

QUALITY ASSURANCE/QUALITY CONTROL DOCUMENTATION SERIES	
TITLE	<b>ANNUAL SITE VISITS FOR OPTICAL MONITORING INSTRUMENTATION (IMPROVE PROTOCOL)</b>
TYPE	<b>STANDARD OPERATING PROCEDURE</b>
NUMBER	<b>4115</b>
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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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## 1.0 PURPOSE AND APPLICABILITY

This technical instruction (TI) outlines and describes the procedures involved in performing annual routine site visits to Optec LPV-2 and LPV-3 transmissometer sites operated according to IMPROVE Protocol, with the primary purpose of ensuring quality data recovery and minimizing data loss from the transmissometer system. This TI is referenced in standard operating procedure (SOP) 4115, *Annual Site Visits for Optical Monitoring Instrumentation (IMPROVE Protocol)*.

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).
- Removing the existing transmissometer and AT/RH sensor.
- Installing the replacement transmissometer and AT/RH sensor.
- Verifying replacement system operation (post-installation).
- Performing inspections, operational checks, maintenance, and/or replacing support equipment.
- Performing a field audit of existing and replacement transmissometers with a reference transmissometer.
- Testing window transmittance.
- Servicing, cleaning, and maintenance.
- 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 field audit and window transmittance procedures (refer to 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 transmissometer 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.
- 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.
- 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 transmissometer 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 transmissometer 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 specialist, 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 transmissometer system replacement and other tasks that require assistance.

## **2.6 TECHNICAL ASSISTANT**

The technical assistant shall:

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

## **3.0 REQUIRED 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 Transmissometer Annual Site Visit Shipping Checklist.



**OPTEC LPV-2 TRANSMISSOMETER  
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 #
		Transmissometer with Lamps		
		AT/RH Sensor		
		M16 Voltage Regulator with Spare Fuses		
		Batteries & Battery Interconnects(3 pair/XMTR, 1 pair/RCVR)		
		Surge Suppressor		
		DCP		
		DCP Support Equipment: <input type="checkbox"/> Trickle Charger		
		<input type="checkbox"/> RCVR to DCP Cable <input type="checkbox"/> AT/RH to DCP Cable		
		<input type="checkbox"/> DVM <input type="checkbox"/> Pigtail Connector <input type="checkbox"/> Probe Tips		
		<input type="checkbox"/> Battery Monitor cable		
		Log Sheets, SOP's, & TI's		
		Fed Ex Airbills		
		Windows: <input type="checkbox"/> Transmitter <input type="checkbox"/> Receiver		
		Cleaning Supplies		
		Power Cords with Polarized Plugs		
		10-Amp Power Supply		
		5-Amp Power Supply		

**SITE VISIT FORMS**

		Servicing Site Visit Trip Report		
		Cal Memo (2 ea. Removal, Installation, & Audit)		
		Audit Forms (2 sets)		
		ARS Address Labels		

**AUDIT EQUIPMENT**

		Reference Transmissometer with 4 Lamps		
		Campbell Datalogger with Charger		
		Tool Box		
		Palmtop Computer with cables and instruction set		
		Radio Set with charger		
		AT/RH Audit Kit		
		Aperture Ring		
		Alt/Az Bases with spare pipe		
		Fuse Kit		
		2 DVMs with 2 Pigtail Connectors		
		Analog Output Switch Box		
		Power Cord Kit		
		Canned Air and Misc. cleaning supplies		
		Spare Connector Kit for AT/RH and M16 V Reg. Connectors		
		Cell Phone		
		Digital Camera		
		GPS		
		Day Pack		

Figure 3-1. Optec Transmissometer Annual Site Visit Shipping Checklist.

### 3.1 INSTRUMENTATION

Instrumentation required during a routine site visit includes:

- 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) (supplied by the field specialist).
- An auditing AT/RH sensor.
- Replacement on-site receiver and transmitter DVMs (if needed).

### 3.2 TOOLS

A complete tool kit is recommended as on-site tasks vary from instrument repair to minor shelter 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 battery electrolyte tester.
- A crimp tool for solar panel regulator "quick-connectors."
- A soldering kit.

### 3.3 EQUIPMENT

Equipment required during a routine site visit includes:

- A standard field servicing kit (spare components, chips, hardware, batteries, fuses, connectors, pins, etc.).
- A palmtop computer, capable of programming Handar 540A and 570A data collection platforms, with associated cable connectors.
- A calculator.
- A Campbell 21X datalogger programmed to log transmissometer receiver computer outputs, with associated cable and connector (refer to SOP 4710, *Transmissometer Field Audit Procedures*).
- A switch box and associated cables, plus a digital voltmeter to log the audit transmissometer receiver computer outputs.
- Two 2-way radios.

- A spare cable replacement kit (DCP input cable, AT/RH cable, battery monitoring cable, and a pigtail cable).
- A digital camera for documentation.
- A replacement 10 amp power supply for AC line power transmitter sites (if needed).
- A replacement 5 amp power supply for AC line power receiver sites (if needed).
- Replacement surge protector(s)/suppressor(s) for AC line powered sites (if needed).
- Replacement solar panel regulator(s) with quick-connectors for solar powered receiver and transmitter sites (if needed).

Typically, the deep-cycle batteries used at solar-powered sites should be replaced every two years. Since long-range transport of these batteries is difficult, it is best to order these batteries from a local dealer near the site prior to the site visit. NAPA Group 27 deep-cycle batteries are found to be the most reliable. Verify that the batteries are fully charged prior to installation. Battery interconnect cables should be replaced at this time.

### 3.4 MATERIALS

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

- Transmissometer Servicing Site Visit Trip Report (Figure 4-1)
- Receiver and transmitter site transmissometer field audit forms (see SOP 4710)
- Operational calibration memos for existing and replacement transmissometers (see TI 4200-2100)
- Audit calibration memo for the reference transmissometer (see TI 4200-2100)
- Spare receiver and transmitter station transmissometer operator log sheets (see TI 4110-3100 and TI 4110-3105)
- Optec Transmissometer Annual Site Visit Shipping Checklist (Figure 3-1)

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

- SOP 4110, *Transmissometer Maintenance (IMPROVE Protocol)*
- TI 4110-3100, *Routine Site Operator Maintenance Procedures for Optec LPV-2 Transmissometer Systems (IMPROVE Protocol)* or TI 4110-3105, *Routine Site Operator Maintenance Procedures for Optec LPV-3 Transmissometer Systems (IMPROVE Protocol)*
- TI 4110-3300, *Troubleshooting and Emergency Maintenance Procedures for Optec LPV-2 Transmissometer Systems (IMPROVE Protocol)* or TI 4110-3305, *Troubleshooting and Emergency Maintenance Procedures for Optec LPV-3 Transmissometer Systems (IMPROVE Protocol)*

- TI 4110-3350, *Transmissometer Monitoring System Diagrams and Component Descriptions*
- TI 4110-3375, *Replacing and Shipping Transmissometer Components*
- SOP 4115, *Annual Site Visits for Optical Monitoring Instrumentation (IMPROVE Protocol)*
- TI 4115-3000, *Annual Site Visit Procedures for Optec LPV Transmissometer Systems (IMPROVE Protocol)*
- SOP 4710, *Transmissometer Field Audit Procedures*
- Optec Technical Manual for Theory of Operation and Operating Procedures

#### **4.0 METHODS**

This section describes annual site visit procedures for transmissometer systems, and includes 13 major subsections:

- 4.1 Pre-Visit Preparation
- 4.2 General Trip Information
- 4.3 Initial Conditions at Receiver Stations
- 4.4 Receiver System Operation
- 4.5 AT/RH Removal/Replacement Audit
- 4.6 Receiver Station Initial Inventory
- 4.7 Receiver Station Servicing
- 4.8 Initial Conditions at Transmitter Stations
- 4.9 Transmitter Station Initial Inventory
- 4.10 Transmitter Station Servicing
- 4.11 Training Procedures and Documentation
- 4.12 Field Audit Procedures
- 4.13 Post-Visit Procedures

#### **4.1 PRE-VISIT PREPARATION**

Prior to traveling to the site, the following preparations need to be made (for individual responsibilities refer to Sections 2.1 through 2.6):

- 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; schedule for the day prior to the field audit).
  - Assistance with the internal transmissometer audit and window transmittance tests (approximately 4-6 hours).
  - Any other assistance needed from on-site personnel.

- Organize all instruments, equipment, tools, and materials.
- Arrange for purchasing of any needed equipment, tools, or materials at the site.
- Verify transmissometer calibration numbers and lamp installation order.
- 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 transmissometer system servicing and maintenance) upon arrival at the site. The prearranged schedules for operator training, transmissometer field audit (reference instrument), window transmittance tests, and any other work the field specialist will need assistance with should be confirmed at this time.

The Transmissometer Servicing Site Visit Trip Report, Figure 4-1, 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 4710, *Transmissometer Field Audit Procedures*.

## 4.2 GENERAL TRIP INFORMATION

Refer to Figure 4-1, 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., BRID1).
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.
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.

**TRANSMISSOMETER SERVICING  
SITE VISIT TRIP REPORT**

Technician: \_\_\_\_\_ Site: \_\_\_\_\_  
Dates: \_\_\_\_\_

Site Visit Objectives: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**TRIP SUMMARY**

Day/Date:	Actions:
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
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_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Comments: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Figure 4-1. Transmissometer Servicing Site Visit Trip Report.

**RECEIVER STATION – INITIAL CONDITIONS**

Transmissometer LPV No. \_\_\_\_\_ Does the instrument appear to be working properly: YES NO

Comment: \_\_\_\_\_

Receiver Display: C \_\_\_\_\_ B \_\_\_\_\_ VR \_\_\_\_\_ Local Time \_\_\_\_\_:\_\_\_\_\_ Toggle ON OFF

Settings: Gain \_\_\_\_\_ Cal \_\_\_\_\_ Dist \_\_\_\_\_ A1 \_\_\_\_\_ A2 \_\_\_\_\_ Int \_\_\_\_\_ Cycle \_\_\_\_\_



Alignment: Mark initial location of transmitter light source with a "+".

Comments: \_\_\_\_\_

Window Cleanliness: good moderate poor Comments: \_\_\_\_\_

Lens Cleanliness: good moderate poor Comments: \_\_\_\_\_

Timing:

1. Is your watch synchronized with NBS (WWV) time? (303-499-7111) YES NO

2. Receiver update time (HR:MIN:SEC) \_\_\_\_\_:\_\_\_\_\_:\_\_\_\_\_

\*\*\* Note transmitter on/off times on Transmitter Station – Initial Conditions section \*\*\*

Alti-azimuth Base Operation: \_\_\_\_\_

AT/RH Sensor and Holder: \_\_\_\_\_

DCP Antenna Elements/Cable: \_\_\_\_\_ Alignment Azimuth (°T) \_\_\_\_\_ Incl. \_\_\_\_\_

Instrument Wiring Condition: \_\_\_\_\_

Alignment Aid Operation: \_\_\_\_\_

Power System: Power Supply \_\_\_\_\_ Output \_\_\_\_\_ V  
Solar Panels \_\_\_\_\_ Output \_\_\_\_\_ V  
Batteries (electrolyte levels) \_\_\_\_\_ Output \_\_\_\_\_ V  
Surge Protector Indicators \_\_\_\_\_  
Regulator Operation \_\_\_\_\_  
Wiring Condition \_\_\_\_\_

Shelter: Hood/Window Frame Condition \_\_\_\_\_  
Shelter Cleanliness \_\_\_\_\_  
Shelter Condition \_\_\_\_\_  
Vents: Size \_\_\_\_\_ No. \_\_\_\_\_ Filters \_\_\_\_\_ Foam Inserts \_\_\_\_\_

Comments: \_\_\_\_\_

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

**SYSTEM OPERATION VERIFICATION**

Digital Voltmeter MFR/Model/SN: \_\_\_\_\_

Pre-Removal / Post-Installation

Data Check:            Date: \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_            Time: \_\_\_\_\_ / \_\_\_\_\_ / \_\_\_\_\_

	<u>Front Panel</u>	<u>DCP (570A Only)</u>	<u>Downloaded</u>
A1 Switch (C)	_____ / _____	CH1 _____ / _____	Data _____ / _____
(B)	_____ / _____	_____ / _____	Data _____ / _____
Toggle Lamp	ON   OFF / ON   OFF	CH2 _____ / _____	Data _____ / _____
A2 Switch (SD)		CH3 _____ / _____	Data _____ / _____
(CR)		_____ / _____	Data _____ / _____

Datalogger

A1 Switch (C) \_\_\_\_\_ / \_\_\_\_\_  
    (B) \_\_\_\_\_ / \_\_\_\_\_  
A2 Switch (SD) \_\_\_\_\_ / \_\_\_\_\_  
    (CR) \_\_\_\_\_ / \_\_\_\_\_

Measured

AT (DEG F or C)	_____ / _____	CH4 _____ / _____	Data _____ / _____
RH (%)	_____ / _____	CH5 _____ / _____	Data _____ / _____
DCP Battery (VDC)	_____ / _____	CH10 _____ / _____	Data _____ / _____

b<sub>ext</sub> Check: Raw Reading (C): \_\_\_\_\_ / \_\_\_\_\_    Calculated (b<sub>ext</sub>): \_\_\_\_\_ / \_\_\_\_\_    Receiver Computer b<sub>ext</sub>: \_\_\_\_\_ / \_\_\_\_\_

$b_{ext} (1/km) = -(\ln T/Path \text{ Distance}), T = C (A1 \text{ Raw Counts}) / \text{Cal. No.}$

**AT/RH REMOVAL/REPLACEMENT AUDIT**

Audit Sensor: \_\_\_\_\_  
On-Site Sensor: \_\_\_\_\_  
Replacement Sensor: \_\_\_\_\_  
Physical Condition of On-Site Sensor: \_\_\_\_\_  
Condition of Shield: \_\_\_\_\_  
Weather Conditions: \_\_\_\_\_  
Comments: \_\_\_\_\_

**START:**            **JD**                            **TIME**                            **JD**                            **TIME**

On-Site Sensor: \_\_\_\_\_                            Replacement Sensor: \_\_\_\_\_

**Site Specifications:**    Latitude: \_\_\_\_\_    Longitude: \_\_\_\_\_    Elevation: \_\_\_\_\_

Comments: \_\_\_\_\_

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



**RECEIVER STATION – INITIAL INVENTORY**

---

	Changed		On-Site Mfr./Model/SN		Replacement Mfr./Model/SN	
Transmissometer	<input type="checkbox"/>		_____		_____	
Alti-azimuth Base	<input type="checkbox"/>		_____		_____	
Data Collection Platform	<input type="checkbox"/>		_____		_____	
AT/RH Sensor	<input type="checkbox"/>		_____		_____	
Antenna	<input type="checkbox"/>		_____		_____	
Window	<input type="checkbox"/>		_____		_____	
Batteries	<input type="checkbox"/>		_____		_____	
Power Supply	<input type="checkbox"/>		_____		_____	
Surge Protector	<input type="checkbox"/>		_____		_____	
Solar Panels	<input type="checkbox"/>		_____		_____	
	<input type="checkbox"/>		_____		_____	
	<input type="checkbox"/>		_____		_____	
DCP Solar Panel	<input type="checkbox"/>		_____		_____	
Regulator	<input type="checkbox"/>		_____		_____	
With Quick-connectors?	YES	NO				
Voltmeter			_____			
Battery Replaced?	YES	NO	Spare Battery?	YES	NO	
Vandal Plate?	YES	NO	Comment: _____			
Tool Box	YES	NO	With Detector Head Allen Wrench	YES	NO	
			With Adjustable Wrench	YES	NO	
Alignment Aid	YES	NO	With Medium Flathead Screwdriver	YES	NO	
			With Medium Phillips Screwdriver	YES	NO	
			With Signal Mirror	YES	NO	
Fuse Kit	YES	NO	Numbers and Types: _____			
Supplies:	Kimwipes	_____	Bottle Alcohol	_____	Log Sheets	_____
	Window Cleaner	_____	Blower Brush	_____	Operator's	_____
	Paper Towels	_____	Distilled H <sub>2</sub> O	_____	Manual	_____
			H <sub>2</sub> O Dispenser	_____	b <sub>ext</sub> SVR Sheet	_____
Shipping Cases:	Recvr. Computer	_____	Transmitter	_____	DCP	_____
					Recvr. Telescope	_____
Storage Location(s): _____						
Shelter Type/Size: _____						
Shelter Key: _____			Spare Key Hidden: _____			
Comments: _____						

O:\project\Improve4\Forms\Transmissometer Site Visit.docTransmissometer Site Visit.doc

Page 4 of 8

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

**RECEIVER STATION - SERVICING**

Receiver Replacement      Date: \_\_\_\_\_      Time: \_\_\_\_\_      Receiver No.: \_\_\_\_\_

AA Batteries Installed?	YES	NO
Interconnect Cables:	OK	Replaced
Battery Terminals cleaned?	YES	NO
Power Cable	OK	Replaced
Battery Voltage Monitoring Cable	OK	Replaced

Miscellaneous Replaced Items: \_\_\_\_\_  
\_\_\_\_\_

Antenna Alignment Connection:      Azimuth (@T) \_\_\_\_\_      Incl. \_\_\_\_\_

Additional Power Supply Servicing/Checks: \_\_\_\_\_  
\_\_\_\_\_

Supplement Tool Kit: \_\_\_\_\_

Supplement Cleaning Supplies: \_\_\_\_\_

Supplement Log Sheets/Update Operator's Manual: \_\_\_\_\_

Shelter Cleaning: \_\_\_\_\_

Documentation Photographs: \_\_\_\_\_

Additional Servicing Done: \_\_\_\_\_  
\_\_\_\_\_

Follow-up Tasks Required: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

**\*\*\* Complete and attach LPV-2 Transmissometer Operator Log Sheet – Receiver Station \*\*\***

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

### TRANSMITTER STATION – INITIAL CONDITIONS

Lamp Number: \_\_\_\_\_ Does the instrument appear to be working properly: YES NO  
Comment: \_\_\_\_\_



Alignment: Mark initial location of receiver shelter window with a "+".  
Comments: \_\_\_\_\_

Window Cleanliness: good moderate poor Comments: \_\_\_\_\_

Lens Cleanliness: good moderate poor Comments: \_\_\_\_\_

Lamp Check: **IMPORTANT:** Must be done when lamp is ON under automatic control.

- a) LED (indicator light on side of control box) ON OFF
- b) Lamp voltage with on-site DVM: \_\_\_\_\_ volts audit DVM: \_\_\_\_\_ volts

Timing:

- 1. Is your watch synchronized with NBS (WWW) time? (303-499-7111) YES NO
- 2. Transmitter Light ON, Exact Time (HR:MIN:SEC) \_\_\_\_\_
- 3. Transmitter Light OFF, Exact Time (HR:MIN:SEC) \_\_\_\_\_

Alti-azimuth Base Operation: \_\_\_\_\_

Lamp Voltage Monitoring DVM and Connections: \_\_\_\_\_

Power System: Power Supply \_\_\_\_\_ Output \_\_\_\_\_ V  
Solar Panels \_\_\_\_\_ Output \_\_\_\_\_ V  
Batteries \_\_\_\_\_ Output \_\_\_\_\_ V  
Surge Protector Indicators \_\_\_\_\_  
Regulator Operation \_\_\_\_\_  
Wiring Condition \_\_\_\_\_

Shelter: Hood/Window Frame Condition \_\_\_\_\_  
Shelter Cleanliness \_\_\_\_\_  
Shelter Condition \_\_\_\_\_  
Vents: Size \_\_\_\_\_ No. \_\_\_\_\_ Filters \_\_\_\_\_ Foam Inserts \_\_\_\_\_

Site Specifications: Latitude: \_\_\_\_\_ Longitude: \_\_\_\_\_ Elevation: \_\_\_\_\_

Comments: \_\_\_\_\_  
\_\_\_\_\_

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

**TRANSMITTER STATION – INITIAL INVENTORY**

	Changed	On-Site Mfr./Model/SN	Replacement Mfr./Model/SN
Alti-azimuth Base	<input type="checkbox"/>	_____	_____
Window	<input type="checkbox"/>	_____	_____
Solar Panels	<input type="checkbox"/>	_____	_____
Batteries	<input type="checkbox"/>	_____	_____
	<input type="checkbox"/>	_____	_____
	<input type="checkbox"/>	_____	_____
Power Supply	<input type="checkbox"/>	_____	_____
Surge Protector	<input type="checkbox"/>	_____	_____
Solar Panel Regulator	<input type="checkbox"/>	_____	_____
Digital Voltmeter	<input type="checkbox"/>	_____	_____

Measurement Pigtail Set?      YES      NO      Comment: \_\_\_\_\_

Control Box Stand?      YES      NO      Comment: \_\_\_\_\_

Vandal Plate?      YES      NO      Comment: \_\_\_\_\_

Tool Box?      YES      NO      Comment: \_\_\_\_\_

    Small Flathead Screwdriver      YES      NO

Fuse Kit?      YES      NO      Numbers and Types: \_\_\_\_\_

Supplies:      Kimwipes      \_\_\_\_\_      Bottle Alcohol      \_\_\_\_\_      Log Sheets      \_\_\_\_\_

    Window Cleaner      \_\_\_\_\_      Blower Brush      \_\_\_\_\_      Operator's      \_\_\_\_\_

    Paper Towels      \_\_\_\_\_      Distilled H<sub>2</sub>O      \_\_\_\_\_      Manual      \_\_\_\_\_

    H<sub>2</sub>O Dispenser      \_\_\_\_\_

Shelter Type/Size: \_\_\_\_\_

Shelter Key: \_\_\_\_\_      Spare Key Hidden: \_\_\_\_\_

Comments: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

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

**TRANSMITTER STATION - SERVICING**

Transmitter Replacement      Date: \_\_\_\_\_      Time: \_\_\_\_\_      Transmitter No.: \_\_\_\_\_

Lamp No. Put Into Service: \_\_\_\_\_      Lamps On-Site: \_\_\_\_\_

AA Batteries Installed?	YES	NO
Interconnect Cables:	OK	Replaced
Battery Terminals cleaned?	YES	NO
Power Cable	OK	Replaced
Battery Voltage Monitoring Cable	OK	Replaced
Lamp Voltage Monitoring Cable	OK	Replaced

Miscellaneous Replaced Items: \_\_\_\_\_

Supplement Tool Kit: \_\_\_\_\_

Supplement Cleaning Supplies: \_\_\_\_\_

Supplement Log Sheets/Update Operator's Manual: \_\_\_\_\_

Shelter Cleaning: \_\_\_\_\_

Documentation Photographs: \_\_\_\_\_

Additional Servicing Done: \_\_\_\_\_

Follow-up Tasks Required: \_\_\_\_\_

**\*\*\* Complete and attach LPV-2 Transmissometer Operator Log Sheet – Transmitter Station \*\*\***

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

### 4.3 INITIAL CONDITIONS AT RECEIVER STATIONS

Document the “as found” conditions of the following (refer to Figure 4-1, page 2):

INSTRUMENT NUMBER	Record the Optec instrument number from the receiver telescope, detector head, or computer. All components should have the same number, if not, carefully document the number of each individual component.
OPERATIONAL STATUS	Note if the instrument appears to be operating correctly. Comment on any observed inconsistency.
RECEIVER DISPLAY READING/SETTINGS	Record the current display reading, also noting the local time, and if the toggle light is on or off.
A1 SWITCH READINGS	Record the A1 display values for the <i>C</i> , <i>B</i> , and <i>VR</i> A1 switch settings.
ALIGNMENT	Mark the initial location of the light source inside the reticle diameter on the form. If misaligned, record the severity of the misalignment by using the diameter of the reticle circle and the angle from the center of the reticle (e.g, alignment off by 0.4D @ 345°).
INITIAL WINDOW CLEANLINESS	Record the degree of window cleanliness and type of uncleanliness.
LENS CLEANLINESS	Record the degree of lens cleanliness and type of uncleanliness. If the degree and/or type of uncleanliness is significant, do not clean; this will be incorporated into the post-calibration of the system at the ARS calibration facility.
TIMING	Record the update time of the receiver and on/off times of the transmitter. Ensure that the time corresponds to NIST (National Institute of Standards and Technology) (WWV) time.
ALTI-AZIMUTH BASE OPERATION	Note the operation and condition of the alti-azimuth base.
AT/RH SENSOR AND HOLDER	Note the condition of the AT/RH sensor and holder. Look for any accumulation of dirt, insects, or corrosion on the sensor or shield.
DCP ANTENNA ELEMENTS/CABLE AND ALIGNMENT	Note the condition of the DCP antenna elements and cable. All elements should be tight and perpendicular to the shaft. The cable should be in good condition and all connectors secure. Note the alignment (azimuth and inclination) of the antenna.

INSTRUMENT WIRING  
CONDITION

Check and record the condition of the wiring and its connections. All wires should be in good condition and all connections secure.

ALIGNMENT AIDS  
OPERATION

Check the operation of the alignment aids and the wiring.

POWER SYSTEM

At AC-powered sites, note the condition of the power supply and measure its output voltage at the connectors. Also check the indicator lights on the surge protector.

At solar-powered sites, note the condition of the panels, support frame, and wiring. Panel output voltage is best measured by disconnecting the “quick-connector” at the solar panel regulator on the side coming in from the panels, and measuring the output voltage at this point using the field specialist DVM. Lighting conditions on the panels should also be noted.

Note the battery condition (degree of terminal corrosion, electrolyte levels, etc.). Also record the output voltage. This is best measured at the power cable connection on the back of the receiver after disconnecting the connector.

At solar-powered sites, observe solar panel regulator operation to ensure that it is cycling properly. With adequate incident light on the solar panels to charge the batteries, proper Sun Selector M-16 Status Indicator LED cycling is as follows:

Ready: The ready LED will light when the solar panel voltage is high enough to charge the batteries.

Analyzing: The analyzing LED will light for 10-15 seconds before the charging light engages.

Charging: The charging LED will light when full charging current is flowing to the batteries. Charging continues for a maximum of 5 minutes per cycle or until the batteries have reached the maximum charging voltage. This LED cycles on and off opposite the analyzing LED.

Finishing: The finishing LED will start to flash as the battery voltage increases over 14.0 VDC.

Also refer to the Sun Selector M-8/M-16 Operation and Installation Sheet.

Note the condition of the power system wiring.

SHELTER OR  
ENVIRONMENTAL  
ENCLOSURE

Note the condition of the hood and window frame.

Note the cleanliness of the shelter or the environmental enclosure.

Note the general condition of the shelter and any related maintenance needs.

Note the size and number of vent openings in the shelter and if there are filters and/or foam inserts in the vents.

#### 4.4 RECEIVER SYSTEM OPERATION

The purpose of this check is to ensure agreement between receiver computer display readings, computer output voltages, and DCP transmitted data. If the AT/RH audit is being performed concurrently, readings can be used to compare with the DCP output. The pre-removal verification check is performed prior to any site servicing. The post-installation verification check is performed after the field audit has been completed.

At sites with 570A DCPs, the DCP stored transmissometer outputs, AT/RH measurements, and DCP battery voltage can be checked on the DCP display by scrolling through the channels using the display button. This can be done at any time after half past the hour when the inputs from the transmissometer computer and AT/RH sensor are scanned.

Transmitted DCP data for the time of the operation verification checks should be verified from the field by calling the data analyst to obtain the DCP transmitted values. All transmissometer readings should be taken between 20 minutes after the hour and before the next hourly update, and a DCP reading must be taken between 31 minutes after the hour and before 31 minutes after the next hour, to properly record the current hour's data.

Procedures for performing the operation verification check are detailed below (refer to Figure 4-1, page 3):

DVM Record the make, model, and serial number of the digital voltmeter (DVM).

DATA CHECK Record the date and local time.

A1 Switch. With the receiver computer displaying a valid reading, record the A1 display values for the A1 switch: Raw Reading (C) and  $b_{ext}$  (B). Also record the A1 (C) and (B), and A2 (SD) and (CR) switch values from the 21X datalogger.

Toggle LED. Note the state (on/off) of the toggle light and measure the corresponding voltage at the terminal strip.



AT/RH SENSOR                      If the AT/RH audit is being performed during the verification check, readings can be taken at half-past the hour from the audit sensor. This is when the DCP logs the on-site AT/RH sensor measurement.

b<sub>EXT</sub>                                      Calculate the b<sub>ext</sub> from the raw reading (C) using the following equations:

$$b_{\text{ext}} (1/\text{km}) = -(\ln T/\text{Path Distance}) \quad T=C/\text{Cal. No.}$$

#### 4.5 AT/RH REMOVAL/REPLACEMENT AUDIT

Refer to TI 3750-6116, *Rotronics MP-100F or MP-101A AT/RH Sensor Audit Procedures (IMPROVE Protocol)* for checking the operation of this sensor.

SENSOR NUMBERS                      Document the audit, on-site, and replacement sensors' models and serial numbers. Document the physical condition of the on-site sensor and shield.

WEATHER CONDITIONS                Document the current weather conditions and any other comments that relate to the audit.

JULIAN DATE                            Record the Julian date and start time that each sensor is audited.

COMMENT                                Comment on any problems, conditions, etc. that were encountered during the operation verification check.

#### 4.6 RECEIVER STATION INITIAL INVENTORY

Refer to Figure 4-1, page 4. Inventory all items at the receiver 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.

#### 4.7 RECEIVER STATION SERVICING

Servicing tasks and procedures at the receiver site are primarily replacement or operational checks of instruments and equipment. Shelter cleaning and supplementation of operator servicing materials is also done at this time. The individual tasks, procedures, and operational checks are as follows (refer to Figure 4-1, page 5):

RECEIVER REPLACEMENT                Remove the existing receiver. Install the replacement receiver and record the LPV number and the date and time installed.

RECEIVER REPLACEMENT (continued)	Refer to TI 4110-3375, <i>Replacing and Shipping Transmissometer Components</i> , for procedures in removing and replacing the transmissometer receiver unit.  Note if the AA timing batteries were installed and if cables were replaced.
MISCELLANEOUS REPLACED ITEMS	Record replacement of any items not included above.
ANTENNA ALIGNMENT	If antenna alignment needs to be corrected, document the adjusted alignment azimuth and inclination. (refer to TI 4110-3375, <i>Replacing and Shipping Transmissometer Components</i> ).
ADDITIONAL POWER SUPPLY SERVICING / CHECKS	Document any additional servicing and/or checks that were performed on the power supply system.
SUPPLEMENT TOOL KIT	Document if the tool kit was supplemented with any tools, fuses, or miscellaneous items.
SUPPLEMENT CLEANING SUPPLIES	Document if the cleaning supplies were supplemented; list type and number.
SUPPLEMENT LOG SHEETS/UPDATE SITE OPERATOR'S MANUAL	Document the supplementation of log sheets and/or the updating of the Site Operator's Manual for Transmissometer Monitoring Systems.
SHELTER CLEANING	If the transmitter resides in a shelter rather than an environmental enclosure, note if the shelter was cleaned. Cleaning normally involves wiping down shelves and system components and mounts, sweeping out the shelter, and removing any trash.
DOCUMENTATION PHOTOGRAPHS	Take photographs of the shelter, equipment, power configuration, and cardinal directions if needed. Also take photographs of any changes that are made to the above mentioned items.
ADDITIONAL SERVICING	Document any additional servicing tasks performed.
FOLLOW-UP TASKS	Document the need for any additional servicing/maintenance that is not performed during the site visit and if this is to be done by site or ARS personnel.

#### 4.8 INITIAL CONDITIONS AT TRANSMITTER STATIONS

Document the “as found” condition of the following, (refer to Figure 4-1, page 6):

LAMP NUMBER	Record the lamp number currently in the instrument.
OPERATIONAL STATUS	Note whether or not the transmitter unit appears to be working correctly. If an LPV-3 transmitter is in operation at the site, check the display on the transmitter for any error codes. Comment on any observed inconsistency or error code.
ALIGNMENT	Mark the initial location of the receiver shelter window inside the reticle diameter on the form. If misaligned, record the severity of the misalignment by using the diameter of the reticle circle and the angle from the center of the reticle (e.g., alignment off by 0.4 D @ 345°).
INITIAL WINDOW CLEANLINESS	Record the degree of window cleanliness and type of uncleanliness.
LENS CLEANLINESS	Record the degree of lens cleanliness and type of uncleanliness. If the degree and/or type of uncleanliness is significant, do not clean. This will be incorporated into the post-calibration of the system at the ARS calibration facility.
LAMP CHECK (LPV-2 transmitters only)	<p>If an LPV-2 transmitter is in operation at the site:</p> <p><u>LED.</u> When the lamp is on under automatic control, note if the LED indicator light on the side of the control box is on or off.</p> <p><u>Lamp Voltage Reading.</u> Measure and record the lamp voltage using the on-site DVM and the lamp voltage measurement pigtail. Also measure the voltage with the field specialist’s DVM to confirm correct operation of the on-site DVM.</p>
TIMING (if applicable)	The field technician’s watch should be synchronized with NIST (National Institute of Standards and Technology) (WWV) time; if not, this can be done by calling 303-499-7111. If the transmissometer system is not running continuously, note the exact time (hours, minutes, seconds) that the transmitter light comes on. Also note the exact time the light turns off.
ALTI-AZIMUTH BASE OPERATION	Note the operation and condition of the alti-azimuth base and if the transmitter telescope unit attaches securely to the base.

LAMP VOLTAGE  
MONITORING DVM AND  
CONNECTIONS  
(LPV-2 transmitters only)

If an LPV-2 transmitter is in operation at the site, note the operation and condition of the lamp voltage monitoring digital voltmeter and the cables and connectors.

POWER SYSTEM

At AC-powered sites, note the condition of the power supply and measure its output voltage at the connectors. Also check the indicator lights on the surge protector.

At the solar-powered sites, note the condition of the panels, support frame, and wiring. Panel output voltage is best measured by disconnecting the "quick-connector" at the solar panel regulator on the side coming in from the panels, and measuring the output voltage at this point using the field specialist DVM. Lighting conditions on the panels should also be noted.

At solar-powered sites, observe solar panel regulator operation to ensure that it is cycling properly. With adequate incident light on the solar panels to charge the batteries, proper Sun Selector M-16 Status Indicator LED cycling is as follows:

Ready. The ready LED will light when the solar panel voltage is high enough to charge the batteries.

Analyzing. The analyzing LED will light for 10-15 seconds before the charging light engages.

Charging. The charging LED will light when full charging current is flowing to the batteries. Charging continues for a maximum of 5 minutes per cycle or until the batteries have reached the maximum charging voltage. This LED cycles on and off opposite the analyzing LED.

Finishing. The finishing LED will start to flash as the battery voltage increases over 14.0 VDC.

Also refer to the Sun Selector M-8/M-16 Operation and Installation Sheet.

Note the condition of the power system wiring.

SHELTER OR  
ENVIRONMENTAL  
ENCLOSURE

Note the condition of the hood and window frame.

Note the cleanliness of the shelter or environmental enclosure.

Note general condition of the shelter and any related maintenance needs.

Note the size and number of vent openings in the shelter and if there are filters and/or foam inserts in the vents.

#### 4.9 TRANSMITTER STATION INITIAL INVENTORY

Refer to Figure 4-1, page 7. Inventory all items at the transmitter 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.

#### 4.10 TRANSMITTER STATION SERVICING

Servicing tasks and procedures at the receiver site are primarily replacement or operational checks of instruments and equipment. Shelter cleaning and supplementation of operator servicing materials is also done at this time. The individual tasks, procedures, and operational checks are as follows (refer to Figure 4-1, page 8):

TRANSMITTER REPLACEMENT	Remove the existing transmitter. Install the replacement transmitter and record the LPV number and the date and time installed.  Refer to TI 4110-3375, <i>Replacing and Shipping Transmissometer Components</i> , for procedures in removing and replacing the transmissometer transmitter unit.
LAMPS	Record the lamp number that is put into service and also the lamp numbers that are left on-site.
TIMING BATTERIES AND CABLES	Note if the four (4) AA timing batteries were installed in the transmitter control box (LPV-2 transmitters only). Note if any cables were replaced.
MISCELLANEOUS REPLACED ITEMS	Record replacement of any items not included above.
SUPPLEMENT TOOL KIT	Document if the tool kit was supplemented with any tools, fuses, or miscellaneous items.
SUPPLEMENT CLEANING SUPPLIES	Document if the cleaning supplies were supplemented; type and number.
SUPPLEMENT LOG SHEETS/UPDATE SITE OPERATOR'S MANUAL	Document the supplementation of log sheets and/or the updating of the Site Operator's Manual for Transmissometer Monitoring Systems.
SHELTER CLEANING (if applicable)	If the transmitter resides in a shelter rather than an environmental enclosure, note if the shelter was cleaned. Cleaning normally involves wiping down shelves and system components and mounts, sweeping out the shelter, and removing any trash.

DOCUMENTATION PHOTOGRAPHS	Take photographs of the shelter, equipment, power configuration, and cardinal directions if needed. Also take photographs of any changes that are made to the above mentioned items.
ADDITIONAL SERVICING	Document any additional servicing tasks performed.
FOLLOW-UP TASKS	Document the need for any additional servicing/maintenance that is not performed during the site visit and if this is to be done by on-site personnel or ARS personnel.

#### **4.11 TRAINING PROCEDURES AND DOCUMENTATION**

Scheduling of the operator training session should occur with the scheduling of the annual site visit and the transmissometer field audit. Typically, the training session is scheduled for the day prior to the field audit.

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 following technical instructions should be reviewed by operators unfamiliar with the transmissometer system prior to the training session:

- TI 4110-3100, *Routine Site Operator Maintenance Procedures for Optec LPV-2 Transmissometer Systems (IMPROVE Protocol)* or TI 4110-3105, *Routine Site Operator Maintenance Procedures for Optec LPV-3 Transmissometer Systems (IMPROVE Protocol)*.
- TI 4110-3300, *Troubleshooting and Emergency Maintenance Procedures for Optec LPV-2 Transmissometer Systems (IMPROVE Protocol)* or TI 4110-3305, *Troubleshooting and Emergency Maintenance Procedures for Optec LPV-3 Transmissometer Systems (IMPROVE Protocol)*
- TI 4110-3350, *Transmissometer Monitoring System Diagrams and Component Descriptions*
- TI 4110-3375, *Replacing and Shipping Transmissometer Components*

Approximately 3-4 hours should be allotted for the training session. It is preferable to begin the training at the transmitter station and then proceed to the receiver station. If time constraints, weather, site accessibility, etc. make training at the transmitter station difficult or infeasible, transmitter training can be done at the receiver station or in a room using the reference transmitter unit.

Training topics include:

- Purpose of the monitoring program and the role of Air Resource Specialists, Inc.
- Theory of transmissometer system operation.

The following topics are addressed at both the transmitter and receiver stations using the information and procedures outlined in the technical instructions:

- TI 4110-3100, *Routine Site Operator Maintenance Procedures for Optec LPV-2 Transmissometer Systems (IMPROVE Protocol)* or TI 4110-3105, *Routine Site Operator Maintenance Procedures for Optec LPV-3 Transmissometer Systems (IMPROVE Protocol)*
- TI 4110-3350, *Transmissometer Monitoring System Diagrams and Component Descriptions*
- TI 4110-3375, *Replacing and Shipping Transmissometer Components*

#### **4.12 FIELD AUDIT PROCEDURES**

The field audit of the transmissometer system is performed after site servicing and operator training have been completed. Procedures for performing the field audit are described in SOP 4710, *Transmissometer Field Audit Procedures*.

#### **4.13 POST-VISIT PROCEDURES**

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

- Site visit review
- Inventory verification and update
- Archiving site visit documentation

##### **4.13.1 Site Visit Review**

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

- On-site equipment or operations problems identified.
- Site operator evaluation.
- Audit results.
- Site-related routine servicing requirements.
- Observed factors that could influence transmissometer readings.

- Operations-related requests from the site operator or other on-site personnel.
- Miscellaneous follow-up needs.

#### 4.13.2 Inventory Verification and Update

The IMPROVE equipment inventory is maintained by the technical assistant. Items from the on-site initial inventory (Figure 4-1, pages 4 and 7) that are included in the IMPROVE equipment inventory are:

- Receiver station equipment:
  - Alti-azimuth base
  - Data collection platform (DCP)
  - DCP antenna
  - DCP solar panel
  - AT/RH sensor
  - Solar panels
- Transmitter station equipment:
  - Alti-azimuth base
  - Solar panels

The technical assistant will verify that the on-site initial inventory property numbers match the corresponding property numbers in the IMPROVE inventory for all items listed above. For system components replaced during the annual site visit (Figure 4-1, pages 5 and 8), the technical assistant will update the IMPROVE inventory to reflect these changes. An on-site inventory report (See Figure 4-2 for an example) is prepared by the technical assistant after the inventory has been updated.

SITE INVENTORY REPORT – BANDELIER									
08/13/2001									
Asset Code	Classification	Description	Model No.	Mfg. No.	Serial	Property No.	Location	PO #	PO Date
00000000771	DATA COLLE	ANTENNA – HANDAR	443A	2106		2106	BANDELIER	1233	08/03/88
00000000834		DCP – HANDAR	540A	164		164	BANDELIER		01/01/84
00000000964	MISC EQUIP	SOLAR PANEL - SOLAREX	MSX-20	C-137053TF		C-137053TF	BANDELIER	519	10/08/86
00000001008			MSX-56	K-140031TF		K-140031TF	BANDELIER	1207	05/12/88
00000001010			MSX-56	K-160018TF		K-160018TF	BANDELIER	1207	05/12/88
00000001817		VOLTMETER – EXTECH INSTRUMENTS	EH139472	26001205		26001205	BANDELIER	6098	08/22/96
00000001309	VIS - TRAN	TRANSMIS RECEIV BASE – OPTEC	86230	NPS-90207		NPS-90207	BANDELIER	1382	11/22/88
00000001152		TRANSMIS RECEIV COMPUTER – OPTEC	86210	NPS-90265		LPVR032	BANDELIER		01/11/89
00000001185		TRANSMIS RECEIV DET HEAD – OPTEC	86222	NPS-90266		LPVR032	BANDELIER		01/11/89
00000001216		TRANS MIS RECEIV TELESCOPE - OPTEC	86222	NPS-90267		LPVJ032	BANDELIER		01/11/89
00000001465		TRANSMIS TRANSM BASE – DAN WILSON	WILSON	NO PROP #		NO SERIAL #	BANDELIER	2495	08/20/91
00000001248		TRANSMIS TRANSM CONTROLLER – OPTEC	86200	NPS-90264		LPVT032	BANDELIER		01/11/89
00000001280		TRANSMIS TRANSMITTER - OPTEC	86200	NPS-90263		LPVT032	BANDELIER		01/11/89

Figure 4-2. Example On-Site Inventory Report.



#### **4.13.3 Archiving Site Visit Documentation**

Upon completion of the site visit review and IMPROVE inventory verification/update, 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:

- Transmissometer Servicing Site Visit Trip Report
- On-Site Inventory Report
- Field Installation Shipping Checklist
- Field audit documentation as specified in SOP 4710, *Transmissometer Field Audit Procedures*