QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES
TITLE	**COLLECTION OF OPTICAL MONITORING DATA (IMPROVE PROTOCOL)**
TYPE	**STANDARD OPERATING PROCEDURE**
NUMBER	**4300**
DATE	**MARCH 1993**

AUTHORIZATIONS		
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PROGRAM MANAGER	David L. Dietrich	
QA MANAGER	Gloria S. Mercer	
OTHER		

REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
	Reviewed; no changes necessary.	March 1994	
	Reviewed; no changes necessary.	March 1995	
0.1	Added responsibilities / minor text changes.	June 1996	
	Reviewed; no changes necessary.	June 1997	
	Reviewed; no changes necessary.	June 1998	
	Reviewed; no changes necessary.	June 1999	
	Reviewed; no changes necessary.	June 2000	
	-- continued --		

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REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
	Reviewed; no changes necessary.	June 2001	
	Reviewed; no changes necessary.	June 2002	
1.0	Delete strip charts/delete neph collection via DCP.	December 2004	

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1.0   PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) outlines collection of optical visibility monitoring data from sites operated according to IMPROVE Protocol. Optical monitoring sites include those equipped with an Optec LPV transmissometer and/or Optec NGN nephelometer.

The IMPROVE Program has partitioned visibility-related characteristics and measurements into three groups: optical, scene, and aerosol. This SOP pertains to the optical group and encompasses the following:

- Optical properties pertaining to the ability of the atmosphere to scatter or absorb light passing through it

- Physical properties of the atmosphere described by the atmospheric extinction coefficient (b_{ext}), absorption coefficient (b_{abs}), scattering coefficient (b_{scat}), and scattering phase function, an angular dependence of the scattering

- Optical characteristics integrating the effects of atmospheric aerosols and gases

- Optical extinction measurements made with transmissometers

- Optical scattering measurements made with nephelometers

Data are generally logged on-site by one of four datalogging approaches:

- Satellite data collection platforms (DCPs) (Handar 540/570)

- Campbell Scientific 21XL dataloggers

- Telephone modems

- Campbell Scientific storage modules

This SOP serves as a guide to assure high quality data collection from transmissometer and nephelometer stations operated according to IMPROVE Protocol by:

- Assuring complete, error-free data downloads from Wallops Island or directly from individual monitoring stations via telephone modem.

- Assuring complete, error-free data downloads from sites with Campbell Scientific dataloggers and backup Campbell Scientific storage modules.

- Processing data to reformat raw, downloaded data to Level-A validation.

- Reviewing data and examining error files for details regarding monitoring system performance, datalogger problems, or data acquisition problems.

Because most stations are remote, daily data review is critical to the identification and resolution of field problems.

At sites with a DCP or Campbell Scientific datalogger and telephone modem, data are collected daily. At sites with a Campbell Scientific datalogger and storage module, or at sites where telephone line/telephone modem malfunction occurs, data are collected at approximately two-week intervals until the malfunction problem is resolved.

Separate technical instructions (TIs) are developed for the following cases:

- TI 4300-4000   *Data Collection via DCP (IMPROVE Protocol)*

- TI 4300-4002   *Nephelometer Data Collection via Telephone Modem (IMPROVE Protocol)*

- TI 4300-4006   *Nephelometer Data Collection via Campbell Scientific Data Storage Module (IMPROVE Protocol)*

- TI 4300-4023   *Transmissometer Daily Compilation and Review of DCP-Collected Data (IMPROVE Protocol)*

2.0   RESPONSIBILITIES

2.1   PROJECT MANAGER

The project manager shall:

- Review data collection procedures with the data analyst to identify and correct problems.

- Review editing of instrument constants files with the data analyst.

- Coordinate with the NESDIS for allocation of DCP assignments.

2.2   DATA ANALYST

The data analyst shall:

- Update all constants files pertaining to data collection and review with the project manager.

- Set up and initiate the data collection program(s).

- Check the status of the data collection and review data daily to assure the integrity of the monitoring systems and to achieve complete, error-free data collection.

- Update DCP platform description tables.

- Perform periodic data collection via data storage module for sites without DCP or modem communication.

- Provide technical support to the site operator via telephone.

- Enter any information relating to the collection of the data and operation of the specific monitoring system into the site-specific Quality Assurance Database.

- Review Level-A files with the project manager to identify instrument problems.

3.0 REQUIRED EQUIPMENT AND MATERIALS

All data collection occurs on IBM-PC compatible systems. Refer to the individual TIs for the monitoring system-specific computer system requirements. Required computer system components are as follows:

- IBM-PC Pentium class computer system with VGA and 80 megabyte hard disk and 64 megabytes of RAM

- Microsoft Windows98, or Windows2000 operating system

- Internal or external Hayes compatible modem configured for COM port #2

- Software for collection DCP data via Wallops Island

- Software for processing of data collected via DCP

- Software for telephone modem collection

- Campbell Scientific SC532 storage module interface

- NGN_PULL software Version 3.0 or later (ARS)

- ASCII text editor

- Wallops Island log book

- Julian calendar

Information on the Campbell Scientific software is detailed in the *Campbell Scientific PC208 Datalogger Support Software Instruction Manual*.

4.0 METHODS

This section includes two (2) major subsections:

4.1 Optical Monitoring Station Configurations
4.2 Collection of Optical Monitoring Data

These subsections describe the station configurations and data collection methods for each configuration. Collection of optical monitoring data is dependent on the configuration of individual sites. Transmissometer and nephelometer sites are generally configured differently.

4.1   OPTICAL MONITORING STATION CONFIGURATIONS

Optical monitoring stations are configured based on the following:

- Transmissometer stations are generally configured with a DCP.

- Nephelometer stations are generally configured with a Campbell Scientific datalogger, telephone modem, and storage module.

4.1.1   Transmissometer Stations

Transmissometers measure the ability of the atmosphere to transmit light. These measured light transmission properties can be represented in terms of the atmospheric extinction coefficient (b_{ext}).

IMPROVE transmissometer sites generally include:

- A transmitter station with shelter, transmitter telescope, transmitter control box, and battery-backed power supply.

- A receiver station with shelter, receiver telescope, receiver computer, and battery-backed power supply.

- A data collection platform (DCP).

- A collocated air temperature and relative humidity sensor (naturally aspirated).

- A solar powered operation (at some sites).

The following data are collected via DCP from transmissometer sites operated according to IMPROVE Protocol:

- Ten-minute average raw transmissometer transmission values that are later converted to atmospheric extinction coefficient.

- Standard deviation of the 10 one-minute raw transmission values that make up the 10-minute average transmission value.

- Hourly, single reading ambient air temperature and relative humidity.

4.1.2   Nephelometer Stations

Nephelometers measure the ability of the atmosphere to scatter light. These measured light scattering properties can be represented in terms of the atmospheric scattering coefficient (b_{scat}).

IMPROVE nephelometer sites generally include:

- An NGN-2 nephelometer mounted on a three-meter tower along with datalogger and power supply support system.

- A Campbell Scientific 21XL or 23XL datalogger.

- A Campbell Scientific storage module.

- An optional telephone modem.

- A collocated air temperature and relative humidity sensor (force aspirated).

- A solar powered operation (at some sites).

The following data are collected via telephone modem and storage module from nephelometer sites operated according to IMPROVE protocol:

- Five-minute nephelometer serial data stream

- Five-minute nephelometer analog channels A1 and A2

- Five-minute ambient air temperature and relative humidity

- Hourly codes summarizing the past hour's operation of the nephelometer and support system

4.2   COLLECTION OF OPTICAL MONITORING DATA

The method used to collect optical monitoring data depends on the type of site (transmissometer or nephelometer) and the site-specific configuration (telephone modem, storage module, DCP). The following subsections describe data collection procedures for the above listed station configurations.

4.2.1   Collection of Transmissometer Data via DCP

Collection of transmissometer data via DCP is handled by Wallops.exe software. Specific procedures are detailed in TI 4300-4000, *Data Collection via DCP (IMPROVE Protocol)*. Collection of transmissometer data via DCP includes:

- Updating the current list of sites in the site information file.

- Updating the next time to download data in the Wallops information file.

- Configuring the computer used for automatic data acquisition that downloads the data from Wallops the following day.

- Reviewing all downloaded data file for communication errors or indications of monitoring, logging and data collection problems.

- Initiating manual data collection programs if automatic data collection failed.

- Executing the STRIP program which removes invalid characters and reformats the raw file.

- Executing the APPEND program to add the raw data to site-specific Level-A files.

- Resolving identified system inconsistencies according to TI 4110-3300, *Troubleshooting and Emergency Maintenance Procedures for Optec LPV-2 Transmissometer Systems (IMPROVE Protocol)*.

4.2.2   Collection of Nephelometer Data via Telephone Modem

Collection of nephelometer data via telephone modem from sites configured with a Campbell Scientific datalogger is handled by the NGN_pull.exe software. Specific procedures are detailed in TI 4300-4002, *Nephelometer Data Collection via Telephone Modem (IMPROVE Protocol)*. Collection of nephelometer data via modem includes the following:

- Updating the current list of sites.

- Updating the next time to download data.

- Initiating the automatic download timer.

- Polling each telephone modem station daily using the Campbell Scientific PC208 or LoggerNet program for all data since the last download.

- Dividing each downloaded data file into three parts:

    - Nephelometer serial data, ambient temperature, and relative humidity

    - Nephelometer analog data, ambient temperature, and relative humidity

    - Hourly nephelometer status code and support system status code

- Reformatting and appending each site's nephelometer serial data to site-specific Level-A plottable data files.

- Creating a daily nephelometer log file that contains a summary of the performance of all of the sites downloaded.

- Resolving identified system inconsistencies according to TI 4100-3100, *Routine Site Operator Maintenance Procedures for Optec NGN-2 Nephelometer Systems (IMPROVE Protocol)*.

4.2.3   Collection of Nephelometer Data via Campbell Scientific Storage Module

Collection of nephelometer data via Campbell Scientific storage module is handled by the NGN_pull.exe software. Specific procedures are detailed in TI 4300-4006, *Nephelometer Data Collection via Campbell Scientific Data Storage Module (IMPROVE Protocol)*. Collection of nephelometer data via storage module includes the following:

- Updating the current list of sites.

- Downloading data from the storage module using the Campbell Scientific PC208W or LoggerNet program into site-specific files compatible with data obtained via telephone modem.

- Dividing each downloaded data file into three parts:

  - Nephelometer serial data, ambient temperature, and relative humidity

  - Nephelometer analog data, ambient temperature, and relative humidity

  - Hourly nephelometer status code and support system status code

- Reformatting and appending each site's nephelometer serial data to site-specific plottable data files.

- Creating a nephelometer log file that contains a summary of the performance of all of the sites downloaded.

- Resolving identified system inconsistencies according to TI 4100-3100.

5.0   REFERENCES

Campbell Scientific, Inc., 1989, Campbell Scientific PC208 Datalogger Support Software Instruction Manual, February.

QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES		
TITLE	**NEPHELOMETER DATA COLLECTION VIA TELEPHONE MODEM (IMPROVE PROTOCOL)**	
TYPE	**TECHNICAL INSTRUCTION**	
NUMBER	**4300-4002**	
DATE	**MARCH 1993**	

AUTHORIZATIONS		
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REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	File format change.	January 1995	
1.1	Minor text modifications.	June 1996	
2.0	Updated programs used and file keys.	April 2004	

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LIST OF FIGURES

1.0   PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the steps of daily telephone modem collection, compilation, and review of nephelometer and meteorological data from an Optec NGN-2 ambient nephelometer station operated according to IMPROVE Protocol. The primary purpose of daily data collection via telephone modem is to assure quality data capture and minimize data loss by:

- Calling the Campbell Scientific datalogger at each nephelometer/meteorological station via telephone modem and downloading the past day's data into site-specific daily files.

- Processing the raw data into Level-A validated form.

- Reviewing the daily nephelometer information file to verify nephelometer system operation or identify problems.

This TI, as referenced from Standard Operating Procedure (SOP) 4300, *Collection of Optical Monitoring Data (IMPROVE Protocol)*, is a guide for using the NGN_pull.exe nephelometer data processing software to:

- Setup and update nephelometer station configurations.

- Perform automatic and manual data downloads.

- Perform automatic and manual daily data processing.

- Review daily nephelometer error files.

This TI assumes the operator has basic knowledge of Pentium class computer systems and Microsoft Windows98 or Windows2000 operating systems.

2.0   RESPONSIBILITIES

2.1   PROJECT MANAGER

The project manager shall review daily error files and plots with the data analyst to identify and correct problems.

2.2   DATA ANALYST

The data analyst shall:

- Check the status of the automatic data collection daily to assure complete and error-free data collection.

- Setup and verify correct operation of the automatic data processing.

- Perform manual data collection if necessary.

- Review daily nephelometer information files with the project manager to identify and correct data collection problems.

- Enter any information relating to the collection of the data and operation of the nephelometer station into the site-specific Quality Assurance Database.

3.0 REQUIRED EQUIPMENT AND MATERIALS

The nephelometer data collection system consists of the following hardware and software:

- Pentium class computer system with VGA and 80 megabyte hard disk and 64 megabytes of RAM

- Microsoft Windows98 or Windows2000 operating system

- Internal or external Hayes compatible modem configured for COM port #2

- Campbell Scientific software:
  - PC208W   Version 3.2
    -or-
  - LoggerNet   Version 2.1

- NGN_pull.exe software, Version 3.0 or later (ARS)

Information regarding Campbell Scientific software is detailed in the *Campbell Scientific PC208 Datalogger Support Software Instruction Manual.*

4.0 METHODS

This section includes three (3) major subsections:

4.1 Automatic Data Collection and Handling
4.2 Manual Data Collection and Handling
4.3 File Names and Contents

4.1 AUTOMATIC DATA COLLECTION AND HANDLING

Automatic data collection and processing is handled by PC208W or LoggerNet software, and the NGN_pull.exe program, which performs the following tasks:

- Polls each telephone modem station daily using the Campbell Scientific PC208W or LoggerNet software and retrieves data since the last download into site-specific daily files.

- Processes each site-specific daily file into instrument-specific parts:
  - 5-minute nephelometer, ambient temperature, and relative humidity
  - Hourly average wind speed, wind direction, temperature, and relative humidity
  - Hourly nephelometer status code and support system status code summaries

- Reformats, validates, and appends nephelometer data into quarterly site-specific Level-A data files.

- Reformats, validates, and appends meteorological data to quarterly site-specific files.

- Creates a daily nephelometer log file that contains a summary of the performance of all of the downloaded sites. The log file is NGN*yyjjj*.inf, where *yy* is the year and *jjj* is the Julian date.

The following procedures detail the steps of automatic nephelometer daily data collection via modem:

LOG ONTO NETWORK   Log onto the nephelometer data handling computer using your assigned username and password.

RUNNING THE   The NGN_pull.exe program runs in Microsoft Windows and
NGN_PULL PROGRAM   coordinates both automatic and manual data downloading and processing functions. The program is run by double-clicking on the NGN_pull icon, or selecting **File**, **Run**, **NGN_pull.exe** from the Windows Program Manager. Refer to the *Microsoft Windows2000 Quick Start Guide* for details on running Windows programs. Figure 4-1 presents the screen display of the NGN_pull.exe program.
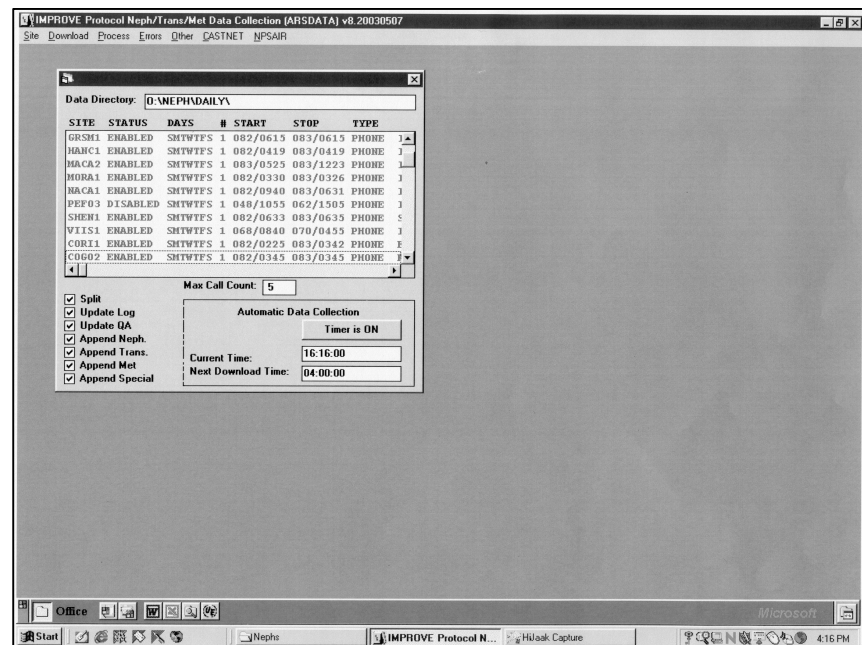

Figure 4-1. NGN_pull Windows Program Screen.

ADDING TO OR EDITING THE STATION LIST

The station list includes the nephelometer stations and station types that are currently operating. The list includes:

- Site abbreviation

- Site type (telephone modem or DCP)

- Days of the week to call

- ARS project code

- First and last date and time of last downloaded file

- Plot title

The list may be edited by clicking **Site** from the menu bar and then selecting **Edit**, **Add**, or **Delete**. A site can be disabled (from calling) or enabled (to call) by clicking **Site** from the menu bar and selecting **Disable** or **Enable**.

The telephone-type stations have a corresponding station definition file (*xxxxx*.dnd) that the PC208W or LoggerNet software uses for datalogger and modem-specific parameters (including the telephone number). The following procedures are used to add, edit, or remove a site from the station list:

To add a new site:

- Click **Site** from the menu bar and select **Add**.

- Complete the fields in the Edit Site Information dialog box.

- Click **OK**.

- Click **Site** from the menu bar and select **Save Site List**.

To edit an existing site:

- Highlight the site to edit in the site list box.

- Click **Other** from the menu bar.

- Select **Run PC208W Program**.

- Select **Setup** from the PC208W3.2 datalogger support software menu.

ADDING TO OR EDITING
THE STATION LIST
(continued)

- Set the following parameters in the station definition file:
  - Type of datalogger (21X)
  - Type of data file
  - Modem type, COM port, and baud rate
  - Telephone number and project charge code

To remove a site:

- Highlight the site to remove in the site list box.

- Click **Site** from the menu bar.

- Click **Delete**.

SETTING THE CALL
(DATA DOWNLOAD)
TIME

The call time is the time the first telephone modem station on the station list is called for data. The stations are called in the order of the station list. The call time may be changed as follows (see Figure 4-1):

- Click **Other** on the menu bar. Click **Set Call/Process Time**.

- Enter the new *call time* in the dialog box that appears on the screen. The time format is HH:MM:SS (hour:minute:second).

- Click **OK** to save the time or **Cancel** to ignore the change.

STARTING THE
AUTOMATIC DATA
COLLECTION TIMER

When the automatic data collection timer is running, the system time is compared to the call time and process time at 5-second intervals. When the times match, the call or process steps are started. When the timer is running, the system time is displayed on the screen. The timer may be started or stopped as follows (see Figure 4-1):

- Click the **Timer Is OFF** button to start the timer. The button will change to *Timer Is OFF* and the current time will be displayed next to the button.

- Click the **Timer Is ON** button to stop the timer. The button will change to *Timer Is ON* and the current time will disappear from the box next to the button.

4.2   MANUAL DATA COLLECTION AND HANDLING

Data may be collected from individual nephelometer stations if automatic data collection or processing failed. This manual method includes the following procedures:

- Running the NGN_pull.exe program in Windows software.

- Updating the nephelometer station list to include the currently operating nephelometer station to be polled (if necessary).

- Highlighting the station to be polled on the station list.

- Initiating the download.

- Processing the downloaded data file.

- Reviewing the daily nephelometer error files for information concerning the operation of the nephelometer stations.

Operation of the NGN_pull.exe program is described above in Section 4.1, Automatic Data Collection and Handling. Additional information related to manual data collection and handling and not covered above includes:

INITIATE MANUAL DOWNLOAD	The following procedures describe downloading data from a single station:

- Highlight the *station* to download on the station list.

- Click **Download** on the menu bar.

- Click **Download/Recent**, or **Download/Process** to initiate manual data collection.

- Downloaded data will be placed in a file named *xxxxxyy*dn.*jjj*, where *xxxxx* is the site abbreviation, *yy* is the year, d stands for "daily" or is a numeral (e.g., 1, 2, 3) indicating the number of times retry is attempted, and *jjj* is the Julian date.

- If *Download/Process* was clicked, the raw data file will process as during automatic operation.

- If *Download/Recent* was clicked, the downloaded data file should be checked before it is processed, to ensure it contains the expected date and time startup for the specific site where data were collected. When it is determined that the downloaded data file contains the proper date and time, that file can be processed using the NGN_pull.exe program.

PROCESS MANUAL
DOWNLOAD DATA

Downloaded data files may be processed similar to the automatic data collection sequence:

- Highlight the *station* to process in the station list.

- Click **Process** on the menu bar.

- Click **Process Phone/SM**.

- A file selection dialog box will appear. Highlight the raw data file to process in the dialog box.

- Click **OK** on the menu bar.

4.3   FILE NAMES AND CONTENTS

4.3.1   Daily Data Compilation and Processing Files

Daily compilation and processing of nephelometer data involves several files. The following describes the processing steps and files used:

- Data for individual nephelometer stations are downloaded into site-specific data files (*xxxxxyy*d*n.jjj*, where *xxxxx* is the site abbreviation, *yy* is the year, d stands for "daily" or is a numeral (e.g., 1, 2, 3) indicating the number of times retry is attempted, *n* is a character from A through 9, and *jjj* is the Julian date). These files contain all data collected from the datalogger.

- Data in the site-specific files are divided into several instrument-specific temporary data files. Five-minute nephelometer and meteorological data are placed in *xxxxx*.nep, hourly code summary information is placed in *xxxxx*.inf, and hourly meteorological data are placed in *xxxxx*.fsm.

- The 5-minute nephelometer and hourly meteorological data in the temporary files (*xxxxx*.nep) are appended to the following site-specific Level-A validation data files:

  Nephelometer: *xxxxx*_N.*yyq*
  Meteorological: *xxxxx*_M.*yyq*

  (where *xxxxx* is the site abbreviation, *yy* is the year, and *q* is the calendar quarter code)

- Hourly code summary data are formatted and written to the daily nephelometer error file. (NGN*yyjjj*.inf, where *yy* is the year and *jjj* is the Julian date).

- Level-A validation data files may be examined or plotted. These files serve as the initial files for further processing as detailed in TI 4400-5010, *Nephelometer Data Reduction and Validation (IMPROVE Protocol)*. The Level-A files are maintained on the system hard disk until completion of quarterly processing.

- Other files used by NGN_pull include:

  NGN_site.lst   A list of active sites that appear in the site list window of NGN_pull.

  NGN_file.lst   A list of raw data file names already in use by NGN_pull.

4.3.2   **Site-Specific Data File Description**

The site-specific daily file consists of the following sets of data:

- Five-minute data synchronized to the 21X or 23X datalogger clock including nephelometer analog channels A1 and A2, ambient temperature, and relative humidity. The format is:

  5-Minute Analog Data

  ```
  01+0163. 02+1993. 03+0059. 04+0755. 05+582.6 06+0999. 07+2.234 08+097.1
  ```

Element #	Description
01	Datalogger program location identifier (not used)
02	Year
03	Julian date
04	Time (HHMM) at the end of the data period
05	Nephelometer A1 channel (mV x 2.0)
06	Nephelometer A2 channel (mV x 2.0)
07	Ambient air temperature (°C)
08	Ambient relative humidity (%)

- Five-minute data output when the nephelometer provides a serial data stream, including nephelometer serial data, analog channels A1 and A2, ambient temperature, and relative humidity. The format is:

  5-Minute Serial Data

  ```
  01+0119. 02+1993. 03+0059. 04+0757. 05+1.000 06+0891. 07+3493. 08+510.0
  09+2.000 10+3.510 11+2.000 12+0755. 13+509.3 14+0999. 15+2.456 16+097.1
  ```

Element #	Description
01	Datalogger program location identifier (not used)
02	Year
03	Julian date
04	Time (HHMM) the serial stream was received by the datalogger
05	Nephelometer status code
06	Nephelometer raw scattered light reading (counts)
07	Nephelometer direct light reading (counts)
08	Nephelometer normalized scattered light readings (counts)
09	Nephelometer integration time (minutes)
10	Nephelometer chamber temperature (°C)
11	Not used

12	Nephelometer time (HHMM)
13	Nephelometer A1 channel (mV x 2.0)
14	Nephelometer A2 channel (mV x 2.0)
15	Ambient air temperature (°C)
16	Ambient relative humidity (%)

- Hourly code summary for the nephelometer and support system. The format is:

  Hourly Code Summary

  ```
  01+0104. 02+1993. 03+0059. 04+0800. 05+50.00 06+0.000
  ```

Element #	Description
01	Datalogger program location identifier (not used)
02	Year
03	Julian date
04	Time (HHMM) at the end of the data period
05	Nephelometer code summary for the past hour
06	Support system code summary for the past hour

  The nephelometer code summary is the sum of any or all of the following:

50	Ambient reading
100	Clean air calibration
300	Span calibration
500	Lamp burned out
1000	Precipitation event detected
2000	Chopper motor start-up failure

  The support system code summary is the sum of any or all of the following:

300	21X datalogger power low
500	DC power supply voltage low
1000	AC power outage
2000	Blue Earth serial data buffer restarted

- Hourly average meteorological data including wind speed, wind direction, ambient temperature, and relative humidity. The format is:

  Hourly Meteorological Data

  ```
  01+0171. 02+1995. 03+0013. 04+0700. 05–3.765 06+090.2 07+6.975 08+312.9 09+13.67
  ```

Element #	Description
01	Datalogger program location identifier (not used)
02	Year
03	Julian date
04	Time (HHMM) at the end of the data period
05	Ambient air temperature (°C or °F)

06	Ambient relative humidity (%)
07	Wind speed (mph)
08	Wind direction (degrees true)
09	Wind direction standard deviation

4.3.3 Level-A Nephelometer File Description

The Level-A nephelometer file is a formatted ASCII site-specific file. A key to the Level-A file format is presented in Figure 4-2.

4.3.4 Level-A Meteorological File Description

The Level-A meteorological file is a formatted ASCII site-specific file. A key to the Level-A file format is presented in Figure 4-3.

5.0   REFERENCES

Campbell Scientific, Inc., 1989, Campbell Scientific PC208 Datalogger Support Software Instruction Manual, February.

Microsoft Corporation, 2000, Windows2000 Professional, Quick Start Guide.

<u>Field</u>

```
1        2          3      4      5     6       7       8       9       10       11      12      13     14
< 10 line informational header at start of file >
VORZ1    19941228   362    0110   10    212.17 212.60  -99.00  -99.00  -99.000  -5.68   -5.44   83.10  3912
VORZ1    19941228   362    0115   10    209.77 207.90  -99.00  -99.00  -99.000  -5.74   -5.37   83.20  3909
VORZ1    19941228   362    0120   10    210.58 209.90  -99.00  -99.00  -99.000  -5.74   -5.51   83.30  3913
```

<u>Field #</u>   <u>Description</u>

1   Site abbreviation
2   Year, month , day (YYYYMMDD)
3   Julian date (JJJ)
4   Time (HHMM)
5   Code summary (3-characters)
           1: Power code (non-space character = power problem)
           2: Nephelometer status code
                   1 = ambient
                   2 = zero
                   3 = span
                   4 = lamp
                   5 = rain
                   6 = chopper
           3: Nephelometer data type code
                   0 = serial
                   1 = analog
                   2 = DCP
6   Nephelometer serial or analog normalized reading (counts)
7   Nephelometer serial normalized reading calculated from the raw readings (counts)
8-10   Not used
11   Chamber temperature (°C)
12   Ambient air temperature (°C)
13   Ambient relative humidity (%)
14   Raw lamp brightness (counts)

Figure 4-2. Key to the Level-A Nephelometer File Format.

```
                                    Field

    1          2          3      4      5       6       7       8        9
    CORG1      19941201   335    0000   50.30   69.12   17.36   273.00   12.27
    CORG1      19941201   335    0100   49.27   73.80   14.20   268.80   34.81
    CORG1      19941201   335    0200   49.51   74.30   14.98   275.60   8.25


    Field #    Description
    1          Site abbreviation
    2          Year, month , day (YYYYMMDD)
    3          Julian date (JJJ)
    4          Time (HHMM), hour ending
    5          Hourly average ambient air temperature (°F)
    6          Hourly average ambient relative humidity (%)
    7          Hourly average wind speed (mph)
    8          Hourly average wind direction (degrees true)
    9          Hourly standard deviation wind direction (degrees)
```

Figure 4-3. Key to the Level-A Meteorological File Format.

QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES		
TITLE	**NEPHELOMETER DATA COLLECTION VIA CAMPBELL SCIENTIFIC DATA STORAGE MODULE (IMPROVE PROTOCOL)**	
TYPE	**TECHNICAL INSTRUCTION**	
NUMBER	**4300-4006**	
DATE	**MARCH 1993**	

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
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REVISION HISTORY			
REVISION NO.	CHANGE DESCRIPTION	DATE	AUTHORIZATIONS
1.0	File format change.	January 1995	
1.1	Minor text modifications.	June 1996	
2.0	Updated programs used and file keys.	April 2004	

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LIST OF FIGURES

1.0   PURPOSE AND APPLICABILITY

This technical instruction (TI) describes the collection, compilation, and review of Optec NGN-2 nephelometer and associated meteorological data stored on Campbell Scientific data storage modules. It specifically addresses data from nephelometer stations operated according to IMPROVE Protocol. The primary purpose of data collection via storage module is to assure quality data capture and minimize data loss by:

- Downloading data from storage modules into site-specific files.

- Processing raw data into Level-A validated form.

- Reviewing the nephelometer downloaded storage module and processed data files to verify nephelometer system operation or identify problems.

This TI, as referenced from Standard Operating Procedure (SOP) 4300, *Collection of Optical Monitoring Data (IMPROVE Protocol)*, is a guide for using the NGN_pull.exe nephelometer data processing software to:

- Setup and update nephelometer station configurations.

- Download data from Campbell Scientific storage modules.

- Perform manual data processing.

- Review the nephelometer downloaded storage module file, and the processed data file.

This TI assumes the operator has basic knowledge of Pentium class computer systems and Microsoft Windows98 or Windows2000 operating systems.

2.0   RESPONSIBILITIES

2.1   PROJECT MANAGER

The project manager shall review information files and plots with the data analyst to identify and correct problems.

2.2   DATA ANALYST

The data analyst shall:

- Download the storage module and process the raw data.

- Review the nephelometer downloaded and processed files with the project manager to identify and correct data collection problems.

- Enter any information relating to the collection of the data and operation of the nephelometer station into the site-specific Quality Assurance Database.

3.0   REQUIRED EQUIPMENT AND MATERIALS

The nephelometer data collection system consists of the following hardware and software:

- Pentium class computer system with VGA and 80 megabyte hard disk and 64 megabytes of RAM

- Microsoft Windows98 or Windows2000 operating system

- Internal or external Hayes compatible modem configured for COM port #2

- Campbell Scientific software:
    - PC208W   Version 3.2
      -or-
    - LoggerNet   Version 2.1

- Campbell Scientific SC532 storage module interface

- NGN_pull.exe software, Version 3.0 or later (ARS)

- UltraEdit-32 software, Version 5.1 or later

Information regarding Campbell Scientific software is detailed in the *Campbell Scientific PC208 Datalogger Support Software Instruction Manual.*

4.0   METHODS

This section includes two (2) major subsections:

4.1 Storage Module Data Collection and Handling
4.2 File Names and Contents

4.1   STORAGE MODULE DATA COLLECTION AND HANDLING

Storage module data collection and handling is executed by using PC208W or LoggerNet software, and the NGN_pull.exe program, which performs the following tasks:

- Downloads data from the storage module using the Campbell Scientific PC208W or LoggerNet software into site-specific files.

- Processes each site-specific file into instrument-specific parts:
    - 5-minute nephelometer, ambient temperature, and relative humidity
    - Hourly average wind speed, wind direction, temperature, and relative humidity
    - Hourly nephelometer status code and support system status code summaries
    - Hourly average transmissometer, temperature, and relative humidity

- Reformats, validates, and appends nephelometer data into quarterly site-specific Level-A data files.

- Reformats, validates, and appends meteorological data to quarterly site-specific files.

- Creates a daily nephelometer log file that contains a summary of the performance of all of the downloaded sites. The log file is NGN*yyjjj*.inf, where *yy* is the year and *jjj* is the Julian date.

The following procedures detail the steps of data collection from a storage module:

LOG ONTO NETWORK

Log onto the nephelometer data handling computer using your assigned username and password.

RUNNING THE
NGN_PULL PROGRAM

The NGN_pull.exe program runs in Microsoft Windows and coordinates both automatic and manual data downloading and processing functions. The program is run by double-clicking on the NGN_pull icon, or selecting **File**, **Run**, **NGN_pull.exe** from the Windows Program Manager. Refer to the *Microsoft Windows2000 Quick Start Guide* for details on running Windows programs. Figure 4-1 presents the screen display of the NGN_pull.exe program.
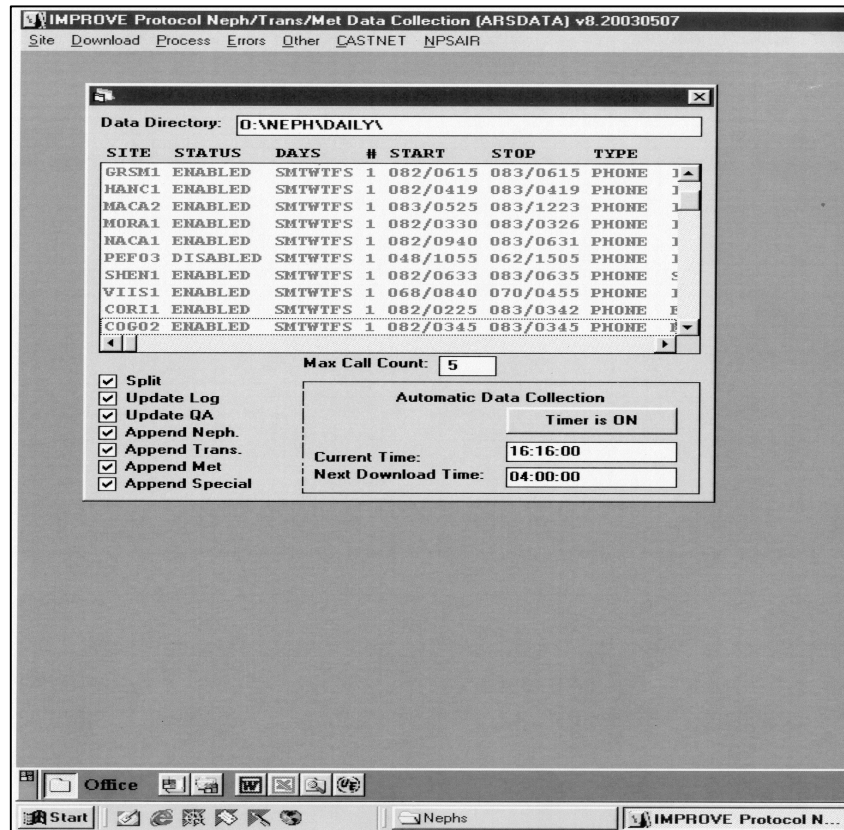

Figure 4-1. NGN_pull Windows Program Screen.

ADDING TO OR EDITING
THE STATION LIST

The station list includes the nephelometer stations and station types that are currently operating. The list includes:

- Site abbreviation

- Site type (telephone modem or DCP)

- Days of the week to call

- ARS project code

- First and last date and time of last downloaded file

- Plot title

The list may be edited by clicking **Site** from the menu bar and then selecting **Edit**, **Add**, or **Delete**. A site can be disabled (from calling) or enabled (to call) by clicking **Site** from the menu bar and selecting **Disable** or **Enable**.

The telephone-type stations have a corresponding station definition file (*xxxxx*.dnd) that the PC208W or LoggerNet software uses for datalogger and modem-specific parameters (including the telephone number). The following procedures are used to add, edit, or remove a site from the station list:

To add a new site:

- Click **Site** from the menu bar and select **Add**.

- Complete the fields in the Edit Site Information dialog box.

- Click **OK**.

- Click **Site** from the menu bar and select **Save Site List**.

To edit an existing site:

- Highlight the site to edit in the site list box.

- Click **Other** from the menu bar.

- Select **Run PC208W Program**.

- Select **Setup** from the PC208W3.2 datalogger support software menu.

- Set the following parameters in the station definition file:
  - Type of datalogger (21X)
  - Type of data file
  - Modem type, COM port, and baud rate
  - Telephone number and project charge code

ADDING TO OR EDITING
THE STATION LIST
(continued)

To remove a site:

- Highlight the site to remove in the site list box.

- Click **Site** from the menu bar.

- Click **Delete**.

USING THE SC532
STORAGE MODULE
INTERFACE

The Campbell Scientific SC532 Storage Module Interface provides the means for the computer RS232 serial port to communicate with the storage module. The SC532 attaches to one of the PC's serial ports (COM1-4) via the 23-pin connector. The 9-pin connector attaches to the storage module. The SC532 is powered by its own AC power adapter. Consult the user's manual or hardware manual for the PC being used for information on the PC's serial COM ports.

DOWNLOADING THE
STORAGE MODULE

Data in the storage module are downloaded using the Campbell Scientific PC208W or LoggerNet program. The PC208W or LoggerNet program provides the means to download the data, set storage module parameters, clear the storage module, and store or retrieve datalogger programs in the storage module. The following procedures describe downloading data from the storage module:

- Run the PC208W or LoggerNet program.

- Select **Stg Module** (storage module) from the menu bar.

- Select the proper storage module model tab (**SM192/SM716** or **SM4M/SM16M**) at the top of the program opening screen.
-
- Select the **Setup** tab (bottom-left of program opening screen). Setup the com port and baud rate (see Figure 4-2).

- Select the **Data** tab. Set up the file format (usually ASCII with Array ID's) and AutoName Control (usually append to current file) options (see Figure 4-3).

- Click **File Naming** options bar to setup file name and location.

- Click **Get All** bar to begin data download.

DOWNLOADING THE
STORAGE MODULE
(continued)

- The raw storage module file will be named *xxxxxyy*s.*jjj* where *xxxxx* is the site abbreviation, *yy* is the year, s is for storage module, and *jjj* is the Julian date (of latest data on storage module).

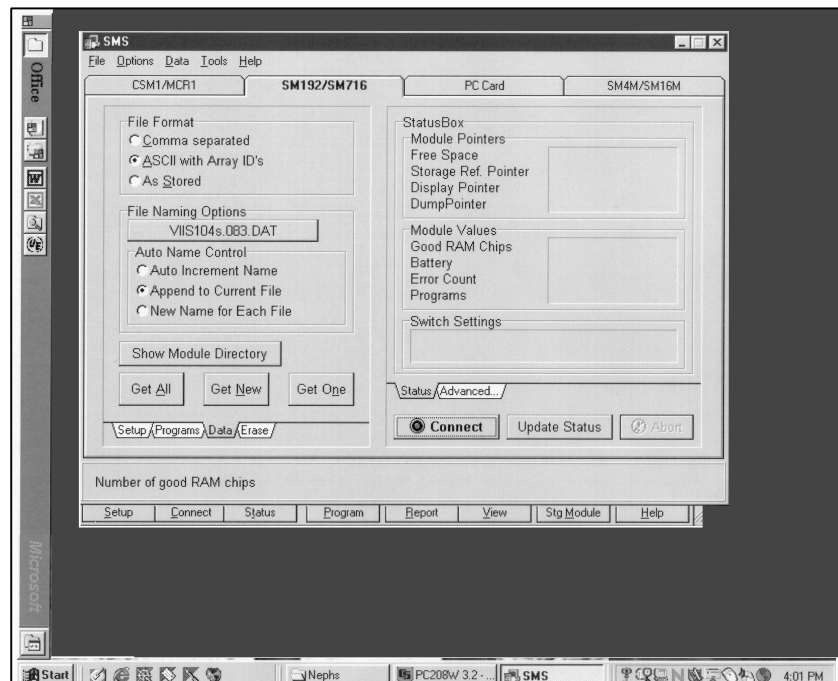Figure 4-2. SMS Screen Setup (Com Port and Baud Rate).

Figure 4-3. SMS Screen Setup (Data File Format and File Naming).

EXAMINE THE
DOWNLOADED
STORAGE MODULE
DATA FILE

The downloaded storage module data files (refer to Section 4.2.2, Site-Specific Data File Description, for analog and serial format) should be checked before they are processed to ensure they contain the expected date and time stamp for the specific site where data were collected. When it is determined that the downloaded storage module data files contain the proper date and time, those files can be processed using the NGN_pull program. After file verification is done, click on the **Erase** tab and erase the storage module (see Figure 4-4).
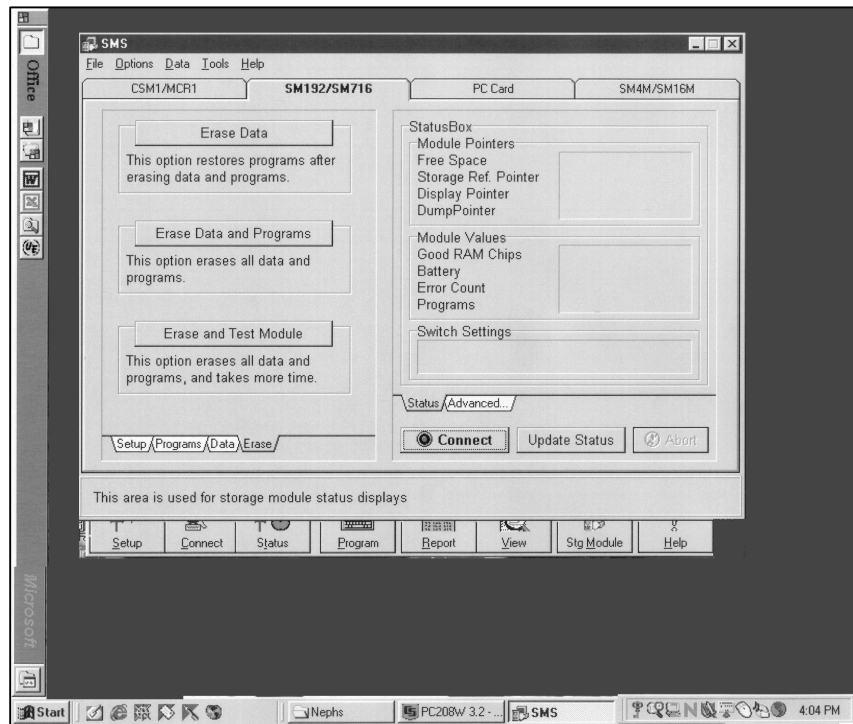
Figure 4-4. SMS Setup Screen (Data and Data Programs, Erase, and Test Module).

PROCESS STORAGE
MODULE DATA

The downloaded storage module data file is processed as follows:

- Highlight the *station* to process in the station list.

- Click **Process** on the menu bar.

- Click **Process Phone/SM**.

- A file selection dialog box will appear. Highlight the raw data file to process in the dialog box.

- Click **OK** on the menu bar.

4.2   FILE NAMES AND CONTENTS

4.2.1 <u>Data Collection and Processing Files</u>

Compilation and processing of nephelometer data involves several files. The following describes the processing steps and files used:

- Data for individual nephelometer stations are downloaded into site-specific data files (*xxxxxyyyy*s.*jjj*, where *xxxxx* is the site abbreviation, *yyyy* is the year, s is the designation for storage module, and *jjj* is the Julian date). These files contain all data collected from the storage module.

- Data in the site-specific files are divided into several instrument-specific temporary data files. Five-minute nephelometer and meteorological data are placed in *xxxxx*.nep, hourly code summary information is placed in *xxxxx*.inf, and hourly meteorological data are placed in *xxxxx*.fsm.

- The 5-minute nephelometer and hourly meteorological data in the temporary files (*xxxxx*.nep) are appended to the following site-specific Level-A validation data files:

      Nephelometer: *xxxxx*_N.*yyq*
      Meteorological: *xxxxx*_M.*yyq*

  (where *xxxxx* is the site abbreviation, *yyyy* is the year, and *q* is the calendar quarter code)

- Hourly code summary data are formatted and written to the daily nephelometer error file (NGN*yyjjj*.inf, where *yy* is the year and *jjj* is the Julian date).

- Level-A validation data files may be examined or plotted. These files serve as the initial files for further processing as detailed in TI 4400-5010, *Nephelometer Data Reduction and Validation (IMPROVE Protocol)*. The Level-A files are maintained on the system hard disk until completion of quarterly processing.

- Other files used by NGN_pull include:

  NGN_site.lst   A list of active sites that appear in the site list window of NGN_pull.

  NGN_file.lst   A list of raw data file names already in use by NGN_pull.

4.2.2 <u>Site-Specific Data File Description</u>

The site-specific daily file consists of the following sets of data:

- Five-minute data synchronized to the 21X or 23X datalogger clock including nephelometer analog channels A1 and A2, ambient temperature, and relative humidity. The format is:

5-Minute Analog Data

```
01+0163. 02+1993. 03+0059. 04+0755. 05+582.6 06+0999. 07+2.234 08+097.1
```

Element #	Description
01	Datalogger program location identifier (not used)
02	Year
03	Julian date
04	Time (HHMM) at the end of the data period
05	Nephelometer A1 channel (mV x 2.0)
06	Nephelometer A2 channel (mV x 2.0)
07	Ambient air temperature (°C)
08	Ambient relative humidity (%)

• Five-minute data output when the nephelometer provides a serial data stream, including nephelometer serial data, analog channels A1 and A2, ambient temperature, and relative humidity. The format is:

5-Minute Serial Data

```
01+0119. 02+1993. 03+0059. 04+0757. 05+1.000 06+0891. 07+3493. 08+510.0
09+2.000 10+3.510 11+2.000 12+0755. 13+509.3 14+0999. 15+2.456 16+097.1
```

Element #	Description
01	Datalogger program location identifier (not used)
02	Year
03	Julian date
04	Time (HHMM) the serial stream was received by the datalogger
05	Nephelometer status code
06	Nephelometer raw scattered light reading (counts)
07	Nephelometer direct light reading (counts)
08	Nephelometer normalized scattered light readings (counts)
09	Nephelometer integration time (minutes)
10	Nephelometer chamber temperature (°C)
11	Not used
12	Nephelometer time (HHMM)
13	Nephelometer A1 channel (mV x 2.0)
14	Nephelometer A2 channel (mV x 2.0)
15	Ambient air temperature (°C)
16	Ambient relative humidity (%)

• Hourly code summary for the nephelometer and support system. The format is:

Hourly Code Summary

```
01+0104. 02+1993. 03+0059. 04+0800. 05+50.00 06+0.000
```

Element #	Description
01	Datalogger program location identifier (not used)
02	Year
03	Julian date
04	Time (HHMM) at the end of the data period
05	Nephelometer code summary for the past hour
06	Support system code summary for the past hour

The nephelometer code summary is the sum of any or all of the following:

50	Ambient reading
100	Clean air calibration
300	Span calibration
500	Lamp burned out
1000	Precipitation event detected
2000	Chopper motor start-up failure

The support system code summary is the sum of any or all of the following:

300	21X datalogger power low
500	DC power supply voltage low
1000	AC power outage
2000	Blue Earth serial data buffer restarted

- Hourly average meteorological data including wind speed, wind direction, ambient temperature, and relative humidity. The format is:

  Hourly Meteorological Data

  ```
  01+0171. 02+1995. 03+0013. 04+0700. 05–3.765 06+090.2 07+6.975 08+312.9 09+13.67
  ```

Element #	Description
01	Datalogger program location identifier (not used)
02	Year
03	Julian date
04	Time (HHMM) at the end of the data period
05	Ambient air temperature (°C or °F)
06	Ambient relative humidity (%)
07	Wind speed (mph)
08	Wind direction (degrees true)
09	Wind direction standard deviation

4.2.3 Level-A Nephelometer File Description

The Level-A nephelometer file is a formatted ASCII site-specific file. A key to the Level-A file format is presented in Figure 4-5.

4.2.4 Level-A Meteorological File Description

The Level-A meteorological file is a formatted ASCII site-specific file. A key to the Level-A file format is presented in Figure 4-6.

5.0 REFERENCES

Campbell Scientific, Inc., 1989, Campbell Scientific PC208 Datalogger Support Software Instruction Manual, February.

Microsoft Corporation, 2000, Windows2000 Professional, Quick Start Guide.

<u>Field</u>

```
1       2           3      4      5    6       7      8      9      10       11     12     13     14
< 10 line informational header at start of file >
VORZ1   19941228    362    0110   10   212.17 212.60 -99.00 -99.00 -99.000 -5.68  -5.44  83.10  3912
VORZ1   19941228    362    0115   10   209.77 207.90 -99.00 -99.00 -99.000 -5.74  -5.37  83.20  3909
VORZ1   19941228    362    0120   10   210.58 209.90 -99.00 -99.00 -99.000 -5.74  -5.51  83.30  3913
```

<u>Field #</u>   <u>Description</u>

1   Site abbreviation

2   Year, month , day (YYYYMMDD)

3   Julian date (JJJ)

4   Time (HHMM)

5   Code summary (3-characters)

        1: Power code (non-space character = power problem)

        2: Nephelometer status code

                1 = ambient

                2 = zero

                3 = span

                4 = lamp

                5 = rain

                6 = chopper

        3: Nephelometer data type code

                0 = serial

                1 = analog

                2 = DCP

6   Nephelometer serial or analog normalized reading (counts)

7   Nephelometer serial normalized reading calculated from the raw readings (counts)

8-10   Not used

11   Chamber temperature (°C)

12   Ambient air temperature (°C)

13   Ambient relative humidity (%)

14   Raw lamp brightness (counts)

Figure 4-5. Key to the Level-A Nephelometer File Format.

```
                                   Field

    1           2           3       4       5       6       7       8       9
    CORG1       19941201    335     0000    50.30   69.12   17.36   273.00   12.27
    CORG1       19941201    335     0100    49.27   73.80   14.20   268.80   34.81
    CORG1       19941201    335     0200    49.51   74.30   14.98   275.60   8.25
```

Field #   Description
1   Site abbreviation
2   Year, month , day (YYYYMMDD)
3   Julian date (JJJ)
4   Time (HHMM), hour ending
5   Hourly average ambient air temperature (°F)
6   Hourly average ambient relative humidity (%)
7   Hourly average wind speed (mph)
8   Hourly average wind direction (degrees true)
9   Hourly standard deviation wind direction (degrees)

Figure 4-6. Key to the Level-A Meteorological File Format.