6.1 Distribution of Monthly Progress Reports

Three copies of the monthly progress report are delivered to the NPS ARD by the 10th of the month following the reported month. A copy of each report is kept on file at ARS.

4.6.2 Distribution of Monthly Preliminary Data Reports

The original pages of each monthly preliminary data report are filed in the IMC and kept on file permanently. Two copies of each report are made and delivered to:

- The site operator.
- The NPS ARD in Lakewood, Colorado.

4.6.3 Distribution of Annual Data Reports

The unbound original pages and one bound copy of each annual data summary report are filed in the IMC. The originals are kept on file permanently. Eleven (11) copies of each report are made. In addition, five (5) CD-ROMs containing monthly data files for all sites for the reported year and one (1) diskette for each reported site containing monthly data files are created. The reports, CDs, and diskettes are distributed as detailed in Table 4-1:

Table 4-1

Report Product Distribution

Recipient	Unbound Report	Bound Report	CD	Diskette
Site Operator		1		
Park Superintendent		2		1
NPS ARD	1	2	3	
NPS Regional Air Quality Coordinator		1		
TIC (NPS Clearinghouse)	1			
Non-NPS Agency Site Operators		1		
IMC Contractor (ARS)	1	1	2	
Totals	3	8	5	1

4.6.4 Distribution of Monthly Ozone Hit Lists

The ozone "hit list" is distributed by e-mail to:

- The NPS ARD.
- The field maintenance group project manager.
- Each member of the IMC staff.

4.6.5 Distribution of Data Requests

Each data request is distributed to the person making the request. The Data Request Form and copies of related documentation are filed in the IMC and kept on file for one year. In certain situations, a copy of the digital data delivered is archived permanently.

4.7 SUBMITTING DATA TO THE EPA AIRS DATABASE

The steps required to submit data to the EPA AIRS database are:

- Create the AIRS transaction files for hourly average criteria pollutant and meteorological data.
- Create the AIRS transaction files for precision data from criteria pollutant analyzer precision checks (typically one per week).
- Create the AIRS transaction files for accuracy data from audit reports on criteria pollutant analyzers (typically one every 6 months to one year).
- Transfer the files to AIRS using FTP (file transfer protocol).
- Load data into the AIRS screening file(s), successfully run the AIRS edit programs, and lock the screening file(s) for update to the AIRS database.

These steps are detailed in TI 3550-5300, *Submitting Ambient Air Quality and Meteorological Monitoring Data to the EPA AIRS Database.*

4.8 SUBMITTING DATA TO THE CASTNET CONTRACTOR

Flow data are distributed to the CASTNet contractor. The data are queried in the AQDBMS for selected sites and dates, and an ASCII file is created. The file is then e-mailed to the CASTNet contractor.

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	**AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA MONTHLY REPORTING**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3550-5000**
DATE	**MARCH 1999**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Betsy Davis-Noland	
PROJECT MANAGER	Robert Deemer	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
NPS COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change all procedures for the DataView system	January 2001	

TABLE OF CONTENTS

Section **Page**

1.0 PURPOSE AND APPLICABILITY 1

2.0 RESPONSIBILITIES 1

2.1 IMC Manager 1
2.2 Data Analyst and Data Technician 2
2.3 Technical Assistant 2

3.0 REQUIRED EQUIPMENT AND MATERIALS 2

4.0 METHODS 2

4.1 Monthly Progress Report 3
4.2 Monthly Preliminary Data Report 3

4.2.1 Preliminary Data Report Contents 5
4.2.2 Generating a Preliminary Data Report 6

4.2.2.1 Verifying Preliminary Validation Status 6
4.2.2.2 Generating Report Tables and Stackplot Data Files 7
4.2.2.3 Generating Report Plots 12

4.2.3 Reviewing Reports 15
4.2.4 Distributing Reports 16
4.2.5 Regenerating Report Pages Due to Comments Received 16

4.3 Monthly Ozone Hit List 17

4.3.1 Generating the Monthly Ozone Hit List 17
4.3.2 Distributing the Monthly Ozone Hit List 18

5.0 REFERENCES 18

LIST OF FIGURES

Figure **Page**

4-1 NPS Ambient Air Quality and Meteorological Monitoring Network Data Collection, Validation, and Reporting Flow Diagram 4

4-2 The Data Validation Log 7

4-3 The Reports Interface 8

4-4 The Dates Tab Page 9

LIST OF FIGURES (CONTINUED)

Figure		Page
4-5	The Sites Tab Page	9
4-6	The Parameters Tab Page	10
4-7	The Options Tab Page	11
4-8	The Destinations Tab Page	12
4-9	Example Report Review Form	16
4-10	Example Ozone Hit List	17

1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the steps of producing ambient air quality and meteorological 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 National Park Service (NPS) Air Resources Division's (ARD) Information Management Center (IMC) includes preparation and distribution of the following monthly report products:

- Monthly progress reports
- Monthly preliminary data reports
- Monthly ozone "hit list" (prepared during the ozone season, May through September)

Monthly progress reports summarize the technical aspects of the National Park Service Ambient Air Quality Network performed during the reported month. These reports include the technical progress of both network operations and information management tasks, along with project-related milestones and maintenance schedules.

Monthly preliminary data reports provide NPS personnel, individual station operators, and other project-related personnel, the opportunity to review and comment on preliminary ambient ozone (O_3) and/or sulfur dioxide (SO_2) data and associated meteorological data collected at individual monitoring sites. A separate report is prepared for each monitoring site operating during the reported month.

The monthly ozone "hit list" is a list of ozone hourly averages hourly averages > 100 and ≥ 124 ppb, and 8-hour averages > 84 ppb, indicating the locations and frequency of high ozone values. This list is forwarded to the NPS ARD.

2.0 RESPONSIBILITIES

2.1 IMC MANAGER

The IMC manager shall:

- Verify that preliminary data validation has been successfully completed for each month.
- Prepare monthly data reports and forward the reports to the NPS ARD and site operators.
- Respond to comments received on monthly data reports and affect appropriate changes in the data and report.
- Prepare and forward the monthly ozone "hit list" to the NPS ARD.

- Submit data to the Environmental Protection Agency's (EPA) Aerometric Information Retrieval System (AIRS) database.

- Summarize IMC-related progress and forward items to the technical assistant for inclusion in the monthly progress report.

2.2 DATA ANALYST AND DATA TECHNICIAN

The data analyst and data technician shall assist the IMC manager with the preparation, review, mailing, and correction of monthly preliminary data reports.

2.3 TECHNICAL ASSISTANT

The technical assistant shall:

- Assemble and organize the information for the monthly progress report.

- Word process the text portions of both reports.

- Copy and mail the monthly data and progress 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:
  - Draft printer
  - 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 monthly progress report for the network is generated each month. Separate monthly reports are produced for each site collecting data during the month. The ozone "hit list" is generated from raw data in the Air Quality Data Base Management System (AQDBMS) database.

This section contains the following three (3) major subsections:

4.1 Monthly Progress Report
4.2 Monthly Preliminary Data Report
4.3 Monthly Ozone Hit List

4.1 MONTHLY PROGRESS REPORT

Monthly progress reports summarize the progress of network-related tasks during the report month. This report is completed and distributed by the 10th of the month following the reported month. Specific content of the progress report varies from month to month, however, each report generally includes the following:

- An introduction including current monitoring site map.
- Task progress updates, milestones, and site visits relating to operational monitoring support.
- Task progress updates, milestones, and ARS/NPS team meetings relating to data collection and validation.
- Contract administration items.

Using the previous month's report as a template, the technical assistant goes through 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 PRELIMINARY DATA REPORT

Monthly data reporting includes generating a preliminary data report for each site in the NPS Ambient Air Quality Network where data were collected during the reported period. Monthly preliminary reports are completed and distributed within 60 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 each site's report.
- Generate and compile the contents of each report.
- Review reports.
- Make corrections and regenerate affected contents.
- Copy and distribute the reports.
- Regenerate report pages if changes are made due to comments received.

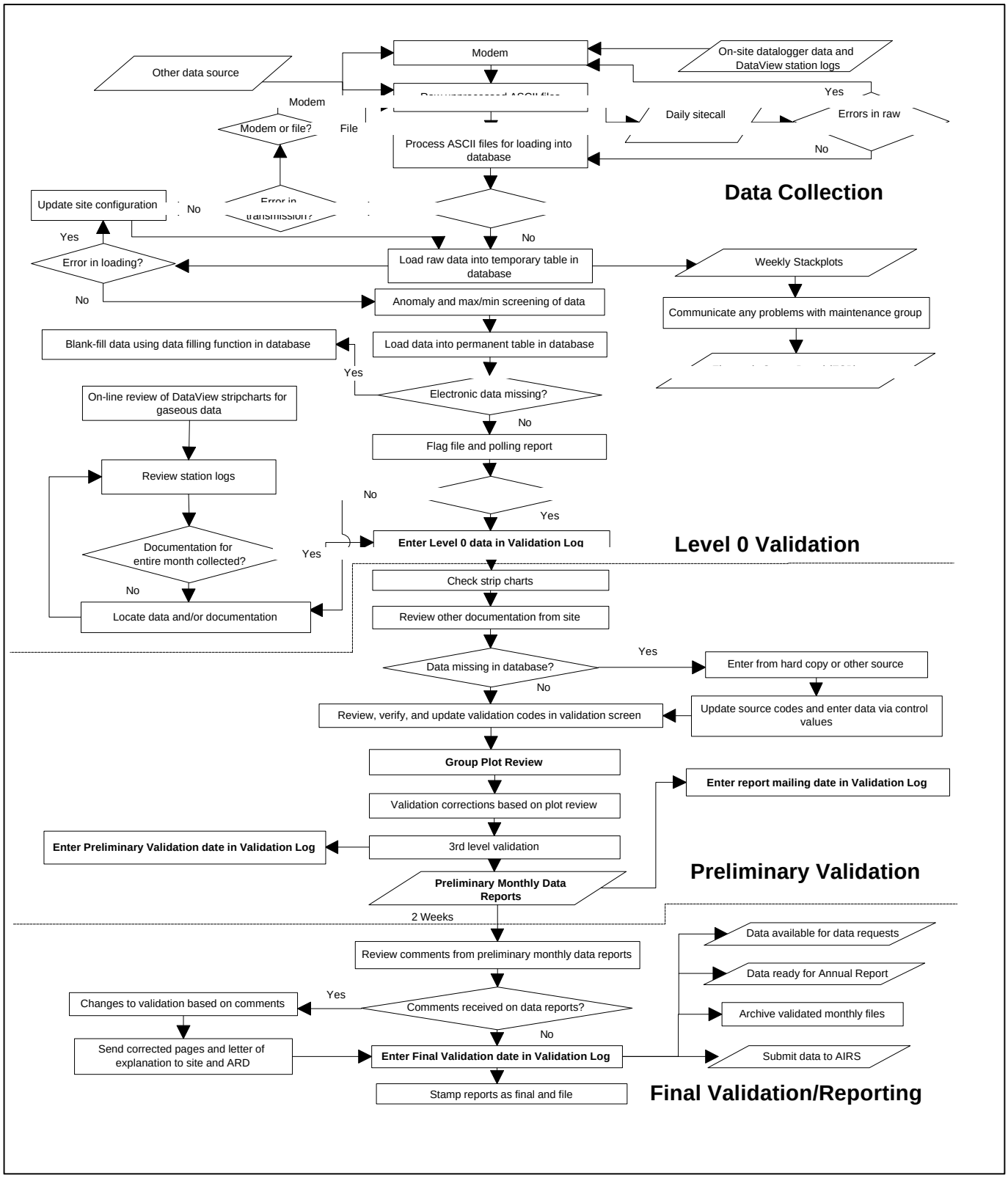


Figure 4-1. NPS Ambient Air Quality and Meteorological Monitoring Network Data Collection, Validation, and Reporting Flow Diagram.

4.2.1 Preliminary Data Report Contents

Before generating report contents, the IMC manager determines which sites are to be reported and the output that needs to be included in each site's report. Each preliminary data report contains the following sections and products:

- Introduction
- Data Summaries and Statistics
- Data Collection Statistics Table
- Stackplots for all parameters, one plot for each 7 or 8 days
- Meteorological Parameter Summary Table (if applicable to the site)
- Wind Rose Plot (if applicable to the site)

At each site where ozone is monitored, the preliminary data report includes:

- Ozone Values Versus National Ambient Air Quality Standards (NAAQS) Table (Ten Highest Daily 1-Hour Average Ozone Concentrations)
- 10 Highest Daily 8-Hour Averages
- Diurnal Ozone Plot
- Ozone Data Summary Plot, by month for the past year
- Ozone Pollutant Rose Plot
- Ozone Hourly Average Table

At each site where sulfur dioxide is monitored, the preliminary data report includes:

- Sulfur Dioxide Values Versus National Ambient Air Quality Standards (NAAQS) Table (Five Highest Daily 1-Hour Average, Five Highest 3-Hour Block Average, and Five Highest 24-Hour Average Sulfur Dioxide Concentrations)
- Diurnal Sulfur Dioxide Plot
- Sulfur Dioxide Data Summary Plot, by month for the past year
- Sulfur Dioxide Pollutant Rose
- Sulfur Dioxide Hourly Average Table

At each site where supplemental sulfur dioxide is monitored, the preliminary data report includes:

- Supplemental Sulfur Dioxide Values Versus National Ambient Air Quality Standards (NAAQS) Table (Five Highest Daily 1-Hour Average, Five Highest 3-Hour Block Average, and Five Highest 24-Hour Average Sulfur Dioxide Concentrations)
- Diurnal Supplemental Sulfur Dioxide Plot
- Supplemental Sulfur Dioxide Summary Plot, by month for the past year
- Supplemental Sulfur Dioxide Pollutant Rose
- Supplemental Sulfur Dioxide Hourly Average Table

4.2.2 Generating a Preliminary Data Report

The steps taken to generate each monthly preliminary data report are:

- Verify completion of preliminary data validation of the reported data.
- Print report tables.
- Create stackplot data files.
- Print report plots.
- Print the cover page and text pages.
- Print review checklists.
- Review reports.
- Make corrections.
- Copy and mail reports, and file the original.
- Replace pages affected by changes resulting from comments.
- Stamp original report “final.”

The following subsections explain how each step is accomplished.

4.2.2.1 Verifying Preliminary Validation Status

Before a preliminary data report for a site 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 4-2).

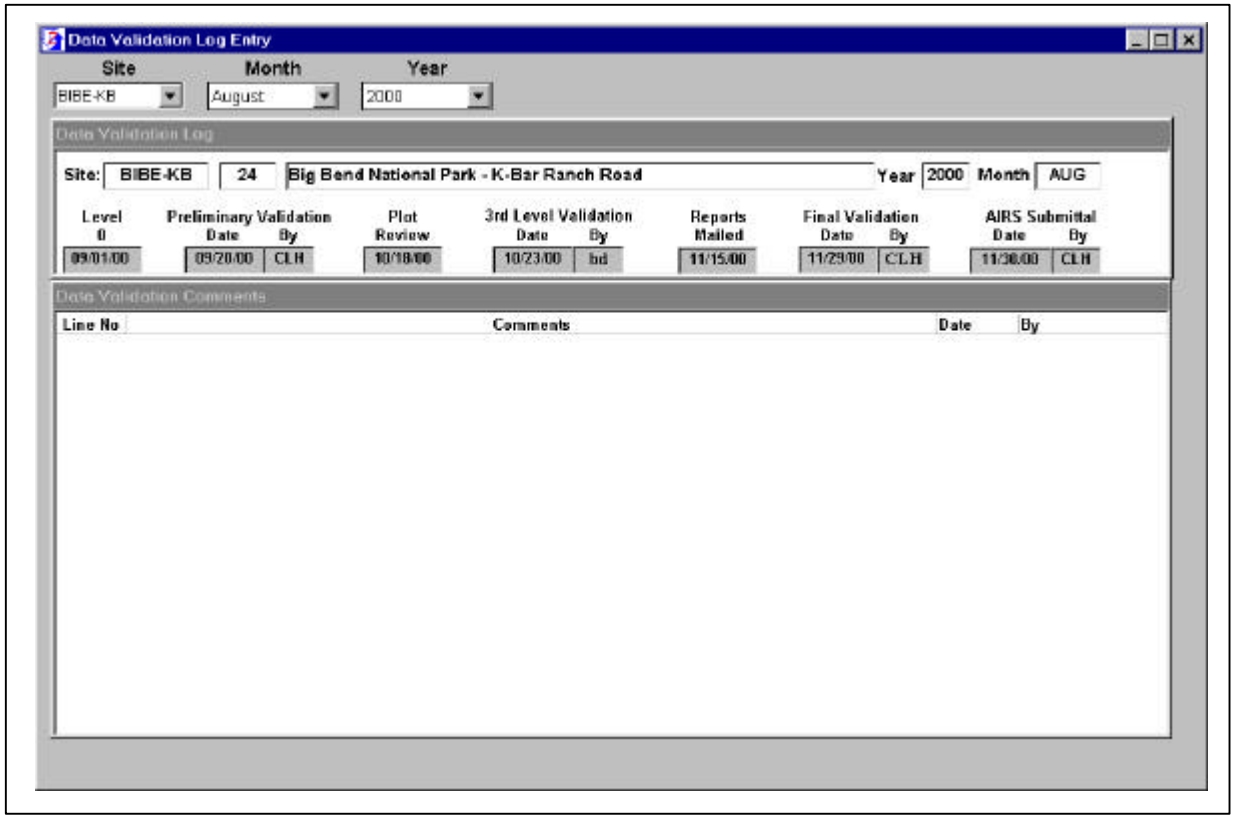


Figure 4-2. The Data Validation Log.

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 and Stackplot 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 4-3. A tab control has been 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.

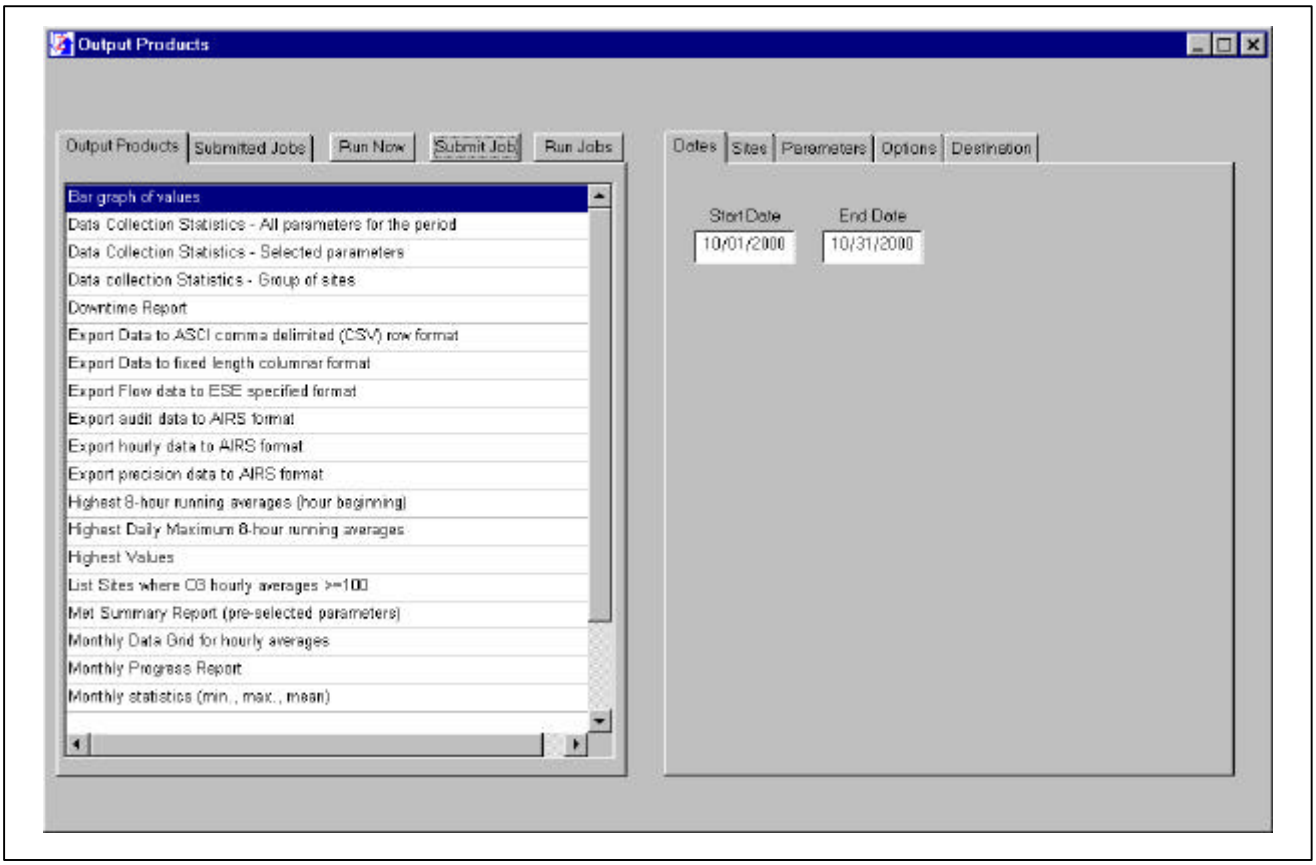


Figure 4-3. The Reports Interface.

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 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 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 discussed below:

1. The Dates 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/yyyy format. Other products may need only a year to be entered. The Dates tab page is shown in Figure 4-4.

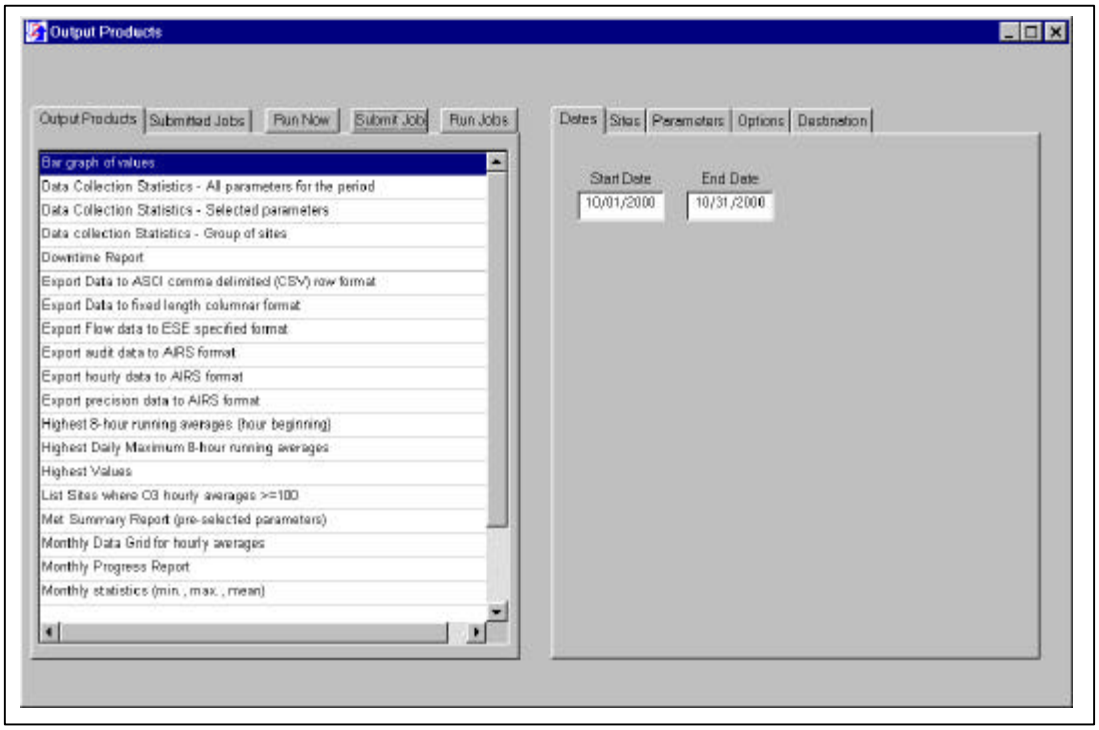


Figure 4-4. The Dates Tab Page.

2. The Sites tab page 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 4-5 shows the Sites tab.

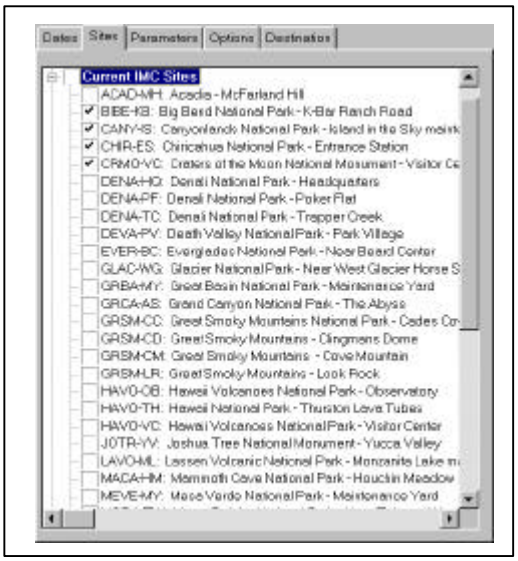


Figure 4-5. The Sites Tab Page.

3. The Parameters tab page displays a list of all parameters as shown in Figure 4-6. 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*.

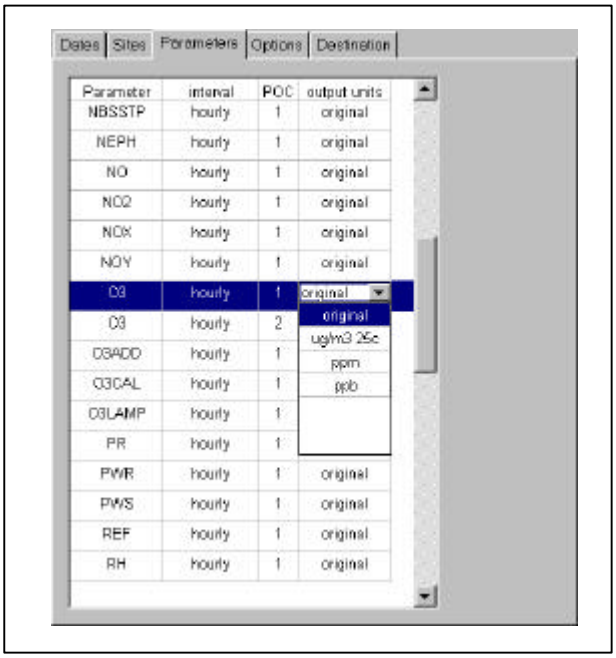


Figure 4-6. The Parameters Tab Page.

4. The Options 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 4-7. 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 filed 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.

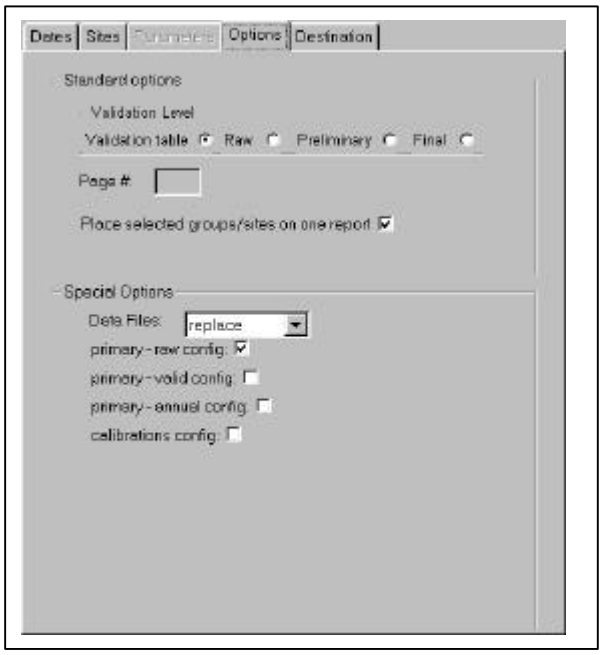


Figure 4-7. The Options Tab Page.

5. The Destinations tab displays options on the type of output to produce as shown in Figure 4-8. 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 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.

- 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.

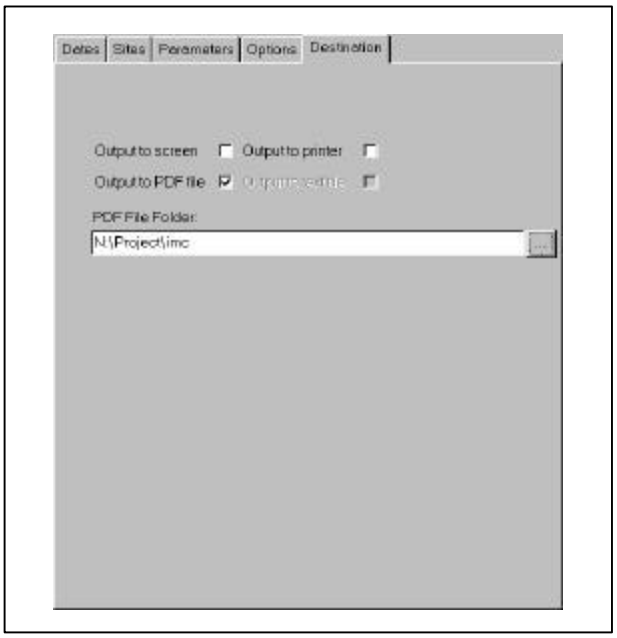


Figure 4-8. The Destinations Tab Page.

4.2.2.3 Generating Report Plots

The report plots are been printed extensively on Hewlett-Packard (HP) Laserjet 4/4M printers. Before generating the monthly report plots, verify the correct printer settings.

To set printer settings for graphics output:

- From the “File” menu, select **Print Setup**.
- Click to select the HP Laserjet 4 or 4M printer, then click the **Setup** button.
- Click on the **Graphics** tab.
- Click the **down arrow** in the “Resolution” box, then select the optimum dots per inch (dpi). Select **600** for all plots and reports.
- Click the **Use raster graphics** radio button in the “Graphics mode” section.
- Click the **Fonts** tab then click the **Print True Type as graphics** button.

Monthly preliminary reports include several plots. Each plot is generated by executing one of the AQDMBS graphics programs as follows:

Plot	Program
Diurnal Plot (Ozone and Sulfur Dioxide)	Aqdiur.exe
Pollutant Rose Plot (Ozone and Sulfur Dioxide)	Aqrose.ese
Data Summary Bar Plot (Ozone and Sulfur Dioxide)	Aqbar.exe
Wind Rose Plot	Aqrose.ese
Stackplot	Stkwin.exe

To generate any of the plots (except stackplot):

- Select the desired *graphics product* from the "Plots" menu in the AQDBMS.
  -or-
  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 Data Summary Bar Plot, which is landscape).

- 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.

- 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.

Plots can be created for multiple sites/parameters for the same month. 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:

- Open a *new file* in a text file editor such as Windows Notepad (**do not** use a word processor such as Word for Windows).

- 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-,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 *\\ars_net3\project\npsair\sitecall\monthly\batch* directory.

To create plots for multiple sites:

- Select the desired *graphics product* from the "Plots" menu in the AQDBMS.
  -or-
  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.

- To not have the plots print automatically, 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 from the file-open dialogue box and click **OK**.

To generate the required stackplots for each monthly preliminary data report, the following files are required:

- An ASCII data file containing the monthly data for the site.
- A *.stk* file containing the stackplot configuration information for the site.

To generate a stackplot:

- Launch STKWIN.EXE from either the Windows desktop or from the "Stackplot" command of the "Plots" menu in the IMC application.
- Select **File/Open** and choose a *.stk* file from the correct directory.
- Click **Start.**
- Click **Print** to send a hard copy of the plot to the printer.

To generate stackplots using a submit file:

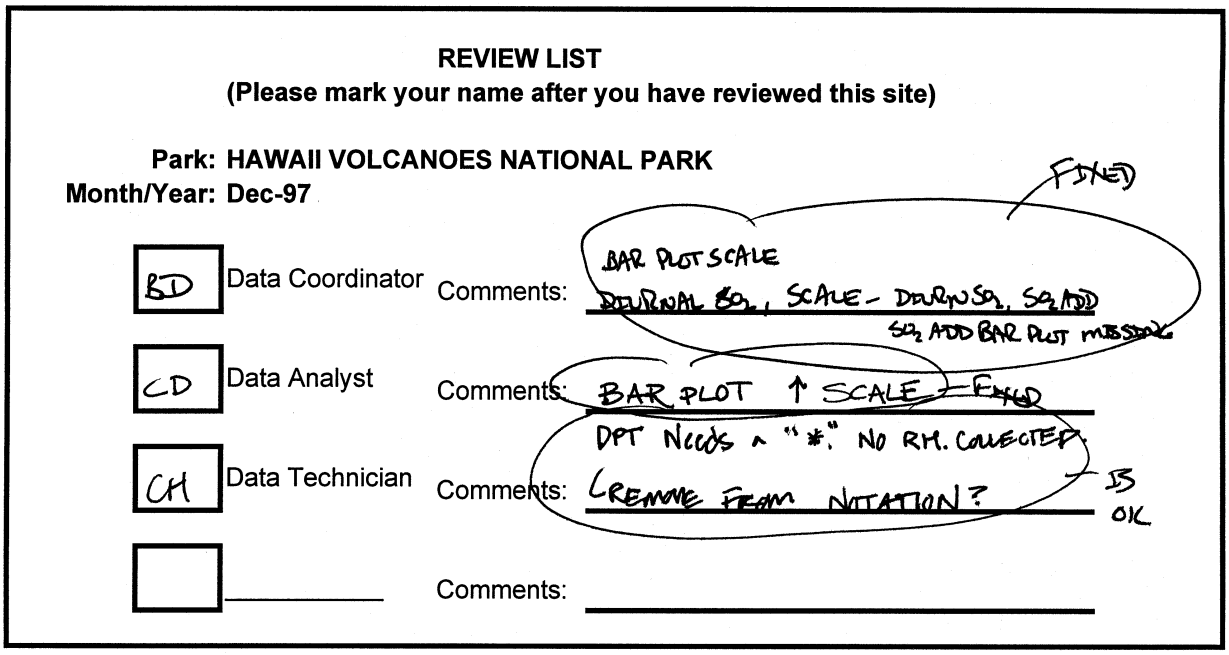
- Launch STKWIN.EXE from either the Windows desktop or from the "Stackplot" command of the "Plots" menu in the IMC application.
- Select **File/Open** and choose a *.sbm* file.
- Click **Start.**
- **C**heck **Autoprint** and **Continuous**.
- Click **Draw**.

For more information on generating plots, see the *Air Quality Data Base Management System (AQDBMS) User's Guide* (ARS, 2001).

4.2.3 Reviewing Reports

A report review form is attached to each report and is used to log comments and error corrections to the reports and/or data during the review process. An example report review form is shown in Figure 4-9.

Each monthly preliminary data report is reviewed by at least three IMC staff people. If errors are found, corrections are made and the affected report contents regenerated. After the review period is complete, the report review form is removed from the report and kept on file in the IMC for 6 months.



REVIEW LIST
(Please mark your name after you have reviewed this site)

Park: HAWAII VOLCANOES NATIONAL PARK
Month/Year: Dec-97

FIXED

BD Data Coordinator Comments: BAR PLOT SCALE JOURNAL SO_2, SCALE - DOWN SO_2, SO_2 ADD SO_2 ADD BAR PLOT MISSING

CD Data Analyst Comments: BAR PLOT ↑ SCALE - FIXED DPT NEEDS A "*" NO RH. COLLECTED

CH Data Technician Comments: REMOVE FROM NOTATION? — IS OK

_____ Comments: _____

Figure 4-9. Example Report Review Form.

4.2.4 Distributing Reports

The original pages of each monthly preliminary data report are filed permanently in the IMC. Two copies of each report are made and sent to:

- The site operator.
- The NPS ARD in Lakewood.

4.2.5 Regenerating Report Pages Due to Comments Received

As part of the Final validation process, recipients of preliminary data reports are given weeks to review the reports and respond to the IMC with comments. If no comments are received, the original reports are stamped "Final." If comments are received, the IMC manager evaluates them and data validation changes are made accordingly (for more information on this process, see TI 3450-5020, *Ambient Air Quality and Meteorological Monitoring Data - Final Validation)*. Pages affected by changes are regenerated and replaced in the monthly preliminary data report. Changes are noted on the cover of the report. The regenerated pages are copied and sent to the site operator and NPS ARD with a cover letter explaining the changes. Copies of the cover letters regarding changes are kept in the sites' correspondence files.

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 hourly averages > 100 and ≥ 124 ppb, and 8-hour averages > 84 ppb. The list is generated from raw data at the end of every month during the ozone season (May through September). An example hit list is shown in Figure 4-10. Since the data have not yet been validated, the IMC manager reviews the list and excludes values recorded during obvious non-ozone events such as daily zero/span calibrations.

```
Episodes with 1-Hour Ozone Concentrations > 100 ppb and > 124 ppb
Time Period: 10/01/97 - 10/31/97
RAW DATA:  This data has not been validated
Data users should acknowledge the National Park Service Air Resources
Division
Site            Beginning      No. of Hours        Max
Abbr    Date      Hour     >100 ppb  >=124 ppb   (ppb)
GSCM  10/01/97     14         02        02        174
MAHM  10/08/97     12         02        02        203
MORA  10/14/97     13         01        01        242
SHBM  10/17/97     10         02        01        157
Totals                       007       006        242
```

Figure 4-10. Example Ozone Hit List.

To generate the ozone hit list:

- Collect the raw stackplots for all sites for the month.
- Launch the IMC application.
- From the "Reports" menu, select **Batch Printing**.
- Select the *month/year* to report in the beginning month and year boxes.
- Select the same *month and year* in the ending month and year boxes.
- Click the **Select All** button to select all sites.
- Deselect the **Send to Printer** box.
- Select **O_3 - RAW Episodes with Concentrations > 100 ppb**.
- Click **GO.** The message "Writing Reports/Files for *xxxx* RAW Ozone > = 100 ppb" appears, where *xxxx* is the four-letter abbreviation for the site). When finished, a table containing the ozone episodes is displayed.

- Examine the raw plots compared to the table on the screen and deselect the events that are not real ozone events. Click the **check box** to the right of the row to remove the checkmark. Unmarked rows are not be printed.

- Click **Print to File** to create an ASCII file.

- Click **Print** to generate a printed copy.

4.3.2 Distributing the Monthly Ozone Hit List

The monthly ozone hit list is distributed by e-mail to:

- The NPS ARD.

- The field maintenance group project manager.

- Each member of the IMC staff.

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	**AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA ANNUAL REPORTING**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3550-5100**
DATE	**MARCH 1999**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Betsy Davis-Noland	
PROJECT MANAGER	Robert Deemer	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
NPS COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change all procedures for the DataView system	January 2001	

TABLE OF CONTENTS

Section **Page**

1.0 PURPOSE AND APPLICABILITY 1

2.0 RESPONSIBILITIES 1

2.1 IMC Manager 1
2.2 Data Analyst and Data Technician 1
2.3 Technical Assistant 1

3.0 REQUIRED EQUIPMENT AND MATERIALS 1

4.0 METHODS 2

4.1 Annual Data Report Contents 2
4.2 Non-Network Data 5

4.2.1 Retrieving and Downloading Data From AIRS 5
4.2.2 Importing AIRS Data into the AQDBMS Database 6

4.3 Generating Annual Data Reports 6

4.3.1 Verifying Final Validation Status 6
4.3.2 Generating Report Tables and Data Files 7
4.3.3 AQDBMS Graphics Products 12

4.3.3.1 Description of AQDBMS Products 13
4.3.3.2 Creating Plots From the AQDBMS Graphics Programs 13
4.3.3.3 Creating Plots for Multiple Sites From the AQDBMS Graphics Programs 14

4.3.4 Generating Report Text Pages 15
4.3.5 Generating Report Maps 16

4.4 Reviewing Reports 16

4.4.1 Generating Digital Data Products 17

4.5 Distribution 18

5.0 REFERENCES 18

LIST OF FIGURES

Figure **Page**

4-1 The Data Validation Log 7

4-2 The Reports Interface 8

LIST OF FIGURES (CONTINUED)

Figure		Page
4-3	The Dates Tab Page	9
4-4	The Sites Tab Page	9
4-5	The Parameters Tab Page	10
4-6	The Options Tab Page	11
4-7	The Destinations Tab Page	12
4-8	Example Report Review Form	17

LIST OF TABLES

Table		Page
4-1	Report Product Distribution	18

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). A report is generated for each network site where monitoring occurred during the reported year. The National Park Service Air Resources Division (NPS ARD) may request that data from specific non-network sites be reported also.

2.0 RESPONSIBILITIES

2.1 IMC MANAGER

The IMC manager shall:

- Verify that Final data validation has been successfully completed for annual reported data.
- Prepare and forward the annual data reports.

2.2 DATA ANALYST AND DATA TECHNICIAN

The data analyst and data technician shall assist the IMC manager with the preparation, review, and distribution of annual data reports.

2.3 TECHNICAL ASSISTANT

The technical assistant shall:

- Word process the text portions of the reports.
- Generate the maps and site specification pages for each report.
- Copy and mail the reports to each recipient.

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:
  - Draft printer
  - 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

Separate annual reports are produced for each site collecting data during the monitoring period. In addition, annual reports are generated for selected NPS sites that are not part of the NPS Ambient Air Quality Network. At these sites, data were collected, validated, and submitted to the EPA's Aerometric Information Retrieval System (AIRS) database by another agency. These data are downloaded from AIRS and loaded into the Air Quality Data Base Management System (AQDBMS) database. Annual data summary schedules are completed and distributed by April following the reported year. Following approval by the contracting officer's technical representative (COTR) by the schedule, the annual data summary reports are completed and distributed by August 31st.

This section contains the following five (5) major subsections:

4.1 Annual Data Report Contents
4.2 Non-Network Data
4.3 Generating Annual Data Reports
4.4 Reviewing Reports
4.5 Distribution

4.1 ANNUAL DATA REPORT CONTENTS

Before generating report contents, the IMC manager determines which sites are to be reported and the output that needs to be included in each site's report. A master checklist is created to track this large volume of output.

Each annual data summary report contains the following sections and products:

- Section 1.0 Introduction:

  - A description of the monitoring network including a site map.

  - A detailed description of the individual monitoring site including a site specifications map.

- Section 2.0 Data Summary:

  - Data collection statistics.

  - Stackplots of all parameters, one for each quarter year.

  - Summary of selected meteorological data.

  At sites where wind speed and wind direction were collected, this section also includes:

  - Quarterly wind rose plots.

  - Annual wind rose plot.

  At sites where ozone was monitored during the year, this section also includes:

  - Ozone precision check data summary.

  - Ozone quick look annual summary statistics.

  - Ozone annual frequency distribution.

  - Ozone standards report and maximum 1-hour concentrations.

  - Ozone daily 1-hour maximum concentrations and National Ambient Air Quality Standards comparison.

  - Attainment status with EPA proposed primary ozone standards.

  - Ten highest daily 1-hour average ozone concentrations.

  - Episodes with 1-hour ozone concentrations > 100 ppb and ≥ 124 ppb.

  - Episodes with 8-hour ozone concentrations > 84 ppb.

  - Ozone rank listings of second highest 1-hour average concentrations, maximum 8-hour average concentrations, and annual Sum60 Exposure Index for all NPS monitoring sites.

  - Plot of maximum ozone concentration comparison for three years.

  - Map of National Park Service Ambient Air Quality Network, second highest hourly ozone concentrations.

  - Quarterly diurnal ozone plots.

  - Annual diurnal ozone plot.

At sites where sulfur dioxide was monitored during the year, this section also includes:

- Sulfur dioxide precision check data summary.
- Sulfur dioxide quick look annual summary statistics.
- Sulfur dioxide annual frequency distribution.
- EPA proposed primary sulfur dioxide standards attainment status.
- Five highest daily 1-hour average, five highest 3-hour block average, and five highest 24-hour average sulfur dioxide concentrations.
- Sulfur dioxide standards report and daily maximum 1-hour concentrations table.
- Sulfur dioxide standards report and daily maximum 3-hour concentrations table.
- Sulfur dioxide standards report and daily maximum 24-hour concentrations table.
- Sulfur dioxide three-year comparison of second highest concentrations.
- Quarterly diurnal sulfur dioxide plots.
- Annual diurnal sulfur dioxide plot.

At each site where a supplemental sulfur dioxide monitor collected data during the year, this section also includes:

- Supplemental sulfur dioxide precision check summary.
- Supplemental sulfur dioxide five highest daily 1-hour averages, 3-hour block averages, and 24-hour block averages.
- Supplemental sulfur dioxide three-year comparison of second highest concentrations.
- Quarterly diurnal supplemental sulfur dioxide plots.
- Annual diurnal supplemental sulfur dioxide plot.
- Quarterly supplemental sulfur dioxide pollutant roses.
- Annual supplemental sulfur dioxide pollutant rose.

At sites where NDDN aerosol samples were taken during the year, this section also includes:

- Quarterly and annual average concentrations.
- Weekly concentrations report.
- Three-year comparison of maximum and average concentrations.

- Average particulate nitrate concentrations.
- Nitric acid concentrations.
- Average total nitrate concentrations.
- Average ammonium concentrations.
- Average particulate sulfate concentrations.
- Average sulfur dioxide concentrations.
- SO_4/SO_2 ratio.

- Section 3.0 National Park Service Air Resources Division Data Sources:
  - Data diskette.
  - NPS IMC and AIRS invalid data codes.
  - Other sources for retrieving NPS gaseous pollutant data.
- Section 4.0 Glossary:
  - Definitions and computational procedures for NPS quick look annual summary statistics table.
  - Air quality glossary
  - Air quality units

4.2 NON-NETWORK DATA

The NPS ARD provides a list of non-network sites at NPS units that are reported in addition to the network sites for each annual reporting period. Data for these sites were collected, validated, and submitted to the EPA AIRS database by other agencies. Data are retrieved from AIRS and loaded into the AQDBMS database to facilitate production of annual data summary reports for these sites.

4.2.1 Retrieving and Downloading Data From AIRS

The AQDBMS includes a program for loading data from Type 1 (one-hour average data) AIRS records. Before the data can be imported, however, they must be retrieved and downloaded from AIRS. Refer to Section 5.0, Retrieving and Downloading Data From AIRS, in the *Air Quality Data Base Management System (AQDBMS) EPA AIRS Reference* (ARS, 1999).

4.2.2 Importing AIRS Data into the AQDBMS Database

In order for all data from an AIRS file to be successfully imported, site and parameter information must be defined in the AQDBMS database for the AIRS codes encountered during the import. If the program finds undefined codes, an error message is written to a log file, and the undefined AIRS record is written to a redo file. The IMC manager 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, *Maintenance Responsibilities for the Ambient Air Quality Data Base Management System (AQDBMS).* Refer to Section 2.11, Importing Data From AIRS Transaction Files, in the *Air Quality Data Base Management System (AQDBMS) User's Guide* (ARS, 2001) for instructions on importing a downloaded AIRS file into the AQDBMS database.

4.3 GENERATING ANNUAL DATA REPORTS

The steps taken to produce each annual data summary report are:

- Verify completion of final data validation of the reported data.
- Generate report tables.
- Generate stackplot data files.
- Generate monthly columnar data files.
- Generate report plots.
- Generate text pages.
- Generate map pages.

The following subsections explain how each step is accomplished.

4.3.1 Verifying Final Validation Status

Before an annual data summary report for a site 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 4-1). A Data Validation Log record must also exist for each non-network site to be reported.

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:

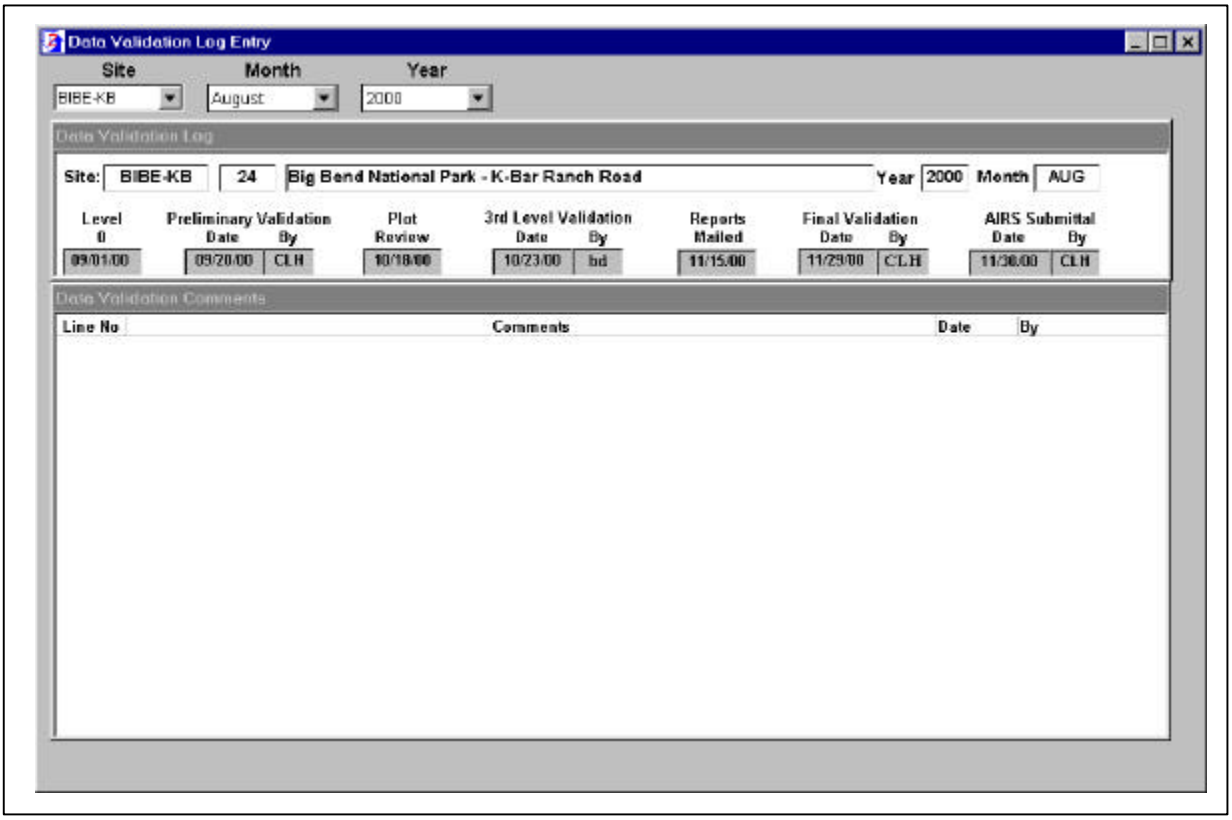


Figure 4-1. The Data Validation Log.

- 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.

4.3.2 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 4-2. A tab control has been 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.

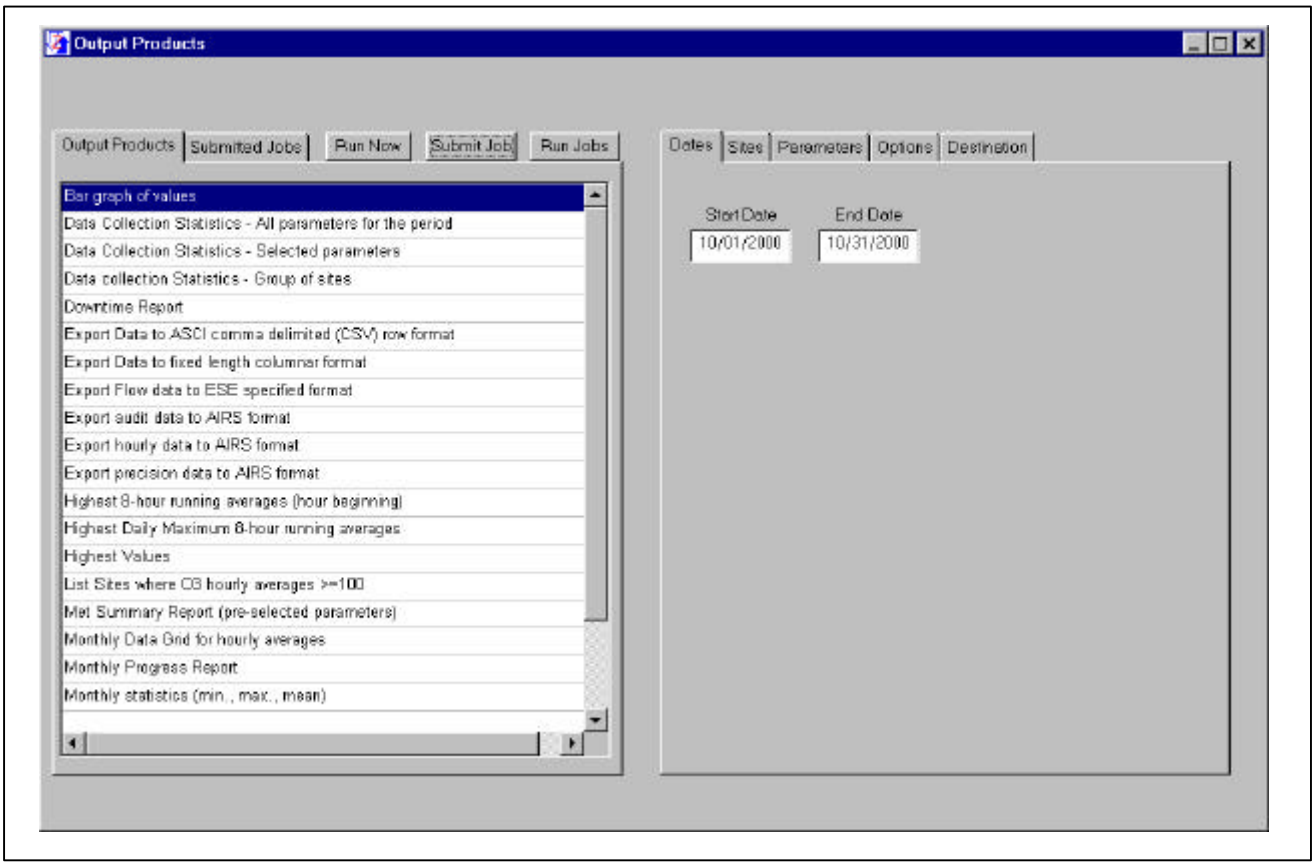


Figure 4-2. The Reports Interface.

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 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 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 discussed below:

1. The Dates 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 4-3.

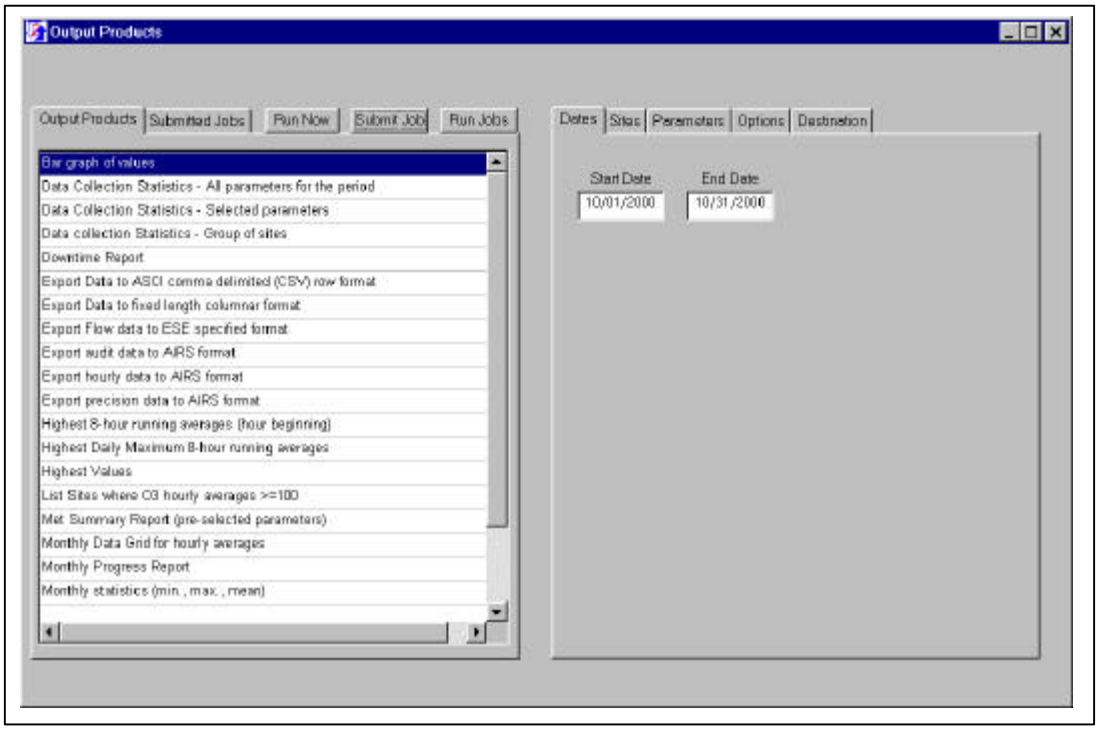


Figure 4-3. The Dates Tab Page.

2. The Sites tab page 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 4-4 shows the Sites tab.

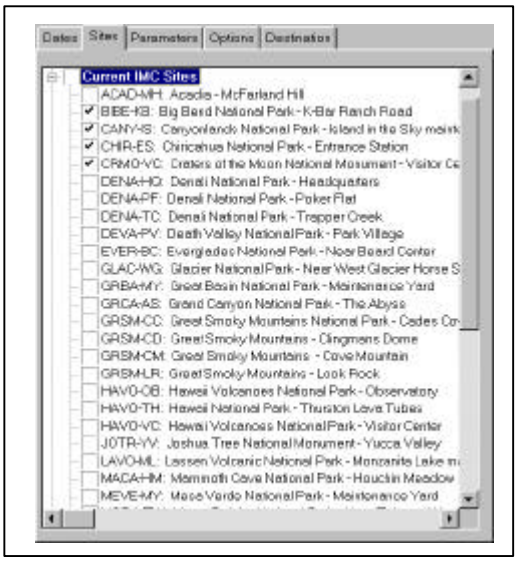


Figure 4-4. The Sites Tab Page.

3. The Parameters tab page displays a list of all parameters as shown in Figure 4-5. 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*.

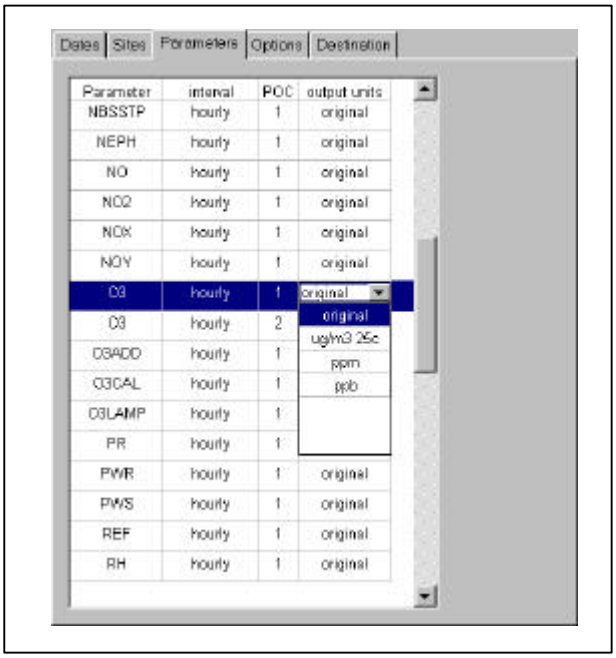


Figure 4-5. The Parameters Tab Page.

4. The Options 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 4-6. 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 filed 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.

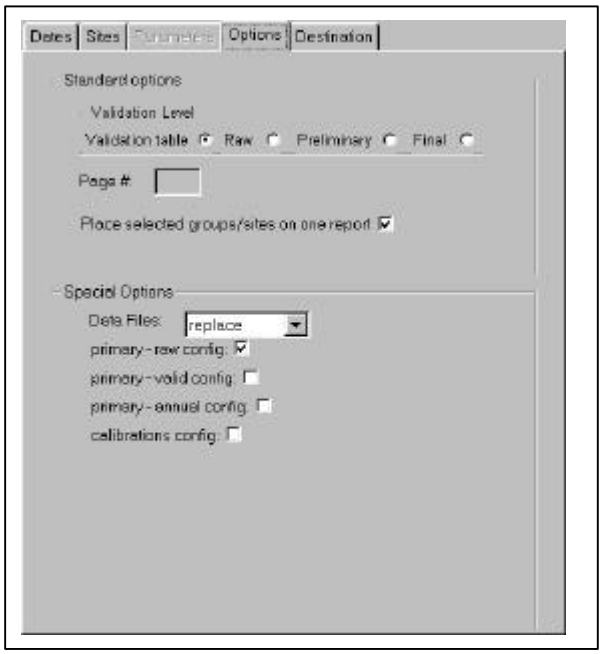


Figure 4-6. The Options Tab Page.

5. The Destinations tab displays options on the type of output to produce as shown in Figure 4-7. 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 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.

- 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.

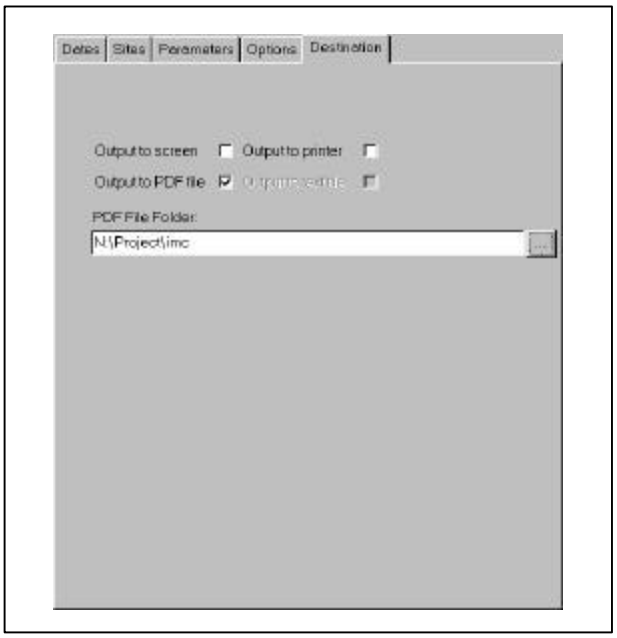


Figure 4-7. The Destinations Tab Page.

4.3.3 AQDBMS Graphics Products

Four programs are provided to create graphical representations of AQDBMS data directly from the database. 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

4.3.3.1 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 parameters. 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.

4.3.3.2 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.
- 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*).

- 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.

4.3.3.3 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 Word for Windows).
- One 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.

- 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:

- 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**.

4.3.4 Generating Report Text Pages

Text pages in the annual data summary reports are standardized, except for Section 1.2, which describes the specific site the report is for. All text pages are generated in Microsoft Word97 word processing software. The standard pages include:

- Section 1.1 The National Park Service Gaseous Pollutant Monitoring Network

- Section 2.2 Overview of the Data Summary Section

- Section 3.1 Guide to Attached Data Disks

- Section 3.2 Other Sources for Retrieving National Park Service Gaseous Pollutant Data
- Section 4.1 Definitions and Computational Procedures for National Park Service Quick Look Annual Summary Statistics Table
- Section 4.2 Air Quality Glossary

4.3.5 Generating Report Maps

Three standard maps are included in the annual data summary report:

- Map of National Park Service Gaseous Pollutant Monitoring Network Ozone and Sulfur Dioxide Monitoring Sites
- Map of National Park Service Gaseous Pollutant Monitoring Network Ozone and Sulfur Dioxide Monitoring Sites
- Second Highest 1-Hour Ozone Concentrations

These maps are generated by importing the longitude and latitude 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. For the first map, a variety of symbols are applied to the plotted points to indicate different types of site configurations. For the second map, the second highest ozone concentration in parts per billion (ppb) is given for each site. The rank of each concentration is visually represented by the size of the plotted point.

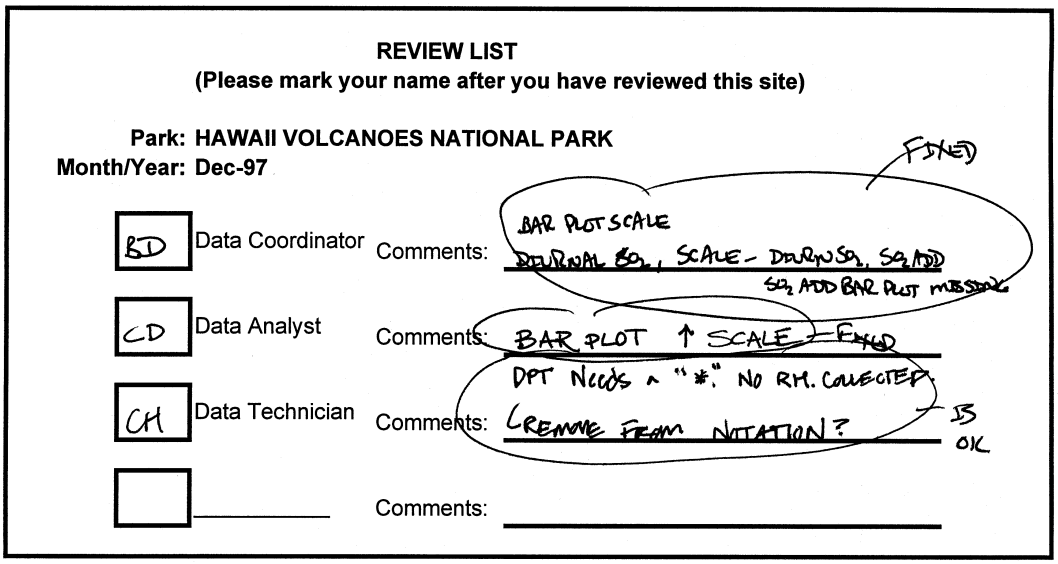
Each report also includes a site specification page for the site the report is for. This page includes:

- A scanned image of a topographic map of the site location and surrounding area.
- A small insert of a state map indicating the location of the site within the state.
- A scanned image of a photograph of the site installation.
- The site coordinates, abbreviation, AIRS codes, instrumentation list, and map information.

The scanned images are created using a high-resolution, flat-bed scanner and scanning software. The pieces are then assembled in Microsoft Word97.

4.4 REVIEWING REPORTS

A report review form is attached to each report and is used to log comments and error corrections to the reports and/or data during the review process. An example report review form is shown in Figure 4-7.



REVIEW LIST
(Please mark your name after you have reviewed this site)

Park: HAWAII VOLCANOES NATIONAL PARK
Month/Year: Dec-97

FIXED

BD Data Coordinator Comments: BAR PLOT SCALE ~~DOURNAL SO2, SCALE - DOURN SO2, SO2 ADD~~ SO2 ADD BAR PLOT MISSING

CD Data Analyst Comments: BAR PLOT ↑ SCALE - FIXED

DPT NEEDS A "*". NO RH. COLLECTED.

CH Data Technician Comments: ~~REMOVE FROM NOTATION?~~ IS OK

_____ Comments:

Figure 4-7. Example Report Review Form.

Each annual data summary report is reviewed by at least three IMC staff people. If errors are found, corrections are made and the affected report contents regenerated. After the review period is complete, the report review form is removed from the report and filed in the IMC for six months.

4.4.1 Generating Digital Data Products

The following products are generated for inclusion with annual data summary reports:

- One file per site/month containing data for all parameters in fixed width columns. These files are generated by the "Fill Data Request" program in the AQDBMS. See Section 8.0, Filling Data Requests, in the *Air Quality Data Base Management System (AQDBMS) User's Guide* (ARS, 2001) for instructions.

- One file per site/month/parameter containing the data value or validation code for each data point in a table where the days are rows and the columns the hours of the day. Hourly, daily, and monthly statistics are included. These files are generated by the selecting the "Monthly Grids for Selected Parameters" option in the "Batch Printing" program in the AQDBMS. See Section 6.0, Output Products, in the *Air Quality Data Base Management System (AQDBMS) User's Guide* (ARS, 2001) for instructions.

- Five rose plot frequency distribution files (containing annual, quarter 1, quarter 2, quarter 3, or quarter 4 data) per site/parameter where parameter is wind speed, ozone, or sulfur dioxide. See Section 6.3.4, Plot-Specific Options in the AQDBMS Graphics Programs, in the *Air Quality Data Base Management System (AQDBMS) User's Guide* (ARS, 2001) for instructions.

4.5 DISTRIBUTION

The unbound original pages and one bound copy of each annual data summary report are filed in the IMC. The originals are kept on file in the IMC permanently. Eleven copies of each report are made. In addition, four CD-ROMs containing all digital data products for all sites and five 3.5" high-density diskettes for each site containing the digital data products for the site are created. The reports, CD-ROMs, and diskettes, are distributed as detailed in Table 4-1:

Table 4-1

Report Product Distribution

Recipient	Unbound Report	Bound Report	CD	Diskette
Site operator		1		
Park superintendent		2		1
NPS ARD	1	2	3	
NPS Regional Air Quality Coordinator		1		
TIC (NPS Clearinghouse)	1			
Non-NPS Agency Site Operators		1		
IMC Contractor (ARS)	1	1	2	
Totals	3	8	5	1

5.0 REFERENCES

Air Resource Specialists, Inc. (ARS), 1999, Air Quality Data Base Management System (AQDBMS) EPA AIRS Reference.

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	**HANDLING REQUESTS FOR AMBIENT AIR QUALITY AND METEOROLOGICAL MONITORING DATA**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3550-5200**
DATE	**MARCH 1999**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Betsy Davis-Noland	
PROJECT MANAGER	Robert Deemer	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
NPS COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change all procedures to the DataView system	January 2001	

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
2.1	IMC Manager	1
2.2	Data Analyst and Data Technician	1
2.3	Technical Assistant	1
2.4	Database Administrator/Programmer	1
3.0	REQUIRED EQUIPMENT AND MATERIALS	1
4.0	METHODS	2
4.1	The Data Request Form	2
4.2	Authorization of Data Requests	2
4.3	Generating Data Files for Data Requests	4
4.4	Other Types of Data Requests	8
4.5	Delivering Data Requests	8
5.0	REFERENCES	10

LIST OF FIGURES

Figure		Page
4-1	Example Data Request Form	3
4-2	The Reports Interface	4
4-3	The Dates Tab Page	5
4-4	The Sites Tab Page	5
4-5	The Parameters Tab Page	6
4-6	The Options Tab Page	7
4-7	The Destinations Tab Page	8

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), 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. This TI is referenced from SOP 3550, *Ambient Air Quality and Meteorological Monitoring Data Reporting*.

2.0 RESPONSIBILITIES

2.1 IMC MANAGER

The IMC manager shall:

- Handle all data requests.
- Communicate with the NPS ARD regarding data requests.

2.2 DATA ANALYST AND DATA TECHNICIAN

The data analyst and data technician shall assist the IMC manager with data requests as needed.

2.3 TECHNICAL ASSISTANT

The technical assistant shall:

- Help prepare supporting documentation and/or correspondence related to data requests.
- Mail/ship data requests to the recipient as needed.

2.4 DATABASE ADMINISTRATOR/PROGRAMMER

The database administrator/programmer shall create custom data summaries, data listings, or graphics, for data requests requiring non-standard output.

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:
  - Draft printer
  - 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 ARD or IMC and forwarded to the IMC manager to fill. This section contains the following five (5) major subsections, which detail the steps taken to complete data requests:

4.1 The Data Request Form
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 REQUEST FORM

The Data Request Form is used to log all pertinent information about an individual data request. An example completed Data Request Form is shown in Figure 4-1. The IMC staff person receiving the request fills in the request information on the form. It is then forwarded to the IMC manager. The IMC manager completes the form as the data request is processed. The completed form is permanently filed in the IMC.

4.2 AUTHORIZATION OF DATA REQUESTS

Data requests that can be handled through the standard output interface require only that the NPS ARD be advised. The NPS ARD must authorize each non-standard data request before processing the request. Data requests made via the NPS ARD have an implied authorization. Otherwise, details of the data request are forwarded to the NPS ARD by telephone, e-mail, or fax. Authorization is returned to the IMC also by telephone, e-mail, or fax. Authorization is noted on the Data Request Form.

Some data requests can be unusually complex or require large volumes of data or non-standard output. In these cases, the IMC manager must estimate the amount of time and materials needed to fill the request and communicate this information to the NPS ARD. Doing so will allow the ARD to judge if filling the request is an appropriate use of the IMC manager's time or if the scope of the request needs to be negotiated with the requester.

Air Resource Specialists, Inc.

Date 5/2/97

DATA REQUEST

By John Faust To Edie Forward To

Name Carl Key Authorization Dave Joseph

Affiliation Glacier National Park Purpose

Address carl_key@nps.gov
or
carl-key@usgs.gov

Phone (406) 888-7991

Date needed by Charge To NPSIMC3-ORIG

Request details All parameters Jan95 - March 95
(GLAC95.DAT)

Date Completed 5/5/97 Shipped Via e-mail

Notes Zipped letter, attachment, and data into GLAC195.ZIP. e-mailed that.

E:\users\ari\forms\general\datareq.frm

Figure 4-1. Example Data Request Form

4.3 GENERATING DATA FILES FOR DATA REQUESTS

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 4-2. A tab control has been 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.

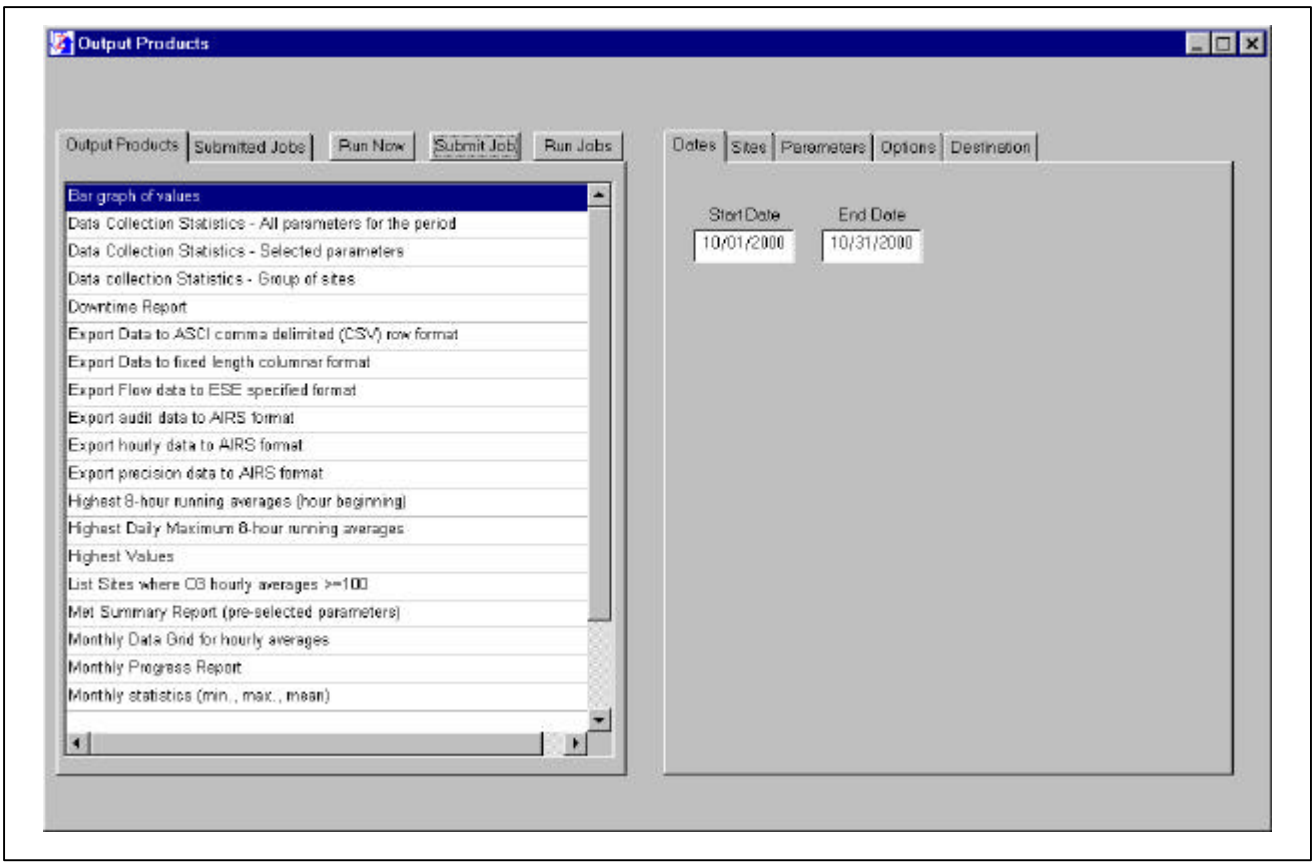


Figure 4-2. The Reports Interface.

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 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 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 discussed below:

1. The Dates 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 4-3.

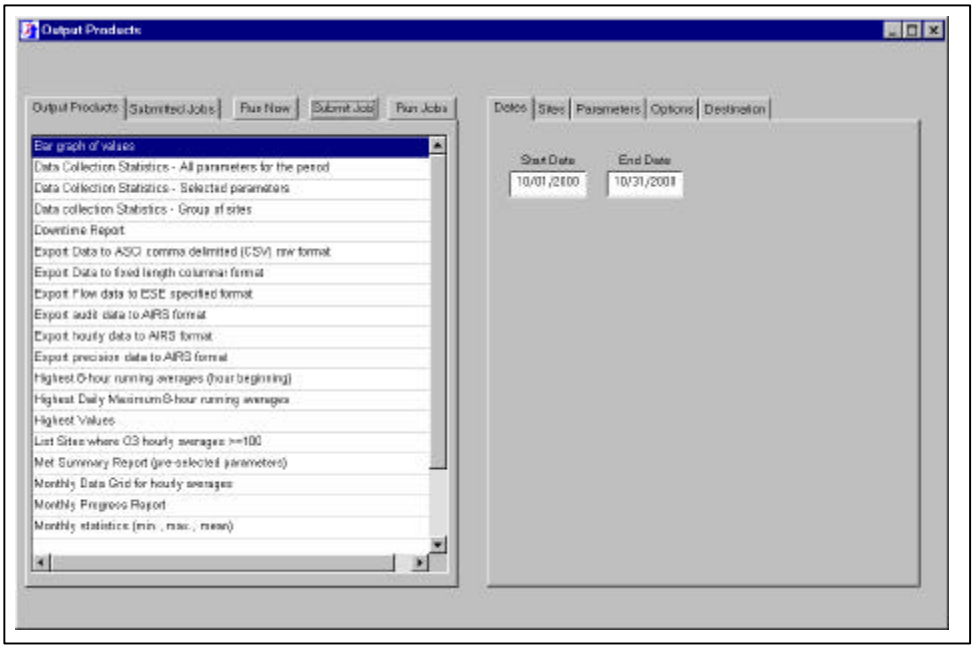


Figure 4-3. The Dates Tab Page.

2. The Sites tab page 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 4-4 shows the Sites tab.

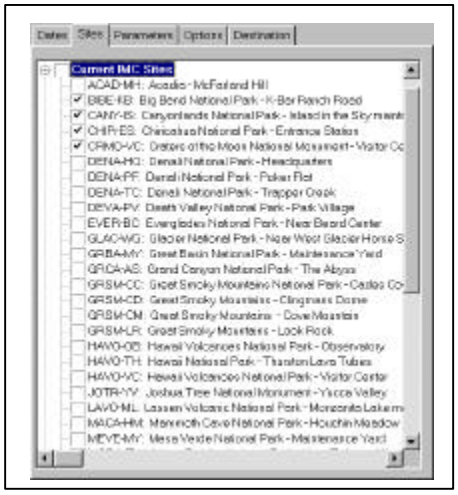


Figure 4-4. The Sites Tab Page.

3. The Parameters tab page displays a list of all parameters as shown in Figure 4-5. 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*.

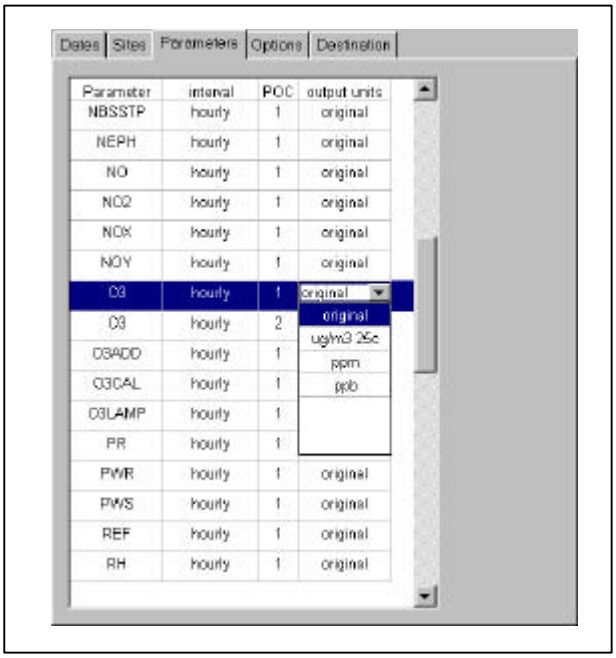


Figure 4-5. The Parameters Tab Page.

4. The Options 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 4-6. 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 filed 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.

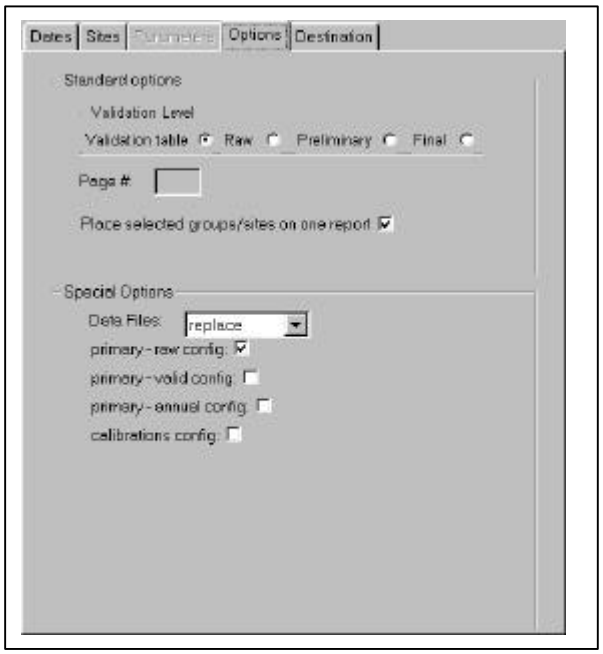


Figure 4-6. The Options Tab Page.

5. The Destinations tab displays options on the type of output to produce as shown in Figure 4-7. 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 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.

- 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.

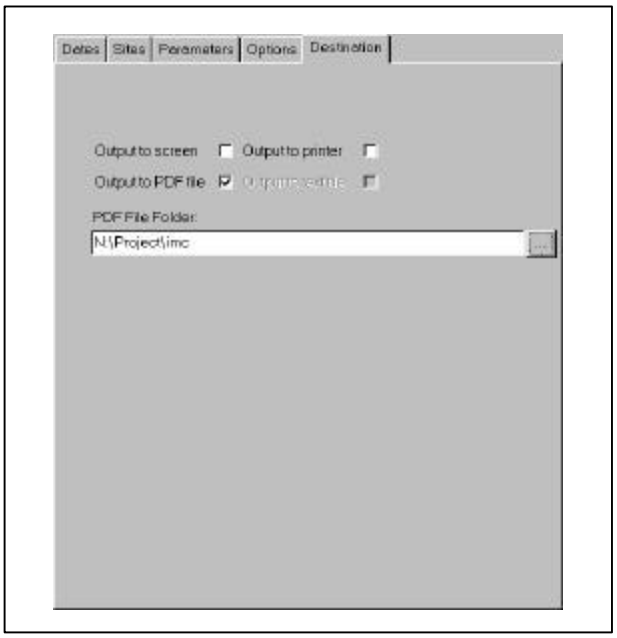


Figure 4-7. The Destinations Tab Page.

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 AQDBMS application at any time. Refer to TI 3550-5000, *Ambient Air Quality and Meteorological Monitoring Data 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, 1999) 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 IMC manager works with the database administrator/programmer to generate the necessary output.

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:

- Written to 3.5" computer diskette(s) and mailed.
- Written to CD-ROM and mailed.
- Transmitted via an e-mail attachment.
- Downloaded by the recipient from the ARS ftp site.

If data files are written to computer diskettes or CD-ROM:

- The IMC manager copies the files to the appropriate media and labels each piece as to its contents.

- The diskette(s) and shipping information for the recipient are forwarded to the technical assistant who generates a cover letter from the standard form in *\\ars_net3\project\npsair\data_req\masterlt.doc* and the standard attachment from *\\ars_net3\project\IMC\data_req\masterat.doc*.

- The IMC manager signs the letter and the package is sent first class mail unless directed otherwise by the ARD.

If the data files are transmitted via an e-mail attachment:

- A text file version of the cover letter and standard attachment (*\\ars_net3\project\npsair\data_req\masterlt.txt* and *\\ars_net3\ project\npsair\data_req\masterat.txt*) is used to create an e-mail message.

- The data file(s) are attached to the e-mail message and the message sent.

- The message requests a response from the recipient regarding if the data request was successfully received or not. If a response is not received within three working days, the IMC manager follows up with a telephone call to the recipient.

If the data files are to be downloaded from the ARS ftp site:

- The files are uploaded to the site.

- A text file version of the cover letter and standard attachment (*\\ars_net3\project\npsair\data_req\masterlt.txt* and *\\ars_net3\ project\npsair\data_req\masterat.txt*) is used to create an e-mail message. The message also includes instructions for downloading the files.

- The message is sent.

- The message requests a response from the recipient regarding if the data request is successfully downloaded or not. If a response is not received within three working days, the IMC manager follows up with a telephone call to the recipient.

- The files are removed from the ftp site after it is confirmed that the recipient has successfully retrieved them.

After the request is completed and delivered, copies of any related documentation, including cover letters, attachments, and e-mail messages, are attached to the completed data request form and filed. The data request is also logged in an Excel spreadsheet file located in *\\ars_net3\project\npsair\dpc\reqstsyy.xls* where *yy* is the contract year. The first sheet in the Excel workbook lists all requests filled during the contract year. Each subsequent sheet represents one month of data requests for the year. A list of all requests filled during the month are included in the monthly progress 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 AIRS DATABASE**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3550-5300**
DATE	**MARCH 1999**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Betsy Davis-Noland	
PROJECT MANAGER	Robert Deemer	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
NPS COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change procedures for generating AIRS files.	January 2001	

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
2.1	IMC Manager	1
2.2	Data Analyst and Data Technician	1
3.0	REQUIRED EQUIPMENT AND MATERIALS	1
3.1	System Hardware and Software Requirements	1
3.2	Communications Requirements	2
3.3	EPA AIRS Training and Documentation	2
4.0	METHODS	2
4.1	Generating AIRS Files From the AQDBMS	3
4.1.1	Hourly Average Files	3
4.1.2	Precision Data AIRS Files	4
4.1.3	Accuracy Data AIRS Files	5
4.2	Transferring an AIRS File to AIRS	5
4.3	Preparing Submit Files for Update to the AIRS Database	6
4.3.1	Loading Data into the Screening File	6
4.3.2	Editing Data in the Screening File	7
4.3.3	Fixing Errors in the Screening File	8
4.3.4	Locking the Screening File for Update	8
5.0	REFERENCES	9

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) Aerometric Information Retrieval System (AIRS) database. These data include hourly average ambient air quality and meteorological data, precision data from criteria pollutant analyzer precision checks, and accuracy data from audit reports on criteria pollutant analyzers.

All data and associated AIRS codes required for creating AIRS transactions are stored in the Air Quality Data Base Management System (AQDBMS). Computer programs within the AQDBMS create the AIRS transaction files and data are submitted on a quarterly basis 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 IMC MANAGER

The IMC manager shall:

- Maintain the required AIRS codes for all sites and parameters within the monitoring network within the AQDBMS and in AIRS.
- Be adequately trained in operating the EPA AIRS interface and be familiar with the set of EPA-issued AIRS documentation.
- Be responsible for generating and submitting hourly ambient and meteorological data and precision and accuracy data to the EPA AIRS on at least a quarterly basis.

2.2 DATA ANALYST AND DATA TECHNICIAN

The data analyst and data technician shall assist the IMC manager with generating and submitting hourly ambient and meteorological data and precision and accuracy data to the EPA AIRS database.

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 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:
  - Draft printer
  - 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 AIRS requires connecting directly to AIRS in two different ways:

- An Internet connection for using FTP (file transfer protocol) software to transfer the AIRS files from the IMC to AIRS. This can be a direct connection or a model connection through an Internet service provider.
- A terminal emulation connection for logging into AIRS and issuing the necessary commands for loading, screening, and locking the transaction files for update to the AIRS database. This can be a direct Internet connection using Telnet software or a direct dial modem connection.

3.3 EPA AIRS TRAINING AND DOCUMENTATION

The EPA provides regularly scheduled training sessions on the EPA AIRS. The IMC manager 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 AIRS. The IMC manager is familiar with and will use this documentation as a supplement to this TI and when working within AIRS.

4.0 METHODS

All data at the Final validation level are submitted to AIRS on a quarterly basis. The data include hourly average ambient air quality and meteorological data, precision data from criteria pollutant analyzer precision checks, and accuracy data from audit reports on criteria pollutant analyzers.

This section contains the following three (3) major subsections, which detail the steps taken to complete data submittal to AIRS:

4.1 Generating AIRS Files From the AQDBMS
4.2 Transferring an AIRS File to AIRS
4.3 Preparing Submit Files for Update to the AIRS Database

The steps required to submit data to the EPA AIRS database are:

- Create AIRS transaction files for hourly average ambient air quality and meteorological data.
- Create AIRS transaction files for precision data from criteria pollutant analyzer precision checks (typically one per week per site/analyzer).
- Create AIRS 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 AIRS using FTP (file transfer protocol).
- Load data into the AIRS screening file(s), successfully run the AIRS edit programs, and lock the screening file(s) for update to the AIRS database.

Refer to the *Air Quality Data Base Management System (AQDBMS) EPA AIRS Reference* (ARS, 1999) for detailed information about submitting data to AIRS.

4.1 GENERATING AIRS FILES FROM THE AQDBMS

4.1.1 Hourly Average Files

Hourly average ambient air quality and meteorological data must be formatted as AIRS Type 1 transactions to be submitted to AIRS. A program in the AQDBMS generates Type 1 transaction files.

To generate transaction Type 1 AIRS files:

- From the AQDBMS, select **AQ and Met Processing**.
- Select **Reports**.
- Select **Export Hourly Data to AIRS Format**.
- Select the *sites*, *parameters*, and *dates* of the data set to use.
- The Site List box is filled with site abbreviations of the sites that have one-hour average data for the time period selected.
  - To select all sites, click the **add all** button.
  - To select a group of sites from the list, click on the *first site* in the group then hold down the **<Shift>** key and click the *last site*. The two clicked sites and all sites in between will be selected. Click the **add** button.
  - To select multiple sites not in a group, click on the *first site* you want then hold down the **<Ctrl>** key as you click *additional sites*. Click the **add** button.

- Click the **Run** button.

A file called AIRS.DAT is written to the *\\ars_net3\vol4\project\npsair\imc\airs* 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 AIRS 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 AIRS data file. If the information is wrong, problems will occur in AIRS.

- If a site does not exist for the entire period that was selected, only the period when valid data exist will be written to the file (i.e., nothing will be written for the times when there are no data). Likewise, if a parameter is chosen and a site does not have that monitor, then that parameter will be skipped.

- Each parameter's associated AIRS code, method code, and POC code is defined in the Parameter Codes Table, under *table maintenance*.

4.1.2 Precision Data AIRS Files

The weekly precision checks conducted on criteria pollutant analyzers within the network are submitted to AIRS as precision or Type 7 transactions. A program in the AQDBMS generates Type 7 transaction files.

To generate transaction Type 7 AIRS files:

- From the AQDBMS, select **AQ and Met Processing**.

- Select **Reports**.

- Select **Export Precision Data to AIRS Format**.

- Select the *sites*, *parameters*, and *dates* of the data set to use.

- The Site List box is filled with site abbreviations of the sites that have one-hour average data for the time period selected.

- Click the **Run** button.

A file called PARS.DAT is written to the *\\ars_net3\vol4\project\npsair\imc\airs\pars* 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 AIRS Files

Data from annual or semiannual audits conducted on criteria pollutant analyzers within the network are submitted to AIRS as accuracy or Type 8 transactions. A program in the AQDBMS generates Type 8 transaction files.

To generate transaction Type 8 AIRS files:

- From the AQDBMS, select **AQ and Met Processing**.
- Select **Reports**.
- Select **Export Audit Data to AIRS Format**.
- Select the *sites*, *parameters*, and *dates* of the data set to use.
- The Site List box is filled with site abbreviations of the sites that have one-hour average data for the time period selected.
- Click the **Run** button.

A file called AUDIT.DAT is written to the *\\ars_net3\vol4\project\npsair\imc\airs\pars* 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 AIRS FILE TO AIRS

Once the AIRS data file is generated, the file is now ready to be sent to the AIRS mainframe. To transfer that file, use the program named "FTP", which is included with any copy of Windows 95.

To transfer an AIRS file using FTP:

- Click on the **FTP icon**.
- A screen similar to a DOS prompt is displayed, except with an FTP prompt that looks like: ftp>
- At the FTP prompt, connect to the AIRS mainframe by typing **open epaibm.rtpnc.epa.gov,** then press the **<Enter>** key. This is the Internet address of the AIRS system. Some header information will be displayed including the time and date of the connection. Enter your *AIRS userid* when prompted and press **<Enter>**.
- Enter your *AIRS password* and press **<Enter>**. If everything was entered correctly, a message is displayed stating that you are now logged in and displaying your working directory.

Note: If your information was entered incorrectly, the mainframe will tell you that the logon was rejected. You will need to type the following command at the FTP prompt: **user *userid***. The "user" command tells the remote system that you are going to logon as this user. Then, enter your *password* again.

- If you are sending an ASCII file, type **quote "site recfm=fb lrecl=80 blocksize=6160 primary=58 secondary=50 cy"**, then press **<Enter>.**
  -or-
  If you are sending a zipped file (a compressed file with a .zip file extension), type **quote "site recfm=u lrecl=6160 blocksize=6160 primary=58 secondary=50 cy"**, then press **<Enter>.** If the line was type correctly, it should respond with: "200 Site command was accepted."

- If you are sending an ASCII file, type **type ascii**, then press **<Enter>.**
  -or-
  If you are sending a zipped file, type **type binary**, then press **<Enter>.**

- Type **lcd *path*** where *path* is the location of the AIRS file on your computer or file server. For example, *\\ars_net3\vol2\project\npsair\dpc\airs* is the default directory for primary data.

- Type **put *filename*** where *filename* is the name of your AIRS data file. For example, Y97Q1.DAT.

- After a few seconds (or minutes depending on how large the file is) the FTP prompt will return and tell you that the transfer was successful.

- Type **close** to disconnect from the AIRS mainframe.

- Type **quit** to end the FTP session.

  Note: The above commands tell the mainframe some details about the file that you are about to send. Know which type of file you are sending and do not skip these steps because the mainframe will not be able to correctly read the file if you do.

4.3 PREPARING SUBMIT FILES FOR UPDATE TO THE AIRS DATABASE

Four general steps are involved in the process of preparing a submit file for update to the main AIRS database. All of these steps take place while you are logged into the AIRS mainframe. This section summarizes the processes of loading and editing data in the screening file in AIRS. The process of setting up multiple sessions in AIRS to facilitate the editing process is also included in this section.

4.3.1 Loading Data into the Screening File

Each data set to be updated to the AIRS database must be loaded into the screening file. To load data into the screening file:

- Log into AIRS.
- At the main AIRS menu, select option **1** (Air Quality Subsystem).
- Enter the screening file password (**hack**).
- Tab to the appropriate screening file (O88AQD01 or O88AQD02 for hourly data, O88AQDSI for site and/or monitor data), type **S** next to the screening file name, then press **<Enter>.**
- A menu with six options is displayed. Select option **1** (Submit Data). Another menu is displayed.
- Select option **1** (Load Data). The next screen is displayed and prompts what data set you want to load into the screening file. Type the *account qualifier and dataset name* in single quotes, then press **<Enter>**. The data set name will be the same as the file name uploaded in Section 3.0. For example, **'BFBNPSD.MAY97.DAT'**.
- Write down the job number for reference, in case an error occurs.
- Select option **5** (Check Messages) to check messages for the screening file. If the load is still processing, the message displayed will be: "Load failed - A system error occurred." When the load process finishes, it will display a message similar to: "Loaded 0013563 records into screening file O88AQD01."
- Repeat the last three steps if you need to load more than one dataset into the screening file.

4.3.2 <u>Editing Data in the Screening File</u>

Once the data have been successfully loaded into the screening file, they are ready to be edited for errors. To edit data in the screening file:

- Select option **2** (Edit Screening File).
- Select a Level **2** edit (the default is always Level 3), then press **<Enter>.**
- Write down the job number displayed for reference.
- Select option **5** (Check Messages) to find out when the edit is completed. When completed, you will hopefully see a line similar to:

"Edited 00013563 records in screening file O88AQD01
L0 = 00000000 L1 - 00000000L2 = 00013563 All = 00000000."
This means that all 13563 records passed to Level 2
-or-
If there are errors in the file, you'll see a line similar to:

"Edited 00013563 records in screening file O88AQD01
L0 = 00000645 L1 - 00000013 L2 = 00012905 All = 00000000."

This means that 12905 records passed to Level 2, 13 passed to Level 1 (i.e., failed the Level 2 edit), and 645 are at Level 0 (i.e., failed both Level 1 and Level 2 edit). See Section 4.3.3, Fixing Errors in the Screening File.

- If all records passed to Level 2, repeat these steps for Level 3.

- When completed, you should see a line similar to:

"Edited 00013563 records in screening file O88AQD01
L0 = 00000000 L1 - 00000000 L2 = 00000000 All = 00013563."

This means that all 13563 records passed to Level 3 and the file is ready for update. If not all records passed to Level 3, see Section 4.3.3, Fixing Errors in the Screening File.

4.3.3 Fixing Errors in the Screening File

To fix errors in the screening file:

- Log into TSO.

- Log into ISPF.

- In ISPF, type **SDSF**. SDSF is where you check the output of any job that has run (Loads, Edits, Deletes, etc.). The output should be in the "Output Queue."

- Select the appropriate job number by pressing the **<Tab>** key until the cursor is next to the correct job and type **<S>**. You can press **<F8>** to scroll through the output.

- After determining what caused the errors, log into AIRS and go back to the main submit menu.

- Select option **3** (Correct Mode), then press **<F9>** (Global Correct Mode), if necessary.

- Fix the transactions that have errors. See the AIRS documentation for complete instructions on correcting data in the screening file.

- After correcting the errors, perform additional Level 2 and/or Level 3 edits and repeat these steps to fix errors until all records pass to Level 3.

4.3.4 Locking the Screening File for Update

After all records in the screening file have passed to Level 3, the screening file is ready to be locked for update. To lock the screening file for update:

- Select option **4** from the submit menu.

- Select **Notify AIRS database administrator for update.**

  At this point, the screening file is locked and will be read from and updated to the AIRS database on the next Monday at 4:00 p.m. Eastern Time.

5.0 REFERENCES

Air Resource Specialists, Inc. (ARS), 1999, Air Quality Data Base Management System (AQDBMS) EPA AIRS Reference.

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 MANAGER'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	
PROJECT MANAGER	Robert Deemer	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
NPS COTR		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Change all procedures for the DataView system	January 2001	

TABLE OF CONTENTS

Section **Page**

1.0 PURPOSE AND APPLICABILITY 1

2.0 RESPONSIBILITIES 1

2.1 IMC Manager 1
2.2 Field Specialist 1

3.0 REQUIRED EQUIPMENT AND MATERIALS 1

4.0 METHODS 1

4.1 Adding New Site Information 2

4.1.1 Creating AIRS Site and Monitor Records 2
4.1.2 Adding a Site to the Site Configuration Table 2
4.1.3 Adding Screening Ranges Records 8
4.1.4 Creating or Modifying Stackplot Configuration Files 8

4.2 Modifying Site Information 10
4.3 Adding an New Parameter and/or Parameter Code 10
4.4 Adding a Conversion Formula 11
4.5 Adding a New Measurement Unit 11
4.6 Adding a New AIRS Method Code 12
4.7 Creating or Modifying Files for Stackplots 12

5.0 REFERENCES 12

LIST OF FIGURES

Figure **Page**

4-1 Example New Site Configuration Form 4

4-2 Example Completed New Site Configuration Form 6

4-3 Stackplot Page Configuration 9

4-4 Stackplot Parameter Configuration 9

1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) describes the steps taken by the National Park Service (NPS) Air Resources Division's (ARD) 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 AIRS. This SOP describes the IMC IMC manager'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 MANAGER

The IMC manager 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, *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 AIRS 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 AIRS 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 Configuration Form (Figure 4-1) is forwarded to the field specialist. This form includes information that will be required to configure the site in the AIRS 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 AIRS Site and Monitor Records

Before data can be successfully submitted to AIRS, related site and monitor records must exist within AIRS. When a new site is configured, or an existing site adds or deletes a parameter, these records must be created. See Section 2.0, Creating AIRS Site and Monitor Records, in the *Air Quality Data Base Management System (AQDBMS) EPA AIRS Reference* (ARS, 1999a) 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.

- 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 the following information into the site configuration record. An example of a completed New Site Configuration Form is presented in Figure 4-2.

New Site/Site Relocation Form
(Page 1 of 2)

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: _____ Logger: _____ Modem: _____

AIRS Codes: State: _____ County: _____ Agency: _____ Site Number: _____ EPA Region: _____

Location: (Nearest City or County, etc.): _____ State: _____ Time Zone: _____

Latitude: _____ Longitude: _____ Elevation: _____

UTM: Northing: _____ Easting: _____ UTM Zone: _____

NPS Region: _____ PLEASE ADVISE DPC PRIOR TO EFFECTIVE DATE OF AS MUCH OF THIS INFORMATION AS POSSIBLE

New Configuration:

Column:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Channel Number																
Channel Name																
Channel Units																
Full Scale Value																
Zero Value																
Input Range																
Input Type																

Comments: _____

F:\USERS\NPSAIR\DPC\DPCFORMS\NEWSITE.XLS 11/5/96

Figure 4-1. Example New Site Configuration Form.

New Site/Site Relocation Form
Page 2 of 2

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 15' (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: _____)

F:\USERS\NPSAIR\DPC\DPCFORMS\NEWSITE.XLS 11/5/96

Figure 4-1 (Continued). Example New Site Configuration Form.

Table 4-1

New Site/Site Relocation Form
(Page 1 of 2)

Entered in AIRS 6/4/97 EP

Today's Date: 12/96 **Change Effective Date:** 1/9/97 **Initials:** EP, MB

Site Name: Sequoia - Lookout Point **Landmark Location Description:** Lookout Point Fire Station, Mineral King Rd

Six-Letter Abbr.: SEKI-LP **Polling Abbr.:** SELP **Password:** SEKILP **Database Site Number:** 83

No. of Parameters: 15 **Site Telephone Number:** (209) 260-6997 **Logger:** Sunny Hill **Modem:** US robotics 14.4

AIRS Codes: **State:** 06 **County:** 107 **Agency:** 915 **Site Number:** 0008 **EPA Region:** 9

Location: **(Nearest City or County, etc.):** Three Rivers, Tulare County **State:** CA **Time Zone:** 4

Latitude: 36°25'45" **Longitude:** 118°45'45" **Elevation:** 4019

UTM: **Northing:** 342008 **Easting:** 4032994 **UTM Zone:** 11

NPS Region: Western

PLEASE ADVISE DPC PRIOR TO EFFECTIVE DATE OF AS MUCH OF THIS INFORMATION AS POSSIBLE

Column:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
New Configuration:	44201 X		61104	61103	61101	61106	62101	62106	63301	65102	X	X	62201	X	X	
Channel Number	1 O3	2 CAG	3 VWD	4 VWS	5 SWS	6 SIG	7 TMP	8 DTP	9 SOL	10 RNF	11 STP	12 FCW	13 RH	14 WET	15 PWR	
Channel Name	X		X	X	X	X	X	X	X	X			X			
Channel Units	PPM	PPM	DEG	M/S	M/S	DEG	DEG	DEG	WMS	INC	DEG	LPM	%	+/-	VAC	
Full Scale Value	.500	.777	359	50.0	50.0	359	50.0	-7.00	1396	20.00	100.0	5.00	100.0	100	5.00	
Zero Value	.000	-.021	0	0	0	0	-50.0	5.00	0	.00	0	.00	0	0	0	
Input Range	1	1	1	1	1	1	1	1	1		1	5	1	1	5	
Input Type	S	S	S	S	S	S	S	S	S	S	S	D	D	D	D	

Comments: 44201 AQI400 Urban Area Represented: 0000

F:\USERS\NPSAIR\DPC\DPCFORMS\NEWSITE.XLS 11/5/96

0002, 0006

Figure 4-2. Example Completed New Site Configuration Form.

New Site/Site Relocation Form
Page 2 of 2

SITE:

Sequoia NP - Lookout Point

LOCATION SETTING:

_____ Urban (1)

_____ Suburban (2)

X Rural (3)

LAND USE:

X Forest (5)

_____ Desert (6)

_____ Other (Specify)

ROAD TYPE:

_____ Arterial (1)

_____ Expressway (2)

_____ Freeway (3)

_____ Major Street or Highway (4)

_____ Through Street or Highway (5)

X Local Street or Highway (6)

ESTIMATED DAILY TRAFFIC FLOW:

10-100 cars/day

NEAREST STREET NAME:

Mineral King Rd.

MSA
Modesto 5170

AQCR - 031
MSA - 8780
CMSA - 0000
City 70980

ESTIMATE OF ACCURACY IN DETERMINING LAT/LONG:

1 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 15' (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: 125,000) USGS

_____ Other Method (Specify: _____)

F:\USERS\NPSAIR\DPC\DPCFORMS\NEWSITE.XLS 11/5/96

Figure 4-2 (Continued). Example Completed New Site Configuration Form.

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 4-3. 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 4-4 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.

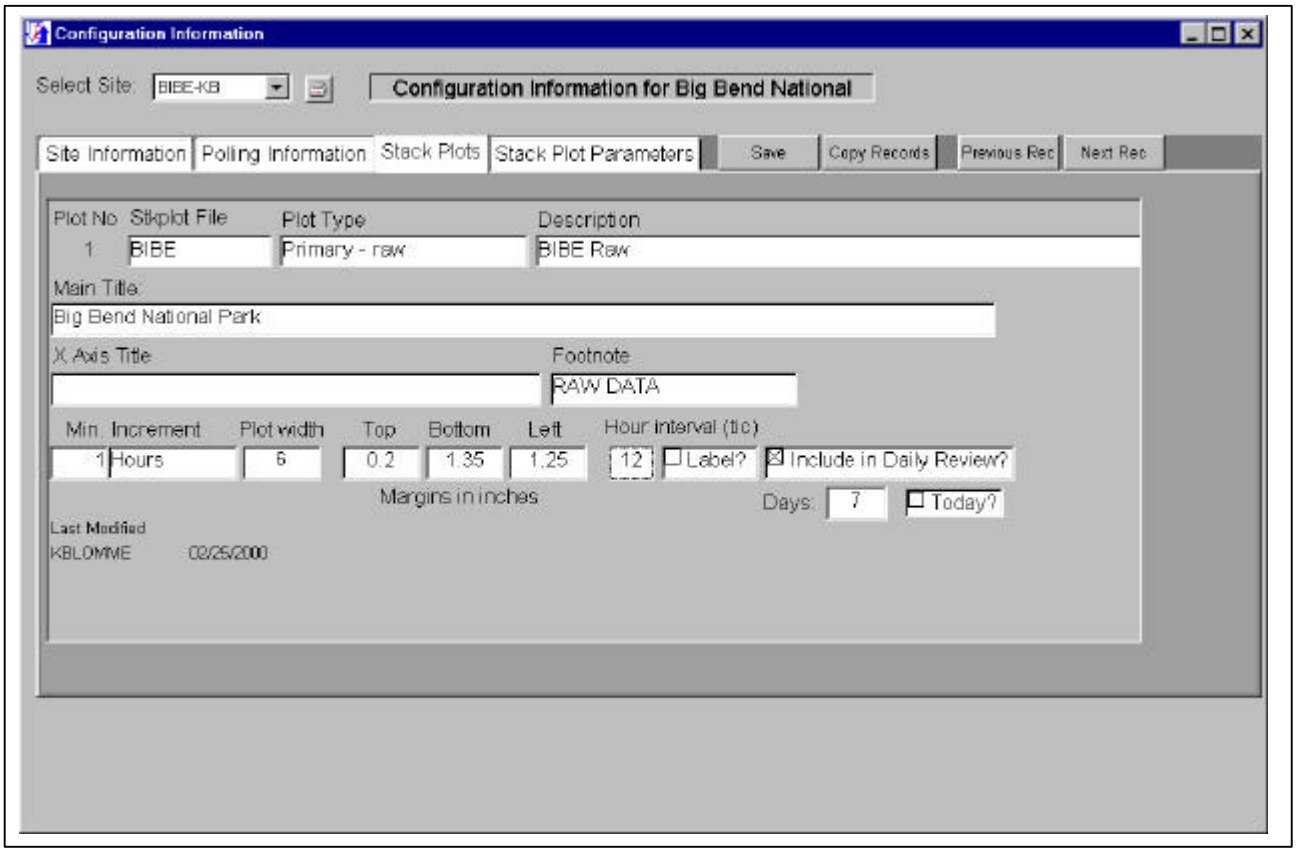


Figure 4-3. Stackplot Page Configuration.

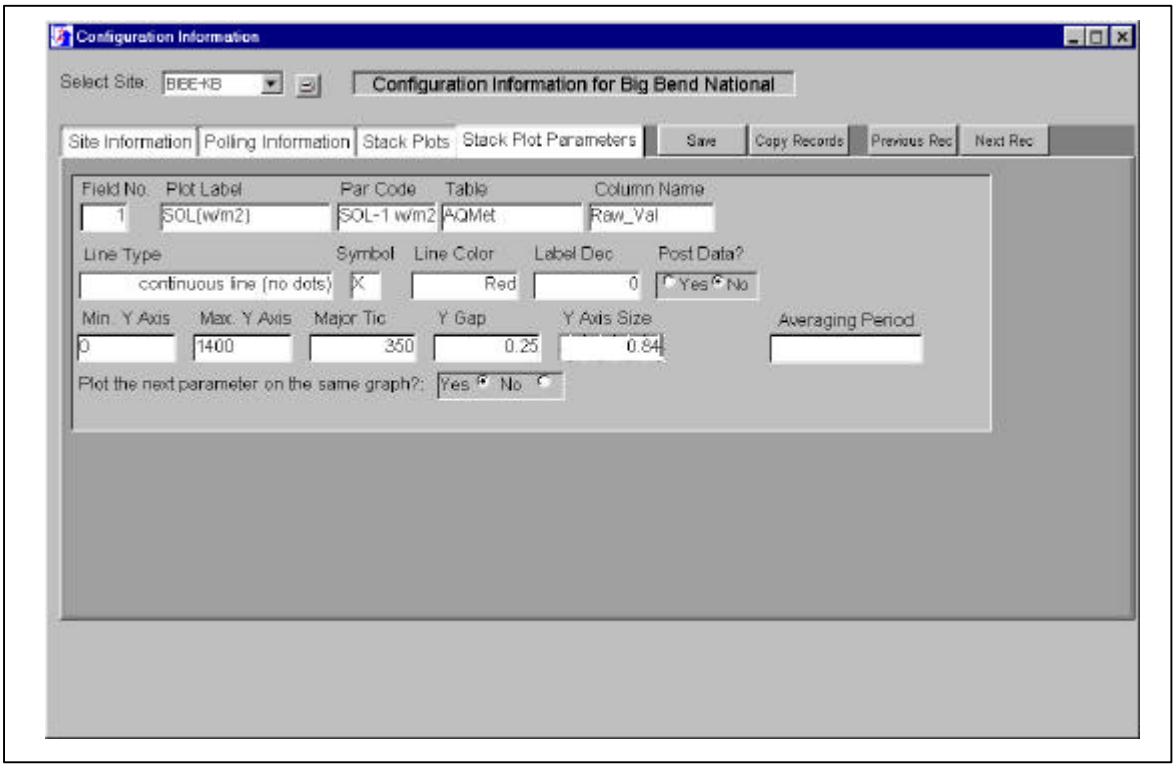


Figure 4-4. Stackplot Parameter Configuration.

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 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 AIRS.
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 AIRS.
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 AIRS. • 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 the *Air Quality Data Base Management System (AQDBMS) EPA AIRS Reference* (ARS, 1999a).

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 AIRS codes. The *Parameter Codes Table* holds records that further define each parameter, such as the units of measurement and the AIRS 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, 2001).

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, 2001).

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 AIRS code for each unit. Since AIRS 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 in stead of millimeters or inches, the IMC manager would find the AIRS unit code for buckets in the AIRS 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, 2001).

4.6 ADDING A NEW AIRS METHOD CODE

AIRS 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 AIRS. 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 AIRS 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, 2001).

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 *\\ars_net3\project\npsair\sitecall*. File names are *ssss*STD.STK, where *ssss* is the 4-letter site abbreviation. Refer to the *Stackplot User's Guide* (ARS, 1999b) for layout information.

5.0 REFERENCES

Air Resource Specialists, Inc. (ARS), 1999a, Air Quality Data Base Management System (AQDBMS) EPA AIRS Reference.

Air Resource Specialists, Inc. (ARS), 1999b, Stackplot User's Guide.

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	**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	
OTHER		

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

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	2
2.1	Project Manager	2
2.2	Field Specialist	2
2.3	Administrative Assistant	3
2.4	Station Operator	3
3.0	REQUIRED EQUIPMENT AND MATERIALS	3
4.0	METHODS	5
4.1	Pre-Semiannual Site Visit Preparation	5
4.2	Semiannual Site Visit Procedures	6
4.2.1	Shelter and Tower Integrity Check	6
4.2.2	Support Systems Integrity Checks	9
4.2.3	Air Quality Equipment Calibrations and Maintenance	9
4.2.4	Dry Deposition Sampling Equipment	11
4.2.5	Meteorological Equipment Calibrations and Maintenance	11
4.2.6	Data Acquisition Calibrations, Maintenance, and Operational Verification	12
4.2.7	Station Modifications and Configuration Enhancements	13
4.2.8	Observe/Train Station Operator	13
4.2.9	Verify and Update Site Equipment Inventories	14
4.2.10	Supplemental Flow Checks	14
4.3	Post-Semiannual Visit Procedures	14

LIST OF FIGURES

Figure		Page
3-1	Semiannual Site Visit Pre-Trip Preparation Checklist	4
4-1	Semiannual Site Visitation Checklist for the NPS Ambient Air Quality Monitoring Program	7
4-2	Equipment Maintenance/Repair Record (Blue Card)	10
4-3	Example Computer Printout of Inventory Items	15
4-4	NPSAIR Capital Equipment Inventory Checklist	16

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 NPS COTR, NPS Regional Air Quality Coordinators, park superintendent, 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.

- 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, COTR, Information Management Center, 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.
- 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
_____	Digital voltmeter
_____	Laptop computer
_____	Forms, CALCU software, Forms (NPS.XLT)
_____	Calculator, notebook
_____	Digital camera (if better pictures are required)
_____	Telephone list with site addresses, motel list, site information table
_____	Trip pack (from Administrative Assistant): inventory, repair cards, site visit checklist
_____	AC power cords and power strip (at least 4 plugs)
_____	Strapping tape
_____	Calibration stickers, labels, shipping folder, ARS luggage tags
_____	Road maps, atlas
_____	Campbell datalogger with charger and program instructions
_____	Various equipment batteries (WS motor, flashlight) 9v, AAA, AA
_____	First aid kit
_____	Climbing belt and bucket

✓	GASEOUS CALIBRATION AND MAINTENANCE EQUIPMENT AND SUPPLIES
_____	Transfer standard
_____	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 (20μm and 5μm)
_____	Alcohol, Kimwipes, and Q-Tips
_____	Extra lamps (both photometer and generator)
_____	Ozone scrubbers
_____	Canned air and Snoop
_____	Solenoid valves (ML, Dasibi, 115 VAC, 24 VDC, etc.)
_____	Datalogger EPROM version upgrade (2 chips)

✓	METEOROLOGICAL CALIBRATION AND MAINTENANCE EQUIPMENT AND SUPPLIES
_____	Sling psychrometer and MP601 reference RH sensor
_____	Thermometers
_____	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/Qualimetrics/RMYoung)
_____	Reference solar radiation sensor
_____	Barometer and GPS
_____	Compass and tripod assembly

✓	NDDN SAMPLING CALIBRATION AND MAINTENANCE EQUIPMENT AND SUPPLIES
_____	Thomas pump rebuild kit (2 required at NDDN sites)
_____	"Quick-connect" with tubing to reach BIOS (white color keyed for existing system)
_____	Balston filters
_____	Equipment documentation (usually does not exist on-site)

AAQ pretrip checklist.doc (1/01)

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.
- Contracting Officer's Technical Representative (COTR).
- Information Management Center (IMC).
- 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 and clean, and check function of thermostats.

- **Meteorological tower** – Check the integrity of the tower, including supports, guys, hardware, and grounding.

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

SEMIANNUAL SITE VISITATION CHECKLIST
NPS Ambient Air Quality Monitoring Program

Air Resource Specialists, Inc.

Station: _____ Visit Conducted By: _____
Station Operator: _____ 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)	
___	Power and Telephone Lines	
___	Interconnect Cabling (tower and shelter)	
___	Intake and Exhaust Manifolds	
___	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)	
____	____	____	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

			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

ITEM	CORRECTIVE ACTION
___ Inventory Completed	

10. SUPPLEMENTAL FLOW CHECKS (please note)

			ITEM	CORRECTIVE ACTION
___	___	___	_____	
___	___	___	_____	
___	___	___	_____	
___	___	___	_____	

Semiannual visit checklist.doc (10/00)

-- 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. 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 any preventive maintenance, repair, or adjustment in the station log book, 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 upon the instrument's strip chart record (if applicable) and upon the appropriate ARS calibration document found in the instrument-specific TI.

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:

Air Resource Specialists, Inc.
1901 Sharp Point Drive, Suite E
Fort Collins, CO 80525
Phone: 970-484-7941
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 Dry Deposition Sampling Equipment

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 sample tubing** as required.

4.2.5 Meteorological Equipment Calibrations and Maintenance

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 ribbon 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, strip chart annotations, 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.

- **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

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.

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).
- COTR (in the Monthly Technical Progress Report).
- IMC Manager.

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

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				
	Recorder - O_3				
	Recorder - SO_2				
	Calibrator(s)				
	Zero air source				
	Power supply				
	Mainframe				
	Aspirator (upper)				
	Telephone				
	Modem				
	Datalogger				
	Computer				
	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.

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	**CALIBRATION OF AMBIENT AIR QUALITY ANALYZERS**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3100**
DATE	**JUNE 1990**

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

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Modifications to precision calculations.	June 1996	
2.0	Modifications to format.	February 1997	

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
2.1	Project Manager	1
2.2	Field Specialist	1
3.0	REQUIRED EQUIPMENT AND MATERIALS	2
3.1	O_3 Analyzer Calibration	2
3.2	SO_2, NO_2, or CO Analyzer Calibration	2
4.0	METHODS	3
4.1	Principles and Policy	3
4.1.1	Equipment Applications and Use	3
4.1.2	Instrument Adjustments	4
4.2	Preparation for Analyzer Calibration	4
4.3	Multipoint Calibration of Analyzers	5
4.4	In-Station Calibrator Verification	6
4.5	Documentation	6
5.0	DEFINITIONS	6
6.0	REFERENCES	7

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 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 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 (OZONE.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.

4.1.1 <u>Equipment Applications and Use</u>

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
- Adjustments to analyzers

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. Calculate the percent difference (Δ%) between designated input and analyzer response. 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. 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 Δ% > 5%: analyzer adjustment is required. If Δ% $\leq$ 5%: analyzer adjustment is optional.
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), re-calculate Δ%, and check linearity.

Ozone analyzers that do not continuously measure the absorption cell pressure and temperature (Dasibi 1003) may have their span numbers calculated by an alternative method. After calculating the span number, perform a post-maintenance calibration check.

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), 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).

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	**CALIBRATION AND ROUTINE MAINTENANCE OF THERMO ENVIRONMENTAL INSTRUMENTS MODEL 49 (TECO 49) OZONE ANALYZERS**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3100-2002**
DATE	**APRIL 1996**

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

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Additional procedures detailed.	February 1997	

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
2.1	Project Manager	1
2.2	Field Specialist	2
3.0	REQUIRED EQUIPMENT AND MATERIALS	2
4.0	METHODS	3
4.1	Preparation for Analyzer Calibration	3
4.2	Calibration Checks	3
4.3	Ozone Transfer Standard Preparation	5
4.4	Multipoint Calibration	6
4.4.1	Initiate Calibration	6
4.4.2	Record and Evaluate Analyzer Response	7
4.4.3	Calibrate (Adjust) Analyzer	8
4.5	Analyzer Maintenance	9
4.6	Analyzer Zero Offset Selection	12
4.7	Post-Maintenance Calibration Checks	12
4.8	Documentation	12
5.0	REFERENCES	12

LIST OF FIGURES

Figure		Page
4-1	Example Ozone Calibration Form	4
4-2	ARS Calibration Sticker	12

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 49 (TECO 49) 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 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 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
- TECO 49 instrument manual
- Station log book
- Ozone calibration forms
- Pen or pencil
- Laptop computer loaded with Excel spreadsheet form (OZONE.XLT) and CALCU 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 Dasibi 1003 analyzers and transfer standards. Calibration and maintenance include tasks that are detailed in the following eight (8) 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 Analyzer Zero Offset Selection
4.7 Post-Maintenance Calibration Checks
4.8 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. 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 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.

Air Resource Specialists, Inc.

OZONE CALIBRATION FORM

PRE - MAINTENANCE

Network:	Station:	Date:	By:
DVM Model & #: FLUKE 8060A	S/N:	Date of Last Calibration:	
Date of Last Maintenance and Calibration Visit:			

EQUIPMENT IDENTIFICATION

	Calibrator	Analyzer	Station Reference
Model #			
Serial #			
Last Certification			
Span setting			
Sample Frequency			
Control Frequency			
Sample Flow (L/min.)			
Offset			
Cell Temp. (celcius)			

STATION TUBING *

Reference Calibrator OFFSET= ppm			Analyzer OFFSET= ppm				Station Reference OFFSET= ppm			Calibrator/ Analyzer		Calibrator/ Station Reference	
Calibration point	Mechanical Setting	Conc. (ppm)	Display (ppm)	DVM (volts)	Data Logger	Recorder (%)	Display (ppm)	DVM (volts)	Data Logger	Actual Difference (ppm)	Percent Difference (%)	Actual Difference (ppm)	Percent Difference (%)
ZERO													
1													
2													
3													
4													
5													
ZERO													

Average % Difference =

AUDIT TUBING

Calibration point	Mechanical Setting	Conc. (ppm)	Display (ppm)	DVM (volts)	Data Logger	Recorder (%)	Display (ppm)	DVM (volts)	Data Logger	Actual Difference (ppm)	Percent Difference (%)	Actual Difference (ppm)	Percent Difference (%)
ZERO													
1													
2													
3													
ZERO													

Average % Difference =

EVENT RESPONSE

Station Reference			Analyzer Response			
Calibration point	Mechanical Setting	Conc. (ppm)	Display (ppm)	DVM (volts)	Data Logger	Recorder (%)
ZERO						
Precision						
Span						

RESULTS *

Linear Regression		
Parameter	Analyzer	Station Reference
Slope		
Y Intercept		
Correlation coefficient		

COMMENTS:

Signature:_____

OZONE.XLT
Revision 5/3/96

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, serial number of the analyzer, date of the last 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" detector frequency output by pressing the **TEST A** push button. This frequency is directly proportional to the light intensity reaching Detector A. Record the display value on the Ozone Calibration Form (Figure 4-1) in the "Sample Frequency" column. Expected values are 70 to 120 kHz. Press the **NOISE** push button and observe the instrument display for 20 seconds. The value displayed is the frequency fluctuations of the detector output averaged over the past 20 seconds. Record the instrument display after the Detector A frequency value in the "Sample Frequency" column. Expect a value below 4.0 Hz.

Check the "B" detector frequency output by pressing the **TEST B** push button. Record the value in the "Control Frequency" column. Press the **NOISE** push button and record that value in similar fashion.

PRESSURE/ TEMPERATURE

Press **TEST P/T** to display the cell pressure (in mmHg). Press the push button two more times to display the cell temperature. Record both values in the "Cell Temperature" column.

NOTE: Make sure the **P/T ON** push button is engaged (pushed in) so the ozone measurement is automatically corrected for temperature and pressure. If **P/T ON** is disengaged (button out) a pressure of "760" and a temperature of "0.0" will be displayed when **TEST P/T** is selected.

FLOW RATE CHECK

Check the flow rate by observing the two front panel flowmeters. Record the values in the "Sample Flow" field of the calibration form. The flow rates should be even and show approximately 1.0 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 to the sample "INLET" port (loopback tube) of the transfer standard (Dasibi models only). 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	Turn the "sample pump" and the "calibration pump" toggle switches of the transfer standard on (Dasibi model only).
ADJUST FLOW	Adjust the transfer standard sample and output flow appropriately Zero air is now flowing to both the transfer standard and 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	Select "AUTO" (Dasibi model) on the transfer standard ozone control switch. Known concentrations of gas that cover the response range of the analyzer are introduced. Dial in the desired ozone concentration output on the ozone output thumbwheels. 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

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 manipulating the transfer standard ozone output thumbwheels and 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%

Calculate the percent difference (Δ%) between designated input and analyzer response (if not automatically calculated by Excel spreadsheet) with the following formula:

$$\%\,Difference = \frac{Analyzer\ \mathrm{Re}sponse - Designated\ \ Input}{Designated\ Input} x100$$

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.

LINEARITY CHECK	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 DATA	Review data to determine if analyzer adjustment (calibration) is required: If Δ% > 5%, analyzer adjustment is required. If Δ% ≤ 5%, analyzer adjustment is optional.

4.4.3 Calibrate (Adjust) Analyzer

The span thumbwheels set the effective span on the analyzer. The nominal value is 500. Increase the span thumbwheel to compensate for an under-reporting instrument. A change of one digit changes the span by 0.2% (1/500). In a properly operating instrument, any span or offset correction should be small (e.g., ±10 for span, ±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.
INTRODUCE OZONE	Introduce a concentration of ozone at approximately 80% of the operating full scale of the analyzer.
ADJUST SPAN SWITCH	Allow the analyzer to stabilize and adjust the span switch until the analyzer output agrees with the designated input as reported by the transfer standard.

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)
- Is the ozone generator lamp 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 span 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 on the sample rotameter, should drop from "1.0" 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.

SOLENOID VALVE LEAK CHECK

The system leak check will not detect leaks across the solenoid valve. To check for a solenoid valve leak, introduce an ozone concentration of about 0.500 ppm to the ozone analyzer and energize the **TEST A/B** push button. When the analyzer has stabilized, the average of 10 readings of the A and B values should be within 3% of each other. A constant low reading from one cell indicates an imbalance. An imbalance can be caused by either one cell being extremely dirty or a leaky valve. Interchange cells to determine if imbalance is caused by a dirty cell.

SAMPLE OR CALIBRATION PUMP REPLACEMENT

A pump needs replacement whenever it cannot maintain at least 1.8 (sample) or 4.5 (calibration) lpm of flow. Intermittent starting or noisy bearings may also indicate need of replacement. Replacement of either pump is similar. Lift the instrument onto its side and:

- 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.

OZONE GENERATOR LAMP REPLACEMENT

The ozone generator lamp needs replacement when it no longer illuminates or cannot maintain adequate (<400 ppb at 5.0 lpm) ozone concentration outputs. Replace the ozone generator lamp:

- Unplug the lamp from its motherboard connector.
- Loosen the knurled hold-down nut and withdraw the lamp and its o-ring from the generator.
- Install a new lamp by installing an o-ring and knurled nut on the lamp housing, insert the lamp into the generator and tighten firmly. Plug the lamp into the motherboard socket. Mark the lamp with the installation date.

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

ABSORPTION CELL TUBE AND MIRROR 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 1/4" 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.
- 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 and Mirror Cleaning).

Adjust Detector A Frequency

- Select the **TEST A** push button.
- Loosen the "Detector A" light adjuster lock-down screw.
- Twist the light adjuster until the frequency value indicates above 100 kHz.
- Tighten the adjuster lock-down screw.

Adjust Detector B Control Frequency

- Select the **TEST B** push button and adjust the detector frequency B in a similar manner as "Detector A."

4.6 ANALYZER ZERO OFFSET SELECTION

The offset thumbwheels are located on the front panel of the instrument. The nominal value for a zero reading is 50. A change of one digit adds or subtracts 1 ppb from both the digital and analog output. This instrument is capable of outputting negative values, and adjustment of the offset thumbwheels is not recommended.

4.7 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.

4.8 DOCUMENTATION

Analyzer calibrations require 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 analyzer, marking the date the instrument was certified and the name of the technician who calibrated it.

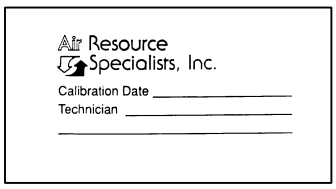


Figure 4-2. ARS Calibration Sticker.

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, 1989, Instrument Manual Series 49 (Including) Model 49, U.V. Photometric Ambient O_3 Analyzer; Model 49-100/103, U.V. Photometric Ambient O_3 Analyzer With Internal Ozonator; Model 49 PS, U.V. Photometric Ambient O_3 Calibrator, September, Franklin, MA.

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

REVISION HISTORY

REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Calibration form changes/update methods.	March 1996	
2.0	Delete operator respon./add maintenance	September 1997	
3.0	Revise SR and RH proc./ remove dew point	September 1998	
3.1	Add RH time limit for replacement	May 2000	

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	2
2.1	Project Manager	2
2.2	Field Specialist	2
3.0	REQUIRED EQUIPMENT AND MATERIALS	2
4.0	METHODS	3
4.1	Calibration Checks	4
4.2	Sensor Adjustments	7
4.3	Sensor Maintenance	7
4.4	Post-Maintenance Calibration Checks	8
4.5	Documentation	8
5.0	REFERENCES	8

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
- Barometric pressure
- Precipitation
- Wetness

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 this TI.
- 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
- Digital voltmeter (4-1/2 digit)
- Field service tools
- Tower climbing belt and safety equipment
- Station log book
- Wind Speed/Wind Direction Calibration Forms
- Weather Parameters Calibration Forms
- Pen or pencil

- Laptop computer loaded with Excel workbook (NPS.XLT) and CALCU program software
- ARS calibration stickers
- Calibrated 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
- Reference relative humidity sensor and audit aspirator
- Portable water heater or hot water
- Campbell Scientific 21XL datalogger
- Campbell Scientific instrument manual
- Climatronics or Qualimetrics instrument manual
- Campbell Scientific 21XL datalogger manual
- R.M. Young instrument manual

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

<u>Orientation</u> - 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 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 ±2° 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

Motor Response - Remove the anemometer cups from the sensor and mount the R. M. Young Model 18801 variable speed motor assembly to the sensor shaft. Select 300 rpm, and record the sensor's output on the wind speed calibration form. Repeat for 600, 900, and 1800 rpm, and record the values. Refer to the applicable TI for designated wind speed values for suggested rpm's. 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 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 ±0.2°C requires investigation and corrective action.

DELTA (Δ) TEMPERATURE	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 0.1°C 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 psychrometer derived value or to a transfer standard capacitive-resistance sensor. 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	Attach a reference solar radiation sensor to the existing solar radiation support bracket. Connect the reference output to a datalogger and record several hours' values. Compare values with data from the station's solar radiation sensor.
SOLAR RADIATION (ALTERNATE METHOD)	Attach a reference solar radiation sensor to the existing solar 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.

	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.
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.
TEMPERATURE/ DELTA (Δ) TEMPERATURE	Adjustments are only possible at the translator card.
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 located under the plastic cover on the front panel for offset fine adjustment.

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.

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, 1995, Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV. Meteorological Measurements, EPA-600/R-94/038d (March).

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	**CALIBRATION AND ROUTINE MAINTENANCE OF CLIMATRONICS F460 OR QUALIMETRICS 12XX WIND SPEED AND DIRECTION SENSOR SYSTEMS**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3150-2100**
DATE	**AUGUST 1990**

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

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Calibration form changes/update methods.	June 1996	
1.1	Added respon and equip/formatting change	September 1997	
1.2	Updated calibration form/ added table values.	September 1998	

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
2.1	Project Manager	1
2.2	Field Specialist	2
3.0	REQUIRED EQUIPMENT AND MATERIALS	2
4.0	METHODS	3
4.1	Calibration Checks	3
4.2	Wind Direction Sensor	5
4.2.1	Sensor Checks	5
4.2.2	Evaluation of Sensor Checks	6
4.2.3	Sensor Adjustments	7
4.2.4	Sensor Maintenance	8
4.2.5	Post-Maintenance Calibration Checks	8
4.3	Wind Speed Sensor	8
4.3.1	Sensor Checks	8
4.3.2	Evaluation of Sensor Checks	9
4.3.3	Sensor Adjustments	9
4.3.4	Sensor Maintenance	9
4.3.5	Post-Maintenance Calibration Checks	10
4.4	Documentation	10
5.0	DEFINITIONS	10
6.0	REFERENCES	11

LIST OF FIGURES

Figure		Page
4-1	Example Wind Speed/Wind Direction Calibration Form	4
4-2	ARS Calibration Sticker	10

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 Figure 4-1, Example Wind Speed/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/Wind Direction 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.

Air Resource Specialists, Inc.

WIND SPEED / WIND DIRECTION CALIBRATION FORM

Network:		Station:		Date:	By:
DVM Mfg.& SN:	FLUKE 8060A	S/N:		Calibration Expiration:	
To Landmark #1:	Degrees True	From Landmark #1:		LM Description:	
To Landmark #2:	Degrees True	From Landmark #2:		LM Description:	
Declination:	Degrees			Date of last maintenance and calibration visit:	

WIND DIRECTION

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Model Name		
Model #		
Serial #		
Translator Serial #		

WIND DIRECTION TRANSLATOR CARD

Card Setting	DVM (volts)	Data Logger (degrees)	Recorder (%)	DVM (volts)	Data Logger (degrees)	Recorder (%)
Zero			N/A			N/A
Span			N/A			N/A
540			N/A			N/A

SENSOR ORIENTATION

Land Mark Reference	DVM (volts)	Data Logger (degrees)	Recorder (%) pre	Recorder (%) post	DVM (volts)	Data Logger (degrees)	Degrees Difference pre	Degrees Difference post
To 1			N/A	N/A				
From 1			N/A	N/A				
To 2			N/A	N/A				
From 2			N/A	N/A				
						Average =		

SENSOR LINEARITY

Check Point	DVM (volts)	Data Logger (degrees)	Recorder (%) pre	Recorder (%) post	DVM (volts)	Data Logger (degrees)	Degrees Difference pre	Degrees Difference post
1			N/A	N/A				
2			N/A	N/A				
3			N/A	N/A				
4			N/A	N/A				
5			N/A	N/A				
6			N/A	N/A				
7			N/A	N/A				
8			N/A	N/A				
						Average =		

Wind direction bearing threshold should be (<3 gm-cm)

STARTING THRESHOLD	
Torque = (gm-cm)	Torque = (gm-cm)

WIND SPEED

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Model Name		
Model #		
Serial #		
Translator Serial #		

WIND SPEED TRANSLATOR CARD

Card Setting	DVM (volts)	Data Logger (m/s)	Recorder (%)	DVM (volts)	Data Logger (m/s)	Recorder (%)
Zero			N/A			N/A
Span			N/A			N/A
Oscillator Frequency (Hz) =				Data Logger Should Read		

SENSOR SPEED CHECK

Motor Speed (RPM)	DVM (volts)	Data Logger (m/s)	Recorder (%)	DVM (volts)	Data Logger (m/s)	Recorder (%)
			N/A			N/A
			N/A			N/A
			N/A			N/A
			N/A			N/A

WIND SPEED SENSOR REFERENCE

Motor Speed	Climatronics Model F460		Qualimetrics Model 2030		R. M. Young Model 05305AQ Wind Mark AQ	
	vinyl and aluminum cups	stainless steel cups	Weather Measure Stainless Steel cups		(MPH = RPM x 0.01096) 4 Blade Propeller	
(rpm)	(m/s) *(mph)	(m/s) *(mph)	(m/s)	*(mph)	(mph)	(mps)
100	2.574 *5.757	2.368 *5.296	2.426	*5.427	1.15	0.51
300	7.274 *16.271	6.656 *14.888	6.813	*15.240	3.44	1.54
600	14.324 *32.042	13.088 *29.277	13.394	*29.960	6.87	3.07
900	21.375 *47.815	19.520 *43.665	19.974	*44.681	10.31	4.61
1200	28.425 *63.585	25.952 *58.054	26.555	*59.401	13.74	6.14
1800	42.526 *95.128	38.817 *86.831	39.716	*88.842	20.61	9.22
4000	N/A		N/A		45.80	20.48
7000	N/A		N/A		80.15	35.84

Wind speed bearing threshold should be (<0.1 gm-cm)

STARTING THRESHOLD	
Torque = (gm-cm)	Torque = (gm-cm)

COMMENTS:

Signature:_____

WSWD.XLT
REVISION 3/10/98

Figure 4-1. Example Wind Speed/Wind Direction Calibration Form.

RECORD READINGS

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

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/Wind Direction Calibration Form is presented in Figure 4-1.

  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 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 four indexed positions should increase in 45° increments ±2°.

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.

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.

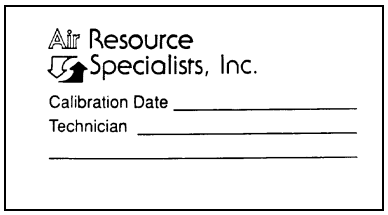


Figure 4-2. ARS Calibration Sticker.

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.

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	**CALIBRATION AND ROUTINE MAINTENANCE OF CLIMATRONICS OR QUALIMETRICS TEMPERATURE/DELTA TEMPERATURE SYSTEMS**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3150-2105**
DATE	**AUGUST 1990**

AUTHORIZATIONS

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

REVISION HISTORY

REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Update for delta temperature systems.	July 1996	
1.1	Change responsibilities and documentation.	September 1997	
1.2	Update calibration form.	September 1998	

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
2.1	Project Manager	1
2.2	Field Specialist	2
3.0	REQUIRED EQUIPMENT AND MATERIALS	2
4.0	METHODS	2
4.1	Calibration Checks	3
4.1.1	Evaluation of Temperature/Delta Temperature Sensor Checks	5
4.2	Sensor Adjustments	5
4.3	Sensor Maintenance	6
4.4	Post-Maintenance Calibration Checks	6
4.5	Documentation	6

LIST OF FIGURES

Figure		Page
4-1	Example Weather Parameters Calibration Form (Temperature, Solar Radiation, and Barometric Pressure)	4
4-2	ARS Calibration Sticker	6

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
- Weather Parameters 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 Weather Parameters 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 Weather Parameters 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.

Air Resource Specialists, Inc.

WEATHER PARAMETERS CALIBRATION FORM

Network:		Station:		DATE:	BY:
DVM Mfg. & SN:	FLUKE 8060A	S/N:		Calibration Expiration:	
REFERENCE THERMOMETERS:	#1 S/N:	Range:	#2 S/N:	Range:	
SOLAR RADIATION REFERENCE:	S/N:	REFERENCE FACTOR:	(W/m2)/mv		

TEMPERATURE

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Model Name		
Model #		
Serial #		
Translator Serial #		

PRE- TRANSLATOR CARD RESPONSE

SETTING	TEMPERATURE		Δ TEMPERATURE	
	DVM (volts)	DAS (deg. C)	DVM (volts)	DAS (deg. C)
Zero				
Span				

POST TRANSLATOR CARD RESPONSE

SETTING	TEMPERATURE		Δ TEMPERATURE	
	DVM (volts)	DAS (deg. C)	DVM (volts)	DAS (deg. C)
Zero				
Span				

PRE-MAINTENANCE SENSOR RESPONSE

BATH TEMP	TEMPERATURE		Δ TEMPERATURE		Difference (deg. C)
	DVM (volts)	DAS (deg. C)	DVM (volts)	DAS (deg. C)	

POST MAINTENANCE SENSOR RESPONSE

BATH TEMP	TEMPERATURE		Δ TEMPERATURE		Difference (deg. C)
	DVM (volts)	DAS (deg. C)	DVM (volts)	DAS (deg. C)	

SOLAR RADIATION

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Model Name		
Model #		
Serial #		
Translator Serial #		

TRANSLATOR CARD

SETTING	Pre-Maintenance		Post Maintenance	
	DVM (volts)	DAS (W/m2)	DVM (volts)	DAS (W/m2)
Zero				
Span				

SENSOR READING AT TIME OF MEASUREMENT

	REFERENCE		SITE SENSOR		
	DVM (mvt)	(W/m2)	DVM (volts)	DAS (W/m2)	Difference (%)
PRE-					
POST					

BAROMETRIC PRESSURE

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Model Name		
Model #		
Serial #		

SENSOR RESPONSE

Pre-maintenance			Post maintenance		
Reference	DVM (Volts)	DAS (inHg)	Reference	DVM (Volts)	DAS (inHg)

COMMENTS:

Signature:_____

WEATHER.XLT
REVISION 3/10/98

Figure 4-1. Example Weather Parameters Calibration Form (Temperature, Solar Radiation, and Barometric Pressure).

- 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 CONDITIONING 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 Temperature	Zero (low)	+5.0	0.000	0.000	0.00
	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 CONDITIONING CARD — Adjust the signal conditioning card to the following designated values:

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

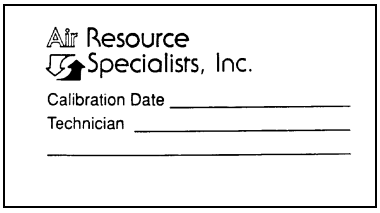


Figure 4-2. ARS Calibration Sticker.

TRIP REPORT

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

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

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

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Add respon./service form/tracking order.	May 2000	

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
2.1	Project Manager	1
2.2	Instrument Technician	2
2.3	Technical Assistant	2
2.4	Data Technician	2
3.0	REQUIRED EQUIPMENT AND MATERIALS	2
4.0	METHODS	3
4.1	Sensor Tracking and Calibration Order	4
4.2	Pre-Maintenance Calibration	4
4.3	Sensor Adjustments and Repair	12
4.4	Post-Calibration Checks	12
4.5	Documentation	14
5.0	REFERENCES	14

LIST OF FIGURES

Figure		Page
4-1	Instrument Service Order Form	5
4-2	AT/RH Sensor Calibration Form	7
4-3	Example Excel Calibration Data Printout	11
4-4	ARS Calibration Sticker	14

LIST OF TABLES

Table		Page
4-1	Specifications of Rotronics AT/RH Sensor	13
4-2	Rotronics AT/RH Sensor Wiring	14

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 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.

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 or Rotronics MP-601A Relative Humidity Sensors*
- Miscellaneous adapters
- Microsoft Excel 97 spreadsheet software
- Rotronics MP-101A Instruction Manual
- Rotronics MP-601A Instruction Manual

4.0 METHODS

The procedures described in this TI are specific to Rotronics MP-101A AT/RH sensors and Rotronics MP-601A RH sensors. Laboratory calibration includes tasks that are detailed in the following four (4) 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*, 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 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, AT/RH Sensor Calibration Form, when performing pre-maintenance calibrations, and perform the following procedures:

COMPLETE GENERAL SENSOR INFORMATION	Before beginning the calibration, complete the following fields on the AT/RH Sensor Calibration Form: sensor serial number, model number, calibration date, service technician, owner/network, operational period, last operational site, and date of last calibration. Indicate the service type (i.e., scheduled, repair, or warranty), and list any necessary comments.
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. • Select the program *C:\PC208W\vapor\stndatrh.dld***.** • Click **ok** after the Successful Transfer window appears.

Air Resource Specialists, Inc.

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.

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

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

AT/RH SENSOR CALIBRATION FORM

AT/RH Serial Number: _____ Owner/Network: _____
AT/RH Model Number: _____ Operational Period: _____
Calibration Date: _____ Last Operational Site: _____
Service Technician: _____ Last Calibration: _____

Service Type: ☐ Scheduled ☐ Repair ☐ Warranty
Comments: _____

PRE-CALIBRATION **DATE:** _____

Relative Humidity Values in Percentages								
Test Value	10%	35%	50%	60%	70%	80%	90%	95%
Nominal Time	10 min.	10 min.	10 min.	10 min.	10 min.	10 min.	10 min.	10 min.
NIST Tracable RH								
Sensor RH								
Deviation (difference ±)								

Ave. error: _____% Min.: _____% Max.: _____% Within Mfgr's specifications* _____

Temperature Values in °C			
Test Value	15°	25°	35°
Nominal Time	10 min.	10 min.	10 min.
NIST Tracable Temperature			
Sensor Temperature			
Deviation (difference ±)			

Average error: _____ °C

Minimum: _____ °C

Maximum: _____ °C

Within Mfgr's specifications* _____

ADJUSTMENTS/REPAIR: **DATE:** _____

RH Adjustments Made at Set Points: ☐ 10% ☐ 35% ☐ 80%
Temperature Adjustments Made at Set Points: ☐ 25°C
Repairs Made: _____

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

POST-CALIBRATION **DATE:** _____

Relative Humidity Values in Percentages								
Test Value	10%	35%	50%	60%	70%	80%	90%	95%
Nominal Time	0.5 hours	0.5 hours	0.5 hours	0.5 hours	1 hour	1 hour	1 hour	2 hours
NIST Tracable RH								
Sensor RH								
Deviation (difference ±)								

Ave. error: _____% Min.: _____% Max.: _____% Within Mfgr's specifications* _____

Temperature Values in °C			
Test Value	15°	25°	35°
Nominal Time	30 min.	30 min.	30 min.
NIST Tracable Temperature			
Sensor Temperature			
Deviation (difference ±)			

Average error: _____ °C

Minimum: _____°C

Maximum: _____°C

Within Mfgr's specifications* _____

NIST tracable standards:

Hygrometer:	TESTO 600+	Serial #: 01-00028	Date last calibrated: _____
Probe:	TESTO 801	Serial #: 06369742	Date last calibrated: _____
System:	Vaportron H-100L	Serial #: 9810-R49426	Date last calibrated: _____

* Manufacturer's Specifications:

Manufacturer	Model #	Temperature	RH
Rotronic	MP-100F	± 0.5°C	± 2.0% full scale; ± 1.5% from 0% to 35%
Rotronic	MP-101A	± 0.3°C	± 2.0% full scale
Rotronic	MP-601A	N/A	± 2.0% full scale
Vaportron	H-100L	± 1.0°C (from 10C° - 40°C)	

Notes:

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

- Click the **associate dld program** button.
- Select the program *C:\PC208W\vapor\stndatrh.dld***.**
- Click the **numeric display** tab at the bottom of the CR10 window.
- 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\yyRHjd.dat*, where *yy* is the year and *jd* is the Julian date.
- Click the **save edits** button.
- Close the Setup Connections window.

PREPARE SENSOR FOR CALIBRATION

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 ¾ of its length into a port of the Vaportron, making sure the O-ring makes a good seal.

Attach the sensor connector to an CR10 connector.

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

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 *O:\vaprtron\trash.dat***.**
- Click the **save edits** button.
- Close the Setup Connections window.

REDUCE DATA

To reduce the calibration data that was saved in the file:

- Open Microsoft Excel.
- From the File menu, click **open.**
- Click on the file that was used to capture the data (i.e., *yyRHjd.dat*, and click **open**.
- In the Text Import Wizard window, click **delimited** and click **next**.
- Click on **comma delimiters** and click **next**.
- Click on the *first column* and click the *do not import column*. Repeat for any column that is not data and then click **finish**.
- Round to 1 decimal and average 10 points from each of the eight relative humidity and three temperature values.
- Subtract the Vaportron average from each sensor average to determine the difference for all the relative humidity and temperature steps.
- Round to 1 decimal and average all the differences for each sensor for relative humidity average error and temperature average error.
- Edit the Excel calibration data file to place in table format. An example data file printout is shown as Figure 4-3.

38888	32732	26672	26668	Vaportron	38888	32731	26672	26668	Vaporti
	Relative Humidity					Temperature			
9.7	10.4	9.4	11.8	9.9	14.4	15	15.4	14.2	14.8
35.2	35.3	34.5	36.6	35.1	24.8	25.6	25.7	24.8	25.3
48.8	48.8	48.6	49.9	50.1	35.1	36.2	36	35.3	35.7
59.1	58.8	58.9	60	60.1					
69.8	69.3	69.2	70.7	70.1					
80.3	79.5	79.8	81	80.1					
90.5	89.3	90.3	91.2	90					
95.4	94	95.6	96.4	95.1					
	Difference					Difference			
-0.2	0.5	-0.5	1.9		-0.4	0.2	0.6	-0.6	
0.1	0.2	-0.6	1.5		-0.5	0.3	0.4	-0.5	
-1.3	-1.3	-1.5	-0.2		-0.6	0.5	0.3	-0.4	
-1	-1.3	-1.2	-0.1						
-0.3	-0.8	-0.9	0.6						
0.2	-0.6	-0.3	0.9						
0.5	-0.7	0.3	1.2						
0.3	-1.1	0.5	1.3						
	Average Error					Average Error			
-0.2	-0.6	-0.5	0.9		-0.5	0.3	0.4	-0.5	
	Min / Max					Min / Max			
-1.3	-1.3	-1.5	-0.2		-0.6	0.2	0.3	-0.6	
0.5	0.5	0.5	1.9		-0.4	0.5	0.6	-0.4	

Figure 4-3. Example Excel Calibration Data Printout.

RECORD VALUES ON CALIBRATION FORM	Record the date of the pre-calibration on the calibration form.
	Record the Vaportron averages in the *NIST traceable* portions of the form.
	Record the sensor averages and differences for relative humidity and temperature on the form.
	Note the average error and the min and max difference for relative humidity and temperature on the form.
	State if the relative humidity or the temperature is within manufacturer's specifications.

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 are listed on the calibration form and in Table 4-1. 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 4-2 presents the wiring diagram.

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.

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

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

4.5 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.

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	**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
ORIGINATOR	Mikell T. Bagby	
PROJECT MANAGER	John F. Faust	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
OTHER		

REVISION HISTORY

REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
0.1	Change responsibilities and documentation	September 1997	
1.0	Add sensor model and update calibration form	September 1998	
1.1	Add time specifications for sensor replacement	May 2000	

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
2.1	Project Manager	1
2.2	Field Specialist	2
3.0	REQUIRED EQUIPMENT AND MATERIALS	2
4.0	METHODS	2
4.1	Calibration Checks	3
4.1.1	Evaluation of Relative Humidity Checks	6
4.2	Sensor Replacement	6
4.3	System Maintenance	6
4.4	Post-Maintenance Calibration Checks	6
4.5	Documentation	9
5.0	REFERENCES	9

LIST OF FIGURES

Figure		Page
4-1	Weather Parameters Calibration Form (Relative Humidity, Dew Point, Wetness, and Precipitation)	4
4-2	Rotronics AT/RH Sensor Wiring Diagram	7
4-3	ARS Calibration Sticker	9

LIST OF TABLES

Table		Page
4-1	Specifications of Rotronics AT/RH Sensor	8

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
- Weather Parameters 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 Weather Parameters 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 Weather Parameters 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.

Air Resource Specialists, Inc.

WEATHER PARAMETERS CALIBRATION FORM

Network:		Station:		DATE:	By:
DVM Mfg. & Model:	FLUKE 8060A	S/N:	Date of Last Calibration:		

REFERENCE PSYCHROMETER	PRE-MAINTENANCE WET BULB = Deg. C	PRE-MAINTENANCE DRY BULB = Deg. C
	POST MAINTENANCE WET BULB = Deg. C	POST MAINTENANCE DRY BULB = Deg. C

RELATIVE HUMIDITY

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Model Name		
Model #		
Serial #		
Translator Serial #		

TRANSLATOR CARD

SETTING	Pre-Maintenance DVM (volts)	Pre-Maintenance DAS (%)	Post Maintenance DVM (volts)	Post Maintenance DAS (%)
Zero				
Span				

SENSOR RESPONSE

	Reference (CALCU)	DVM (volts)	DAS (%)	Difference (%)
Pre-maintenance				
Post Maintenance				

DEW POINT

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Model Name		
Model #		
Serial #		
Translator Serial #		

TRANSLATOR CARD

SETTING	Pre-Maintenance DVM (volts)	Pre-Maintenance DAS (Deg. C)	Post Maintenance DVM (volts)	Post Maintenance DAS (Deg. C)
Zero				
Span				

SENSOR RESPONSE

	Reference (CALCU)	DVM (volts)	DAS (%)	Difference (%)
Pre-maintenance				
Post Maintenance				

WETNESS

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Model Name		
Model #		
Serial #		

SENSOR RESPONSE

	DVM (volts)	DAS (%)	LED (ON/OFF)	DVM (volts)	DAS (%)	LED (ON/OFF)
DRY						
WET						

PRECIPITATION

SENSOR IDENTIFICATION

	Pre-Maintenance	Post Maintenance
Model Name		
Model #		
Serial #		

TIPPING BUCKET RESPONSE

	Calibration Volume	Target # of Tips	# of tips	Difference
PRE -				
POST				

COMMENTS:

Signature:_____

WEATHER.XLT
REVISION 3/10/98

Figure 4-1. Weather Parameters Calibration Form (Relative Humidity, Dew Point, Wetness, and Precipitation).

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

- Record the calculated RH value as the reference value listed on the calibration form, then record the corresponding datalogger and DVM values.

4.1.1 Evaluation of Relative Humidity Checks

Evaluate the results of the relative humidity calibration check, and verify that the station relative humidity value is within ±5% of the calculated reference value.

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.

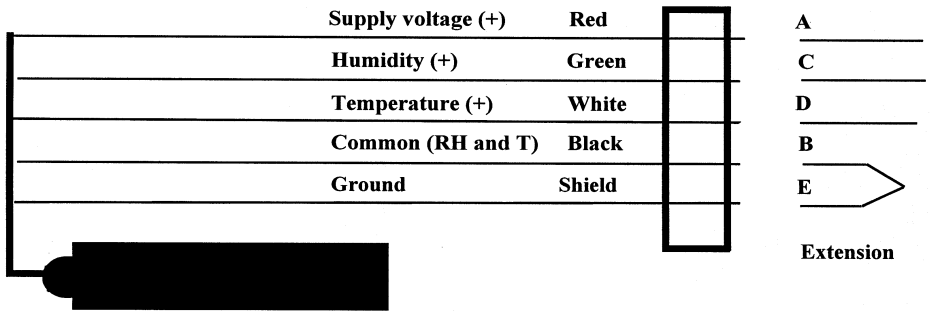
4.3 SYSTEM MAINTENANCE

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:

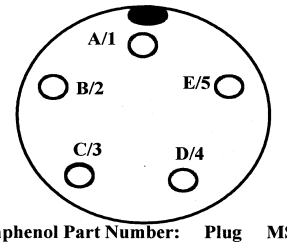
WIRING INSPECTION AND REPAIR	Inspect all AT/RH wiring for abrasions, cuts, or loose connections. Measure the supply voltage between pins 1 and 2 of the 5-pin Rotronics connector (or between the green and black pins of the Lemo connector), verifying that the sensor has a supply voltage between 5 and 26 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.

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.



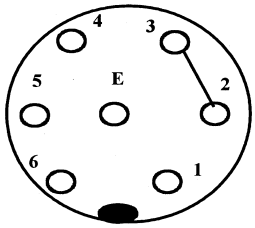
Rotronics 5-pin connector



A or 1:	Red	Supply Voltage (+)
B or 2:	Black	Common
C or 3:	Green	% RH (+)
D or 4:	White	Temp. (+)
E or 5:	Shield	Ground

Amphenol Part Number: Plug MS3106A-14S-5P
Clamp MS3057-6A
Mating MS3101A-14S-5S

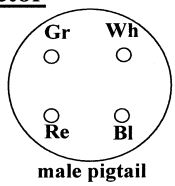
Rotronics 7-pin connector



1:	Green	Supply Voltage (+)
2 & 3:	Black	Ground
4:	Red	Temp. (+)
5:	Yellow	Common
6:	Blue	%RH (+)

Consult factory for part number.

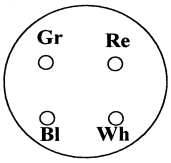
Lemo 4-pin connector



male pigtail

Stock Number: LUS21981

Green	Supply Voltage (+)
White	%RH (+)
Red	Temp. (+)
Black	Ground



female sensor

Stock Number: LUS21981

Green	%RH (+)
Red	Supply Voltage (+)
Black	Ground
White	Temp. (+)

MP101A - 03/18/94
MP601A - 07/24/95

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

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.

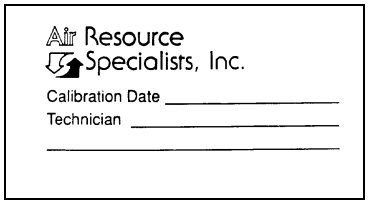


Figure 4-3. ARS Calibration Sticker.

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.

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	**CERTIFICATION OF OZONE TRANSFER STANDARDS**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3300**
DATE	**JUNE 1990**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Robert M. Lehman	
PROJECT MANAGER	John F. Faust	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	Changes to format/orig'r/update forms.	February 1997	

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
2.1	Project Manager	1
2.2	Laboratory Technician	1
3.0	REQUIRED EQUIPMENT AND MATERIALS	2
4.0	METHODS	2
4.1	Preparation for Ozone Transfer Standard Certification	3
4.2	Certification (Six-by-Six) of an Ozone Transfer Standard	3
4.2.1	Introduce Known Ozone Concentrations and Record Instrument Responses	3
4.2.2	Compile Certification Data	5
4.3	Re-Certification of an Ozone Transfer Standard	7
4.4	Documentation	7
5.0	DEFINITIONS	8
6.0	REFERENCES	8

LIST OF FIGURES

Figure		Page
4-1	Example Laboratory Ozone Calibration Form	4
4-2	Ozone Transfer Standard Certification Worksheet	6
4-3	ARS Calibration Sticker	7

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 Testing (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
- Laboratory Ozone Calibration Forms
- Pen or pencil
- Instrument-specific manufacturer's manual
- Ozone Transfer Standard Certification Worksheets
- Laptop computer loaded with Excel spreadsheet form (LABCAL.XLT) 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 Laboratory Ozone Calibration Form, used to record daily six-point checks, is presented as Figure 4-1.

4.2.1 <u>Introduce Known Ozone Concentrations and Record Instrument Responses</u>

RECORD PARAMETERS	Check all instrument-specific operational parameters for operation and record parameter values on a Laboratory Ozone Calibration Form.
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.

Air Resource Specialists, Inc.

LAB O_3 CALIBRATION FORM

Date _____ **Client** _____ **Tech.** _____

DVM Manufacturer _____ **Model** _____

Last Certification Date _____ **Serial Number** _____

Z Air Make _____ **Model** _____

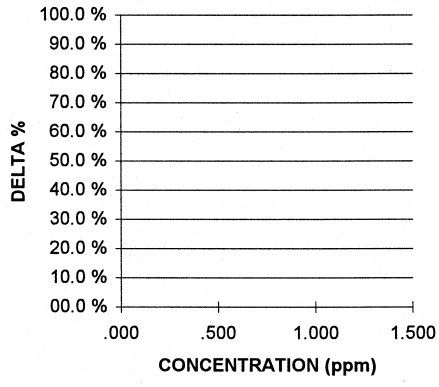
Serial Number _____ **Last Maintenance Date** _____

PRIMARY	
Last Cal. Date	
Manufacturer	
Model	
Serial Number	
Span Setting	
A Frequency	
B Frequency	
Flow	
Cell Temperature	
Inst. Offset (ppm)	

Instrument to be Calibrated	
Last Cal. Date	
Manufacturer	
Model	
Serial Number	
Span Setting	
A Frequency	
B Frequency	
Flow	
Cell Temperature	
Inst. Offset (ppm)	

Input Conc. (ppm)	Display Reading (ppm)	Output Voltage VDC	Actual O3 (ppm)	Error in ppm	Error Delta Percent
					NA
					#DIV/0!
					#DIV/0!
					#DIV/0!
					#DIV/0!
					#DIV/0!
					NA

SLOPE	#DIV/0!
INTERCEPT	#DIV/0!
CORRELATION	#DIV/0!
AVERAGE DELTA%	#DIV/0!



Remarks

Signature

Rev. 10/10/95

Figure 4-1. Example Laboratory Ozone Calibration Form.

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 designated ozone concentration and the candidate transfer standard as the analyzer response. Also record the electrical output of the candidate transfer standard as measured by the digital voltmeter.

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 six calibration forms are compiled as follows:

CALCULATE VALUES — Calculate the slope and intercept value for each set (day) of calibration check data.

ENTER VALUES ON WORKSHEET — Enter the calculated slope and intercept from each day on the Ozone Transfer Standard Certification Worksheet (see Figure 4-2).

COMPLETE WORKSHEET — Complete the Ozone Transfer Standard Certification Worksheet as follows:

- Sum the slopes and intercepts and calculate the average.
- Square each slope and intercept.
- Total the sums of each squared value.
- Fill in each variable with the previously calculated values.
- Solve the equations on the Ozone Transfer Standard Certification Worksheet.

OZONE TRANSFER STANDARD CERTIFICATION

Certfication Completion Date: _____ Client: _____

	Primary Standard	Transfer Standard
Manufacturer:		
Model:		
Serial Number:		
Certification Date:		

Date:	Slope	Intercept	Slope ^{2}	Intercept ^{2}
Sums:				

Square of the sum of slopes: _____

Square of the sum of intercepts: _____

$\overline{M}$ = _____ $\overline{I}$ = _____

Rel. std. dev. of slopes (Sm): _____ (Should be < 3.7%)

Quantityof the intercepts (Si): _____ (Should be < 1.5)

Standard O3 concentration = $\frac{1}{\overline{M}}$ (Indicated O3 conc. - $\overline{I}$)

Standard O3 concentration = _____ (Indicated O3 concentration -)

Signature

Rev. 4/14/95

Figure 4-2. Ozone Transfer Standard Certification Worksheet.

COMPARE RESULTS	Determine if the certification process was successful by comparing the results of the worksheet against the stated limits. Standard deviation of slope must be $\leq$ 3.7% Standard deviation of intercept must be $\leq$ 1.5.
TROUBLESHOOT	If certification is unsuccessful, troubleshoot the instrument, implement corrective action, and repeat the certification process.
COMPLETE DOCUMENTATION	If certification is successful, complete all final documentation procedures.

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 4-3. 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).

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	**CASTNET AMBIENT AIR QUALITY MONITORING AUDIT PROCEDURES**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**3755**
DATE	**JANUARY 2001**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Gloria S. Mercer	
PROJECT MANAGER	Don Cobb	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	2
2.1	Project Manager	2
2.2	Auditor/Field Specialist	2
2.3	Site Operator	3
3.0	REQUIRED EQUIPMENT AND MATERIALS	3
4.0	METHODS	4
4.1	Acceptance Criteria	4
4.2	Recording Audit Results	4
4.3	Auditing Specific Parameters	4
4.4	Reporting Audit Results	6
4.5	Distributing Audit Results	6

1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) describes the procedures for conducting performance and systems audits of Clean Air Status and Trends Network (CASTNet) ambient air quality monitoring stations, including meteorological sensors, ambient gas analyzers, particulate monitors, data acquisition systems, flow systems, etc. The purpose of a performance audit is to assess the measurement process under normal operating conditions without any special preparation or adjustment of the system. The purpose of a systems audit is to evaluate the entire monitoring process by inspecting the planning, organization, and operations, and to ensure that good quality assurance/quality control practices are being applied. Performance audit results are used to:

- Ensure the integrity of the data.
- Assess the data for accuracy.

Field systems audit results are used to:

- Verify that the instruments are properly sited, installed, and operated.
- Verify that procedures are in place to ensure that data collected at the site are of sufficient quality to meet the project objectives.
- Verify that documentation related to each component of the measurement system is present on-site.

The performance audit includes:

- Verifying that the sensors, analyzers, associated systems, and datalogger are capable of making valid measurements.
- Challenging each sensor or analyzer with an independent audit standard (traceable to National Institute of Standards and Technology (NIST) or other authoritative standards) to determine if the instrument is operating within project accuracy goals.
- Documenting audit results on the appropriate form(s).
- Distributing audit results to designated project personnel.

The field systems audit includes verifying the following:

- Site coordinates – elevation, latitude, longitude, and or Universal Transverse Mercators (UTM's).
- Site equipment – instrument shelter, security fencing, towers, instrumentation, OSHA safety compliance etc.

- Instrument probe siting and its compliance with guidelines.
- Instrument inventory – model, serial numbers, last calibration, etc.
- Completeness of site documentation and the site operator's understanding of his/her duties.

Ambient air quality equipment is typically audited at least once a year, but can be audited at any time. The following technical instructions (TIs) provide detailed information regarding specific CASTNet auditing procedures:

- TI 3755-6100 *Ozone Analyzer Audit Procedures (CASTNet Installations)*
- TI 3755-6110 *Meteorological Sensor Audit Procedures (CASTNet Installations)*
- TI 3755-6120 *Data Acquisition System Audit Procedures (CASTNet Installations)*
- TI 3755-6130 *Dry Deposition/Visibility Mass Flow Controlled Audit Procedures (CASTNet Installations)*
- TI 3755-6140 *Field Systems Audit Procedures (CASTNet Installations)*

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

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

2.2 AUDITOR/FIELD SPECIALIST

The auditor or field specialist shall:

- Perform all required audits in accordance with approved audit protocols as described in specific technical instructions.
- Coordinate with the project manager regarding audit schedules, procedures, accuracy goals, and required audit standards.

- Maintain all audit standards.
- Obtain the assistance of the site operator as needed during audits.
- Document the audit results on the appropriate form(s).
- Prepare and forward audit reports to designated personnel.

2.3 SITE OPERATOR

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

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment is required to audit ambient air quality equipment:

- Sensor audit standards
- Station Log
- Laptop computer loaded with Microsoft Word and Excel spreadsheet and audit data forms
- Digital Voltmeter (DVM) certified to NIST standards capable of measuring voltages between zero and one volt to one milivolt resolution
- Current site-specific USGS maps
- Brunton compass
- Geographical Positioning System
- Miscellaneous supplies
- Primary flow standard BIOS International Model DC-1 or equivalent (mass flow controllers audits)
- A thirty foot length of .375-inch Teflon tubing configured with a swagelok keyed stainless steel quick connect-fitting coupled to a short length of .250-inch Teflon tubing with a .250-inch swagelok tube fitting on the other (mass flow controllers audits)
- Certified gaseous primary or transfer standard (ambient gas analyzer audits)
- Zero air supply (ambient gas analyzer audits)
- Manufacturer’s instruction manuals

4.0 METHODS

The specific methods for auditing ambient air quality systems are detailed in the following sections:

4.1 Acceptance Criteria
4.2 Recording Audit Results
4.3 Auditing Specific Parameters
4.4 Reporting Audit Results
4.5 Distributing Audit Results

4.1 ACCEPTANCE CRITERIA

Meteorological measurement systems are audited in accordance with the EPA's *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV - Meteorological Measurements.* Ambient gas analyzers and flow systems are audited in accordance with the EPA's *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II – Ambient Air Specific Methods.* Accuracy goals for all parameters are obtained from the project-specific Quality Assurance Project Plan (QAPP). ARS uses NIST-traceable test equipment for all meteorological parameters except solar radiation; solar radiation is traceable to the World Meteorological Organization (WMO) standard. Gas analyzer audit standards are traceable to EPA primary standards, and flow standards are traceable to NIST.

Specific acceptance criteria for type of system being audited is provided in specific TIs, as listed in Section 1.0.

4.2 RECORDING AUDIT RESULTS

Audit results are written or input into electronic audit data forms on-site. The electronic forms have been developed using key features of Microsoft Excel and Microsoft Word to assist the auditor with inputting the required data.

4.3 AUDITING SPECIFIC PARAMETERS

GAS ANALYZERS — A transfer standard, in-station calibrator, or dilution system is used to audit, with "ZERO" and three upscale gas concentrations.

METEOROLOGICAL SENSORS

- Wind Speed - Dynamic tests of the horizontal wind speed sensors are performed using a wind speed calibrator. Each sensor is challenged at zero plus four (4) shaft revolution speeds. A bearing integrity check is also performed by using a torque wheel to check the starting threshold of the sensor.

- Wind Direction - Wind direction sensor audits include the verification of sensor orientation, linearity, and bearing integrity.

- Temperature and Temperature Difference - Each temperature sensor is audited by immersion in three (3) temperature baths. Temperature differences (ΔT) systems are assessed by simultaneously immersing both sensors in each of the three baths and noting the measured temperature difference between sensors.

- Relative Humidity - The relative humidity (RH) sensor is audited by comparison to a NIST-traceable audit sensor over a range of readings.

- Solar Radiation - The solar radiation sensors are audited by collocating a certified reference sensor next to the station sensor. Three to four 3 to 4 hours of data collected for comparison.

- Precipitation - The tipping bucket precipitation gauges are audited using a volumetric precipitation gauge calibrator and transferring a known amount of water through the gauge orifice at a rate equivalent to approximately 2 inches/hour of precipitation. Weighing bucket precipitation gauges are challenged with six calibration weights and the values on the gauge drum chart recorder noted.

- Wetness - The wetness sensor is challenged in both its “wet” and “dry” states. Audit results are reported as pass or fail.

- Wet-Dry Deposition - The wet/dry deposition system is challenged in both its “precipitating” and “not-precipitating” states. Audit results are reported as pass or fail.

DATA ACQUISITION SYSTEMS (DAS)

The accuracy of the DAS analog to digital converter(s) is challenged by connecting a voltage reference and DVM between an input channel and system ground. Using the voltage reference, test voltages are applied between 0.000 and 1.000 volts in 0.002V increments.

MASS FLOW CONTROLLERS

- CASTNet dry deposition flow systems – Remove the filter pack and turn the flow pump on without the flow audit device. Connect the system flow to the primary flow audit device. Obtain the flow readings observed on the audit flow device, mass flow controller display, and the dry deposition flow voltage on the DAS display.

- CASTNet visibility flow systems - The CASTNet visibility mass flow controlled system contains three filter packs and is commonly referred to as the “tri-flow” system. Audits of the

tri-flow system involve the audit of three mass flow controllers. Select the filter channel to be audited on the mass flow controller system. Turn the sampling pump on and record the mass flow controller display and DAS voltage readings for each filter system. Using the appropriate Swagelok quick-connect fitting, connect the tubing between the primary flow measurement device and the filter inlet on the tower. Allow the flow to run for several minutes until a stable reading is displayed on the audit flow measurement device. Record the mass flow controller display readings, DAS voltage, and the actual and standard flow values observed on the audit flow measurement device.

FIELD SYSTEMS

Verify that the site location and configuration match those provided in the project Quality Assurance Project Plan (QAPP). Verify that instruments and equipment are properly located. Inspect all equipment for damage and inventory. Verify that all instruments are operational and in current calibration. Verify that documentation related to each monitoring component is complete and present and that the site operator fully understands and is able to perform his or her duties.

4.4 REPORTING AUDIT RESULTS

Audit results are provided as follows:

- If the auditor determines that any parameter is operating outside of project accuracy goals (at the warning or fail levels), the responsible project personnel will be immediately notified.
- At the conclusion of a performance audit, a written “spot” report will be e-mailed within a day to project personnel.
- Final, fully documented written performance audit reports and systems audit reports are normally delivered within 45 days of an audit.

4.5 DISTRIBUTING AUDIT RESULTS

Audit reports will be distributed to the project personnel specified in individual site or network QAPPs or in specific contract documentation.

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	**OZONE ANALYZER AUDIT PROCEDURES (CASTNet Installations)**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3755-6100**
DATE	**JANUARY 2001**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Don Cobb	
PROJECT MANAGER	Don Cobb	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
2.1	Project Manager	1
2.2	Auditor/Field Specialist	2
2.3	Site Operator	2
3.0	REQUIRED EQUIPMENT AND MATERIALS	2
4.0	METHODS	2
4.1	Ozone Acceptance Criteria	3
4.2	Recording Audit Results	3
4.3	Pre-Audit Checks	3
4.4	Ozone Transfer Standard Preparation	4
4.5	Multipoint Audit	5
4.6	Reporting Audit Results	5
4.7	Distributing Audit Results	5
APPENDIX A	AUDIT DOCUMENTATION FORMS	A-1

LIST OF TABLES

Table		Page
4-1	Ozone Analyzer Audit Challenge Values and Acceptance Criteria	3

1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the procedures for conducting performance audits of ozone analyzers at Clean Air Status and Trends Network (CASTNet) monitoring sites. The purpose of the audit is to assess the measurement process under normal operating conditions without any special preparation or adjustment of the system. Performance audit results are used to:

- Ensure the integrity of the data.
- Assess the data for accuracy.

The audit of an ozone analyzer includes:

- Verifying that the analyzer, sample intake system, and datalogger are capable of providing valid measurements.
- Challenging the analyzer with an independent audit standard (traceable to authoritative standards) to determine if the instrument is operating within project accuracy goals.
- Documenting audit results on the appropriate form(s).
- Distributing audit results to the CASTNet contractor's project manager and other designated project personnel.

Ozone analyzers are typically audited at least once a year, but can be audited at any time. This technical instruction is intended for use by either internal or independent auditors who understand general instrument audit concepts and have the appropriate audit standards and audit documentation form(s).

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

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

2.2 AUDITOR/FIELD SPECIALIST

The auditor or field specialist shall:

- Perform all required audits in accordance with approved audit protocols.
- Coordinate with the project manager regarding audit schedules, procedures, accuracy goals, and required audit standards.
- Obtain the assistance of the site operator as needed during audits.
- Document the audit results on the appropriate form(s).
- Inform the CASTNet contractor immediately by telephone if any parameters are found to be operating outside of project accuracy goals.
- E-mail "spot reports" to the CASTNet contractor.
- Prepare and forward a final audit report to designated CASTNet contractor personnel.

2.3 SITE OPERATOR

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

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment is required to audit an ozone analyzer:

- Certified ozone primary or transfer standard
- Digital voltmeter (DVM)
- Zero air supply
- Ozone analyzer manufacturer’s instruction manual
- Station log
- Laptop computer loaded with Excel spreadsheet and CASTNet audit data forms

4.0 METHODS

The objective of the audit is to challenge the instrument by introducing known concentrations of ozone at the sample inlet to ensure that the audit gas travels through the entire sample line and all particulate filters used for routine ozone sampling. The specific methods for auditing CASTNet meteorological sensors are detailed in the following sections:

4.1 Ozone Acceptance Criteria
4.2 Recording Audit Results
4.3 Pre-Audit Checks
4.4 Ozone Transfer Standard Preparation
4.5 Multipoint Audit
4.6 Reporting Audit Results
4.7 Distributing Audit Results

4.1 OZONE ACCEPTANCE CRITERIA

Ozone analyzers are audited in accordance with the *EPA's Quality Assurance Handbook for Air Pollution Measurement Systems: Volume II – Ambient Air Specific Methods*. Accuracy goals for analyzer audits are obtained from the project Quality Assurance Project Plan (QAPP). ARS uses a certified primary or transfer standard for ozone audits. Audit ranges including acceptable criteria and warning thresholds for ozone are summarized in Table 4-1.

Table 4-1

Ozone Analyzer
Audit Challenge Values and Acceptance Criteria

Parameter	Audit Concentration Ranges (ppm)			Warning Criteria	Acceptance Criteria (difference between audit test gas concentration and analyzer response)
	Level 1	Level 2	Level 3		
O_3	0.03-0.08	0.15-0.20	0.36-0.45	Slope > 1.05 or < 0.95	Slope = 1.0 $\pm$ 10%
				Intercept $\geq$ .004 ppm $\leq$ .005 ppm	Intercept $\leq \pm$ 1 %
				Correlation < .997 or $\geq$ .995	Correlation $\geq$ 0.9950

4.2 RECORDING AUDIT RESULTS

Audit results are input into electronic audit data forms on-site. An electronic form specific to ozone analyzer audits has been developed. The form computes the engineering value and percent difference for each audit value as well as computing the "Pass/Fail/Warning" results. The warning parameter was designed to alert CASTNet contractor personnel of potential analyzer problems. The forms have been developed using key features of Microsoft Excel to assist the auditor with entering the required data. Upon initiation of each audit, the auditor accesses a blank audit form that has been saved as a template on his/her laptop computer. The color and cell locking capabilities of Excel have been employed to guide the auditor to designated cells for which audit data are required. All cells requiring input data are presented on the laptop computer in red letters. In addition, cells that require other auditor input (e.g., instrument internal settings, model and serial numbers, etc.) are highlighted on the audit form in red lettering with a yellow background. Cells that require no auditor input are locked to prevent accidental corruption. In addition to the audit data form, the audit results are also transferred to a summary of audit data form. At the conclusion of the audit, the summary form is copied to a separate file to form a "spot report" file. The "spot report" file is transferred to CASTNet contractor via e-mail before the auditor departs the site. Copies of the ozone audit data forms are provided in Appendix A.

4.3 PRE-AUDIT CHECKS

Prior to introducing audit gas into the analyzer, the following checks should be completed and documented on the ozone audit form:

RECORD GENERAL INFORMATION — Record the instrument serial number and last calibration date on the audit data form. Note any non-conforming aspects of the

	ozone monitoring system in the station log and the audit summary spreadsheet. Down the ozone channel on the DAS and toggle the display to show the analog input voltage for ozone. Note the time the analyzer is offline for the audit, and when it is placed back online, in the station log.
RECORD ANALYZER DETECTOR FREQUENCY AND NOISE	Check and record the detector frequency outputs and "NOISE" levels for test channels A and B.
RECORD ANALYZER TEMPERATURE AND PRESSURE	Using the front panel switches, check and record the analyzer temperature and ambient pressure values.
VERIFY ANALYZER FLOWMETER READINGS	Observe the analyzer flowmeter readings and verify that they are reading approximately 1.0 lpm.
CAP-OFF INLET	Cap-off the sample inlet on the 10-meter tower with a Teflon plug and verify that the flow drops to zero.

4.4 OZONE TRANSFER STANDARD PREPARATION

WARM UP	Turn on power to the ozone transfer standard and allow it to warm up for a minimum of one hour.
CONNECT ZERO AIR	If using the standard to generate ozone, connect a zero air supply to the inlet port.
RECORD SERIAL NUMBER AND LAST CAL DATE	Record the instrument serial number and last calibration date on the audit data form.
RECORD DETECTOR INTENSITIES AND CALIBRATION FACTORS	Check and record the detector intensities for test channels A and B. Record the calibration O3 ZERO and O3 COEF.
RECORD TEMPERATURE AND PRESSURE	Check and record the analyzer lamp temperature and ambient pressure values.
CONNECT TEFLON TUBING	If using the audit standard to generate the audit concentration of ozone, connect a clean length of Teflon tubing from the OZONE OUTLET port of the transfer standard to the SAMPLE INLET on the tower. Ensure that the ozone gas is vented at the back of the audit standard by using a Teflon "T" in the audit sample gas line.

If using the in-station ozone source to generate the audit concentration of ozone, connect a clean length of Teflon tubing to the sample inlet of the audit standard.

CAP OTHER PORTS — Cap all other OZONE OUTLET ports.

4.5 MULTIPOINT AUDIT

Using the ozone transfer standard or in-station calibrator, generate a "ZERO" and three upscale ozone concentrations. The upscale concentrations should be located within the ranges specified in Table 4-1. Allow the instrument a sufficient amount of time to stabilize at each point and record the results of the analyzer and transfer standard observed concentrations. The values of the instrument being audited should be obtained from the datalogger, and the units of the audit standard from the instruments display. When the audit is complete, place the ozone channel on the datalogger back on-line and record the time in the station log.

4.6 REPORTING AUDIT RESULTS

Audit results are reported as follows:

- If the auditor determines that some parameters are operating outside of project accuracy goals, the responsible party at the CASTNet contractor will be notified by telephone of the warning or failure status prior to the auditor's departure from the site.

- At the conclusion of the performance audit, a single "SPOT REPORT" summary sheet will be prepared for transfer to designated CASTNet contractor personnel. Prior to departure from the site, the auditor will e-mail a copy of the spot report (see Appendix A) to the CASTNet contractor project operations manager, technical staff, and data management personnel.

4.7 DISTRIBUTING AUDIT RESULTS

Written, final audit reports will be distributed within 45 days of the completion of each field audit group. An audit group consists of all sites visited during an individual field trip. CASTNet sites are currently audited in nine groups as designated in ARS' subcontract. Each report includes copies of each individual sensor audit data sheet, audit accuracy results, and a pass/fail summary table. Copies of the systems report for each site are also included in the written report. Four (4) hard copies of each report and one (1) CD-ROM containing a .PDF file of each report will be delivered to the CASTNet contractor.

APPENDIX A
AUDIT DOCUMENTATION FORMS

Air Resource Specialists, Inc.

OZONE AUDIT

Network: _____ Audit Date: _____ Auditor: _____

Site ID: _____ Start Time: _____ Operator: _____

Site Location: _____ End Time: _____ Last Calibration: _____

Station Equipment

Analyzer Manufacturer: TEI Model: 49 EPA S/N: _____ Inlet Height: 10 m

Analyzer Range: 0 - 500 ppb Span: _____ Offset: _____

"A" Dtr. Freq. (>75kHz): _____ "A" Noise (<4.0): _____ "B" Dtr. Freq. (>75kHz): _____ "B" Noise (<4.0): _____

Audit Equipment

Analyzer Manufacturer: Dasibi Model: 1003-PC EPA S/N: 1871 Certification Date: _____

Lamp Temp.(50-60°C): _____ °C Barimetric Pressure: _____ mmHg.

"A" Intensity (45-150 kHz): _____ "B" Intensity (45-150 kHz): _____ O_3 Bkg. ppb: _____ O_3 Coef.: _____

AUDIT REFERENCE		PRIMARY DAS			BACKUP DAS		
Audit Point	Input Conc. (ppb)	Voltage Reading	Concentration (ppb)	% Difference Ref. vs. Analyzer	Voltage Reading	Concentration (ppb)	%Differenence Ref. vs. Audit
Zero			0.000			0.000	
1			0.000			0.000	
2			0.000			0.000	
3			0.000			0.000	

LINEAR REGRESSION

Analyzer	
Slope (m)	
Intercept (b)	
Correlation (r)	
Average % Difference	

AUDIT RESULTS:

AUDIT CRITERIA			
Slope (m)	>= 0.9 and <= 1.1	SLOPE	
Intercept (b)	= +/- 5 ppb	INTERCEPT	
Correlation (r)	>= 0.9950	CORRELATION	

Remarks:

Signature:

Air Resource Specialists, Inc.

Summary of Audit Findings

Site ID and Location: _____ **Audit Date:** _____

Audited Parameter	Pass/Fail Criteria	Max. or Avg. Error	Pass/Warn/Fail
Wind Speed	+/- 0.5 m/s (WS < 5 m/s) +/- 5% (WS >= 5 m/s)		
Wind Speed Torque	<= g cm		
Wind Direction Orientation	+/- 5 º		
Wind Direction Linearity	+/- 5 º		
Wind Direction Torque	<= g cm		
Temperature	+/- 0.5 ºC		
Delta Temperature	+/- 0.5 ºC		
Relative Humidity	+/- 5% (RH >= 85%) +/- 20% (RH < 85%)		
Solar Radiation	+/- 10%		
Precipitation (tip)	+/- 5%		
Precipitation (weigh)	+/- 5%		
Ozone Slope (m)	0.9 >= m <= 1.1		
Ozone Intercept (b)	+/- 5 ppb		
Ozone Correlation (r)	r >= .9950		
NDDN Flow	+/- 5%		
Tri-Flow 1	+/- 5%		
Tri-Flow 2	+/- 5%		
Tri-Flow 3	+/- 5%		
Primary DAS Time	+/- 5 minutes		
Backup DAS Time	+/- 5 minutes		
Primary DAS Voltage	+/- 0.003 volts		
Backup DAS Voltage	+/- 0.003 volts		
Wet/Dry Collector	Pass		
Wetness Sensor	Pass		

Remarks:

Performance Audit Findings:

System Audit Findings:

Signature:

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	**METEOROLOGICAL SENSOR AUDIT PROCEDURES (CASTNet Installations)**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3755-6110**
DATE	**JANUARY 2001**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Don Cobb	
PROJECT MANAGER	Don Cobb	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
2.1	Project Manager	1
2.2	Auditor/Field Specialist	2
2.3	Site Operator	2
3.0	REQUIRED EQUIPMENT AND MATERIALS	2
4.0	METHODS	2
4.1	Sensor Acceptance Criteria	3
4.2	Recording Audit Results	3
4.3	Auditing Specific Parameters	5
4.4	Reporting Audit Results	7
4.5	Distributing Audit Results	7
APPENDIX A	AUDIT DOCUMENTATION FORMS	A-1

LIST OF TABLES

Table		Page
3-1	Audit Equipment	3
4-1	Meteorological Sensors Audit Values and Acceptance Criteria	4

1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the procedures for conducting performance audits of meteorological sensors at Clean Air Status and Trends Network (CASTNet) monitoring sites. The purpose of the audit is to assess the measurement process under normal operating conditions without any special preparation or adjustment of the system. Performance audit results are used to:

- Ensure the integrity of the data.
- Assess the data for accuracy.

The audit of a meteorological sensor includes:

- Verifying that the sensor, cables, datalogger, and support systems are capable of making valid measurements.
- Challenging each sensor with an independent audit standard (traceable to National Institute of Standards and Technology (NIST) or other authoritative standards) to determine if the instrument is operating within project accuracy goals.
- Documenting audit results on the appropriate form(s).
- Distributing audit results to the CASTNet contractor's project manager and other designated project personnel.

Meteorological sensors are typically audited at least once a year, but can be audited at any time. This technical instruction is intended for use by either internal or independent auditors who understand general instrument audit concepts and have the appropriate audit standards and audit documentation form(s).

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

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

2.2 AUDITOR/FIELD SPECIALIST

The auditor or field specialist shall:

- Perform all required audits in accordance with approved audit protocols.
- Coordinate with the project manager regarding audit schedules, procedures, accuracy goals, and required audit standards.
- Obtain the assistance of the site operator as needed during audits.
- Document the audit results on the appropriate form(s).
- Inform the CASTNet contractor immediately by telephone if any parameters are found to be operating outside of project accuracy goals.
- E-mail "spot reports" to the CASTNet contractor.
- Prepare and forward a final audit report to designated CASTNet contractor personnel.

2.3 SITE OPERATOR

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

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment is required to audit the meteorological equipment:

- Sensor audit standards listed in Table 3-1
- Station Log
- Laptop computer loaded with Excel spreadsheet and CASTNet audit data forms

4.0 METHODS

The specific methods for auditing CASTNet meteorological sensors are detailed in the following sections:

4.1 Sensor Acceptance Criteria
4.2 Recording Audit Results
4.3 Auditing Specific Parameters
4.4 Reporting Audit Results
4.5 Distributing Audit Results

Table 3-1

Audit Equipment

Sensor	Parameter	Audit Equipment		
		Manufacturer	Model	Description
Wind Speed	Accuracy	R.M. Young	18801	Anemometer drive 100-10,000 RPM.
	Threshold	R.M. Young	18310	Propeller/cup torque disc.
Wind Direction	Orientation Linearity	Brunton	5006 LM	Magnetic compass, site declination derived by USGS GEOMAG software based on site latitude and longitude.
		R.M. Young	18212	Vane angle fixture – tower mount.
		Air Resource Specialists	---	Vane angle fixture – notched at 45° increments.
	Threshold	R.M. Young	18331	Vane torque gauge.
		R.M. Young	18312	Cupwheel torque disc (Climatronics).
Temperature and Temperature Difference	Accuracy and Linearity	Ever Ready Thermometer Co (ERTCO)	89C 90C 91C	Thermometers calibrated to NIST standards with 0.1°C resolution.
Relative Humidity	Accuracy	Rotronics	GT-L MP-100	Calibrated to NIST standards.
Solar Radiation	Accuracy	Eppley	PSP	Primary radiometer standard.
Precipitation	Accuracy	Novalynx Belfort	260-2595 5633-1	Approximately 940 ml flask 10 ml syringe. 6 each 1-inch calibration weights weighed to 825 grams ± 8 grams.
Wetness	Yes/No	Various	---	Spray bottle with clear water.
Wet/Dry	Yes/No	Various	---	Spray bottle with clear water.

4.1 SENSOR ACCEPTANCE CRITERIA

Meteorological measurement systems are audited in accordance with the EPA's *Quality Assurance Handbook for Air Pollution Measurement Systems: Volume IV - Meteorological Measurements*, (March 1995). Accuracy goals for the meteorological parameters are obtained from the project Quality Assurance Project Plan (QAPP). ARS uses NIST-traceable test equipment for all meteorological parameters except solar radiation; solar radiation is traceable to the World Meteorological Organization (WMO) standard. Audit ranges including acceptable criteria and warning thresholds for each parameter are summarized in Table 4-1.

4.2 RECORDING AUDIT RESULTS

Audit results are input into electronic audit data forms on-site. An electronic form specific to each parameter has been developed. Each form converts all units to engineering units, and computes the percent difference for each audit value as well as computing the “Pass/Fail/Warning” results. The warning parameter was designed to alert CASTNet contractor personnel of potential instrument/sensor problems. The forms have been developed using key features of Microsoft Excel to assist the auditor with entering the required data. Upon initiation of each audit, the auditor accesses a blank audit sheet that has been saved as a template on his/her laptop computer. The color

and cell locking capabilities of Excel have been employed to guide the auditor to the designated cells for which audit data are required. All cells requiring input data are presented on the laptop computer in red letters. In addition, cells that require other auditor input (e.g., instrument internal settings, model and serial numbers, etc.) are highlighted on the audit form in red lettering with a yellow background. Cells that require no auditor input are locked to prevent accidental corruption. In addition to the audit data form, the audit results are transferred to a summary of audit data form. At the conclusion of the audit, the summary form is copied to a separate file to form a "spot report." The "spot report" is transferred to the CASTNet contractor via e-mail before the auditor departs the site. Copies of the audit data sheets for each meteorological parameter are provided in Appendix A.

Table 4-1

Meteorological Sensors
Audit Values and Acceptance Criteria

Sensor	Parameter	Audit Challenge Ranges	Warning Criteria	Acceptance Criteria (Accuracy)
Wind Speed	Speed Accuracy	Zero and four RPM values (15%, 30%, 45%, and 90% of full scale)	< 5mps ≥.2 mps > 5mps ≥ 3% ≤ 5%	± .5mps < 5mps; ± 5% of input for speeds > 5 mps
	Starting Threshold	Starting torque	> 75% of specification	≤ 0.2 gm/cm (Climatronics) ≤ 0.3 gm/cm (RM Young)
Wind Direction	Orientation Accuracy	Parallel to alignment rod/ or crossarm	> 3 ° < 5 °	± 5 ° from True North
	Response Threshold	Starting torque	> 75% of specification	< 8.0 gm/cm Climatronics < 10 gm/cm R.M. Young
	Linearity	Eight cardinal points	> 3 ° < 5 °	± 5 ° mean absolute error; ± 10° per input
Temperature and Temperature Difference	Accuracy and Linearity	Three temperature baths; 0 °C, near ambient, and near full-scale	> 0.2°C ≤ 0.5°C > 0.2°C ≤ 0.5°C	Temperature ± 0.5 °C △ temperature ± 0.5 °C
Relative Humidity	Accuracy	Compared to ambient, reference salt solutions, or selected calibration chamber humidities	>± 3% ≥ 85% RH >± 15% < 85% RH	± 5 % RH ≥ 85% ± 20% RH < 85%
Solar Radiation	Accuracy	3-with collocated audit sensor hourly averages	> 5.0% ≤ 10%	± 10 % of observed
Precipitation	Accuracy	Compared to known amount of introduced water / standard weights	> 3% ≤ 5%	± 5 % of observed or ± 0.05 inch per 1.00 inches
	Tip Response	10 manual tips		One contact closure per tip
Wetness	Yes/No	Spray mist	Not applicable	Positive response
Wet/Dry	Yes/No	Spray mist	Not applicable	Positive response

4.3 AUDITING SPECIFIC PARAMETERS

DAS PREPARATION	Prior to the auditing the meteorological parameters, use the in-station computer to "down" all of the applicable DAS channels, and note the channels and time in the station log. Prior to auditing each parameter, toggle the datalogger to display the analog input voltage for the parameter being audited. The display voltages are used for input into the audit spreadsheets.
METEOROLOGICAL TOWER PREPARATION	After downing the applicable channels on the DAS, lower the meteorological tower to its holding bracket to position the sensors near ground level for auditing.
WIND SPEED	Dynamic tests of the horizontal wind speed sensors are performed using an R. M. Young model 18801 pulsed motor wind speed calibrator. Each sensor is challenged at zero plus three (3) shaft revolution speeds (approximately 15, 30, 45, and 90 % of full scale). The equivalent wind speed is calculated according to the manufacturer's specified values for shaft rpm versus wind velocity and compared to readings displayed on the on-site datalogger. A bearing integrity check is also performed by using an R. M. Young torque wheel to check the starting threshold of the sensor.
WIND DIRECTION	Wind direction sensor audits include the verification of sensor orientation, linearity, and bearing integrity. ARS first verifies the proper orientation of the wind direction monitoring system using a magnetic compass. Compass readings are converted to degrees true using the site magnetic declination as determined using the site latitude and longitude coordinates. The sensor is then pointed in four cardinal directions using the sensor crossarm or a directional reference rod attached to the tower for guidance. Sensor linearity is verified using a test fixture which allows the sensor to be challenged in 45-degree intervals. Sensor bearing integrity is tested using an R.M. Young torque wheel.
TEMPERATURE AND TEMPERATURE DIFFERENCE	Each temperature sensor is audited by immersion in three (3) temperature baths with NIST- traceable thermometers. The temperature tests are performed at 0°C, ambient (approximately 20°C), and as near to full-scale as possible. Bath temperature readings obtained with the NIST-traceable thermometers are compared to the on-site datalogger output. Temperature differences (ΔT) systems are assessed by simultaneously immersing both sensors in each of the three baths and noting the measured temperature difference between sensors. Data displayed on the on-site datalogger are used to assess the accuracy and linearity of each sensor.

RELATIVE HUMIDITY

The relative humidity (RH) sensor is audited by comparison to a NIST-traceable audit sensor over a wide range of readings (20% to 90%). Two (2) methods are available to the auditor to challenge the relative humidity measurements:

1. Using a NIST-traceable relative humidity reference sensor, a series of three collocated instantaneous readings are taken and compared with those recorded by the on-site datalogger.

2. Both the on-site sensor and the audit reference sensor are collocated in a humidity reference. Readings near 35%, 80%, and 90% are compared to determine sensor accuracy.

SOLAR RADIATION

The solar radiation sensors are audited by collocating an Eppley model PSP certified reference sensor next to the station sensor. The reference sensor is signal conditioned to the appropriate scale for the on-site datalogger, connected to a spare channel, and 3 or more hours of data collected for comparison.

PRECIPITATION

Tipping Bucket

The tipping bucket precipitation gauges are audited using a volumetric precipitation gauge calibrator and transferring a known amount of water through the gauge orifice at a rate equivalent to approximately 2 inches/hour of precipitation. The datalogger output is recorded and compared to the volume of water transferred to the instrument. The gauges are also manually tipped 10 times and their response verified.

Weighing Bucket

The weighing gauges are challenged with six calibration weights and the values on the gauge drum chart recorder noted. The gauge weights are weighed on-site using the CASTNet scales, and their weights noted on the audit form.

WETNESS

The wetness sensor is challenged in both its “wet” and “dry” states. If the wetness sensing grid is dry at the beginning of the audit the initial values are recorded. The sensor is then challenged by wetting the sensing grid to verify that it changes state to report “wet” conditions. The values in the wet condition are recorded. If the sensor is “wet” when challenged the sensor is dried to verify it is operational in the “dry” state. Audit results are reported as “PASS” and “FAIL”.

WET/DRY DEPOSITION	The wet/dry deposition system is challenged in both its "precipitating" and "not-precipitating" states. If the deposition monitoring system is in the "not-precipitating" mode at the beginning of the audit, the auditor verifies that the lid is covering the "wet-deposition" bucket. The precipitation sensor is then wetted to verify that the lid transfers to cover the "dry-deposition" bucket. The system is then monitored to verify that the bucket returns to the "not-precipitating" state when the precipitation sensor dries out. If the sensor is in the "precipitating" state when challenged the precipitation sensor is dried to verify that the lid covering the "dry-deposition bucket" transfers to the "wet" bucket. Audit results are reported as "PASS" and "FAIL".
RETURN METEOROLOGICAL TOWER TO OPERATIONAL STATUS	When all of the meteorological parameters have been audited, return the meteorological tower to its vertical position.
RETURN DAS TO OPERATIONAL STATUS	After all of the meteorological parameters have been audited, and the tower returned to its vertical position, use the on-site computer to "up" the applicable DAS channels and note the time in the station log.

4.4 REPORTING AUDIT RESULTS

Audit results are provided as follows:

- If the auditor determines that any parameter is operating outside of project accuracy goals, the responsible party at the CASTNet contractor will be notified by telephone of the warning or failure status prior to the auditor's departure from the site.

- At the conclusion of the performance audit, a single "spot report" summary sheet is prepared for transfer to designated CASTNet contractor personnel. Prior to departure from the site, the auditor will e-mail a copy of the spot report (see Appendix A) to the CASTNet contractor project operations manager, technical staff, and data management personnel.

4.5 DISTRIBUTING AUDIT RESULTS

Written, final audit reports will be distributed within 45 days of the completion of each field audit group. An audit group consists of all sites visited during an individual field trip. CASTNet sites are currently audited in nine groups as designated in ARS' subcontract. Each report will include copies if each individual sensor audit sheet, project accuracy, and a pass/fail summary table. Copies of the systems report for each site are also included in the written report. Four (4) hard copies of each report and one (1) CD-ROM containing a .PDF file of each report will be delivered to the CASTNet contractor.

APPENDIX A
AUDIT DOCUMENTATION FORMS

Air Resource Specialists, Inc.

WIND SPEED AUDIT

Network: _____ Audit Date: _____ Auditor: _____

Site ID: _____ Start Time: _____ Operator: _____

Site Location: _____ End Time: _____ Last Calibration: _____

Station Equipment

WS Sensor Manufacturer: _____ WS Model: _____ EPA S/N: _____ Cups or Prop. S/N: _____

Maximum Bearing Torque: _____ gm/cm WS Units: meters/sec. WS Range: 0 - 50 m Sensor Height: 10 m

Audit Equipment

Torque Disc. Mfg: RM Young Model: 18310 S/N: 1501

Anemometer Drive Mfg: RM Young Model: 18801 S/N: 1501 Cal Date: _____

	Primary DAS						Backup DAS				
RPM	Designated	DAS Volts	DAS mps	Error mps	Error %	Pass (Y/N)	DAS Volts	DAS mps	Error mps	Error %	Pass (Y/N)
0	0.20				N/A					N/A	
300											
1800											
3600											
6600											

Torque (g-cm)	CW		CCW		

AUDIT RESULTS: Audit Criteria Velocity +/- 0.5 m/s for ws <= 5 m/s and +/- 5% for ws > 5 m/s VELOCITY

Torque <= g cm TORQUE

Remarks:

Signature:

Air Resource Specialists, Inc.

WIND DIRECTION AUDIT

Network: _____ Audit Date: _____ Auditor: _____

Site ID: _____ Start Time: _____ Operator: _____

Site Location: _____ End Time: _____ Last Calibration: _____

Station Equipment

WD Sensor Manufacturer: _____ WD Model: _____ EPA S/N: _____ Vane S/N: _____

Maximum Bearing Torque: _____ gm/cm Range: _____ Sensor Height: 10 m

Orientation Method: Compass Magnetic Declination ° _____

Audit Equipment

Vane Torque Gauge Mfg:	RM Young	Model:	18331	S/N:	1501
WD Angle Fixture Mfg:	RM Young	Model:	18212	S/N:	1501
Compass Mfg:	Brunton	Model:	5006LM	S/N:	5041192218

Direction Point		Primary DAS: DAS Voltage	Primary DAS: DAS Degrees	Primary DAS: Error Degrees	Primary DAS: Pass (Y/N)	Backup DAS: DAS Voltage	Backup DAS: DAS Degrees	Backup DAS: Error Degrees	Backup DAS: Pass/Fail Warning
To #1	0								
From #1	180								
To #2	90								
From #2	270								

Landmark #1: Aligned with Bar

Landmark #2: Aligned perpendicular to Bar

Crossarm/rod: _____

Linearity Point	Primary DAS: DAS Voltage	Primary DAS: DAS Degrees	Primary DAS: Error Degrees	Primary DAS: Pass (Y/N)	Backup DAS: DAS Voltage	Backup DAS: DAS Degrees	Backup DAS: Error Degrees	Backup DAS: Pass/Fail Warning
0								
45								
90								
135								
180								
225								
270								
315								

Torque (g-cm)	CW		CCW		

AUDIT RESULTS:

Audit Criteria: Orientation = +/- 5°
Linearity = +/- 5°
Torque = <= g cm

ORIENTATION	
LINEARITY	
TORQUE	

Remarks:

Signature:

Air Resource Specialists, Inc.

TEMPERATURE / Δ TEMPERATURE AUDIT

Network: _____ Audit Date: _____ Auditor: _____

Site ID: _____ Start Time: _____ Operator: _____

Site Location: _____ End Time: _____ Last Calibration: _____

Station Equipment

T_1 Manufacturer: _____ T_1 Model: _____ T_1 Height: 8.5 m T_1 S/N: _____

T_1 Range: _____ to _____ C T_1 Blower: _____

T_2 Manufacturer: 0 T_2 Model: _____ T_2 Height: 2 T_2 S/N: _____

T_2 Range: _____ to _____ C T_2 Blower: _____

Δ T Range: _____ to _____ C Δ T Configuration: T2 - T1

Audit Equipment

Range: _____ ° to _____ ° C Model: _____ S/N: _____ Last Cal. _____

Range: _____ ° to _____ ° C Model: _____ S/N: _____ Last Cal. _____

Range: _____ ° to _____ ° C Model: _____ S/N: _____ Last Cal. _____

Audit Reference	Primary DAS											
	T_1				T_2				Δ T			
Bath Temp.	DAS	Deg. C	Error	Status	DAS	Deg. C	Error	Status	DAS	Deg. C	Error	Status
Backup DAS												

AUDIT RESULTS:

AUDIT CRITERIA:

Temperature +/- 0.5 °C TEMPERATURE

Delta Temperature +/- 0.5 °C DELTA TEMPERATURE

Remarks:

Signature:

Air Resource Specialists, Inc.

RELATIVE HUMIDITY AUDIT

Network: _____ Audit Date: _____ Auditor: _____

Site ID: _____ Start Time: _____ Operator: _____

Site Location: _____ End Time: _____ Last Calibration: _____

Station Equipment

Sensor Manufacturer: Rotronics Model: MP100 EPA S/N: _____

Measurements Units: Percent Range: 0 - 100%

Audit Equipment

Reference Manufacturer: Rotronics Model: GL-T S/N: R16095

Last Calibration Date: _____

AUDIT REFERENCE			PRIMARY DAS				BACKUP DAS			
Point	Time	Ref.	Voltage	%RH	Error %RH	Status	Voltage	%RH	Error %RH	Status
1										
2										
3										
4										
				Average				Average		

AUDIT RESULTS: AUDIT CRITERIA = +/- 5% FOR RH >= 85%

OR +/- 20% FOR RH < 85%

Remarks:

Signature:

Air Resource Specialists, Inc.

SOLAR RADIATION AUDIT

Network:		Audit Date:		Auditor:	
Site ID:		Start Time:		Operator:	
Site Location:		End Time:		Last Calibration:	

Station equipment

Sensor Manufacturer:	LiCor	Model:	LI-200 SZ	EPA S/N:	
Measurement Units:	W/m2	Range:	0 - 1396		
Sensor Clean?		Sensor Level?			

Audit Equipment

Reference Manufacturer:	Eppley	Model:	PSP	S/N:	26387F3
Calibration Constant:	Watts/meter ^{2}			Last Calibration Date:	

AUDIT REFERENCE			PRIMARY DAS			
Point	Time	W/m^2	W/m^2	Error	Error %	Status
Zero					NA	NA
1						
2						
3						
4						
			Average			

AUDIT RESULTS: AUDIT CRITERIA = +/- 10% OF OBSERVED

Remarks:

Signature:

Air Resource Specialists, Inc.

PRECIPITATION AUDIT

Network:		Audit Date:		Auditor:	
Site ID:		Start Time:		Operator:	
Site Location:		End Time:		Last Calibration:	

Station Equipment

Tipping Bucket:

Sensor Manufacturer: Climatronics Model: 100508-G1 S/N:

Volume of Water / Tip: 4.54 milliliters Units: Inches EPA S/N:

Weighing Bucket:

Sensor Manufacturer: Model: EPA S/N:

Calibration Weights: gm +/- gm

Audit Equipment

Precipitation Calibrator Manufacturer: Novalynx Model: 260-2595 S/N: 6863

Tipping Bucket Audit Volume (ml) = Calibration Date:

TIPPING BUCKET

	DAS Reading	Error	Error %	Status
Manual 10 tips				
Expected =				

WEIGHING GAUGE

AUDIT REFERENCE			OBSERVED RESPONSE			
WEIGHTS	WATER	PRECIP.	CHART	Error	Error	Status
#	ml	inch	inch	inch	%	
0	0	0.00		0.00	NA	**N/A**
1	824	1.00				
2	1,648	2.00				
3	2,475	3.00				
4	3,296	4.00				
5	4,100	5.00				
6	4,944	6.00				

AUDIT RESULTS: AUDIT CRITERIA = +/- 5% OF OBSERVED OR 0.05 INCH

TIPPING BUCKET

WEIGHING GAUGE

Remarks:

Signature:

Air Resource Specialists, Inc.

WET / DRY COLLECTOR AND WETNESS SENSOR AUDIT

Network:		Audit Date:		Auditor:	
		Start Time:		Operator:	
Site Location:		End Time:		Last Calibration:	

Wet / Dry Collector Equipment

Sensor Manufacturer:		Model:		EPA S/N:		Sensor Height:	

Wetness Sensor Equipment

Sensor Manufacturer:	RM Young	Model:	58120	EPA S/N:		Sensor Height:	

WET / DRY COLLECTOR AUDIT

Action	Status PASS or FAIL
Place distilled water on sensor switch and confirm cover plate activation	
Confirm that cover plate returns to tightly cover wet bucket when sensor switch dries	
Note that event counter and hour meter increment	

WETNESS SENSOR AUDIT

Action	Volts	Status PASS or FAIL
Place distilled water on sensor and confirm WET response		
Dry sensor and confirm DRY response		

AUDIT RESULTS:

WET / DRY COLLECTOR

WETNESS SENSOR

Remarks:

Signature:

Air Resource Specialists, Inc.

Summary of Audit Findings

Site ID and Location: _____ **Audit Date:** _____

Audited Parameter	Pass/Fail Criteria	Max. or Avg. Error	Pass/Warn/Fail
Wind Speed	+/- 0.5 m/s (WS < 5 m/s) +/- 5% (WS >= 5 m/s)		
Wind Speed Torque	<= g cm		
Wind Direction Orientation	+/- 5 º		
Wind Direction Linearity	+/- 5 º		
Wind Direction Torque	<= g cm		
Temperature	+/- 0.5 ºC		
Delta Temperature	+/- 0.5 ºC		
Relative Humidity	+/- 5% (RH >= 85%) +/- 20% (RH < 85%)		
Solar Radiation	+/- 10%		
Precipitation (tip)	+/- 5%		
Precipitation (weigh)	+/- 5%		
Ozone Slope (m)	0.9 >= m <= 1.1		
Ozone Intercept (b)	+/- 5 ppb		
Ozone Correlation (r)	r >= .9950		
NDDN Flow	+/- 5%		
Tri-Flow 1	+/- 5%		
Tri-Flow 2	+/- 5%		
Tri-Flow 3	+/- 5%		
Primary DAS Time	+/- 5 minutes		
Backup DAS Time	+/- 5 minutes		
Primary DAS Voltage	+/- 0.003 volts		
Backup DAS Voltage	+/- 0.003 volts		
Wet/Dry Collector	Pass		
Wetness Sensor	Pass		

Remarks:

Performance Audit Findings:

System Audit Findings:

Signature:

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	**DATA ACQUISITION SYSTEM AUDIT PROCEDURES (CASTNet Installations)**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3755-6120**
DATE	**JANUARY 2001**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Don Cobb	
PROJECT MANAGER	Don Cobb	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
2.1	Project Manager	1
2.2	Auditor/Field Specialist	2
2.3	Site Operator	2
3.0	REQUIRED EQUIPMENT AND MATERIALS	2
4.0	METHODS	2
4.1	Data Acquisition System Acceptance Criteria	3
4.2	Recording Audit Results	3
4.3	Auditing the Data Acquisition System	4
4.3.1	System Time Check	4
4.3.2	Direct Wiring Configuration	4
4.3.2.1	Primary Data Acquisition	4
4.3.2.2	Backup Data Acquisition	5
4.3.3	Wiring Interface Block	5
4.4	Reporting Audit Results	6
4.5	Distributing Audit Results	6
APPENDIX A	AUDIT DOCUMENTATION FORMS	A-1

LIST OF TABLES

Table		Page
4-1	Data Acquisition System Audit Challenge Values and Acceptance Criteria	3

1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the procedures for conducting performance audits of data acquisition systems (DAS) at Clean Air Status and Trends Network (CASTNet) monitoring sites. The purpose of the audit is to assess the measurement process under normal operating conditions without any special preparation or adjustment of the system. Performance audit results are used to:

- Ensure the integrity of the data.
- Assess the data for accuracy.

The audit of a DAS includes:

- Verifying that the dataloggers are capable of making valid measurements.
- Challenging each analog to digital (A/D) converter and multiplexer in the DAS with an independent audit standard (traceable to National Institute of Standards and Technology (NIST) to determine if the DAS is operating within project accuracy goals.
- Documenting audit results on the appropriate form(s).
- Distributing audit results to the CASTNet contractor's project manager and other designated project personnel.

Data acquisition systems are typically audited at least once a year, but can be audited at any time. This technical instruction is intended for use by either internal or independent auditors who understand general instrument audit concepts and have the appropriate audit standards and audit documentation form(s).

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

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

2.2 AUDITOR/FIELD SPECIALIST

The auditor or field specialist shall:

- Perform all required audits in accordance with approved audit protocols.
- Coordinate with the project manager regarding audit schedules, procedures, accuracy goals, and required audit standards.
- Obtain the assistance of the site operator as needed during audits.
- Document the audit results on the appropriate form(s).
- Inform the CASTNet contractor immediately by telephone if any parameters are found to be operating outside of project accuracy goals.
- E-mail "spot reports" to the CASTNet contractor.
- Prepare and forward a final audit report to designated CASTNet contractor personnel.

2.3 SITE OPERATOR

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

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment is required to audit the DAS:

- Reference voltage source capable of generating test DC voltages between zero and one volt with one milivolt resolution
- Digital voltmeter (DVM) certified to NIST standards capable of measuring voltages between zero and one volt to one milivolt resolution
- A variety of test leads with banana jacks for connecting the DVM and voltage source to the DAS analog inputs
- Station Log
- Laptop computer loaded with Excel spreadsheet and CASTNet audit data forms

4.0 METHODS

The specific methods for auditing CASTNet data acquisition systems are detailed in the following sections:

4.1 Data Acquisition System Acceptance Criteria
4.2 Recording Audit Results
4.3 Auditing the Data Acquisition System
4.4 Reporting Audit Results
4.5 Distributing Audit Results

4.1 DATA ACQUISITION SYSTEM ACCEPTANCE CRITERIA

Audit values including acceptable criteria and warning thresholds for the DAS systems are summarized in Table 4-1.

Table 4-1

Data Acquisition System
Audit Challenge Values and Acceptance Criteria

Audit Challenge Values (volts)	Warning Criteria	Acceptance Criteria (Difference between reference input volts and DAS response)
.000 .002 .004 .006 .008 1.000	± .003V	± .003V
DAS Time (minutes) NIST Local Standard Time	> ± 4 minutes	± 5.0 minutes

4.2 RECORDING AUDIT RESULTS

Audit results are input into electronic audit data forms on-site. An electronic form specific to the DAS has been developed. The form converts all units to engineering units, and computes the error for each audit value as well as computing the "Pass/Fail/Warning" results. The warning parameter was designed to alert CASTNet contractor personnel of potential instrument/sensor problems. The forms have been developed using key features of Microsoft Excel to assist the auditor with entering the required data. Upon initiation of each audit, the auditor accesses a blank audit sheet that has been saved as a template on his/her laptop computer. The color and cell locking capabilities of Excel have been employed to guide the auditor to the designated cells for which audit data are required. All cells requiring input data are presented on the laptop computer in red letters. In addition, cells that require other auditor input (e.g., instrument internal settings, model and serial numbers, etc.) are highlighted on the audit form in red lettering with a yellow background. Cells that require no auditor input are locked to prevent accidental corruption. In addition to the audit data form, the audit results are transferred to a summary of audit data form. At the conclusion of the audit, the summary form is copied to a separate file to form a "spot report." The "spot report" is transferred to the CASTNet contractor via e-mail before the auditor departs the site. Copies of the audit data and summary of audit data sheets for DAS audits are provided in Appendix A.

4.3 AUDITING THE DATA ACQUISITION SYSTEM

The specific methods for auditing CASTNet DAS systems are detailed in this section. Each CASTNet site is configured with two DAS systems. The primary DAS is configured to monitor 16 analog input parameters. The backup DAS is configured to monitor 8 analog input parameters. The Odessa DSM3260 DAS installed at CASTNet sites use a separate analog to digital converter for each of 8 analog inputs. In addition, two different wiring configurations are employed at various CASTNet sites. The method for connecting the voltage reference source to the DAS in each of the configurations is discussed below.

4.3.1 System Time Check

Both the primary and backup DAS clocks are compared to NIST local standard time at each site. The clock must be accurate to within ± 5 minutes to be acceptable. Data are recorded in the audit spreadsheet form for the DAS.

4.3.2 Direct Wiring Configuration

4.3.2.1 Primary Data Acquisition

In this configuration, cabling from all measurement devices are connected directly to the analog input screw terminals at the rear of the DAS. The logger A/D converter and channel-specific multiplexer for analog input channels 1 through 8 is audited as follows:

- Using the on-site laptop computer “down” the appropriate channels on the primary and backup DAS and note the channel and time in the station log.
- Remove the wind direction input (channel 2) from the rear of the DAS.
- Connect the voltage reference and DVM between the wind direction input channel and system ground on the screw terminal.
- Toggle the DAS display to show channel 2 voltage readings.
- Using the voltage reference, develop test voltages between 0.000 and 1.000 volts in 0.002V increments.
- Verify the input challenge voltage on the NIST traceable DVM.
- Record the DAS observed voltage values on the DAS audit spreadsheet.
- Remove the voltage source and DVM and reconnect the wind direction wiring to channel 2 on the screw terminal at the rear of the DAS.
- After the audit of the DAS is complete “up” the appropriate channels on the DAS and note the channels and time in the station log.

The audit of the logger A/D converter and channel-specific multiplexer associated with channels 9 through 16 is accomplished by connecting the voltage source and DVM to one of the channels nine or greater. At most sites not all 16 input channels are used, therefore an open channel can be used. At most sites channel 13 is used to audit the upper A/D converter. Once the voltage source and DVM have been connected the procedures described above for channels 1 through 8 are followed.

4.3.2.2 Backup Data Acquisition

The backup DAS is also an Odessa DSM 3260; however, this system is only configured to record 8 analog channels. Audit of the backup system in this wiring configuration is accomplished by removing the wind direction input wiring from channel 2 and connecting the voltage source and DVM between the channel 2 analog input and system ground. The remainder of the audit challenge is accomplished as above.

4.3.3 <u>Wiring Interface Block</u>

Several of the sites have been installed with a wiring interface block. The cabling from the sensors and monitoring instruments is first connected to one side of the interface block. The other side of the interface block is connected to both the primary and backup DAS loggers using a wiring harness. One of the advantages of this configuration is that both the primary and backup DAS can be audited at the same time.

To challenge the logger A/D converter and channel-specific multiplexer for channels 1 through 8 follow the procedures listed below:

- Locate and remove the wind direction input that feeds DAS channel 2 on the wiring interface block.
- Connect the voltage reference and DVM between the wind direction input channel and the system ground on the interface block.
- Toggle the DAS display to show the channel 2 voltage readings on both the primary and backup DAS.
- Using the voltage reference develop test voltages between 0.000 and 1.000 volts in 0.002 volt increments.
- Verify the input challenge voltage on the NIST traceable DVM.
- Record the primary and backup DAS observed voltage values on the DAS audit spreadsheet.
- Remove the voltage source and DVM and reconnect the wind direction wiring to channel 2 on the wiring interface block.

To challenge the logger A/D converter and channel-specific multiplexer for channels 9 through 16 select a channel 9 or higher on the wiring interface block. Connect the voltage source and DVM to the input of the selected channel, toggle the primary DAS to display the voltage readings of the selected channel. Audit the primary DAS as described above.

4.4 REPORTING AUDIT RESULTS

Audit results are provided as follows:

- If the auditor determines that any parameter is operating outside of project accuracy goals, the responsible party at the CASTNet contractor will be notified by telephone of the warning or failure status prior to the auditor's departure from the site.

- At the conclusion of the performance audit, a single "spot report" summary sheet is prepared for transfer to designated CASTNet contractor personnel. Prior to departure from the site, the auditor will e-mail a copy of the spot report (see Appendix A) to the CASTNet contractor project operations manager, technical staff, and data management personnel.

4.5 DISTRIBUTING AUDIT RESULTS

Written, final audit reports will be distributed within 45 days of the completion of each field audit group. An audit group consists of all sites visited during an individual field trip. CASTNet sites are currently audited in nine groups as designated in ARS' subcontract. Each report will include copies if each individual sensor audit sheet, project accuracy, and a pass/fail summary table. Copies of the systems report for each site are also included in the written report. Four (4) hard copies of each report and one (1) CD-ROM containing a .PDF file of each report will be delivered to the CASTNet contractor.

APPENDIX A
AUDIT DOCUMENTATION FORMS

Air Resource Specialists, Inc.

DATA ACQUISITION SYSTEM AUDIT

Network: _____ Audit Date: _____ Auditor: _____

Site ID: _____ Start Time: _____ Operator: _____

Site Location: _____ End Time: _____ Last Calibration: _____

Station Equipment

Primary DAS Manufacturer: _____ Model: _____ EPA S/N: _____

Local Time: _____ DAS Time: _____

Backup DAS Manufacturer: _____ Model: _____ EPA S/N: _____

Local Time: _____ DAS Time: _____

Computer Manufacturer: _____ Model: _____ EPA S/N: _____

Audit Equipment

Reference Manufacturer: Fluke Model: 87 S/N: 50101272

Last Calibration Date: 0 Voltage Source: Calib. Inc. S/N: 700735

AUDIT REFERENCE		PRIMARY DAS			BACKUP DAS		
Point	(mVDC)	Voltage	Error	Status	Voltage	Error	Status
1	0.000						
2	0.200						
3	0.400						
4	0.600						
5	0.800						
6	1.000						
7	0.000						
8	0.200						
9	0.400						
10	0.600						
11	0.800						
12	1.000						

Primary DAS time difference =

Backup DAS time difference =

Points 1-6 on DAS input channel 2, points 7-12 on DAS input channel 13

AUDIT RESULTS: TIME AUDIT CRITERIA = +/- 5 MINUTES

PRIMARY DAS TIME _____ BACKUP DAS TIME _____

VOLTAGE AUDIT CRITERIA = +/- 0.003 Volts @ EACH POINT

PRIMARY DAS VOLTAGE _____ BACKUP DAS VOLTAGE _____

Remarks:

Signature:

Air Resource Specialists, Inc.

Summary of Audit Findings

Site ID and Location: _____ **Audit Date:** _____

Audited Parameter	Pass/Fail Criteria	Max. or Avg. Error	Pass/Warn/Fail
Wind Speed	+/- 0.5 m/s (WS < 5 m/s) +/- 5% (WS >= 5 m/s)		
Wind Speed Torque	<= g cm		
Wind Direction Orientation	+/- 5 º		
Wind Direction Linearity	+/- 5 º		
Wind Direction Torque	<= g cm		
Temperature	+/- 0.5 ºC		
Delta Temperature	+/- 0.5 ºC		
Relative Humidity	+/- 5% (RH >= 85%) +/- 20% (RH < 85%)		
Solar Radiation	+/- 10%		
Precipitation (tip)	+/- 5%		
Precipitation (weigh)	+/- 5%		
Ozone Slope (m)	0.9 >= m <= 1.1		
Ozone Intercept (b)	+/- 5 ppb		
Ozone Correlation (r)	r >= .9950		
NDDN Flow	+/- 5%		
Tri-Flow 1	+/- 5%		
Tri-Flow 2	+/- 5%		
Tri-Flow 3	+/- 5%		
Primary DAS Time	+/- 5 minutes		
Backup DAS Time	+/- 5 minutes		
Primary DAS Voltage	+/- 0.003 volts		
Backup DAS Voltage	+/- 0.003 volts		
Wet/Dry Collector	Pass		
Wetness Sensor	Pass		

Remarks:

Performance Audit Findings:

System Audit Findings:

Signature:

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	**DRY DEPOSITION/VISIBILITY MASS FLOW CONTROLLED AUDIT PROCEDURES (CASTNet Installations)**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3755-6130**
DATE	**JANUARY 2001**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Don Cobb	
PROJECT MANAGER	Don Cobb	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
2.1	Project Manager	1
2.2	Auditor/Field Specialist	2
2.3	Site Operator	2
3.0	REQUIRED EQUIPMENT AND MATERIALS	2
4.0	METHODS	3
4.1	Mass Flow Controlled System Acceptance Criteria	3
4.2	Recording the Audit Results	4
4.3	Auditing the Mass Flow Controlled System	4
4.3.1	Dry Deposition Flow Systems	4
4.3.2	Visibility Flow Systems	5
4.4	Reporting Audit Results	6
4.5	Distributing Audit Results	6
APPENDIX A	AUDIT DOCUMENTATION FORMS	A-1

LIST OF TABLES

Table		Page
4-1	Mass Flow Controlled Flow Systems Audit Values and Acceptance Criteria	3

1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the procedures for conducting performance audits of mass flow controller systems at Clean Air Status and Trends Network (CASTNet) monitoring sites. The purpose of the audit is to assess the measurement process under normal operating conditions without any special preparation or adjustment of the system. Performance audit results are used to:

- Ensure the integrity of the data.
- Assess the data for accuracy.

The audit of a mass flow controller includes:

- Verifying that the mass flow controllers and dataloggers are capable of providing valid measurements.
- Verifying the accuracy of the mass flow controllers with an independent audit standard (traceable to National Institute of Standards and Technology (NIST) or other authoritative standards) to determine if they are is operating within project accuracy goals.
- Documenting audit results on the appropriate form(s).
- Distributing audit results to the CASTNet contractor's project manager and other designated project personnel.

Mass flow controllers are typically audited at least once a year, but can be audited at any time. This technical instruction is intended for use by either internal or independent auditors who understand general instrument audit concepts and have the appropriate audit standards and audit documentation form(s).

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

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

2.2 AUDITOR/FIELD SPECIALIST

The auditor or field specialist shall:

- Perform all required audits in accordance with approved audit protocols.
- Coordinate with the project manager regarding audit schedules, procedures, accuracy goals, and required audit standards.
- Obtain the assistance of the site operator as needed during audits.
- Document the audit results on the appropriate form(s).
- Inform the CASTNet contractor immediately by telephone if any parameters are found to be operating outside of project accuracy goals.
- E-mail "spot reports" to the CASTNet contractor.
- Prepare and forward a final audit report to designated CASTNet contractor personnel.

2.3 SITE OPERATOR

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

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment is required to audit the mass flow controlled systems:

- Primary flow standard BIOS International Model DC-1 or equivalent
- A thirty foot length of .375-inch Teflon tubing configured with a swagelok keyed stainless steel quick-connect fitting coupled to a short length of .250-inch Teflon tubing with a .250-inch swagelok tube fitting on the end.
- Latex gloves
- Clean plastic bag
- Station Log
- Laptop computer loaded with Excel spreadsheet and CASTNet audit data forms

4.0 METHODS

The specific methods for auditing CASTNet mass flow controller systems are detailed in the following sections:

4.1 Mass Flow Controlled System Acceptance Criteria
4.2 Recording Audit Results
4.3 Auditing the Mass Flow Controlled System
4.4 Reporting Audit Results
4.5 Distributing Audit Results

4.1 MASS FLOW CONTROLLED SYSTEM ACCEPTANCE CRITERIA

The CASTNet monitoring systems can be configured with two mass flow controlled monitoring systems. All sites are configured with dry deposition filter packs, and mass flow controllers. The eastern sites mass flow controller systems are set to operate between 1.0 and 3.0 SLpm flow rates. The western sites are set to operate between 2.0 and 4.0 SLpm. The mass flow controller setting and expected flow in SLpm are posted at each site. Visibility monitoring sites are equipped with three mass flow controllers. Nylon/denudder and quartz mass flow controllers are set to operate between 9.0 and 11.0 SLpm. The Teflon filter pack mass flow controllers are set to operate between 15.0 and 17.5 SLpm. All mass flow controller systems flow measurements are audited under standard conditions of 760 mmHg and 25°C.

Audit values including acceptable criteria and warning thresholds for the mass flow controlled systems are summarized in Table 4-1.

Table 4-1

Mass Flow Controlled Flow Systems
Audit Values and Acceptance Criteria

Parameter	Designated Flow Range	Warning Criteria	Acceptance Criteria (accuracy)
Dry Deposition			
East Sites	1 to 3 SLpm	>3%	± 5%
West Sites	2 to 4 SLpm	>3%	± 5%
Visibility			
Nylon	9 to 11 SLpm	>3%	± 5%
Quartz	9 to 11 SLpm	>3%	± 5%
Teflon®	15 to 17.5 SLpm	>3%	± 5%

4.2 RECORDING AUDIT RESULTS

Audit results are input into electronic audit data forms on-site. Electronic forms specific to the mass flow controller systems has been developed. The form converts all units to engineering units, and computes the error for each audit value as well as computing the "Pass/Fail/Warning" results. The warning parameter was designed to alert CASTNet contractor personnel of potential instrument/sensor problems. The forms have been developed using key features of Microsoft Excel to assist the auditor with entering the required data. Upon initiation of each audit, the auditor accesses a blank audit sheet that has been saved as a template on his/her laptop computer. The color and cell locking capabilities of Excel have been employed to guide the auditor to the designated cells for which audit data are required. All cells requiring input data are presented on the laptop computer in red letters. In addition, cells that require other auditor input (e.g., instrument internal settings, model and serial numbers, etc.) are highlighted on the audit form in red lettering with a yellow background. Cells that require no auditor input are locked to prevent accidental corruption. In addition to the audit data form, the audit results are transferred to a summary of audit data form. At the conclusion of the audit, the summary form is copied to a separate file to form a "spot report." The "spot report" is transferred to the CASTNet contractor via e-mail before the auditor departs the site. Copies of the audit data and summary of audit data sheets for mass flow audits are provided in Appendix A.

4.3 AUDITING THE MASS FLOW CONTROLLED SYSTEM

4.3.1 Dry Deposition Flow Systems

The following procedures should be used in auditing the mass flow controlled dry deposition filter pack flows:

- Turn off the flow to the filter pack and note the time indicated on the filter pack hour meter in the station log
- Down the appropriate channel on the data acquisition system (DAS).
- Toggle the DAS to display the dry deposition flow voltage.
- Lower the 10-meter tower to ground level.
- Using latex gloves remove the filter pack from the tower and place it in a clean Teflon bag in the instrument shelter.
- Turn the flow pump on without the flow audit device installed and check for flow system leaks.
- Using the appropriate swagelok quick-connect fitting attached to the audit flow tubing, connect the dry deposition flow to the primary flow audit device.

- Allow the flow through the audit device to operate for several minutes until a stable reading has been obtained, record the both the actual and standard flow readings observed on the audit flow device, mass flow controller display, and the dry deposition flow voltage on the DAS display on the audit spreadsheet.

- Dry deposition flow systems are also equipped with a rotameter. Record the observed value of the rotameter on the audit spreadsheet.

- Remove the audit flow measurement device and turn off the dry deposition flow pump.

- Using latex gloves re-install the filter back on the tower.

- Raise the tower back to the operational position.

- Record the dry deposition flow hour meter reading in the station log and turn the flow pump back on.

- Up the dry deposition flow channel on the DAS.

4.3.2 Visibility Flow Systems

The visibility mass flow controlled system contains three filter packs and is commonly referred to as the "tri-flow" system. The tri-flow is operational just one day per week. When possible, audits of this system should be scheduled on a non-operational day. If the tri-flow system is audited on an operation day the procedures described above would apply. Because the tri-flow only operates for 24-hours it is important to minimize the down time for this instrument to avoid the sample being lost due to insufficient run time.

Audits of the tri-flow system involve the audit of three mass flow controllers. The procedures for auditing the tri-flow system on a non-operational day are described below:

- Use the on-site computer to down the applicable channels on the DAS, and note the Tri-flo hour meter reading and DAS time in the station log.

- Select the filter channel to be audited on the mass flow controller system.

- Toggle the DAS to display the voltage of the selected filter channel.

- Lower the sampling tower to ground level.

- If filter packs are installed, use latex gloves to remove them, and store them in a Teflon bag to avoid contamination of the filters.

- Turn the sampling pump on and check the flow system for leaks by monitoring the mass flow controller display (the DAS voltage for the filter pack being audited). Record the results on the audit spreadsheet.

- Using the appropriate Swagelok quick-connect fitting, connect the tubing between the primary flow measurement device and the filter inlet on the tower.

- Allow the flow to run for several minutes until a stable reading is displayed on the audit flow measurement device.

- Record the mass flow controller display readings, DAS voltage, and the actual and standard flow values observed on the audit flow measurement device on the audit spreadsheet.

- Repeat the above procedures for the remaining two channels.

- Turn the mass sampling pump off.

- Remove the flow measurement device.

- If filter packs were installed, use latex gloves to place them back on the monitoring tower.

- Restore the tower to its up and locked position

- Use the on-site computer to up the applicable channels, and note the reading of the Tri-flow hour meter and DAS time in the station log.

4.4 REPORTING AUDIT RESULTS

Audit results are provided as follows:

- If the auditor determines that any parameter is operating outside of project accuracy goals, the responsible party at the CASTNet contractor will be notified by telephone of the warning or failure status prior to the auditor's departure from the site.

- At the conclusion of the performance audit, a single "spot report" summary sheet is prepared for transfer to designated CASTNet contractor personnel. Prior to departure from the site, the auditor will e-mail a copy of the spot report (see Appendix A) to the CASTNet contractor project operations manager, technical staff, and data management personnel.

4.5 DISTRIBUTING AUDIT RESULTS

Written, final audit reports will be distributed within 45 days of the completion of each field audit group. An audit group consists of all sites visited during an individual field trip. The CASTNet sites are currently audited in nine groups as designated in ARS' subcontract. Each report will include copies if each individual sensor audit sheet, project accuracy, and a pass/fail summary table. Copies of the systems report for each site are also included in the written report. Four (4) hard copies of each report and one (1) CD-ROM containing a .PDF file of each report will be delivered to the CASTNet contractor.

APPENDIX A
AUDIT DOCUMENTATION FORMS

Air Resource Specialists, Inc.

NDDN FLOW SAMPLER AUDIT DATA SHEET

Network: _____ Audit Date: _____ Auditor: _____

Site ID: _____ Start Time: _____ Operator: _____

Site Location: _____ End Time: _____ Last Calibration: _____

Audit Equipment

Manufacturer: BIOS

Model: DC2 S/N 740 Audit Device Calibration Date: _____

Station Equipment and Audit

pler Model: _____ EPA S/N: _____

Sampler Calibration Relationship: Zero = _____ Full Scale = _____ Set Point = _____

	Audit Reference			Outputs			
	Sampler	Audit Flow	Audit Flow	Primary DAS		Backup DAS	
	Display	Actual LPM	Standard LPM	DAS Volts	DAS SLPM	DAS Volts	DAS SLPM
Flow On							
Flow Off							

Rotameter: _____ lpm

% Error	Results	% Error	Results

AUDIT RESULTS: CRITERIA = +/- 5 % OF OBSERVED

Remarks:

Signature:

Air Resource Specialists, Inc.

TRI-FLOW SAMPLER AUDIT DATA SHEET

Network: _____ Audit Date: _____ Auditor: _____

Site ID: _____ Start Time: _____ Operator: _____

Site Location: _____ End Time: _____ Last Calibration: _____

Audit Equipment

Audit Device Manufacturer: BIOS

Audit Device Model: DC2 S/N 740 Audit Device Calibration Date: _____

Station Equipment and Audit

Sampler Model: _____ (Denuded) EPA S/N: _____

Sampler Calibration Relationship: Zero = _____ Full Scale = _____ Set Point = _____

	Sampler	Audit Flow	Audit Flow	Primary DAS		Backup DAS	
	Display	Actual LPM	SLPM	DAS Volts	DAS SLPM	DAS Volts	DAS SLPM
Flow On							
Flow Off							

% Error	Results	% Error	Results

Sampler Model: _____ (Teflon Filter) EPA S/N: _____

Sampler Calibration Relationship: Zero = _____ Full Scale = _____ Set Point = _____

	Sampler	Audit Flow	Audit Flow	Primary DAS		Backup DAS	
	Display	Actual LPM	SLPM	DAS Volts	DAS SLPM	DAS Volts	DAS SLPM
Flow On							
Flow Off							

% Error	Results	% Error	Results

Sampler Model: _____ (Quartz Filter) EPA S/N: _____

Sampler Calibration Relationship: Zero = _____ Full Scale = _____ Set Point = _____

	Sampler	Audit Flow	Audit Flow	Primary DAS		Backup DAS	
	Display	Actual LPM	SLPM	DAS Volts	DAS SLPM	DAS Volts	DAS SLPM
Flow On							
Flow Off							

% Error	Results	% Error	Results

AUDIT RESULTS: CRITERIA = +/- 5 % OF OBSERVED

Remarks:

Signature:

Air Resource Specialists, Inc.

Summary of Audit Findings

Site ID and Location: _____ **Audit Date:** _____

Audited Parameter	Pass/Fail Criteria	Max. or Avg. Error	Pass/Warn/Fail
Wind Speed	+/- 0.5 m/s (WS < 5 m/s) +/- 5% (WS >= 5 m/s)		
Wind Speed Torque	<= g cm		
Wind Direction Orientation	+/- 5 º		
Wind Direction Linearity	+/- 5 º		
Wind Direction Torque	<= g cm		
Temperature	+/- 0.5 ºC		
Delta Temperature	+/- 0.5 ºC		
Relative Humidity	+/- 5% (RH >= 85%) +/- 20% (RH < 85%)		
Solar Radiation	+/- 10%		
Precipitation (tip)	+/- 5%		
Precipitation (weigh)	+/- 5%		
Ozone Slope (m)	0.9 >= m <= 1.1		
Ozone Intercept (b)	+/- 5 ppb		
Ozone Correlation (r)	r >= .9950		
NDDN Flow	+/- 5%		
Tri-Flow 1	+/- 5%		
Tri-Flow 2	+/- 5%		
Tri-Flow 3	+/- 5%		
Primary DAS Time	+/- 5 minutes		
Backup DAS Time	+/- 5 minutes		
Primary DAS Voltage	+/- 0.003 volts		
Backup DAS Voltage	+/- 0.003 volts		
Wet/Dry Collector	Pass		
Wetness Sensor	Pass		

Remarks:

Performance Audit Findings:

System Audit Findings:

Signature:

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	**FIELD SYSTEMS AUDIT PROCEDURES (CASTNet Installations)**
TYPE	**TECHNICAL INSTRUCTION**
NUMBER	**3755-6140**
DATE	**JANUARY 2001**

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
ORIGINATOR	Don Cobb	
PROJECT MANAGER	Don Cobb	
PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS

TABLE OF CONTENTS

Section		Page
1.0	PURPOSE AND APPLICABILITY	1
2.0	RESPONSIBILITIES	1
2.1	Project Manager	1
2.2	Auditor/Field Specialist	2
2.3	Site Operator	2
3.0	REQUIRED EQUIPMENT AND MATERIALS	2
4.0	METHODS	3
4.1	Audit Procedures	3
4.2	Recording Audit Results	3
4.3	Reporting Audit Results	4
4.4	Distributing Audit Results	4
APPENDIX A	AUDIT DOCUMENTATION FORMS	A-1

1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the procedures for conducting field systems audits at Clean Air Status and Trends Network (CASTNet) monitoring sites. A systems audit is a qualitative appraisal of the total measurement system. The purpose of the systems audit is evaluate the entire monitoring process by inspecting the sites planning, organization, and operation, and to ensure that good quality assurance/quality control practices are being applied. Field systems audit results are used to:

- Verify that the instruments are properly sited, installed, and operated.
- Procedures are in place to ensure that data collected at the site are of sufficient quality to meet the project objectives.
- Documentation related to each component of the measurement system is present on-site.

The field systems audit includes verifying the following:

- Site coordinates – elevation, latitude, longitude, and or Universal Transverse Mercators (UTM's).
- Site equipment – instrument shelter, security fencing, towers, instrumentation, OSHA safety compliance etc.
- Instrument probe siting and its compliance with guidelines.
- Instrument inventory – model, serial numbers, last calibration, etc.
- Completeness of site documentation and the site operator's understanding of his/her duties.
- Audit results are distributed to the CASTNet contractor's project manager and other designated project personnel.

Field system audits are typically conducted at least once a year, but can be scheduled at any time. This technical instruction is intended for use by either internal or independent auditors who understand general systems audit concepts and have the appropriate audit standards and audit documentation form(s).

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Coordinate with the auditor regarding audit schedules, procedures, calibration constants, and required supplies.
- Review all audit results.

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

2.2 AUDITOR/FIELD SPECIALIST

The auditor or field specialist shall:

- Perform all required audits in accordance with approved audit protocols.
- Coordinate with the project manager regarding audit schedules, procedures, accuracy goals, and required audit standards.
- Obtain the assistance of the site operator as needed during audits.
- Document the audit results on the appropriate form(s).
- Inform the CASTNet contractor immediately by telephone if any parameters are found to be operating outside of project accuracy goals.
- E-mail "spot reports" to the CASTNet contractor.
- Prepare and forward a final audit report to designated CASTNet contractor personnel.

2.3 SITE OPERATOR

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

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following equipment is required to conduct a field systems audit.

- Current USGS map
- Brunton compass
- Geographical Positioning System
- Station Log
- Laptop computer loaded with Microsoft Word and CASTNet field systems audit forms

4.0 METHODS

The specific methods for conducting field system audits of CASTNet monitoring sites are detailed in the following sections:

4.1 Audit Procedures
4.2 Recording Audit Results
4.3 Reporting Audit Results
4.4 Distributing Audit Results

4.1 AUDIT PROCEDURES

Specific procedures related to the systems audit that will be completed by the auditor are:

- Verify that the site location and configuration match those provided in the project Quality Assurance Project Plan (QAPP).
- Verify that meteorological instruments are located at appropriate height and distances from obstacles to meet EPA ambient monitoring guidelines (EPA-600/4-82-060).
- Inspect the shelter and surrounding area for accessibility, orderliness, shelter temperature control, and OSHA safety standards.
- Inspect the normal sampling lines for leaks, kinks, visible contamination, weathering, and moisture.
- Inventory all monitoring and recording equipment by manufacturer, model number, serial number, and/or EPA property tag.
- Verify that all ambient air quality instruments are operational, are being operated in the appropriate range, and that the zero air supply desiccant is unsaturated.
- Verify that all meteorological systems are in good physical and operational condition, and are properly sited.
- Confirm that all instruments are in current calibration.
- Review site documentation (logs, maintenance schedules, calibrations documents, on-site standard operating procedures) to confirm that correct procedures are being followed, and log book records are complete.

4.2 RECORDING AUDIT RESULTS

Audit results are input into an electronic audit data form on-site. An electronic form specific to the field systems audit has been developed using Microsoft Word. If the field systems audit is the initial audit for the site being audited, the auditor starts with a clean audit form and completes the audit data form. If the site has been previously audited, prior to traveling to the site the auditor copies the field systems audit report from the previous audit. This form is used as a basis for the

current audit. Findings from the previous audit are reviewed to determine if corrective actions have been implemented. The form is edited to include any additional findings from the current audit. In addition to the field systems audit data form, any significant systems finding are also noted on the summary of audit results on the performance audit spreadsheet form. At the conclusion of the audit, the summary form is copied to a separate file to form a "spot report." The "spot report" is transferred to the CASTNet contractor via e-mail before the auditor departs the site. Copies of the audit data forms for the field systems audit are provided in Appendix A.

4.3 REPORTING AUDIT RESULTS

Audit results are provided as follows:

- If the auditor determines that any parameter is operating outside of project accuracy goals, the responsible party at the CASTNet contractor will be notified by telephone of the warning or failure status prior to the auditor's departure from the site.

- At the conclusion of the performance audit, a single "spot report" summary sheet is prepared for transfer to designated CASTNet contractor personnel. Prior to departure from the site, the auditor will e-mail a copy of the spot report (see Appendix A) to the CASTNet contractor project operations manager, technical staff, and data management personnel.

4.4 DISTRIBUTING AUDIT RESULTS

Written, final audit reports will be distributed within 45 days of the completion of each field audit group. An audit group consists of all sites visited during an individual field trip. The CASTNet sites are currently audited in nine groups as designated in ARS' subcontract. Each report will include copies if each individual sensor audit sheet, project accuracy, and a pass/fail summary table. Copies of the systems report for each site are also included in the written report. Four (4) hard copies of each report and one (1) CD-ROM containing a .PDF file of each report will be delivered to the CASTNet contractor.

APPENDIX A
AUDIT DOCUMENTATION FORMS

CASTNet FIELD SYSTEMS AUDIT REPORT

1.0 GENERAL

1.1 Site Identification

Site ID Number:_____
Site Location:_____
Site Operator:_____
Alternate:_____

Date Site Operation Began:_____
Audit Date:_____
Auditor:_____
Others Present:_____

1.2 Site Map

USGS Map:_____
Map Scale:_____
GEOMAG Declination:_____deg. West

Map Date:_____
Photorevised:_____
GEOMAG Declination Date:_____

1.3 Site Coordinates

INDICATED BY ESE	DETERMINED BY AUDITOR
Latitude:_____ north	Latitude:_____north
Longitude:_____ west	Longitude:_____west
Elevation:_____meters	Elevation:_____ meters

2.0 ADDITIONAL SITE INFORMATION

2.1 General Appearance and Safety

- Does the site appear to be clean, organized, and well maintained both inside and outside? **YES** / NO — Comment:_____
- Does the instrument shelter have adequate working room? **YES** / NO — List Shelter Size:_____ Comment:_____
- Does the site appear to be safe and reasonably hazard free? **YES** / NO — Comment:_____

Indicate with an "**X**" if present.			
X	Fire Extinguisher	X	Electrical Grounding
X	First-aid Kit		Security Fence
O	Stable Tower *	X	Stable Entry Steps

3.0 SITE SURROUNDINGS

3.1 Major Nearby Pollution Sources

- Are any of the following sources of pollution within a 10-km radius of the site? **YES** / NO

If **YES**, indicate with an "**X**", describe, and give direction and distance from site.		
	Power Plant	
	Industrial Complex	
	Active Quarry	
X	Smelters/Mills	
	Refinery	
	Chemical Production	
	Major Highway	
	Major Airport	
	Railroad Yard	
	Major Agriculture	
X	Other	

3.2 Close Features (If helpful, include sketch of the surroundings.)

- Does the site exhibit adequate spacing from nearby features, natural or man-made, that may affect the monitored parameters?
  (e.g. tall trees, buildings, steep slopes, hollows, parking lots, etc.)

  YES **NO** Comment:_____

- Is the ground surface surrounding the site natural material?
  (e.g. grass, dirt, brush, etc.)

  YES NO Comment:_____

4.0 INSTRUMENT AND PROBE SITING

4.1 Meteorological Sensors (Refer to EPA QA Handbook, Vol. IV, 8/89)

- Are the wind speed and direction sensors sited so as to avoid being influenced by any obstructions?

  (i.e. WS and WD sensors should be sited on level, open terrain and no closer to any obstruction, natural or man-made, than 10x the height of that obstruction.)

  YES NO Comment:_____

- Are the wind speed and wind direction sensors mounted so as to minimize tower effects?

  (i.e., WS and WD sensors should be mounted on top of the tower, or on a boom that extends horizontally into the prevailing wind, and spaced >2x the maximum diameter of the tower away from the nearest point on the tower.)

  YES NO Comment:_____

- Are the tower and WS/WD sensors plumb?

  YES NO Comment:_____

- Are the temperature probe inlets pointed north or otherwise positioned to avoid radiated heat sources such as buildings, walls, etc?

  YES NO Comment:_____

- Are the temperature and RH sensors sited to avoid unnatural conditions? **YES** NO Comment:_____

  (i.e. Ground surface below the temperature and RH sensors must not be concrete or asphalt. Steep slopes, ridges, hollows and areas of standing water should be avoided.)

- Is the solar radiation sensor plumb and positioned to avoid shading, or any artificial or reflected light sources such as buildings, walls, lamps, etc.? **YES** NO Comment:_____

- Is the rain gauge plumb and positioned to avoid sheltering effects from buildings, trees, etc? **YES** NO Comment:_____

4.2 Pollution Samplers (Refer to 40 CFR 58, Appendix E)

- Do the sample inlets have at least a 270 degree arc of unrestricted airflow? **YES** NO Comment:_____

- Do the sample inlets meet acceptable siting criteria? **YES** NO Comment:_____

  (i.e. The sample inlets should be 3-15 meters above ground, >1 m from any major obstruction, and >20 m from trees.)

- Are the Wet/Dry Collectors placed to avoid sheltering effects from buildings, trees, etc.? YES NO Comment:_____

5.0 INSTRUMENTATION

5.1 Meteorological Instruments

Parameter	Make	Model	Serial No.
Wind Speed	RM Young	05305	**SEE PERFORMANCE REPORTS**
Wind Direction	RM Young	05305	
Temperature	RM Young	43347	
Temperature Difference	RM Young	43347	
Humidity	Rotronic	MP-101 A	
Solar Radiation	Li-Cor	Pyranometer	
Precipitation (tip)	Climatronics	100508-2	
Precipitation (weigh)	NA	NA	
Moisture	RM Young	58120	

- Do all the meteorological sensors appear to be intact, in good condition, and well maintained? **YES** NO List deficiencies:_____

- Are all the meteorological sensors operational, on-line, and reporting data? **YES** NO List deficiencies:_____

- Are the aspirated shield motors for the temperature, temperature difference, and RH probes working?

YES NO

Comment:_____

- Is the solar radiation sensor's upper surface clean and free of scratches?

YES NO

Comment:_____

5.2 Pollution Instruments

Parameter	Make	Model	Serial No.
Ozone	TECO	49	**SEE PERFORMANCE REPORTS**
Wet/Dry Collector	NA	NA	
Filter Pack Power Supply	Tylan	CPR-1A	
Filter Pack Flow Controller	Tylan	FC 280	

- Do the pollution monitoring instruments appear to be in good condition and well maintained?

YES NO

List deficiencies:_____

- Are all the pollution monitors operational, on-line, and reporting data?

YES NO

List deficiencies:_____

- Are the ozone sample lines constructed of glass or Teflon?

YES NO

Describe line length and size:_____

- Is the zero air supply desiccant unsaturated?
  (i.e. blue in color)

YES NO

Comment:_____

- Are in-line filters used on the ozone sample line?

YES NO

If YES, indicate location and how often they are changed:_____

- Are the filter pack and ozone sample lines clean and free of moisture or obstructions?

YES NO

Comment:_____

5.3 Data Acquisition System (DAS)

Parameter	Make	Model	Serial No.
Primary Data Logger	Odessa	DSM 3260	**SEE PERFORMANCE REPORTS**
Backup Data Logger	Odessa	DSM 3260L	
Computer	Computer Library	Turbo XT	
Modem	Ven-Tel	1200-32	
Printer	Star	NX-1000 II	

- Do the DAS instruments appear to be in good condition and well maintained? **YES** NO — List deficiencies:_____

- Are all the components of the DAS operational? **YES** NO — List deficiencies:_____

- Are all the instrument signal leads connected to the correct DAS channel? **YES** NO — Comment:_____

5.4 Instrument Shelter

- Is the instrument shelter temperature controlled? **YES** NO — Indicate operating limits:_____

- Does the site have a stable power source? **YES** NO — Comment:_____
  (i.e., no low or fluctuating power problems)

6.0 DOCUMENTATION

6.1 Instrument Reference Manuals

- Does the site have all the required instrument manuals? YES **NO**

Indicate with an "**X**" if the manuals are present, an "**O**" if missing.			
O	Wind Speed Sensor	X	Tipping Bucket Rain Gauge
O	Wind Direction Sensor	NA	Weighing Rain Gauge (if present)
O	Temperature Probe	NA	Wet/Dry Collector (if present)
O	Temperature Difference Probe	X	Data Logger
O	Relative Humidity Probe	X	Computer
O	Solar Radiation Sensor	X	Modem
O	Ozone Monitor	O	Printer
O	Filter Pack Flow Meter	X	Moisture Sensor

6.2 Station Operation Report Forms

- Does the site have all the required and most recent QC documents and report forms? **YES** NO

Indicate with an "**X**" if the documents are present, an "**O**" if missing.		
X	Station Activity Log	Last entry date: 27 September 1996
X	Site Status Report Form	Version ID: 8/93ss
X	Site Operator's Manual	Dated: 12/16/88
X	Calibration Reports	Latest dated: 6/27/96 (S. Grenville)
X	Field Operations Manual	Dated: July 1990
X	Site Health & Safety Plan	Dated: June 1993

- Are the report forms and site log properly completed and current? **YES** NO Comment:_____

- Are chain-of-custody forms used to document transferring samples to and from ESE? **YES** NO Describe form:_____

7.0 OPERATIONAL PROCEDURES

7.1 General

- Is the site visited regularly on the required Tuesday schedule? **YES** NO Comment:_____

- Are the standard CASTNet operational procedures being followed by the site operator? **YES** NO Comment:_____

- Does a station preventative maintenance schedule exist? **YES** NO Comment:_____

- Are site visitors and maintenance activities properly documented in the Site Activity Log? **YES** NO Comment:_____

- Is the site operator knowledgeable and competent regarding the required tasks for effective operation of the site? **YES** NO Comment:_____

- Has the site operator attended a formal CASTNet training course? **YES** NO Indicate when and where trained:_____

7.2 Meteorological Sensors

- Are regular operational QC checks performed on the meteorological instruments? **YES** NO

If **YES**, indicate with an "**X**" and note frequency of check.		
Type of QC check		**Frequency**
X	Multipoint Calibrations	Semiannually by ESE staff
X	Visual inspection of sensors	Tuesday
NA	Elec. zero/full scale check (Climatronics)	NA
X	Manual tips of precipitation gauge bucket	Tuesday
X	Confirm reasonableness of current values	Tuesday
X	Check operation of radiation shield motors	Tuesday

7.3 Ozone Analyzer

- Are regular operational QC checks performed on the ozone analyzer? **YES** NO

If **YES**, indicate with an "**X**" and note frequency of check.		
Type of QC check		**Frequency**
X	Multipoint Calibrations	Semiannually by ESE staff
X	Automatic zero/span checks	Weekly (00:10 Sunday)
X	Manual zero/span checks	As needed
X	Automatic precision level checks	Weekly (00:10 Sunday)
X	Manual precision level checks	As needed
X	Detector frequency checks	Tuesday
X	Lamp noise checks	Tuesday
X	Check sample flow rate	Tuesday
X	Check for dirt or water in sample lines	Tuesday

- Do multipoint calibration gases go through the complete sample line, including all filters, connectors, and scrubbers? **YES** NO Comment:_____

- Do the automatic and manual zero, span, and precision level gases go through the complete sample line, including all filters, connectors, and scrubbers? YES Comment:_____

- Are the automatic zero, span, and precision level checks monitored and reported? **YES** NO If YES, how?:_____

7.4 Filter Pack System (Trace Gases)

- Are regular operational QC checks being per-formed on the trace gas collection system? **YES** NO

If **YES**, indicate with an **"X"** and note frequency of check.		
Type of QC check		**Frequency**
X	Flow Meter Calibrations	Semiannually by ESE staff
X	System Leak Checks	Tuesday
X	Flow Rate Setting Checks	Tuesday
X	Check for dirt or water in lines and trap	Tuesday

- Is the filter pack being changed out every Tuesday as scheduled? **YES** NO Comment:_____
- Are sample flow rates recorded? **YES** NO If YES, how?:_____
- Are the filter packs sent to the laboratory on a regular schedule? **YES** NO If YES, how?:_____ Frequency :_____
- Are the filters protected from contamination during handling and shipping? **YES** NO If YES, how?:_____

8.0 ADDITIONAL AUDITOR NOTES AND COMMENTS

Air Quality Monitoring Protocol for Denali National Park & Preserve, Alaska

Standard Operating Procedure (SOP) # 5

Denali Backup Site Operator Instructions

Version 6.0 (March 2004)

TUESDAY MORNING INSTRUCTIONS

for

BACKUP AIR QUALITY SITE OPERATORS

Denali National Park & Preserve

SECTION I: OVERVIEW

A. TIME CONSTRAINTS

1. NADP/NTN bucket must be changed every Tuesday at 0900 local time (with ~15 minutes leeway on either side). Local time is the time your watch should be set at, which will be on Alaska Standard Time from October to April, and Alaska Daylight Savings Time from April to October.

2. NADP bucket must be mailed by Thursday morning, so it needs to be at headquarters by Wednesday night.

3. IMPROVE filters must be changed each week on Tuesday.

4. The CASTNet filter must be changed every Tuesday between 0900 and noon (local time).

5. The impactor film and filter must be changed on Tuesday.

B. REMINDERS BEFORE YOU LEAVE THE OFFICE

1. Bring a "black box" NTN bucket/mailer from the left side of the stack.

C. REFERENCE MATERIALS

1. **NADP**

- National Trends Network Site Operation Manual (green notebook). Gives detailed instructions on bucket change, lab procedures and equipment troubleshooting.

- NADP/NTN Field Report Forms. There is a blue folder in the lab cupboard containing copies of completed forms and rain gauge charts.

2. **OZONE MONITORING**

- Detailed instructions can be found on the monitoring station laptop under "Station Documentation."

3. **IMPROVE**

- Version II IMPROVE Sampler – Operating Procedures Manual. Located in the AQ monitoring shelter. Gives detailed information on samplers and filter changes.

- Previous week's data sheet (initial readings).

4. **PHONE LIST**

- In case something goes wrong, don't hesitate to call the appropriate person. There is a phone list posted on the wall in the monitoring shelter.

Ozone, CASTNet and meteorology - Air Resource Specialists
1-800-344-5423

IMPROVE - (530) 752-1123
NADP/NTN - Scott Dossett 1-800-952-7353

SECTION II: National Atmospheric Deposition Network/National Trends Network (NADP/NTN)
BUCKET CHANGE

1. At the monitoring shelter, write the following on a new rain gauge chart, using a Sharpie pen: Station ID (**AK03**), date and time (usually 0900). NADP is recorded in local time, except in the AQ logbook, which always uses Alaska Standard Time.

2. Fold the left side of the chart, and bring it to the NADP site along with a squeeze bottle of distilled water and a black box. In winter, also bring a snow brush, coffee can, cup, antifreeze and ink.

3. Check the dry-side bucket for precipitation. Empty the contents on the ground, being careful not to touch the inside or rim of the bucket. Replace the bucket and clip in the handle.

4. Activate the NADP sensor with snow or distilled water, snap the new lid onto the wet-side bucket, and bag the bucket and lid. **IMPORTANT:** Do not touch the lid itself while attaching it to the bucket; use the bag as a glove.

5. If it has snowed, brush snow from the collector lid and frame before putting on the new bucket.

6. Install the new bucket and clip in the handle, but leave the bag covering the bucket until you're ready to move the collector lid back over the wet-side bucket.

7. Open the rain gauge door, make a tick mark on the chart with both pens, and remove the chart drum.

8. If the lower chart trace from last week is above the 2.5" mark, remove slush (winter) or dilute antifreeze (summer) from the weighing bucket. Renew the antifreeze if it is very light in color. Dispose of the used propylene glycol in the lab sink.

9. Install the new chart and replace the drum, making sure that both are firmly in place.

10. Refill the ink wells if they look very low or if they ran out completely during the previous week.

11. Start the pens flowing on the chart, set the LOWER pen at the correct time and make tick marks with both pens.

12. Remove the bag from the wet-side bucket, then blow on the sensor to move the collector lid.

13. Make sure that the precipitation gauge event recorder pen (upper one) dropped down to the "dry-collect" position, then close the gauge housing door. NADP laboratory/office procedures are discussed in a separate manual.

SECTION III: LOGBOOK NOTATIONS

1. When you get back to the monitoring shelter, document your presence as a backup site operator in the paper logbook. Use the clock on the wall to determine the correct time. It is kept at Alaska Standard Time, which will be the same as local time from October to April, and one hour early from April to October.

2. Log the time that the NADP bucket was changed (in Alaska Standard Time) and any non-standard occurrences (i.e. snow brushed off of collector frame, dog hairs in the wet bucket, snow accumulation in the dry-side bucket).

3. Scan the previous week's logbook notations for NADP comments, and jot these down on a piece of scrap paper to take back to the office. Be sure to make note of bucket on/off dates and times.

4. Document the occurrence of wildfire smoke, other types of haze, or volcanic ash in the area, noting approximately when the event began.

SECTION IV: QUICK CHECK OF OZONE MONITORING INSTRUMENTS

1. If you have been through a full backup site operator training session in the past year and are conducting a complete ozone station check, skip this section and instead follow the guidelines on the DataView laptop. If this is a quick check only, please continue.

2. Check the answering machine for any messages you should respond to.

3. Check the displays on the front of the ozone instruments. The top one (ozone analyzer) should look like this:

O3 PPB		*ozone value (no offset)*
SAMPLE	*current time (AST)*	REMOTE

The calibrator display (bottom instrument) should look like this:

O3 PPB		**0.0**
	ALARM	REMOTE

4. Log onto the datalogger (on the shelf above the laptop). Hit escape to get to the login menu. Select: *L Login / Set User Level*

5. Type in the password: xxxxxxx

6. Hit the "disp. flags" (F6) hot key to view the current ozone and weather data.

7. If anything looks particularly odd, call Air Resource Specialists at 1-800-344-5423, and ask for the ozone techs.

8. Log onto the DataView program on the laptop. Use your initials and the same password as on the datalogger: xxxxxxx

9. When the station log entry screen appears, click on "Done." The screen often displays the wrong login date and user, even though it gets logged correctly.

10. Check to see if the "NumLock" icon is showing in the laptop status window. If it is, turn the function off by pressing the function key and F9

11. If the "alarms" page brings up something you think might affect the data, call Air Resource Specialists.

12. Document any instrument manipulations in the laptop logbook.

SECTION V: CASTNet FILTER CHANGE

1. Log the CASTNet filter change in the paper logbook.

2. Open the mailing tubes from last week and this week.

3. The ozone and flow columns must be taken off line before the tower is tipped.

4. If you're not already logged onto the datalogger, follow the steps in the previous section to log on and get to the home menu. When in doubt, keep hitting the escape key to get back to the home screen.

5. Select the following from the series of menus:

   C Configuration Menu
   D Configure (Data) Channels
   M Disable/Mark Channel Offline

   From the list that appears on screen, use the space bar to select:

   O3 [01]
   FLW [15]

   Hit enter to activate your selections.

6. View the real-time data with flags to make sure the channels are off line. Use the hot key or hit escape twice to get back to the main menu, then select:

   D Real-Time Display Menu

F Display Readings w/ flags

O3, O3R8 and FLW should be flagged with a “D”

7. On the laptop under "Station documentation," record the time the ozone and flow channels are taken off line.

8. Record the following in the “filter off” column of the previous week’s Site Status Report Form (SSRF):
   a) date
   b) time as Alaska Standard Time
   c) DAS flow (data acquisition system flow, which is the datalogger readout)
   d) rotameter flow (call Air Resource Specialists if it is not between 1.0 and 5.0 liters per minute)
   e) elapsed time

9. Turn off the pump and timer (elapsed time indicator) on the multi-position plug strip.

10. In good weather (i.e. no ice, lightning, or strong winds), lower the tower until it rests on top of the shelter.

11. Put on a clean pair of gloves and remove the exposed filter by pulling up on the locking ring.

12. Place the end caps on the filter and place it in the ziploc bag that it came in.

13. Record the MFC (pump off) value in the “filter off” column. This is the mass flow controller readout on the Tylan unit.

14. If it's above -10 degrees F, perform a leak check on the system by turning on the pump and testing for zero flow with the fitting valve sealed. After one minute, the Tylan readout should be ± 0.03 of the value recorded with the pump off. Record the Tylan display as “MFC leak check.” Call Air Resource Specialists if the leak check is not within tolerance.

15. Turn off the pump and release the vacuum in the line with a clean, sharp object. Listen for the faint hiss.

16. Sign and date the form, and record the date you expect to mail the filter back to the lab.

17. Place the white and yellow copies of the data sheet in the mailing tube with the filter.

18. Put on a second pair of gloves and remove the new filter from the mailing tube labeled with **today’s date.**

19. Install the filter by clicking it firmly into the fitting. Raise the tower and lock it with the bolt.

20. Turn on the pump and elapsed time indicator.

21. Mark the columns on line by escaping to the home menu, then selecting:
    C Configuration Menu
    D Configure (Data) Channels
    E Enable/Mark Channel Online

    From the list that appears on screen, use the space bar to select:
    O3 [01]
    FLW [15]

22. Follow the instructions in step 5 to view the data and make sure the channels are no longer flagged.

23. Log the ozone and flow channels online in the laptop station log.

24. Record the following on the new data sheet:
    a) site name and number (site number is printed as "site" on the lower middle portion of the form)
    b) visit date and day of the week
    c) filter pack id # (printed as "QST id #" on the lower middle portion of the form)
    d) "shipment opened by" (your name) and date on the lower middle portion of the form

25. In the "filter on" column, record the MFC "pump off" and "leak check" values from the previous week's data sheet (The "filter off" column where you just wrote it down).

26. Record the following in the "filter on" column:
    a) date
    b) time as Alaska Standard Time
    c) DAS flow (datalogger readout)
    d) rotameter flow (call Air Resource Specialists if it is not between 1.0 and 5.0 liters per minute)

27. Record the first five lines of "Site Observations" on the right side of the data sheet.

28. Zero the elapsed time indicator.

29. Put the pink copy of the old data sheet in the CASTNet folder in the top left desk drawer.

SECTION VI: IMPROVE FILTER CHANGE

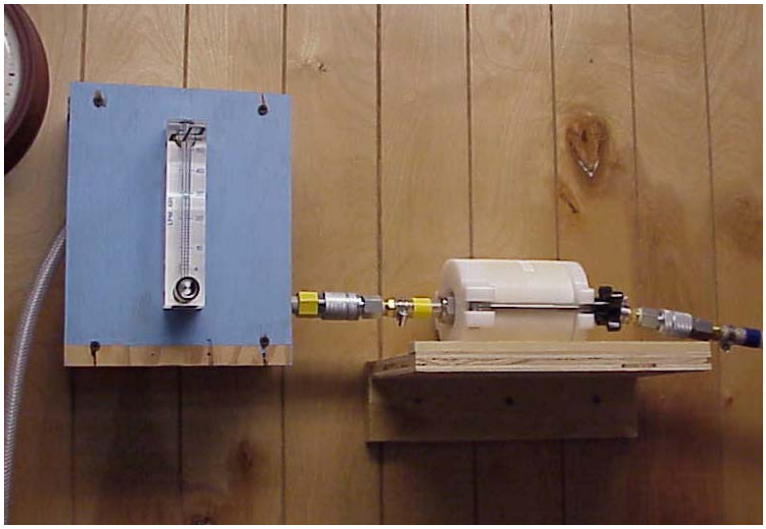
1. Document the time of "IMPROVE filter change" in the logbook.

2. Record the date, time, current temperature, and your initials at the top of the data sheet. Note your name at the bottom of the sheet as a backup operator.

3. Follow the instructions posted on the door of the control module. There is also a glossy instruction sheet in the top desk drawer if you need it.

4. Please make a copy of the data sheet that goes with the exposed filters, and put it in the IMPROVE folder in the top desk drawer.

SECTION VII: IMPACTOR FILM &FILTER CHANGE



1. Prep the working area by getting out the filter holder stand and putting crew wipes on the desk. Set up the methanol spill pan and a box of kimwipes, and get out petri dishes, tweezers, new filters, and new films.

2. Fill out the data sheet for the samples you will be removing: flow, date and time off, and any comments regarding unusual circumstances or hazy conditions. Write your name as a backup operator in the comment field.

3. Unplug the black and orange power cord, and remove the impactor unit by pulling on the quick release connectors. Place it on the blue wooden stand.

4. Unclamp the casing and remove the white plastic case, exposing the stack of metal impactor parts.

5. Put on a pair of gloves and clean the three sample tweezers (don't use the clunky tweezers in the methanol spill pan, except on parts that come in contact with grease).

6. **IMPORTANT: when unstacking impactor sections, use both hands and make sure that parts of a lower section aren't sticking to the section you are removing.**

7. Remove the top section (numbered CH-17-6D) and set it aside on the clean crew wipe.

8. Separate and remove the next three sections (6,4, and 1), and place them on the clean crew wipe.

9. Using clean tweezers, remove the filter from section 1. You can push up on the bottom ring from below to get to the edge of the ring holding the filter in place. Sometimes the filter sticks to the ring. Only touch the edge of the filter with the tweezers.

10. Place the filter in the smaller petri dish and fold it in half like a taco, with the sampled side in (shiny side out). Use a second pair of tweezers to crease the fold.

11. Clean all parts of section 1 with a kimwipe and methanol.

12. Clean the tweezers you just used. Do this every time you use them.

13. Using the tweezers, place a new filter in section 1, shiny side down. Center it on the disc, and place the ring on top.

14. Place section 1 on the base section (labeled BSP).

15. Remove the parts of section 4 that hold the film in place by pushing up from the bottom to expose the edges. Place them on the clean crew wipe.

16. Using freshly cleaned tweezers, grasp the edge of the sampled film and fold it in half in the larger petri dish with the sampled side in. Do not crease the film as you did the filter. It will be held in place by the petri dish lid.

17. Clean the bottom of section 4, the spacer ring, the perforated plate, and the tweezers you used with methanol and kimwipes. Check to see that none of the holes on the perforated plate are plugged up.

18. Place a new film in section 4, then the spacer ring and the perforated plate. Place section 4 on top of section 1.

19. Check the top of section 6 and replace the grease if there are a lot of bugs in it. Use the high vacuum grease and a fancy Q-tip from the middle blue shelf.

20. Place section 6 on top of section 4, with section 6D on top of section 6, and replace the white plastic casing. Clamp the unit shut.

21. Attach the impactor to the quick release connectors, matching the blue and yellow tape on the fittings with the corresponding color on the connectors.

22. Plug in the pump cord, and make sure the other impactor cord is also plugged in.

23. Record the date and time on, and the flow, which should be adjusted to 30.0 L/min. Let the pump run for a bit before fine tuning the flow adjustment.

24. Write down the filter/film number for this week's sample on the data sheet. "DEN-YY-" is already printed on the sheet. The last digits are the Julian date that the sample will be removed, which is usually the following Tuesday.

25. On the two petri dishes containing the sampled filter and film, write the filter and film ID number, date and time on, initial flow, date and time off, and final flow value. You can skip the flow values on the smaller petri dish. Tape the larger petri dish shut, and bag the petri dishes.

26. Before you leave the air quality shelter, click the "logoff" option on the main menu of the DataView laptop, and note the time of your departure in the paper logbook. Double check the flow on the impactor and CASTNet systems, and check that the IMPROVE control screen displays either elapsed time information if it's a sample day, or the following screen:

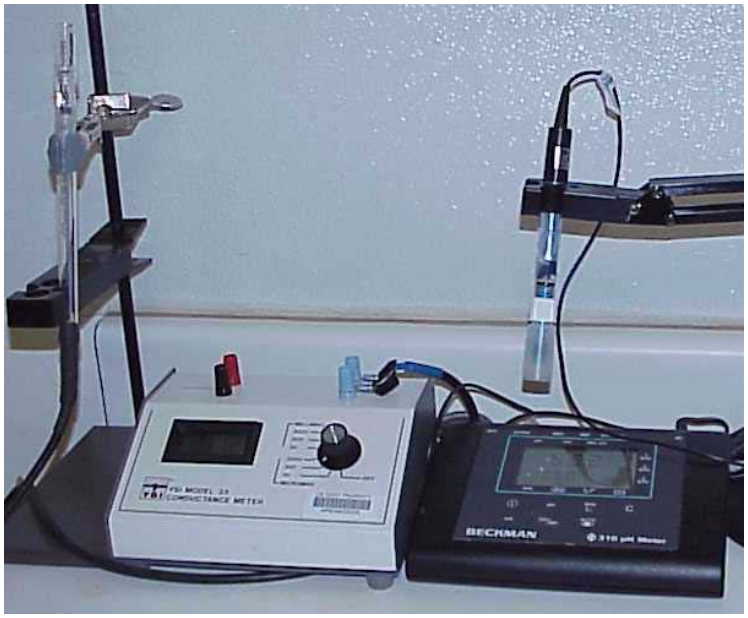
A	B	C	D
OFF	OFF	OFF	OFF

Tuesday Morning Instructions

for

Backup Air Quality Site Operators

Laboratory Procedures



Denali National Park & Preserve

Revised March 2004

NTN LAB PROCEDURES

A. GENERAL NOTES

1. The NTN sample must be melted and at room temperature when you do the precipitation chemistry. Take the bucket out of the black mailer to facilitate warming and thawing the sample, but always leave the bag on to prevent contamination.

2. When pouring solutions and precipitation samples between bottles, buckets and vials, never allow the rim of one container to touch the other.

3. You will need the following, which are located in the laboratory:

   - a blank NTN Field Observer Report Form
   - the metal clipboard containing control charts
   - the blue folder containing completed field forms
   - your notes on NTN from the station logbook.
   - a calculator

B. NTN FIELD OBSERVER REPORT FORM, PART 1

1. Fill out blocks 1-3, using the dates and times from the rain gauge chart and the station logbook.

   - Block 1: Site Name = Denali
     ID = AK03
   - Block 2: Print your full name.
   - Block 3: Self-explanatory. Chart and logbook dates and times should agree. Remember that NTN forms are written in local time, but the station logbook uses Alaska Standard Time for NTN notations

2. Fill in the "date off" and "time off" boxes on the precipitation gauge chart.

3. Delineate the days on the lower line of the precipitation gauge chart, as shown on previous xeroxed charts. This is the precipitation record from the gauge. The upper line records movement of the collector lid from one bucket to the other, and is called the event recorder.

4. Use a scrap piece of paper to transfer the times of collector lid movement from the upper line to the lower one.

5. Look at the lower chart trace and see if the collector lid was open during all precipitation events. The line will drop throughout the week due to evaporation, and increase as the bucket fills.

6. For each day, determine the amount of precipitation recorded and write the number on the chart. The chart trace reverses direction at the top and keeps recording downward in the event of excessive rain or snow (that's why the 5" mark is also the 7" mark). Each chart division equals 0.05" of rain.

7. When you've finished marking the chart, fill in Blocks 4 and 7 on the Report Form.

8. Block 4: Use your best judgment and the information available from the comparison between the event recorder and the precipitation record to answer the questions. If there are any unusual observations, make note of them in the remarks section.

9. Block 7: Use the notes written on the chart to fill out the weekly precipitation record. For each day, circle or write in the amount of precipitation that fell (zero, trace, missing, or the amount determined from the chart). If there was precipitation recorded, circle the type (rain and/or hail, snow, mixture or unknown).

10. Total the daily precipitation amounts and write the sum in the space labeled "Total Raingage Depth".

11. Block 6: Turn the electronic balance on and zero it with the tare button. Before weighing the bucket, remove the bag and use a kimwipe to wipe any moisture off of the outside of the bucket.

12. Use the numbers written on the bucket and lid to determine their combined weight, and record on the space provided. Subtract this from the weight of the bucket + lid + sample to obtain the sample weight.

13. Multiply the sample weight by the number provided on the form to calculate the sample depth, and determine whether or not it agrees within 5% of the rain gauge depth. To do this, multiply either depth value by 0.05 to get 5% of the total depth. Compare this number with the difference between the two depth values. If the difference is less than 5%, the values agree within 5%.

14. If the precipitation amounts from the collector and rain gauge don't agree within 5%, reweigh the bucket, document the reweighing in the remarks section, and change the weight on the field form if necessary.

15. Get a bagged sample bottle and a pair of gloves from the cupboard.

16. With the gloves on, remove the lid from the bucket, observe if there are any contaminants in the sample, and decant the sample into the bottle. Pour from opposite the side that you removed the lid from, and leave any detritus in the bucket if possible. Fill the sample bottle only to 1" below the top, leaving any excess in the bucket until the precipitation chemistry measurements are completed. Cap the bottle.

17. Tightly seal the bucket and put it aside for now. You can take off the gloves once the bucket lid is sealed.

18. Block 5: Check yes or no for all 6 types of contaminants that may be present in the sample. Also record observed contaminants in greater detail in the remarks section.

19. Block 7, far right: Mark whether or not you poured the bucket contents into the sample bottle. Even if the bucket contains only a few drops of precipitation, it should be transferred to the bottle.

20. **If the sample weight is less than 70 grams,** you don't have to do any chemistry. Skip to Section E, "NTN Field Report Form, Part 2."

    If the sample weight is 70 grams or more, continue on with sample chemistry.

21. Rinse and fill 4 vials with a portion of the sample, and set them in a safe place in the vial holder, covered with the green-labeled beaker.

22. Cap the sample bottle tightly. Using a Sharpie pen, fill in the blanks on the ziplock bag that came with the bottle (site i.d., date and time off, and contamination summary), and seal the bottle in the bag.

C. CONDUCTIVITY MEASUREMENT

1. Always measure specific conductance (conductivity) first.

2. Make measurements in the order indicated on the Field Observer Report Form.

3. Turn the YSI model 35 conductance meter on to the 200 micromho (µmhos/cm) position. The cell should already be connected to the blue terminals on the meter. If not, connect them.

4. Uncap the cell and rinse it at least 3 times with distilled water. As with all other objects that the sample will come in contact with, do not touch the inside or rim of the cell.

IMPORTANT: For all measurements, rinse and condition the cell by filling it with the solution to be measured, then dumping the solution out. Do this a few times until consecutive measurements are the same. The cell must then be rinsed three times with distilled water before it is conditioned again for the next measurement.

ALSO IMPORTANT: Avoid spilling or contaminating the check solution, conductance standard or pH buffers. They take a long time to be replaced, and should be used sparingly. Keep the lids on except while the solutions are being poured, and do not touch the rims or the insides of the lids. **Never put anything back into the bottles**, even if you think the solution is uncontaminated.

5. In Block 8, record the date the chemistry is being conducted.

6. Rinse the cell at least twice with the 75 µmhos/cm Spec. Conductance Standard by filling it to the rim and dumping the solution out, then take a measurement when the readings are consistent. Always shake the bottles gently before unscrewing the cap to be sure the sample is well mixed.

7. The digital display should be fairly stable, but the readings will change after several seconds. Take the reading within a few seconds of pouring the solution unless the display is changing rapidly.

8. Write the Standard measurement in Block 8.

9. Divide the certified value for the standard by the reading you took, as shown in Block 8, to determine the correction factor. This is necessary because there is no way to physically calibrate the instrument to adjust for factors such as temperature change.

10. Turn the meter to the 20 micromho setting, rinse the cell, and measure the distilled water. It should be near 2 micromhos, but the longer it's in storage, the less pure it becomes. If the corrected value is greater than 5 micromhos, stop the chemistry measurements and beg, borrow or buy fresher distilled water before continuing. Record your results in the lower left portion of Block 8.

11. Condition the cell with the Quality Control Check Sample solution, remembering to shake the bottle gently before opening the lid. Repeat the same steps to measure and record the check sample.

12. If the corrected value is outside the acceptable range (12.0 - 16.0 μmhos/cm), something is wrong and should be fixed before you measure the precipitation sample. If you need help, call Scott Dossett at the NTN lab.

13. Rinse the cell again with distilled water, then condition it with the precipitation sample and take a measurement. Record the value on the Field Report Form.

14. Fill the cell with distilled water, cap it, and store it right side up to keep the cell hydrated.

D. pH MEASUREMENT

1. Turn the Beckman 310 pH meter on by pushing the button that looks like a 1 with a circle around it.

2. The black triangles on the screen point to settings printed on the meter case. The upper arrow should point to "pH" and the lower arrow should point to the "ATC" with a line through it.

3. Read the thermometer on the shelf where the pH buffer solution is stored. It should be at 25 degrees C, plus or minus 5 degrees. If the temperature is outside this range, please heat up the lab before continuing.

4. Carefully remove the soaker bottle from the end of the pH probe (also called an electrode) and rinse the entire probe thoroughly with distilled water. Put a clean kimwipe or crew wipe on the lab counter and gently blot the end of the probe dry on it. Never wipe the probe, always blot it.

5. Uncover the fill hole and check to see that the KCl electrolyte solution reaches the bottom of the hole. If it is low, add solution to the fill hole, using only the bottle of 3.8M KCl with a conical spout and red cap. The fill hole should always be covered during storage and always be open while taking measurements.

6. Condition a vial and the probe. Place the probe in the vial and fill it with the first solution to be measured; the yellow pH 7 buffer solution. Hold it there for about 30 seconds, then dump the solution and fill the vial again for measuring.

7. Stir the buffer solution with the tip of the probe then set the probe in its holder without removing it from the vial. Adjust the holder arm so the probe is suspended in the solution without touching the sides or bottom of the vial.

8. Push the STD button (it has an arrow on it) and watch the initial reading before it automatically resets to 7.00.

9. Record the initial stabilized reading of the pH 7 buffer on the NTN control chart (Calibration and Measurement Record).

10. Rinse the probe thoroughly with distilled water and gently blot it dry on a clean kimwipe or crew wipe.

11. Condition a new vial and measure the pH 4 buffer using the STD button. Record the value on the control chart.

12. Measure the pH 7 buffer, using the pH button this time, not the STD button. If it reads 7.00 +/- 0.03 pH units, rinse the probe again and continue on with the measurements. If it is out of range, start over with the standardize and slope adjustments. Call Scott Dossett if you can't get the meter to calibrate.

13. Rinse the probe with distilled water, then soak it for at least 2 minutes in a vial of distilled water to "erase the memory" of the buffer solutions.

14. The electrode is extremely sensitive to any movement around it, so keep still while waiting for readings to stabilize. If the meter takes longer than 3 minutes to stabilize, redo the measurement. When the probe is in a vial, the KCl electrolyte solution is continually flowing into the vial, and will eventually change the pH of the sample.

15. Measure the Quality Control Check Sample by conditioning a vial and pushing the pH button for the final reading. The meter should be in the auto read mode (the eyeball icon will flash). When the eyeball stops flashing, write the value on the control chart and the Field Observer Report Form. If the reading is out of range (4.75 - 5.05 pH units), call Scott Dossett for assistance. Do not measure the precipitation sample unless the check sample is within range.

16. As always, rinse the electrode, gently blot it dry, then condition a vial and measure the precipitation sample.

17. Block 8 of the Field Report Form should now be completely filled out. Complete the control chart and put it away; the chart is for our reference, and stays in the park.

18. Turn the pH meter off and cover it with plastic. Gently put the soaker bottle back on the probe and cover the fill hole with the rubber sleeve. If the solution in the bottle is low, refill it with the same electrolyte solution used to fill the hole in the probe. It helps to unscrew the lid instead of filling through the gasket hole.

19. Put both the pH probe and conductivity cell back in the holders and cover with plastic. Remember that the conductivity cell needs to be filled with distilled water and stored right side up.

E. NTN FIELD REPORT FORM, PART 2

1. Block 10: Write your name as a backup site operator, and any unusual occurrences during the previous week. Remember to check the notes you took from the site logbook.

2. Block 9: If you notice that any supplies are low, check the previous four or five Report Forms to see if they have already been ordered, and circle any that have not.

3. Check the whole Field Report Form one last time to make sure that all blocks have been filled out completely and accurately, then remove the pink copy for the Denali files. Put the pink copy and a xerox of the rain gauge chart in the blue folder.

4. Using a Sharpie pen, label the bucket bag with the Site ID (AK03), then put the bucket and bagged sample bottle in the black mailer. Make sure the bottle bag is also labeled. Ship an empty sample bottle back to the lab for cleaning if there was no precipitation (keep it in its bag, but don't label it).

5. Check the address card on the mailer to be sure it's facing the right way, then place the white and yellow copies of the Field Report Form along with the original precipitation gauge chart into the mailer. Double check the list on the inside of the mailer lid. Tighten as many of the straps as you can and leave the mailer behind the receptionist's desk at headquarters.

6. This marks the end of your Tuesday tasks. Your time, energy and attention to the details of keeping these monitoring networks operating smoothly are truly appreciated.

Air Quality Monitoring Protocol for
Denali National Park & Preserve, Alaska

Standard Operating Procedure (SOP) # 6

Data Review

Version 1.0 (November 2004)

Revision History Log:

Prev. Version #	Revision Date	Author	Changes Made	Reason for Change	New Version #

This Standard Operating Procedure describes park-level opportunities for reviewing data from the nationwide air quality monitoring networks. The monitoring networks currently represented at Denali are:

1. National Atmospheric Deposition Program **(NADP)**
2. Interagency Monitoring of Protected Visual Environments **(IMPROVE)**
3. NPS Gaseous Pollutant Monitoring Network **(ozone monitoring)**
4. Clean Air Status and Trends Network **(CASTNet)**

Data for each nationwide monitoring network are collected, validated, and archived by network personnel. Data quality assurance and quality control standards are determined at the nationwide network level. Although copies of all datasets are kept at Denali, they are not considered to be archival copies.

On-site data validation procedures begin when samples are collected. Questionable data or unreliable instrument performance are documented on the data sheets and in the site logbook during weekly sample changes. Problems are fixed as quickly as possible, with the assistance of nationwide air quality monitoring network personnel, in order to minimize data loss. Ozone and meteorology instruments are checked weekly on site. Network contractors remotely download ozone and meteorology data from the station datalogger via modem, and send automatic daily data summary emails to the air quality program manager. These summaries are scanned daily for values that seem out of range of ambient conditions, and potential problems are addressed before the next weekly sample change. Filter samples are analyzed in network laboratories, and the analytical data obviously cannot be checked on site, but the filter sampling networks each have methods for verifying correct air flow rates across the filters.

The NADP, IMPROVE, and CASTNet programs, with their emphasis on laboratory analyses, conduct all data validation without further review by park air quality program managers. Monthly ozone and meteorology data are sent to each park for review between preliminary and final data validation. Each nationwide monitoring network also prepares data summaries and reports. The IMPROVE network publishes data synthesis reports once every three years, and the other networks produce annual data summaries. Spatial and temporal trends are reported to varying degrees by the networks. Reports and validated data are available online at the following monitoring network web sites:

NADP
http://nadp.sws.uiuc.edu/

IMPROVE
http://vista.cira.colostate.edu/improve/

NPS ozone monitoring
http://www2.nature.nps.gov/ard/gas/

CASTNet
http://www.epa.gov/castnet/