

QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	ANNUAL SITE VISITS FOR OPTICAL MONITORING INSTRUMENTATION (IMPROVE PROTOCOL)
TYPE	STANDARD OPERATING PROCEDURE
NUMBER	4115
DATE	MARCH 1994

AUTHORIZATIONS		
TITLE	NAME	SIGNATURE
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1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) outlines the general tasks performed during annual routine site visits to optical monitoring sites operated according to IMPROVE Protocol. Annual visits to optical monitoring sites are performed to assure quality data capture and minimize data loss by:

- Replacing all field monitoring instrumentation annually with fully refurbished and calibrated instrumentation.
- Ensuring that instrumentation removed from the field after one year of service is fully refurbished and calibrated.
- Ensuring that field support equipment (shelters, towers, power systems, system wiring, etc.) is in good condition and properly maintained.
- Verifying instrument performance in the field.
- Training site operator(s) in routine operations and system troubleshooting.

Two (2) types of optical monitoring instruments are currently operating in the IMPROVE visibility monitoring network:

- Ambient nephelometers (NGN-2)
- Transmissometers (LPV-2 and LPV-3)

General tasks performed during an annual site visit are basically the same for both instruments. Detailed instrument-specific annual site visit procedures referenced by this SOP are as follows:

- TI 4115-3000 *Annual Site Visit Procedures for Optec LPV Transmissometer Systems (IMPROVE Protocol)*
- TI 4115-3005 *Annual Site Visit Procedures for Optec NGN-2 Nephelometer Systems (IMPROVE Protocol)*
- SOP 4700 *Optec NGN-2 Nephelometer Audit Procedures (IMPROVE Protocol)*
- SOP 4710 *Transmissometer Field Audit Procedures*

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Coordinate with the site operator, his/her supervisor, field specialist, instrument technician, and data analyst regarding priority and scheduling of routine servicing trips.

- Coordinate with the field specialist and instrument technician regarding scheduling, preparation, calibrations, and assignment of instrumentation for each optical field site.
- Communicate to the field specialist, data analyst, and site operator any on-site problems, maintenance needs, supplies, etc., that should be addressed during the site visit.
- Provide the Contracting Officer's Technical Representative (COTR) with a list of scheduled site servicing dates, ARS personnel who will visit each site, and names of the primary site contacts. Site operators and their supervisors must be notified either directly or through the COTR at least two weeks prior to a site visit.
- Review site visit documentation with the field specialist, data analyst, and instrument technician.
- Provide the field specialist with calibration numbers for the installation and reference transmissometers.
- Review on-site audit data to confirm correct system operation before the field specialist leaves the site.

2.2 FIELD SPECIALIST

The field specialist shall:

- Coordinate with the site operator, his/her supervisor, project manager, instrument technician, and data analyst regarding priority and scheduling of routine servicing trips.
- Coordinate with the project manager and instrument technician regarding scheduling, preparation, calibrations, and assignment of instrumentation for each nephelometer field site.
- Communicate to the instrument technician, data analyst, and site operator any on-site problems, maintenance needs, supplies, etc., that should be addressed during the site visit.
- Ensure that all instrumentation (and associated calibrations), equipment, materials, and tools are properly prepared and are fully functional.
- Perform all procedures outlined in this TI.
- Make travel and shipping arrangements.
- Follow-up on resolution of any problems encountered on-site that could not be resolved during the site visit.

- Arrange for on-site purchase and delivery of equipment and/or materials that are best obtained locally.
- Hold a training session for site operators during the site visit.
- Review site documentation with the project manager, instrument technician, and data analyst.

2.3 INSTRUMENT TECHNICIAN

The instrument technician shall:

- Coordinate with the site operator, his/her supervisor, field specialist, project manager, and data analyst regarding priority and scheduling of routine servicing trips.
- Coordinate with the field specialist and project manager regarding scheduling, preparation, calibrations, and assignment of instrumentation for each nephelometer field site.
- Perform all servicing, maintenance, modifications, and calibration of instrumentation prior to the site visit.
- Ensure that all instrumentation is in good operating condition prior to shipment.
- Communicate to the field specialist any equipment or instrument modification, or servicing requirements that must be performed on-site.
- Review site visit documentation with the field specialist, data analyst, and project manager.

2.4 DATA ANALYST

The data analyst shall:

- Coordinate with the site operator, his/her supervisor, field specialist, instrument technician, and project manager regarding priority and scheduling of routine servicing trips.
- Communicate to the instrument technician, project manager, and site operator any on-site problems, maintenance needs, supplies, etc., that should be addressed during the site visit.
- Review site documentation with the project manager, field specialists, and instrument technician.
- Communicate to the field specialist during the site visit any problems evident in the collected data.

2.5 SITE OPERATOR

The site operator shall:

- Coordinate with the project manager, field specialist, instrument technician, and data analyst regarding priority and scheduling of routine servicing trips.
- Communicate to the instrument technician, data analyst, and field specialist any on-site problems, maintenance needs, supplies, etc., that should be addressed during the site visit.
- Be available for training during the site visit and arrange to have at least one backup operator also attend the training session.
- Assist the field specialist with the optical system replacement and other tasks that require assistance.

2.6 TECHNICAL ASSISTANT

The technical assistant shall:

- Verify and update the IMPROVE transmissometer inventory using on-site inventory information recorded during the annual visit.
- Prepare transmissometer on-site inventory report after updating the inventory.

3.0 REQUIRED EQUIPMENT AND MATERIALS

The following subsections provide summary lists of equipment and materials required to perform routine on-site maintenance and servicing tasks during annual site visits to optical monitoring sites. Other system components or special tools may be required to perform non-routine field maintenance.

3.1 EQUIPMENT AND MATERIALS FOR NEPHELOMETER SITE VISITS

Specific instrumentation, equipment, tools, and materials generally required for a nephelometer annual site visit include the following (see TI 4115-3005 for a detailed list):

- A replacement nephelometer.
- A replacement datalogging and control subsystem (if needed).
- A replacement data collection platform (DCP) (if needed).
- A replacement AT/RH sensor.
- A digital voltmeter (DVM).
- An auditing AT/RH sensor.

- A replacement tank of calibration gas, calibration gas regulator, and uninterruptable power supply (if needed).
- A standard field service tool kit.
- An HP200LX Palmtop or laptop computer with programs required to communicate with and control the NGN-2 nephelometer, Campbell 21X or 23X datalogger, and the Blue Earth micro-controller.
- A telephone handset, line simulator, cables, and a cellular telephone for remote sites.
- Documentation cameras.
- A replacement flowmeter (rotameter).
- A replacement Campbell storage module.
- Nephelometer Servicing Site Visit Trip Report.
- Optec NGN-2 Nephelometer Field Installation Shipping Checklist.
- Post-maintenance nephelometer calibration data.
- Miscellaneous site information (maps, contacts, directions, gates, locks, keys, etc.).
- A Site Operator's Manual containing all applicable technical instructions.
- Optec NGN-2 Technical Manual for Theory of Operation and Operating Procedures.
- Log sheets.

3.2 EQUIPMENT AND MATERIALS FOR TRANSMISSOMETER SITE VISITS

Specific instrumentation, equipment, tools, and materials generally required for a transmissometer annual site visit include the following (see TI 4115-3000 for a detailed list):

- A replacement transmissometer with calibrated lamps.
- A reference transmissometer with calibrated lamps.
- A replacement data collection platform (DCP) (if needed).
- A replacement AT/RH sensor.
- A digital voltmeter (DVM).
- An auditing AT/RH sensor.
- Replacement on-site receiver and transmitter DVMs (if needed).
- A Campbell 21X datalogger for audits.
- A standard servicing tool kit.

- A palmtop computer, capable of programming Handar 540A and 570A data collection platforms, with associated cable connectors.
- A calculator.
- Two 2-way radios.
- Documentation cameras.
- Replacement power supplies and surge protectors/suppressors.
- Replacement solar panel regulator(s) (if needed).
- Transmissometer Servicing Site Visit Trip Report.
- Optec Transmissometer Field Installation Shipping Checklist .
- Receiver and transmitter site transmissometer field audit forms.
- A Site Operator's Manual containing all applicable technical instructions.
- Log sheets.
- Optec Technical Manual for Theory of Operation and Operating Procedures.

4.0 METHODS

Optical monitoring instruments at IMPROVE Protocol monitoring sites are removed from the field for laboratory servicing on an annual basis. Spare monitoring systems are installed as replacements for instruments and support equipment removed for laboratory servicing. Field specialists visit sites to perform this changeout of monitoring system components. As a part an annual site visit, a field specialist also performs a number of equipment checks and performance tests that provide information relating to the system's operation during the past 12 months, and verify that the replacement system has a high probability of operating successfully over the next 12 months. To further ensure successful operation and collection of high quality data, a comprehensive site operator training session, which includes a thorough review of routine operations and system troubleshooting procedures, is conducted by the field specialist.

General procedures included in an annual site visit are basically the same for nephelometers and transmissometers. This section outlines the general procedures for each type of instrument and includes two (2) subsections:

- 4.1 Nephelometer Annual Site Visits
- 4.2 Transmissometer Annual Site Visits

Detailed descriptions of annual site visit procedures for nephelometers and transmissometers are provided in TI 4115-3000 and TI 4115-3005.

4.1 NEPHELOMETER ANNUAL SITE VISITS

The nephelometer annual site visit includes the following procedures:

- Pre-visit preparation
- Pre-removal system inspection and equipment inventory
- Pre-removal system performance check and nephelometer calibration
- Pre-removal AT/RH field audit
- Removal and replacement of nephelometer and AT/RH sensor
- Post-installation system performance check and nephelometer calibration
- Post-installation AT/RH field audit
- Post-installation system inspection and equipment inventory
- On-site training of the site operator
- Post-visit site operations review and inventory verification
- Archiving of all annual site servicing documentation

4.2 TRANSMISSOMETER ANNUAL SITE VISITS

The transmissometer annual site visit includes the following procedures:

- Pre-visit preparation
- Pre-removal system inspection and equipment inventory
- Pre-removal system operations and performance verification
- Pre-removal AT/RH field audit
- Field audit and removal of the on-site transmissometer
- Installation and field audit of the replacement transmissometer
- Installation and field audit of the replacement AT/RH sensor
- Post-installation system operations and performance verification
- Post-installation system inspection and equipment inventory
- On-site training of the site operator
- Post-visit site operations review and inventory verification
- Archiving of all annual site servicing documentation

QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
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1.1	Add in-line filter to calibration system	August 2000	
2.0	Add Type 2 systems (with 23X datalogger)	May 2004	

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1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) outlines and describes the procedures involved in performing annual routine site visits to Optec NGN-2 nephelometer sites operated according to IMPROVE Protocol, with the primary purpose of ensuring quality data recovery and minimizing data loss from the nephelometer system. This TI is referenced in standard operating procedure (SOP) 4115, *Annual Site Visits for Optical Monitoring Instrumentation (IMPROVE Protocol)*.

Operational nephelometers and collocated AT/RH sensors undergo annual laboratory maintenance. These systems are replaced by backup operational systems during an annual site visit. In addition to replacement of the monitoring components, sites are maintained to ensure continued safe operation and site operator(s) are fully trained.

The annual routine site visit includes:

- Scheduling the visit.
- Preparing and shipping equipment and instrumentation to the site.
- Documenting initial conditions.
- Verifying system operation (pre-removal).
- Performing clean air (zero) and upscale span calibrations of the existing system.
- Removing the existing nephelometer, datalogging and control subsystem (if required), and AT/RH sensor.
- Installing the replacement nephelometer, datalogging and control subsystem, and AT/RH sensor. The replacement systems are fully serviced, upgraded, and calibrated, at ARS prior to shipment to the site.
- Replacing the calibration system in-line filter assembly (if required).
- Verifying replacement system operation (post-installation).
- Performing clean air (zero) and upscale span calibrations of the replacement system.
- Inspecting and maintaining all support equipment.
- Updating site inventories.
- Providing operator training.
- Preparing and return shipping of all instruments, tools, etc.
- Documenting all aspects of the site visit.

This TI outlines annual site visit procedures, except audit procedures (refer to SOP 4700, *Optec NGN-2 Nephelometer Audit Procedures (IMPROVE Protocol)*).

2.0 RESPONSIBILITIES

2.1 PROJECT MANAGER

The project manager shall:

- Coordinate with the site operator, his/her supervisor, field specialist, instrument technician, and data analyst regarding priority and scheduling of routine servicing trips.
- Coordinate with the field specialist and instrument technician regarding scheduling, preparation, calibrations, and assignment of instrumentation for each nephelometer field site.
- Communicate to the field specialist, data analyst, and site operator any on-site problems, maintenance needs, supplies, etc., that should be addressed during the site visit.
- Provide the Contracting Officer's Technical Representative (COTR) with a list of scheduled site servicing dates, ARS personnel who will visit each site, and names of the primary site contacts. Site operators and their supervisors must be notified either directly or through the COTR at least two weeks prior to a site visit.
- Review site visit documentation with the field specialist, data analyst, and instrument technician.

2.2 FIELD SPECIALIST

The field specialist shall:

- Coordinate with the site operator, his/her supervisor, project manager, instrument technician, and data analyst regarding priority and scheduling of routine servicing trips.
- Coordinate with the project manager and instrument technician regarding scheduling, preparation, calibrations, and assignment of instrumentation for each nephelometer field site.
- Communicate to the instrument technician, data analyst, and site operator any on-site problems, maintenance needs, supplies, etc., that should be addressed during the site visit.
- Ensure that all instrumentation (and associated calibrations), equipment, materials, and tools are properly prepared and are fully functional.
- Perform all procedures outlined in this TI.
- Make travel and shipping arrangements.
- Follow-up on resolution of any problems encountered on-site that could not be resolved during the site visit.

- Arrange for on-site purchase and delivery of equipment and/or materials that are best obtained locally.
- Hold a training session for site operators during the site visit.
- Review site documentation with the project manager, instrument technician, and data analyst.

2.3 INSTRUMENT TECHNICIAN

The instrument technician shall:

- Coordinate with the site operator, his/her supervisor, field specialist, project manager, and data analyst regarding priority and scheduling of routine servicing trips.
- Coordinate with the field specialist and project manager regarding scheduling, preparation, calibrations, and assignment of instrumentation for each nephelometer field site.
- Perform all servicing, maintenance, modifications, and calibration of instrumentation prior to the site visit.
- Ensure that all instrumentation is in good operating condition prior to shipment.
- Communicate to the field specialist any equipment or instrument modification, or servicing requirements that must be performed on-site.
- Review site visit documentation with the field specialist, data analyst, and project manager.

2.4 DATA ANALYST

The data analyst shall:

- Coordinate with the site operator, his/her supervisor, field specialist, instrument technician, and project manager regarding priority and scheduling of routine servicing trips.
- Communicate to the instrument technician, project manager, and site operator any on-site problems, maintenance needs, supplies, etc., that should be addressed during the site visit.
- Review site documentation with the project manager, field specialists, and instrument technician.
- Communicate to the field specialist during the site visit any problems evident in the collected data.

2.5 SITE OPERATOR

The site operator shall:

- Coordinate with the project manager, field specialist, instrument technician, and data analyst regarding priority and scheduling of routine servicing trips.
- Communicate to the instrument technician, data analyst, and field specialist any on-site problems, maintenance needs, supplies, etc., that should be addressed during the site visit.
- Be available for training during the site visit and arrange to have at least one backup operator also attend the training session.
- Assist the field specialist with the nephelometer system replacement and other tasks that require assistance.

3.0 REQUIRED INSTRUMENTATION, TOOLS, EQUIPMENT, AND MATERIALS

All required equipment and materials are listed on a checklist, which the field specialist completes when preparing for a site visit. Figure 3-1 presents the Optec NGN-2 Nephelometer Field Installation Shipping Checklist.

3.1 INSTRUMENTATION

Instrumentation required during a routine site visit includes:

- A replacement nephelometer.
- A replacement datalogging and control subsystem (if required due to failure).
- A replacement AT/RH sensor.
- A digital voltmeter (DVM) (supplied by the field specialist).
- An auditing AT/RH sensor.
- A watch set to National Institute of Standards (NIST) time.

3.2 TOOLS

A complete tool kit is recommended as on-site tasks vary from instrument repair to minor tower and support system repairs or modifications. Non-standard tools often required include:

- A cordless drill with screw bits, drill bit set, and assorted ($\frac{3}{4}$ " – 1 $\frac{1}{2}$ ") wood bits.
- A telephone line crimp tool and modular plugs.
- A crimp tool for datalogger box connections, spare pins, sockets, and connectors.

**OPTEC NGN-2 NEPHELOMETER
ANNUAL SITE VISIT SHIPPING CHECKLIST**

Site: _____

Date: _____

Method of Shipping: _____

<input type="checkbox"/> [✓] TO TAKE	<input type="checkbox"/> [✓] WHEN PACKED	ON-SITE EQUIPMENT	QUANTITY	SERIAL #
		Nephelometer		
		AT/RH Sensor with Dielectric Grease and Electrical Tape		
		Nephelometer Hood		
		Fuse Kit		
		Lamps		
		Clean Air Filters		
		Log Sheets, SOP's & T's		
		Fed Ex Airbills		

AUDIT EQUIPMENT

		Reset Switch		
		Display		
		AT/RH Fan		
		Green Indicator Light		
		Red Indicator Light		
		Fuse Holder		
		Telespike Surge Protector		
		Spare Connector Kit for AT/RH		
		Rotameter		
		6' Refrigerant Hose		
		Storage Module		
		WD40 Lubricant Spray		
		Calibration System In-Line Filter Assembly		
		Palmtop Computer with cables and instruction set		
		DVM with test probes		
		Tool Kit		
		Rope with Carabiner		
		Tower Belt		
		Telephone Handset		
		AT/RH Audit Kit		
		Digital Camera		
		GPS		

SITE VISIT FORMS

		Servicing Site Visit Trip Report		
		Cal Memo Removal, and Installation		
		ARS Address Labels		

N:\Project\ARS\FORMS\NEPH\nephsitevisitshipchklist.doc Modified on 6/11/01

Figure 3-1. Optec NGN-2 Nephelometer Field Installation Shipping Checklist.

3.3 EQUIPMENT

Equipment required during a routine site visit includes:

- An HP200LX Palmtop computer or laptop computer, capable of programming the NGN-2 nephelometer with associated cables, connectors, and hardware.
- Software for the palmtop computer:
 - Site-specific data programs for the Campbell 21X or 23X datalogger
 - Campbell Scientific PC208W (including SMCOM, TERM, and EDLOG)
 - DATACOMM terminal emulator (built-in the palmtop)
 - Blue Earth micro-controller programs
- Software for the laptop computer:
 - HyperTerminal
 - Campbell Scientific PC208W
 - Site specific programs for the Campbell 21X or 23X datalogger
- A calculator.
- A telephone handset.
- A telephone line simulator and cables.
- A cellular telephone for remote sites.
- A digital camera for documentation.
- A replacement SUVA calibration gas tank (if needed).
- A replacement calibration gas regulator (if needed).
- A replacement UPS (uninterruptable power supply).
- A multi-outlet surge protector.
- A replacement telephone line surge suppressor for telephone sites (if needed).
- A replacement flowmeter.
- A replacement Campbell storage module with program.
- A 21X rechargeable battery pack.
- A replacement calibration system in-line filter assembly
- Snoop leak detector for Type 2 systems.

- Miscellaneous relays, solenoid valves, and power supply for span gas system.
- A standard field servicing kit:
 - Spare components
 - Display chips
 - Hardware
 - Fuses and fuse holders
 - Nephelometer lamps
 - Connectors
 - Standard cables
 - Clean air filters
 - AC and DC indicator lamps
 - 21X or 23X charging units
 - Hoisting rope
 - AT/RH fan

3.4 MATERIALS

The following documentation forms and information sheets should be taken on each visit:

- Nephelometer Servicing Site Visit Trip Report (for Type 1 or Type 2 systems) (Figures 4-1 and 4-2)
- Optec NGN-2 Nephelometer Field Installation Shipping Checklist (Figure 3-1)
- Calibration parameters for the AT/RH sensor (if applicable)
- Post-maintenance nephelometer calibration data
- Miscellaneous site information (maps, contacts, directions, gates, locks, keys, etc.)

The site operator's manual on-site should contain the following for reference:

- TI 4100-3100, *Routine Site Operator Maintenance Procedures for Optec NGN-2 Nephelometer Systems – Type 1 (IMPROVE Protocol)* or TI 4100-3105, *Routine Site Operator Maintenance Procedures for Optec NGN-2 Nephelometer Systems – Type 2 (IMPROVE Protocol)*
- TI 4100-3350, *NGN-2 Nephelometer Monitoring System Diagrams and Component Descriptions*
- TI 4100-3375, *Replacing and Shipping Nephelometer System Components*
- Optec NGN-2 Technical Manual for Theory of Operation and Operating Procedures
- Log sheets

4.0 METHODS

This section describes annual site visit procedures for nephelometer systems (Type 1 and Type 2), and includes nine (9) major subsections:

- 4.1 Pre-Visit Preparation
- 4.2 General Trip Information
- 4.3 System Inspection
- 4.4 Nephelometer Calibration
- 4.5 System Operation Verification
- 4.6 Servicing Summary
- 4.7 Training Procedures and Documentation
- 4.8 Post-Visit Procedures
- 4.9 Initial Inventory

4.1 PRE-VISIT PREPARATION

Prior to travel to the site, the following preparations need to be made (for individual responsibilities refer to Sections 2.1 through 2.5):

- Schedule the site visit and notify the COTR.
- Schedule and perform instrument servicing, calibrations, and tests.
- Coordinate with site personnel to arrange for:
 - Site operator training (approximately 2-4 hours).
 - Assistance with replacement of all necessary components (approximately 1-2 hours).
 - Any other assistance needed from on-site personnel.
- Organize all instruments, equipment, tools, and materials.
- Arrange for on-site procurement of equipment, tools, or materials.
- Verify that the replacement nephelometer, datalogging and control subsystem, and AT/RH sensor have received the appropriate testing and/or calibrations.
- Investigate what site-specific problems need to be addressed on-site.
- Ship instruments, equipment, tools, and materials directly to the site or preferably airfreight all items to a major airport near the site to be held for pick-up by the field specialist.
- Arrange travel.

The field specialist should contact the site operators and their supervisor (if involved with the on-site nephelometer system servicing and maintenance) upon arrival at the site. The prearranged schedules for operator training, system replacement, and any other work the field specialist will need assistance with should be confirmed at this time.

The Nephelometer Servicing Site Visit Trip Report, Figure 4-1 and Figure 4-2 (for Type 1 and Type 2 systems, respectively), must be used to document servicing tasks. This form generally follows the order in which procedures are performed and serves as a checklist for site conditions review, operational verifications and checks, and inventories. Procedures not included on the trip report are included in SOP 4700, *Optec NGN-2 Nephelometer Audit Procedures (IMPROVE Protocol)*.

NEPHELOMETER STATION – SYSTEM INSPECTION I

Pre-removal Post-installation Internal audit

Support Tower and Structural Components

Physical condition: _____
Condition of guy wires or tower brackets: _____
Condition of the span gas hoses: _____
Condition of the span gas enclosure: _____

Nephelometer Support Hanger

Physical condition of hanger: _____
Attachment of hanger to tower: _____

Nephelometer

Physical condition of nephelometer: _____
Condition of sample inlet screen: _____
Condition of nephelometer signal and power cable: _____

Condition of light trap and clean air filter (perform after calibration):

Does the instrument appear to be functioning correctly? _____

Document serial counts on *6 locations 5 and 6, and analog counts on *6 locations 4 and 7:

Document current lamp value (*6 17) location: _____

Data Logging and Control Subsystem

Physical condition of the system exterior: _____
Condition of ventilation screen: _____
Padlock type, manufacturer, ID, and number: _____
Condition of the support system interior: _____
Condition of the inlet ventilation screen: _____
Condition of the wiring: _____
21X data logger program version currently installed: _____
Storage module currently installed: _____
Date and time on the 21X datalogger (mm/dd/yy and Julian): _____
Record the concurrent NIST time: _____

***** Change 21X to current time (on final inspection) *****

Condition of the interface circuit board and Blue Earth: _____

Blue Earth indicator LEDs? Red: ON OFF Yellow: ON OFF Green: ON OFF

Front panel LCD display: ON OFF Display: _____ 21X *6 11 location: _____

Figure 4-1. (Continued).Type 1 Nephelometer Servicing Site Visit Trip Report.

NEPHELOMETER STATION – SYSTEM INSPECTION II

Power System

Are AC and DC indicator lamps operational? _____ Fuses OK? _____
DC power supply (VDC): _____
Download Data: _____
21X Power with AC Connected: _____
21X Power with AC Disconnected: _____
Condition of the AC power line and plug on the enclosure: _____
Condition of the AC wiring inside the enclosure: _____

Telephone System

Communication possible with Campbell modem? YES NO
Communication possible with Campbell 21X? YES NO

AT/RH REMOVAL/REPLACEMENT AUDIT

AUDIT SENSOR# _____
ON SITE SENSOR # _____
REPLACEMENT SENSOR # _____
Physical Condition of On Site Sensor: _____
Condition of Shield and Fan: _____
Condition of Screen: _____
Weather Conditions: _____
Comments: _____

	START:	JD	TIME
ON SITE SENSOR	_____	_____	_____
REPLACEMENT SENSOR	_____	_____	_____

Site Specifications: Latitude: _____ Longitude: _____ Elevation: _____

Additional Maintenance Performed

Document any additional maintenance performed: _____

Figure 4-1. (Continued). Type 1 Nephelometer Servicing Site Visit Trip Report.

NEPHELOMETER STATION – SYSTEM INSPECTION III

Nephelometer Manual Calibration

Record the log file name: _____
Weight of the span gas container: _____
Flow meter and regulator functioning OK? _____
In-line filter condition? _____

POST Information

	<u>Pre-removal</u>	<u>Post-installation</u>
ROM version:	_____	_____
Serial number:	_____	_____
Run mode:	_____	_____
Clean air intervals (INTERVALS):	_____	_____
Date and time:	_____	_____
Automatic span flag (AUTO SPAN):	_____	_____
Store start-up baud rate (STORED BAUD RATE):	_____	_____
Automatic test flag (AUTO TEST):	_____	_____
Total run time:	_____	_____
Memory checks: CSUM:	_____	ROMTOP: _____

POST Mechanical Functions

Pre-Removal

Door: OPEN CLOSED Fan: ON OFF Pump: ON OFF
Lamp: ON OFF Solenoid: ON OFF Valve: ON OFF
Average manual clean air calibration: _____ Average manual span gas calibration: _____

Post Installation

Door: OPEN CLOSED Fan: ON OFF Pump: ON OFF
Lamp: ON OFF Solenoid: ON OFF Valve: ON OFF
Average manual clean air calibration: _____ Average manual span gas calibration: _____

Automatic Nephelometer Calibration

	<u>Pre-removal</u>	<u>Post-installation</u>
Automatic clean air zero serial (*6 12):	_____	_____
Automatic span serial (*6 13):	_____	_____
Automatic clean air zero serial output from computer:	_____	_____
Automatic span serial output from computer:	_____	_____

Figure 4-1. (Continued). Type 1 Nephelometer Servicing Site Visit Trip Report.

NEPHELOMETER STATION – SERVICING SUMMARY

Pre-removal condition documented? YES NO
Pre-removal system operation checked? YES NO
Pre-removal site inventory completed? YES NO
Pre-removal nephelometer calibration completed? YES NO
Pre-removal AT/RH audit completed? YES NO

Replace existing nephelometer? YES NO

Comment: _____

Replace existing logging and control subsystem? YES NO

Comment: _____

Replace existing AT/RH? YES NO

Comment: _____

Other replacement? YES NO

Comment: _____

System Operational Verification

System operation checked? YES NO
Site inventory completed? YES NO
Post-installation nephelometer calibration completed? YES NO
AT/RH audit completed? YES NO
Communications verified? YES NO
Site operator(s) trained? YES NO
Operator Manual complete and current? YES NO

Comment: _____

Figure 4-1. (Continued). Type 1 Nephelometer Servicing Site Visit Trip Report.

NEPHELOMETER STATION – SITE INVENTORY

	Pre-removal			Post-installation		
	<u>Manufacturer</u>	<u>Model #</u>	<u>Serial #</u>	<u>Manufacturer</u>	<u>Model #</u>	<u>Serial #</u>
Antenna	_____	_____	_____	_____	_____	_____
AT/RH Sensor	_____	_____	_____	_____	_____	_____
AT/RH Shield	_____	_____	_____	_____	_____	_____
Data logger	_____	_____	_____	_____	_____	_____
Modem	_____	_____	_____	_____	_____	_____
Nephelometer	_____	_____	_____	_____	_____	_____
Power Supply	_____	_____	_____	_____	_____	_____
Blue Earth	_____	_____	_____	_____	_____	_____
Storage Module	_____	_____	_____	_____	_____	_____
UPS	_____	_____	_____	_____	_____	_____
Tower	_____	_____	_____	_____	_____	_____
Precip/Solar Rad. Shield	_____	_____	_____	_____	_____	_____
Logging/Control Subsystem	_____	_____	_____	_____	_____	_____
Span Gas Enclosure	_____	_____	_____	_____	_____	_____
Span Gas Regulator	_____	_____	_____	_____	_____	_____
Rotameter	_____	_____	_____	_____	_____	_____
Nephelometer Hood	_____	_____	_____	_____	_____	_____
Cellular Telephone	_____	_____	_____	_____	_____	_____
Cellular Phone Antenna	_____	_____	_____	_____	_____	_____
Other:						
Other:						
Spare parts on site:	_____					

Figure 4-1. (Continued). Type 1 Nephelometer Servicing Site Visit Trip Report.

NEPHELOMETER STATION – SYSTEM INSPECTION I

Pre-removal Post-installation Internal audit

Support Tower and Structural Components

Physical condition: _____
Condition of guy wires or tower brackets: _____
Condition of the span gas hoses: _____
Condition of the span gas enclosure: _____

Nephelometer Support Hanger

Physical condition of hanger: _____
Attachment of hanger to tower: _____

Nephelometer

Physical condition of nephelometer: _____
Condition of sample inlet screen: _____
Condition of nephelometer signal and power cable: _____

Condition of light trap and clean air filter (perform after calibration):

Does the instrument appear to be functioning correctly? _____

Document serial counts on *6 locations 5 and 6, and analog counts on *6 locations 4 and 7:

Document current lamp value (*6 17) location: _____

Data Logging and Control Subsystem

Physical condition of the system exterior: _____
Padlock type, manufacturer, ID, and number: _____
Condition of the support system interior: _____
Condition of the junction box: _____
Condition of the wiring: _____
23X data logger program version currently installed: _____
Storage module currently installed: _____
Date and time on the 23X datalogger (mm/dd/yy and Julian): _____
Record the concurrent NIST time: _____

Span Gas Control Enclosure

Physical condition of the system exterior: _____
Are the relays and solenoid valves functioning: _____
Check for gas leaks in the gas flow system: _____
Condition and operation of flowmeter and regulator: _____
Condition of the in-line filter: _____

Figure 4-2. (Continued). Type 2 Nephelometer Servicing Site Visit Trip Report.

NEPHELOMETER STATION – SYSTEM INSPECTION II

Power System

Is the DC indicator lamp operational? _____ Fuse OK? _____
DC power supply (VDC): _____
23X Power with AC Connected: _____
23X Power with AC Disconnected: _____
Condition of the AC power line and plugs on the enclosures: _____
Condition of the multi outlet surge protector: _____
Condition of the indicator lights on the surge protector: _____

Telephone System

Communication possible with Campbell modem? YES NO
Communication possible with Campbell 23X? YES NO

AT/RH REMOVAL/REPLACEMENT AUDIT

AUDIT SENSOR# _____
ON SITE SENSOR # _____
REPLACEMENT SENSOR # _____
Physical Condition of On Site Sensor: _____
Condition of Shield and Fan: _____
Condition of Screen: _____
Weather Conditions: _____
Comments: _____

	START:	JD	TIME
ON SITE SENSOR	_____	_____	_____
REPLACEMENT SENSOR	_____	_____	_____

Site Specifications: Latitude: _____ Longitude: _____ Elevation: _____

Additional Maintenance Performed

Document any additional maintenance performed: _____

Figure 4-2. (Continued). Type 2 Nephelometer Servicing Site Visit Trip Report.

NEPHELOMETER STATION – SYSTEM INSPECTION III

Nephelometer Manual Calibration

Record the log file name: _____

Weight of the span gas container: _____

POST Information

Pre-removal

Post-installation

ROM version: _____

Serial number: _____

Run mode: _____

Clean air intervals (INTERVALS): _____

Date and time: _____

Automatic span flag (AUTO SPAN): _____

Store start-up baud rate (STORED BAUD RATE): _____

Automatic test flag (AUTO TEST): _____

Total run time: _____

Memory checks: CSUM: _____ ROMTOP: _____

POST Mechanical Functions

Pre-Removal

Door: OPEN CLOSED Fan: ON OFF Pump: ON OFF

Lamp: ON OFF Solenoid: ON OFF Valve: ON OFF

Average manual clean air calibration: _____ Average manual span gas calibration: _____

Post Installation

Door: OPEN CLOSED Fan: ON OFF Pump: ON OFF

Lamp: ON OFF Solenoid: ON OFF Valve: ON OFF

Average manual clean air calibration: _____ Average manual span gas calibration: _____

Automatic Nephelometer Calibration

Pre-removal

Post-installation

Automatic clean air zero serial (*6 12): _____

Automatic span serial (*6 13): _____

Automatic clean air zero serial output from computer: _____

Automatic span serial output from computer: _____

Figure 4-2. (Continued). Type 2 Nephelometer Servicing Site Visit Trip Report.

NEPHELOMETER STATION – SERVICING SUMMARY

Pre-removal condition documented? YES NO
 Pre-removal system operation checked? YES NO
 Pre-removal site inventory completed? YES NO
 Pre-removal nephelometer calibration completed? YES NO
 Pre-removal AT/RH audit completed? YES NO

Replace existing nephelometer? YES NO

Comment: _____

Replace existing logging and control subsystem? YES NO

Comment: _____

Replace existing AT/RH? YES NO

Comment: _____

Other replacement? YES NO

Comment: _____

System Operational Verification

System operation checked? YES NO
 Site inventory completed? YES NO
 Post-installation nephelometer calibration completed? YES NO
 AT/RH audit completed? YES NO
 Communications verified? YES NO
 Site operator(s) trained? YES NO
 Operator Manual complete and current? YES NO

Comment: _____

Figure 4-2. (Continued). Type 2 Nephelometer Servicing Site Visit Trip Report.

NEPHELOMETER STATION – SITE INVENTORY

	Pre-removal			Post-installation		
	Manufacturer	Model #	Serial #	Manufacturer	Model #	Serial #
Antenna	_____	_____	_____	_____	_____	_____
AT/RH Sensor	_____	_____	_____	_____	_____	_____
AT/RH Shield	_____	_____	_____	_____	_____	_____
Data logger	_____	_____	_____	_____	_____	_____
Modem	_____	_____	_____	_____	_____	_____
Nephelometer	_____	_____	_____	_____	_____	_____
Power Supply	_____	_____	_____	_____	_____	_____
Blue Earth	_____	_____	_____	_____	_____	_____
Storage Module	_____	_____	_____	_____	_____	_____
UPS	_____	_____	_____	_____	_____	_____
Tower	_____	_____	_____	_____	_____	_____
Precip/Solar Rad. Shield	_____	_____	_____	_____	_____	_____
Logging/Control Subsystem	_____	_____	_____	_____	_____	_____
Span Gas Enclosure	_____	_____	_____	_____	_____	_____
Span Gas Regulator	_____	_____	_____	_____	_____	_____
Rotameter	_____	_____	_____	_____	_____	_____
Nephelometer Hood	_____	_____	_____	_____	_____	_____
Cellular Telephone	_____	_____	_____	_____	_____	_____
Cellular Phone Antenna	_____	_____	_____	_____	_____	_____
Other:						
Other:						
Spare parts on site:	_____					

Figure 4-2. (Continued). Type 2 Nephelometer Servicing Site Visit Trip Report.

4.2 GENERAL TRIP INFORMATION

Refer to Figures 4-1 and 4-2, page 1 for the following:

SITE	Use either the full location name or the five-character site abbreviation (four alpha and one numeric; e.g., ACAD1).
DATES	Record the calendar date duration of the entire servicing trip, including travel.
TECHNICIAN	Use the full name or the first initial and last name.
INSTRUMENT NUMBER	Record the Optec instrument number.
SITE VISIT OBJECTIVES	List the primary objectives of the site visit, especially any that are not standard for site visits.
TRIP SUMMARY	List the major actions taken for each day, including travel and locations. Any general comments pertaining to the trip should be noted in the comments section.

4.3 SYSTEM INSPECTION

The same information must be collected for the pre-removal and post-installation system configurations. Document the following (refer to Figures 4-1 and 4-2, page 2):

SUPPORT TOWER AND STRUCTURAL COMPONENTS	Note the physical condition of the support tower and condition of the guy wires (tension, attachment to tower, stakes, etc.) or the tower brackets (attachment to building). Note the condition of the span gas hoses (cracks, discoloration, etc.) and the general condition of the span gas enclosure.
SUPPORT HANGER	Note the general physical condition of the support hanger including the attachment of the hanger to the tower.
NEPHELOMETER	Inspect the nephelometer for any physical damage and for dirt or debris on the inlet screen and exhaust screen. Check the condition of the signal and power cables as well as the connectors. Observe the operation of the nephelometer and note any deviations from normal operation. After calibrating the nephelometer, remove the light trap and clean air filter and note the condition of each. Record the current lamp value from the *6 17 storage location on the 21X or 23X micrologger. Record the current ambient readings for both serial and analog outputs and verify that these values seem reasonable for the existing conditions.
DATALOGGING AND CONTROL SUBSYSTEM	Note the physical condition of the datalogging and control subsystem exterior, note the type of padlock used, the condition of the support system interior, the condition of the inlet ventilation screen (Type 1), and all wiring. Verify that the storage module is correctly installed.

DATALOGGING AND
CONTROL SUBSYSTEM
(continued)

Document the physical condition of the junction box regarding signs of corrosion, dirt, or loose connections (Type 2).

Record the current Campbell 21X or 23X micrologger program used and the current logger year, Julian date, and time. Record the concurrent NIST time.

For Type 1 Systems: Document the physical condition of the interface circuit board noting corrosion, dirt, loose connections, etc. Note the current state of the Blue Earth interface by observing the colored LEDs (RED always illuminated when powered, YELLOW flashes when the nephelometer outputs on the serial line, GREEN may flash intermittently but can be ignored). Observe the front panel LCD display and compare it to the 21X *6 11 location (b_{scat} or problem code).

For Type 2 Systems: Document the physical condition of the enclosure's exterior noting corrosion and functionality. Check the function of the relays and solenoid valves using a voltmeter and observing during runtime. Check for gas leaks at all connection points in the gas flow system using Snoop. Check the operation of the flowmeter and regulator during runtime. Check the condition of the inline filter for discoloration, and replace if necessary.

Refer to Figures 4-1 and 4-2, page 3 for the following information:

POWER SYSTEM

Type 1: Note if the AC and DC lights are operational.

Type 2: Note if the DC lights are operational

Record the DC power supply output voltage. Inspect all power wiring inside and outside of the enclosure.

Check datalogger power with and without AC connected. Check AC power line and plugs on enclosures. Check multi-outlet surge protector and indicator lights on Type 2 systems.

TELEPHONE SYSTEM

The telephone line is tested by using a handset and calling out. ARS verifies the telephone line and modem by calling into the site.

AT/RH SENSOR

Refer to TI 3750-6116, *Rotronics MP-100F or MP-101A AT/RH Sensor Audit Procedures (IMPROVE Protocol)* or TI 3150-2116, *Field Calibration and Routine Maintenance of Vaisala HMP 45AC AT/RH Sensors* for checking the operation of this sensor.

SITE SPECIFICATIONS

Document the site's latitude, longitude, and elevation using a GPS.

ADDITIONAL MAINTENANCE PERFORMED Fully document any additional maintenance required or inconsistencies noted.

4.4 NEPHELOMETER CALIBRATION

Calibration of the existing and replacement nephelometer systems must be performed. The procedures for the pre-removal and post-installation calibrations are identical (refer to Figures 4-1 and 4-2, page 4):

MANUAL CALIBRATION Attach a palmtop or laptop computer to the RS-232 serial port on the support system. Run the communications software (Datacomm or HyperTerminal) at 9600 baud and open a log file. Record the log file name on the documentation form. Note the type of span gas used and the approximate weight of the span gas tank to determine how much span gas remains.

POST INFORMATION Reset the nephelometer and interrupt its operation by entering ^C. Type the command **POST** and record the following for both re-removal and post-installation instruments. (For Type 1 systems reset the nephelometer by pressing the red button on the loggerbox front panel for approximately 5 seconds. For Type 2 systems, reset the nephelometer by pressing *6A0 to enter the port locations. Press 1 to turn the nephelometer off, then press 1 again to restart the nephelometer.

Record the ROM version used, serial number, and run mode. Record the clean air intervals and date and time. Record the automatic span flag, stored baud rate, and auto test flag. Finally, record the total run time and memory checks.

POST MECHANICAL FUNCTIONS Perform the post mechanical functions manually by giving commands found in the Optec technical manual (door open, close, fan on, off, pump on, off, lamp on, off, solenoid on, off, valve on, off).

Document if the door is open or closed and whether the fan, pump, lamp, solenoid, and valve are on or off.

For Type 1 Systems: Record the average clean air and span gas calibrations performed. Perform a manual clean air and gas calibration by entering nephelometer commands manually. These commands can be found in the Optec technical manual. Work loops of 20 minutes or more of one-minute readings are setup for each type of calibration. The log file will record one-minute updates from the nephelometer, allowing for a more detailed look at the calibration as it occurs. Several manual calibrations should

POST MECHANICAL
FUNCTIONS (continued)

be performed until the field specialist is satisfied with the repeatability of the calibrations. Close the log file when calibrations are completed. Disconnect the cable to the RS-232 port and reset the nephelometer to allow for normal operation. Print the log file and attach it to the site visit documentation form upon return to ARS.

For Type 2 Systems: Perform a manual clean air and gas calibration by entering nephelometer commands manually. These commands can be found in the Optec technical manual. Work loops of 20 or more one-minute readings are setup for each type of calibration. To initiate the gas flow for the gas calibration, press *6A0 on the 23X to enter port locations. Press 2 and 3 to open the solenoid valves. After the gas calibration is complete, press 2 and 3 on the datalogger to close the solenoid valves. Perform the clean air calibration either before or after the gas calibration. When the field specialist is satisfied with the repeatability of the calibrations, close the log file. Disconnect the cable to the RS-232 port and reset the nephelometer to allow for normal operation. Record the manual average clean air and span gas calibration values. Print the log file and attach it to the site visit documentation form upon return to ARS.

AUTOMATIC
NEPHELOMETER
CALIBRATION

An automatic calibration should be performed on the removal nephelometer and at least two automatic calibrations should be performed on the newly installed nephelometer, preferably on different days. Record the automatic calibrations for both the pre-removal and post-installation on the site visit documentation.

For Type 1 Systems: Attach the tubing that connects the nephelometer, regulator, and span gas tank. Adjust the tank output pressure to 6-10 psi. Initiate the automatic zero/span sequence by depressing the red button on the logger box front panel for approximately five seconds. After 2 minutes the front door will close and approximately 30 seconds later the valve will open. Adjust the flow meter to 20 ml. After approximately 40 minutes the calibration will be finished. Document the 21X *6 locations 12 and 13 (serial zero and span).

For Type 2 Systems: Initiate the automatic zero/span sequence by resetting the nephelometer. Press *6A0 to enter the port locations. Press 1 to turn the nephelometer off, then press 1 again to restart the nephelometer. After nephelometer has performed its POST and 1-minute ambient reading and entered calibration mode (approximately 3 minutes) press 2 and 3 to open the solenoid valves. The nephelometer will automatically proceed with a 20-minute upscale span calibration followed by a 1-minute

AUTOMATIC gas exhaust, and conclude with a 15-minute zero calibration.
NEPHELOMETER Document the 23X *6 locations 12 and 13 (serial zero, and span).
CALIBRATION (continued) Turn the solenoid valves off by pressing *6A0 2 and 3 on the
23X.

4.5 SYSTEM OPERATION VERIFICATION

Prior to leaving the site, the field specialist must operationally verify that all systems are fully operational and the operator(s) are fully trained. The field specialist must verify that the Site Operator's Manual is up-to-date and complete, and that the operator has all necessary monitoring supplies. The field specialist must also verify that ARS is able to automatically collect the data and communicate with the nephelometer system. All communication problems that are serviceable by the field specialist must be resolved before the field specialist ends the site visit.

4.6 SERVICING SUMMARY

The site servicing summary page provides a quick reference to tasks performed and problems noted. The page includes comment lines for any necessary explanations. Additional supplemental information, photographs, etc. can be attached to the page (refer to Figures 4-1 and 4-2, page 6).

4.7 TRAINING PROCEDURES AND DOCUMENTATION

Scheduling of the operator training session should occur with the scheduling of the annual site visit. Typically, the training session is scheduled toward the end of the site visit.

All site operators and backup operators should attend the training session, along with the site monitoring manager, if possible. When initially contacting site personnel, confirm that on-site copies of the Site Operator's Manual (refer to Section 3.4) are on hand.

The Site Operator's Manual is the basis for operator training and should be reviewed by operators unfamiliar with the nephelometer system prior to the training session. Approximately 2-4 hours should be allotted for the training session. If time constraints, weather, site accessibility, etc. make training difficult or infeasible, training can be done at another location using system TIs and operator log sheets.

Training topics include:

- Purpose of the monitoring program and the role of Air Resource Specialists, Inc.
- Theory of nephelometer system operation.
- Detailed procedures to be performed during each site visit by the operator.
- Troubleshooting and emergency maintenance procedures.

4.8 POST-VISIT PROCEDURES

The following post-visit procedures must be completed within one (1) week following the field specialists' return:

- Site visit review
- Archiving site visit documentation

4.8.1 Site Visit Review

The field specialist will meet with the project manager, data analyst, and instrument technician to review all annual site servicing documentation. Items to be discussed in this review include:

- On-site equipment or operations problems identified.
- Site operator evaluation.
- Site-related routine servicing requirements.
- Observed factors that could influence nephelometer readings.
- Operations-related requests from the site operator or other on-site personnel.
- Miscellaneous follow-up needs.

4.8.2 Archiving Site Visit Documentation

Upon completion of the site visit review, the data analyst archives all annual site servicing documentation. This documentation is filed in site-specific operations notebooks located in the ARS Data Collection Center. Specific annual site visit documentation archived includes:

- Nephelometer Servicing Site Visit Trip Report
- Field Installation Shipping Checklist

4.9 INITIAL INVENTORY

Refer to Figures 4-1 and 4-2, page 5. Inventory all items at the nephelometer site according to the inventory list on the servicing form. Also note any additional items on-site that do not appear on the inventory list.