DIVISION OF ENVIRONMENT
QUALITY MANAGEMENT PLAN

PART III:

INTERAGENCY MONITORING OF PROTECTED VISUAL ENVIRONMENTS (IMPROVE) PROTOCOL SAMPLING QUALITY ASSURANCE PROGRAM PLAN

Revision 1

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Kansas Department of Health and Environment
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Section 1

OVERVIEW

1.1 Purpose and Scope

The Interagency Monitoring of Protected Visual Environments (IMPROVE) project began in 1987 and continues to protect visibility in Federal Class I wilderness from existing and future man-made air pollution. Through the Kansas Department of Health and Environment (KDHE), the State of Kansas is a participating member of the Central States Regional Air Planning Association (CENRAP), which has been developed to oversee the program for reducing haze and fine particulate matter on a regional basis. An initial CENRAP finding was that there is inadequate visibility-related data for the central portion of the United States. This is due to the fact that there are only a few Federal Class I areas in the CENRAP region. To address this situation, member states and Tribes have located a number of IMPROVE protocol aerosol samplers in a network intended to provide reasonably adequate spatial coverage in the central portion of the country. This quality assurance project plan (QAPP) was developed to document the quality assurance (QA) and quality control (QC) activities of IMPROVE protocol sampling conducted by the State of Kansas.

The provisions of this QAPP apply to IMPROVE protocol aerosol sampling conducted by the Monitoring and Planning Section (MPS). This document also applies to IMPROVE protocol aerosol sampling performed for KDHE by the Kansas Department of Wildlife and Parks (KDWP) at Cedar Bluff State Park.

1.2 Operational Overview

IMPROVE protocol sampling conducted by MPS generates data from intermittent samplers located at a site in the Flint Hills of east-central Kansas and a site located at Cedar Bluff State Park in western Kansas. These samplers are operated in accordance with the national one in three day sampling schedule, and as described in the *Version II IMPROVE Sampler Operating Procedures Manual*, this QAPP, and KDHE's *IMPROVE Protocol Sampling Standard Operating Procedures* (SOPs).

The Flint Hills IMPROVE protocol sampler is operated and maintained by MPS technical staff. The IMPROVE protocol sampler located at Cedar Bluff State Park is operated by KDWP per an interagency agreement with KDHE. Terms of the Cedar Bluff agreement include the following:

(1) KDHE will provide KDWP with technical assistance for project execution and administration by telephone or during scheduled visits to the monitoring site including assistance in resolution of serious malfunctions or unusual problems which arise during operation of the IMPROVE protocol sampler.

(2) KDWP will operate the IMPROVE protocol sampler in accordance with KDHE's QAPP and associated SOPs.

(3) KDWP will remove exposed cartridges from the sampler modules and replace with unused cartridges in accordance with an established sampling schedule.

(4) KDWP will notify KDHE of technical problems or operational failure of the IMPROVE sampler on the day that the difficulty is discovered.

(5) KDWP will properly package and ship exposed IMPROVE sample cartridges to the IMPROVE contract laboratory in accordance with the established schedule.

(6) KDWP will provide KDHE required quarterly project work performance affidavits.

Filter cassettes are prepared, loaded into sampling cartridges, and shipped to site operators by a central IMPROVE contract laboratory. Site operators complete sampling log sheets, exchange exposed filter cassette holder cartridges with unexposed cartridges in the samplers, and prepare and ship exposed cartridges to the contract laboratory.

1.3 Weekly Sample Changes

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

The IMPROVE network will operate according to a one-day-in-three sampling schedule, with sample changes (i.e., exchange of filter cassette holder cartridges) occurring on Tuesdays. This schedule will necessitate that the arrangement of ambient filters will vary slightly for each week, with the pattern repeating every third week. Each Blue Box will contain three bags, three log sheets, and one memory card. Shipments will be made every three weeks. The three types of cartridges to be shipped are listed in Table 1.1. All cartridges will be labeled with the appropriate Tuesday sample-changing date.

Table 1.1. Types of cartridges for 1-day-in-3 sampling.

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

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

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

The field blanks in position 4 are completely transparent to the site operator and to the sampler controller. Flow rate measurements are not taken for field blanks.

Field Operation of the Version II IMPROVE sampler and weekly sample changes are described in Section 5 of the Improve Protocol Sampling SOPs.

Section 2

ORGANIZATIONAL DESCRIPTION

2.1 <u>Organizational Charts</u>

Figure 2.1 below represents the organizational structure of the portion of KDHE responsible for the activities associated with IMPROVE protocol sampling. In addition, KDHE has contracted with KDWP for routine operation of the IMPROVE sampler located at Cedar Bluff State Park.

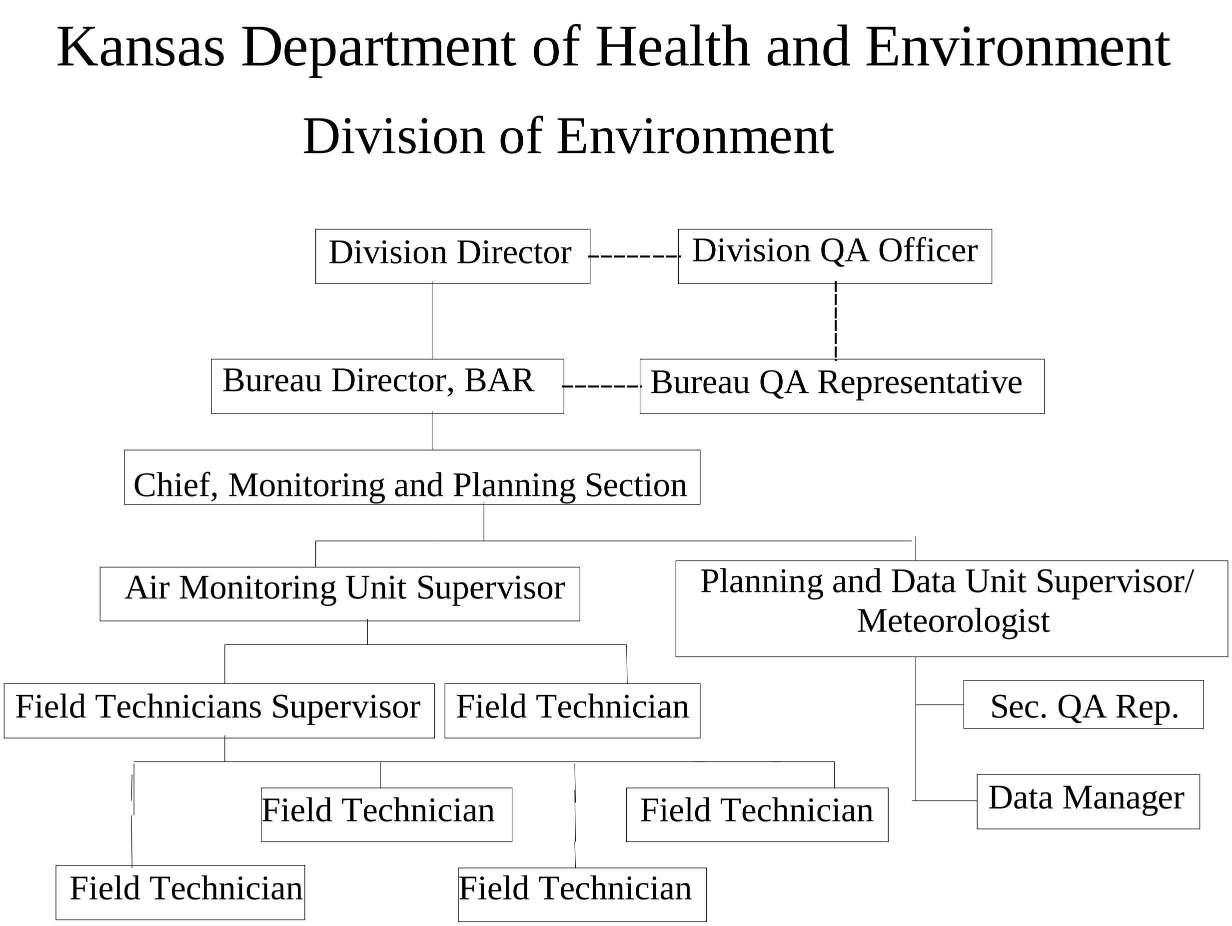

Figure 2.1. Organizational Chart.

2.2 Individual Responsibilities of the Kansas Department of Health and Environment (KDHE)

The QA responsibilities of the **Division of Environment Director** and the **Division QA Officer** are described in the Division of Environment Quality Management Plan (QMP) Part I, Section 3.2.

The QA responsibilities of the **Bureau Director** of the Bureau of Air and Radiation are fully described in the Division of Environment QMP Part III: Ambient Air Criteria Pollutants Monitoring Program Quality Assurance Program Plan (QAPP), Section 2.2. The Bureau Director delegates the responsibility of QA development and implementation in accordance with Division of Environment policy to the Section Chiefs.

The QA responsibilities of the **Section Chief of the Monitoring and Planning Section** (MPS) are fully described in the Division of Environment QMP Part III: Ambient Air Criteria Pollutants Monitoring Program QAPP, Section 2.2. The direct responsibility for assuring data quality rests with line management. The Section Chief is responsible for establishing QA policy and for resolving QA issues identified through the QA program. The Section Chief delegates the responsibility of QA development and implementation in accordance with BAR policy to those in MPS.

The QA responsibilities of the **Bureau QA Representitive** (BQAR) are fully described in the Division of Environment QMP Part III: Ambient Air Criteria Pollutants Monitoring Program QAPP, Section 2.2. The BQAR is the official staff QA contact appointed by the Bureau Director. The BQAR reviews and approves all QAPPs within the bureau. The BQAR is responsible for the QA aspects of the Ambient Air Quality Monitoring Program.

The **Planning and Data Unit Supervisor** (PDUS) directs the activities of the Planning and Data Unit (PDU). The PDUS is responsible for coordinating the data management activities of the ambient air monitoring program.

The **Data Manager** (DM) is responsible for coordinating the data management activities of the ambient air monitoring program. These responsibilities include ensuring that data and information collected for the air monitoring program are properly captured, stored, and transmitted for use by program participants. The BQAR also provides data reports, calculations, and charts as requested.

The **Meteorologist** acquires and manages meteorological data from weather stations in and around Kansas. He/she analyzes air pollution data with respect to meteorological data. This analysis includes study of long range transport and local sources of air pollution. The meteorologist coordinates and edits the Annual Report for distribution to the public.

The **Section Quality Assurance Representative** (SQAR) aids the BQAR in his/her responsibilities (see above). The SQAR is also responsible for providing training related to QA/QC to the BAR.

The **Air Monitoring Unit Supervisor** (AMUS) directs the activities of the Air Monitoring Unit (AMU). The AMU is responsible for carrying out air monitoring and ensuring the data quality results of the air monitoring by adhering to guidance and protocol specified by the QAPP and SOPs for the field activities. The AMUS reviews the required quarterly IMPROVE Protocol Sampling project work performance affidavits submitted by KDWP prior to initiating the quarterly payment process.

The **Field Technicians Supervisor** (FTS) supervises the field technicians who are responsible for carrying out air monitoring and ensuring the data quality results of the air monitoring by adhering to guidance and protocol specified by the QAPP and SOPs for the field activities. Responsibilities include:

- technical review and implementation of the QAPP
- participate in training and certification activities
- participate in the development and modification of SOPs
- verify that all required QA/QC activities are performed as required in the QAPP
- ensure that all manufacturer's operating guidelines are followed
- ensure that preventive maintenance is performed and documented
- document deviations from established procedures and methods
- report all problems and corrective actions to the AMUS
- report observed field/handling conditions which might influence data validity
- prepare and deliver field data to the Bureau QA Representative
- ship/receive equipment and filters according to the QAPP

The four **Field Technicians** are responsible for carrying out air monitoring and ensuring the data quality results of the air monitoring by adhering to guidance and protocol specified by the QAPP and SOPs for the field activities. Responsibilities include:

- technical review and implementation of the QAPP
- participate in training and certification activities
- participate in the development and modification of SOPs
- perform all required QA/QC activities as required in the QAPP
- follow all manufacturer's operating guidelines
- perform and document preventive maintenance
- document deviations from established procedures and methods
- report all problems and corrective actions to the FTS
- report observed field/handling conditions which might influence data validity
- prepare and deliver field data to the Bureau QA Representative

- ship/receive equipment and filters according to the QAPP
- operate the IMPROVE protocol sampler at the Flint Hills sampling site
- provide IMPROVE protocol related operational training and technical assistance to DWP personnel at the Cedar Bluff State Park sampling site

2.3 Individual Responsibilities of the Kansas Department of Wildlife and Parks (KDWP)

Designated Kansas Department of Wildlife and Parks personnel are responsible for routine operation and basic maintenance of the IMPROVE protocol sampler located at the Cedar Bluff State Park sampling site. Specific responsibilities include:

- operate the IMPROVE protocol sampler in accordance with this QAPP and associated SOPs
- remove exposed cartridges from the sampler modules and replace with unused cartridges in accordance with the sampling schedule
- notify KDHE of technical problems or operational failure of the IMPROVE sampler on the day that the difficulty is discovered
- properly package and ship exposed IMPROVE sample cartridges to the IMPROVE contract laboratory in accordance with the shipping schedule
- provide KDHE required quarterly project work performance affidavits

2.4 Distribution

This document and any revisions will be distributed to:

Kansas Department of Health and Environment (KDHE)

KDHE Division of Environment QA Officer
KDHE Bureau of Air and Radiation (BAR) Director
KDHE Bureau of Air and Radiation (BAR) QA Representative
KDHE BAR Monitoring and Planning Section (MPS) Section Chief
KDHE BAR MPS Data and Planning Unit Supervisor
KDHE BAR MPS Air Monitoring Unit Supervisor
KDHE BAR MPS Field Technicians Supervisor
KDHE BAR MPS Field Technicians
KDHE BAR MPS Section QA Representative

Kansas Department of Wildlife and Parks (KDWP, Contract Agency)

Melody Burkholder, Parks Supervisor, KDWP, Region #1
Troy Brown, Park Manager, Cedar Bluff State Park and Wildlife Area
Site Operator, Cedar Bluff State Park and Wildlife Area

United States Environmental Protection Agency (EPA)

Leland Grooms, IMPROVE coordinator, EPA Region VII

Diane Harris, Quality Assurance Manager, Region VII

Section 3

DATA PERFORMANCE CRITERIA

This section provides a description of data performance criteria expressed in terms of data precision, accuracy, completeness, comparability and representativeness for each parameter of interest.

3.1 Precision

Precision is defined as the level of agreement among individual measurements of the same property, conducted under identical or similar conditions. The precision of each monitor is found in the following manner.

3.1.1 Precision Objectives

It is appropriate to use the concept of precision for various components of the concentration calculation, such as volume and analytical calibration. For aerosol concentration, the appropriate concept is uncertainty.

3.1.2 Evaluation of Precision

The precision in the volume is derived primarily from the precision in the flow rate. This enters as a relative uncertainty (e.g. 3%) for every parameter. The relative precision in the flow rate can be estimated from flow audits and from an examination of possible sources of variability. At a minimum, flow audits will be performed at six month intervals as scheduled by the IMPROVE contract laboratory.

The IMPROVE program will have collocated samplers at approximately 4% of the sampling sites. Rather than having a complete collocated sampler at four sites, there will be a single collocated module at sixteen sites. These will be equally divided between the four module types. No collocated IMPROVE protocol aerosol samplers are located in Kansas.

Sampler airflow precision is monitored in three ways:

1) The history of flow rates for each transducer is examined at least once a month to monitor for changes in performance.

2) The comparison of equivalent measurements by different modules is performed by the IMPROVE contract laboratory once a quarter to verify that the flow rates of various modules agree. The most precise test is the comparison of sulfur from Module A with sulfate from Module B. A less precise comparison is between organic matter by hydrogen from Module A with organic by carbon by Module C. A rough comparison is between $PM_{2.5}$ mass from Module A and PM_{10} mass from Module D.

3) Field flow calibrations are conducted at least every six months, and when there is a potential problem with flow measurements. A field calibration is performed annually by an IMPROVE contract laboratory field technician during annual maintenance. The site operator performs a field calibration six months after the annual maintenance using a standard calibration device mailed from the IMPROVE contract laboratory. The calibration device is an orifice with a meter to measure the pressure drop. The meter for the standard computer-based device is a transducer similar to that in the Version II sampler. All calibrations consist of comparison of the system transducer readings with the flow rates of the calibration device at four different flow rates covering the normal range encountered. If the correlation between the calibration and system flow rates has an R^2 value less than 0.99, then the calibration is redone. If the nominal flow rates (i.e., flow rates with a normal clean filter) are not within 5% of the desired nominal values, the site operator will adjust the nominal flow rate and perform a new calibration.

   If the calibration results are not within 5% of the previous calibration results, the past data are reviewed to determine when the change occurred. This is determined by examining the comparisons between similar concentrations measured by separate modules (sulfur sulfate, organic mass by hydrogen and carbon). If no change date can be identified, the samples collected between the two calibrations will be flagged as QD (questionable data). The new calibration is applied to all samples collected after that change.

3.2 Accuracy

Accuracy is defined as the extent to which a measured value actually represents the condition being measured.

3.2.1 Accuracy Objectives

Accuracy is influenced by the degree of random error (precision) and systematic error (bias) inherent in the measurement operation (e.g., environmental sampling and analytical operations). Accuracy is determined by comparing instruments to reference standards traceable to the National Institute of Standards and Technology (NIST). The reference standard for flow rate is an NIST-traceable DryCal Flow Calibrator.

3.2.2 Evaluation of accuracy

Sampler airflow accuracy is maintained be referencing all field calibration devices to a DryCal Flow Calibrator that is certified NIST traceable. The results are verified using a dry gas meter. The contract laboratory maintains a set of calibration orifice meters for field and mail calibrations. All calibration devices are calibrated by the contract laboratory using the same reference flow calibrator. The calibration of each device is verified before and after each use. Problem situations will be examined and a solution will be found to correct the problem.

3.3 Completeness

Completeness is defined as a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions.

Our minimum requirement is 75% valid data at each monitor per calendar quarter. Our goal is 100% valid data at each monitor per calendar quarter. The percentage valid is based on only those days which are planned to be monitored. In the case of aerosol monitoring which is scheduled for less then every day sampling, monitoring on a non-scheduled day does not count as valid when calculating the percent valid.

3.4 Comparability

Comparability is defined as a measure of the confidence with which one item (e.g., data set) can be compared to another. We achieve comparability by using methodology which has been approved by EPA. IMPROVE protocol aerosol sampling in Kansas is conducted through the use of IMPROVE version II aerosol samplers which are operated in accordance with the Version II IMPROVE Sampler Operating Procedures Manual for Use in the IMPROVE Monitoring Network.

3.5 Representativeness

Representativeness is defined as a measure of the degree to which data accurately and precisely represent a selected characteristic of a monitored system. Representativeness is based on the relationship between monitoring objectives and the geographical location of monitoring stations. The locations of the sites have been determined according to IMPROVE site selection criteria. These criteria ensure that sites avoid non-representative meteorology, avoid local sources of pollution and/or airflow obstructions, and represent relatively pristine areas.

Section 4

NETWORK DESCRIPTION

4.1 Purpose

The purpose of this section to provide a description of, and rationale for, intended sampling frequency, sampling network design and monitoring site selection criteria.

The IMPROVE project began in 1987 and continues to protect visibility in Federal Class I wilderness from existing and future man-made air pollution. As a result of KDHE's participation in CENRAP, two IMPROVE protocol aerosol samplers have been added to the Kansas Ambient Air Monitoring Network to provide reasonably adequate spatial coverage for the collection of visibility-related data.

IMPROVE protocol sampling conducted by MPS generates data from intermittent samplers located at a site in the Flint Hills of east-central Kansas and a site located at Cedar Bluff State Park in western Kansas. The Flint Hills IMPROVE protocol sampler is operated and maintained by MPS technical staff. The IMPROVE protocol sampler located at Cedar Bluff State Park is operated by KDWP per an interagency agreement with KDHE. Specific information about these sites is contained in Table 4.1.

Table 4.1. Kansas IMPROVE protocol sampling sites.

Monitor Type	AIRS I.D.	Urban Area	City or County	Location	Address	Latitude/ Longitude	Monitoring Objective	Spatial Scale
IMPROVE	017-0001	0000	Chase Co.	Flint Hills	Tallgrass Prairie National Preserve	38:26:01N 096:33:34W	Visibility	Regional
IMPROVE	195-0001	0000	Trego Co.	Cedar Bluff Reservoir	Cedar Bluff State Park	38:46:13N 099:45:49W	Visibility	Regional

4.2 Sampling Frequency

Minimum sampling frequencies are established by EPA and followed accordingly. These samplers are operated in accordance with the national one in three day sampling schedule. The national sampling schedule is published annually by EPA.

4.3 Site Selection

The selection of a specific monitoring site includes the following activities:

1) developing and understanding the monitoring objective and appropriate data quality objectives;

2) identifying the spatial scale most appropriate for the monitoring objective of the site;

3) identifying general potential locations where the monitoring site could be placed; and

4) identifying the specific monitoring site.

The locations of the IMPROVE protocol sites have been determined according to IMPROVE site selection criteria. Detailed guidance for site selection and sampler placement can be found in the IMPROVE Particulate Monitoring Network Procedures for Site Selection prepared by Crocker Nuclear Laboratory. The basic IMPROVE siting criteria include the following:

1) The site must avoid small valleys with non-representative meteorology. Valleys with towns or other emission sources are definitely to be avoided. Valleys without emission sources, but with significant inversions, should also be avoided.

2) The site must avoid all local sources of pollution.

a. Automotive Sources: vehicle usage, distance between road and sampler.

Table 4.2. Vehicle Usage and Required Distance Between Road and Sampler.

Vehicle Usage	Required Distance Between Road and Sampler
<10,000 vehicles per day	>25 meters
10,000-20,000 vehicles per day	>50 meters
20,000-40,000 vehicles per day	>75 meters
>40,000 vehicles per day	>100 meters

b. Combustion Sources

Avoid any areas influenced by diesel generator emissions, wood smoke, or incinerators.

c. Dust Sources

At least 400m from a large potential source of dust, such as a landfill, agricultural tillage operations, or an unpaved road with more than 400 cars per day.

3) The site should avoid large obstructions, such as trees or buildings. In the standard setup, the inlet will be approximately 3.5m (11 feet) above the bottom of the shelter. The sampler could be placed on a platform to clear obstructions, as well as to be above any snow pack. Raising the height of the inlet by increasing the length of the stack beyond the standard 2m is not recommended, although theoretical calculations and tests show no significant loss of particles on the wall of a stack up to 5m. (For a 1% loss of particles larger than 0.3 µm, the stack length would have to be over 250m.)

a. There should be unrestricted airflow in all directions. The restrictions are listed in items b and c below. If all directions are not possible, the minimum arc of unrestricted airflow is 270°, with the predominant wind direction in the unrestricted 270°.

b. Within 10m of the sampler, any solid barriers or trees should be at least 1m below the inlet. In general, a pole or meteorological tower will not be a solid barrier. We will set as a guideline that a solid barrier is any object that subtends more than 10°.

c. Beyond 10m of the sampler, the solid barriers or trees should not be higher than 30° above the horizontal with respect to the inlet.

4) The site must have electrical power (120 Volt, 60 Hertz, 20 Amperes).

5) The site must be accessible for a weekly sample change in all but the most severe weather conditions.

These criteria ensure that sites avoid non-representative meteorology and local sources of pollution and /or airflow obstructions, and that sites represent relatively pristine areas on a regional scale.

4.4 Monitoring Objectives and Spatial Scales

Data collected within the network must be representative of the spatial area under study. The goal in siting a monitoring station is to match the spatial scale represented by the samples obtained with the spatial scale most appropriate for the monitoring objective of the station.

Each monitor operated by KDHE is assigned a scale of representativeness based on the definitions of 40 CFR Part 58, Appendix D. Microscale defines the concentrations in air volumes associated with area dimensions ranging from several meters up to about 100 meters. Middle Scale defines the concentration typical of areas up to several city blocks in size with dimensions ranging from about 100 meters to 0.5 kilometer. Neighborhood Scale defines concentrations within some extended area of the city that has relatively uniform land use with dimensions in the 0.5 to 4.0 kilometers range. Urban Scale defines the overall, citywide conditions with dimensions on the order of 4 to 50 kilometers. This scale would usually require more than one site for definition. Regional Scale defines usually a rural area of reasonably homogeneous geography and extends for tens to hundreds of kilometers. IMPROVE protocol sampling sites have been selected to produce visibility-related data representative of regional scale.

4.5 Monitor Placement

Final placement of a particular monitor at a selected site is dependent on physical obstructions and activities in the immediate area. The availability of utilities is critical. Monitors must be placed away from obstructions such as trees and fences in order to avoid their effects on air flow. To prevent sampling bias, air flow around the monitor sampling probe must be representative of the general air flow in the area.

The placement of each monitor is generally determined by the defined monitoring objective. Monitors are thus usually placed according to potential exposure to pollution. Due to the various factors discussed above, tradeoffs are often necessary to locate a site for collection of optimally representative data. In the case of IMPROVE protocol monitoring, samplers have been located in accordance with criteria discussed above.

Section 5

DESCRIPTION OF SAMPLING EQUIPMENT

5.1 Description of Version II IMPROVE Sampler

In September of 1999, existing IMPROVE sites began conversion to the version II sampler. The new version of the IMPROVE sampler measures the flow rate and volume more accurately, is more flexible, and is easier to operate than the original sampler, while retaining the same collection characteristics.

The two IMPROVE aerosol samplers employed within the Kansas Ambient Air Monitoring Network are Version II IMPROVE samplers. Each sampler will be protected from direct sunlight by a shelter. The shelter will also protect the filters during sample-changing in rain or snow. The shelters employed by the State of Kansas at IMPROVE protocol sites will be fully enclosed but well-ventilated. These shelters will not be heated or air-conditioned. The length of the inlet stacks will be 1.83m at all sites.

The IMPROVE controller includes a microprocessor and a keypad with display. The flow rate readings and temperature reading are read every minute and a 15-minute average is recorded on a removable memory card. The memory card is shipped between the site and the central laboratory with each shipping container.

Samplers located at Kansas sites will have four modules (designated A, B, C, and D). Each module, which measures 16” x 12” x 7” and weighs 40 pounds, has its own pump requiring 3.3 amperes (A) at 120 volts (V). The IMPROVE aerosol sampler operates with an airflow rate of 22.8 L/min at standard temperature and local pressure for module types A, B, and C. Type D module airflow rates are 16.9 or 19.1 L/min (depending upon inlet stack diameter). The principle of operation is based on the physical behavior of particles in a vortex acted upon by centrifugal force.

The air stream at the filters travels vertically upward, except for module D which collects PM_{10}. The air stream in module D travels vertically downward. All the filters are pre-loaded into cassettes and the cassettes into cartridges at the contract laboratory. Each module has a separate color-coded cartridge.

Installation of the Version II IMPROVE aerosol sampler is described in Section 1 of the Improve Protocol Sampling SOPs, and routine operation is described in Section 5. The standard Version II IMPROVE sampler configuration is shown in Figure 5.1.

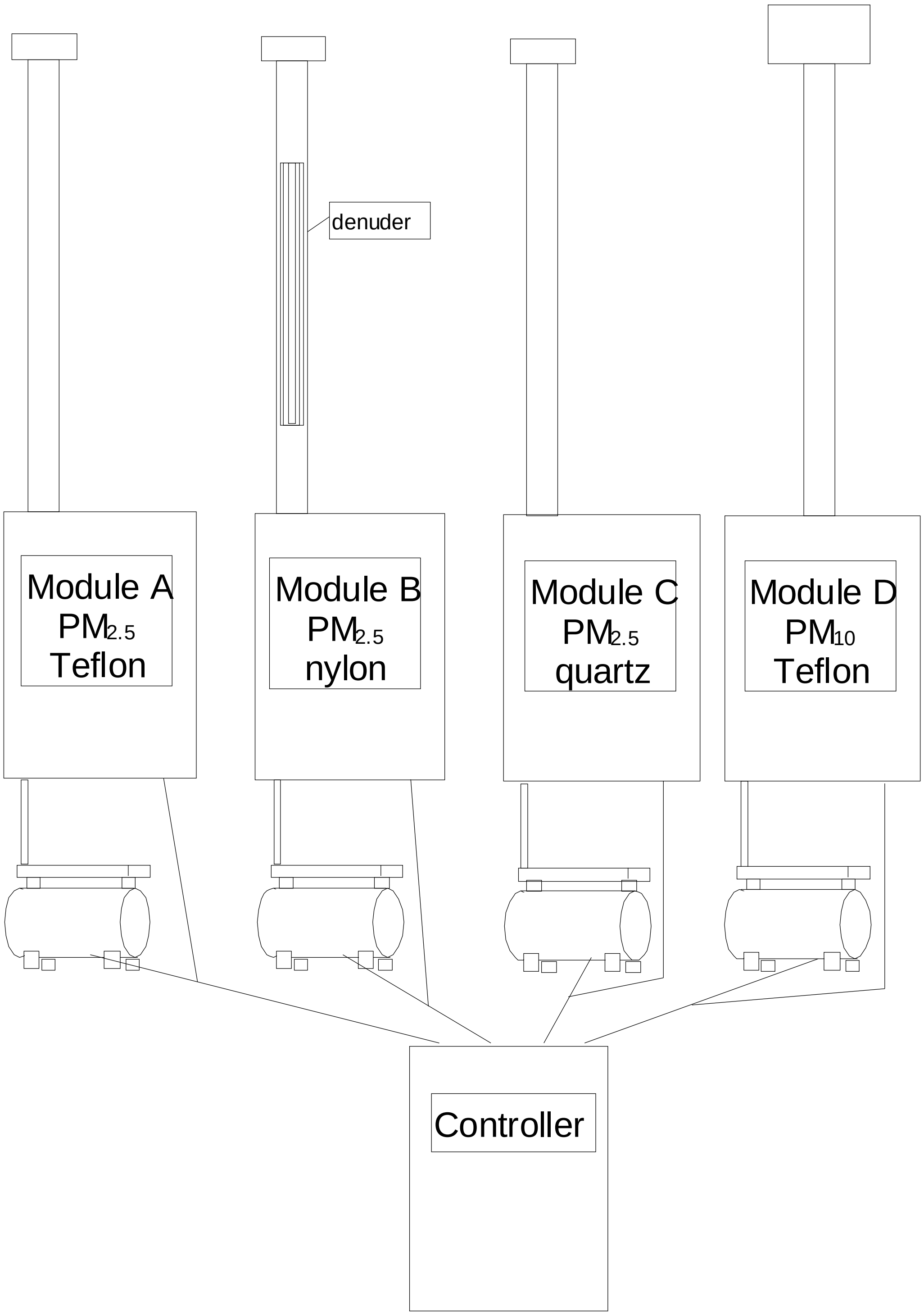

Figure 5.1. Typical Version II IMPROVE sampler configuration.

Section 6

DESCRIPTION OF FIELD PROCEDURES

6.1 Description of Field Procedures

The sample changing procedure is outlined in the sampler manual titled: *Version II IMPROVE Sampler Operating Procedures Manual* for use in the IMPROVE Monitoring Network. The instructions include a troubleshooting guide to diagnose and fix common sampler problems.

6.1.1 Transport and On-Site Storage

Each shipping box is identified with a site ID and with the dates the cartridges are to be installed. The container is received two to three weeks prior to the first installation date. Each site normally has two shipping boxes. All shipments are by First Class US Mail. The boxes are not shipped cool. The site operators prepare and store the shipping boxes in a clean location, either near the office or close to the field site. Acceptable storage locations are either indoor office space or onsite sampler housing units.

6.1.2 Handling Onsite

On the day of installation, the operator removes the current cartridges from the sampler units, seals them inside the labeled plastic bag and places them inside the labeled shipping box. Normally each shipping box holds cassettes for three weeks and field log sheets for each week in a sealed bag. The box is retained in the same clean location described in the previous paragraph. When all three weeks of cassettes have been used, the box will be closed and mailed back to the national contract laboratory, using the reversible mail label on the front of the box. On the days when sampling occurs on the designated change day, the operator must shift one cassette from the current cartridge to the new cartridge. The time of sample change is written on the log sheet and recorded on the memory card. The log sheet must be initialed by the site operator.

6.1.3 Sampling Operations

The IMPROVE sampler controller unit reads the sensors and displays the values for the operator to record on the log sheet. The operator removes the cartridges with exposed filters and installs the new cartridges. Every third week the operator removes one cassette from the old cartridge and places it in the new cartridge. The controller then displays the new flow values for recording. The general duties for the site operator are:

- receive a shipping box containing resealable, labeled bags, each containing filters for one week and the corresponding log sheet. Each bag contains a color-coded cartridge for each module; each box contains a data storage memory card.

- verify the correct dates on the boxes and bags; and initiate the sample changing sequence via keypad of the control unit.

- record final readings for each of the filters and log additional information including date, time, temperature reading, operator's initials, and comments on any anomalous events (i.e. pump noises, extreme sampler pressure values, equipment malfunction, missed sample changes, or sample interference such as wildfires).

- remove the old cartridges and replace with the current cartridge.

- record initial readings of the newly installed filters.

6.1.4 Field Blanks

Field blanks are prepared at a rate of 2% of the normal field samples. The field blank cassette is identical to the normal cassette and placed in the same cartridge. The controller does not allow any air to pass through the field blank. No special treatment for field blanks is needed at the site. The field blanks go through normal sample handling and analysis.

6.2 Troubleshooting

KDHE will assist KDWP with unusual problems related to sampling and sampler maintenance. If necessary, KDHE will contact the sampler manufacturer or the IMPROVE contract laboratory for assistance. When a malfunction occurs, KDHE Ambient Air Monitoring Field Technicians will evaluate the problem and perform initial troubleshooting. If the Field Technicians cannot solve the problem, the sampler manufacturer or the contract laboratory will be contacted by telephone to discuss methods for remediation of the problem. The components in the Version II IMPROVE sampler are generally easily removable. If the problem is a malfunction of any such replaceable components, the replacement part(s) can be shipped to the site via express mail, and the defective item can be returned. Alternatively, a complete module can be exchanged. As a final resort, qualified service personnel will travel to the site to make appropriate repairs.

The IMPROVE contract laboratory will be notified regarding improper labeling of cassettes, or if readings are outside of site-specific, acceptable ranges. The telephone number for the contract sample-handling laboratory is provided both on the sampler manual and on the Field Sample Log sheet. Telephone response is available from 8 a.m. to

5 p.m. every workday. A voice-mail system is available at other times. The IMPROVE Protocol Sampling SOPs include detailed descriptions of field procedures, including sampler configuration (Section 2) and sample collection (Section 5).

6.3 Maintenance

Routine sampler maintenance is performed by the site operator. Maintenance activities are conducted in accordance with *IMPROVE Standard Operating Procedure, SOP201-3: Sampler Maintenance by Site Operators*; Crocker Nuclear Laboratory, University of California; Davis, CA; June 28, 2005.

Section 7

LABORATORY PARAMETERS AND PROTOCOLS

7.1 IMPROVE Filter Analysis

Analysis of IMPROVE filters will be conducted by a national contract laboratory. The IMPROVE aerosol sampler is designed to simultaneously collect material on four different filter media for subsequent analysis.

Module A contains a cyclone (to separate out particles larger than 2.5 µm), 4 solenoids, a critical orifice flow controller, 2 flow gauges, an inlet stack, and associated electronics. This module collects particulate matter on a Teflon filter for measurement of $PM_{2.5}$ by microgravimetric analysis.

Module B contains a denuder to remove nitric acid vapor. This module collects a sample on a Nylon filter for the measurement of sulfate and nitrate ions.

Module C utilizes a quartz filter to collect a sample for the measurement of organic and elemental carbon.

Module D collects a sampler on a Teflon filter for measurement of PM_{10}. This module is similar to the $PM_{2.5}$ module, except that the inlet and cyclone are replaced by a commercial PM_{10} inlet,. and the air stream at the PM_{10} filter travels vertically downward.

The analyses performed by the contract laboratory appear in Table 7.1.

Table 7.1 IMPROVE Sampler Modules and Filter Media:
Module (Filter), Analysis Performed, and Parameters Measured.

Module (Filter)	Analysis Performed	Parameters Measured
A (Teflon)	Gravimetric, HIPS, PESA, PIXE, XRF	$PM_{2.5}$ mass, coefficient of absorption (b_{abs}) H Na, Mg, Al, Si, S, K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Ga, As, Se, Br, Rb, Sr, Zr, Pb
B (Nylon)	Ion Chromatography	Nitrate, Nitrite, Sulfate, Chloride
C (Quartz)	TOR Combustion	Carbon in eight (8) temperature fractions
D (Teflon)	Gravimetric	PM_{10} mass

Hybrid Integrating Plate/Sphere (HIPS); Particle Induced X-ray Emission (PIXE); Proton Elastic Scattering Analysis (PESA); X-ray Florescence (XRF); Ion Chromatography (IC), Thermal Optical Reflectance (TOR)

Section 8

DATA VALIDATION AND MANAGEMENT

8.1 Data Validation and Management

Sample analysis, data reduction, data validation, as well as data storage, transfer, and reporting are under the control of the IMPROVE national contract laboratory.

Section 9

EQUIPMENT CALIBRATION AND AUDITING

This section describes equipment testing, preventive maintenance, calibration, and audit procedures. More detailed information is contained in the IMPROVE protocol sampling SOPs.

9.1 IMPROVE Sampler Preventive Maintenance

Ambient Air Monitoring technical staff will maintain the IMPROVE sampler at the Flint Hills site and assist the KDWP site operator at Cedar Bluff State Park. Preventive maintenance includes periodic cleaning of the inlet head, inlet stack, and internal cyclone. System clocks must be reset as necessary. Any worn or damaged parts will be replaced.

On annual site visits, an IMPROVE contract laboratory Field Technician will check all sampler functions, including solenoid action, vacuum pressure, keypad function, and electronic control. This technician will clean the inlet head, inlet stack, internal cyclone and reset system clocks. Any worn or damaged parts will be replaced. Finally, the flow rates will calibrated, and adjusted if necessary.

9.2 IMPROVE Sampler Calibration

Sampler flow rates are adjusted and calibrated at the time of installation and during annual maintenance. A six-month calibration is conducted by the site operator using equipment provided by the contract laboratory. The calibration device is an orifice meter, which consists of an orifice and meter to measure the pressure drop across the orifice. The orifice is contained in a probe that is inserted at the base of the inlet stack. The calibration system is calibrated at the contract laboratory facility using a DryCal Nexus DC-2 Flow Calibrator that is certified NIST traceable. The log of the meter reading, Mo, is regressed against the log of the flow rate for a set of four flow rates covering the normal range of the device.

At the time of installation, the nominal flow rates are adjusted to provide a flow rate of 23 L/min at 20°C with a typical filter in the cassette. Before any later re-adjustment, a 4-point calibration is performed. The technician adjusts the orifice diameter until the calibration meter has the desired reading.

The flow rate calibration compares the calibration device pressure drop and the pressure drop of each system transducer for four airflow settings covering the expected range. If the regression of the logs of these four points yields a correlation coefficient (R^2) less than 0.99, the system is recalibrated.

9.3 Flow Audits

Flow audits will be performed in accordance with the operation of the IMPROVE contract laboratory. The IMPROVE Protocol Sampling SOPs include detailed descriptions of flow rate calibration (Section 3) and flow rate audit (Section 4) procedures. The SOPs also include procedures for routine sampler maintenance (Section 6) and troubleshooting of sampler problems (Section 7).

Section 10

PURCHASED EQUIPMENT

10.1 Purchased Equipment

The Version II IMPROVE Sampler has been selected for use at IMPROVE protocol sampling sites in CENRAP. The samplers will be delivered and installed by a field technician from the IMPROVE contract laboratory. Acceptance will be based upon verification of proper calibration and operation.

Section 11

CORRECTIVE ACTIONS

11.1 Corrective Actions

If procedures or equipment show anomalous results of any kind, immediate corrective action is taken. Possible Quality Control (QC) failures and appropriate corrective actions appear in the IMPROVE Protocol Sampling SOPs (Section 9) and the table below (Table 11.1.).

Table 11.1. Possible QC Failures and the Associated Corrective Actions.

Instrument	QC Failure	Corrective Actions
	Field Instrument	
IMPROVE Sampler	Site not serviced	If sample days remain then change cassettes and record time missed log sheet. If no sample days remain then change to current cassette and record days missed on log sheet.
	Equipment malfunctions	Use troubleshooting guide in manual to determine corrective action. Call contract laboratory if further assistance is needed. (the Laboratory Manager will help fix the problem or send replacement units with repair instructions.)
	Display values outside operating range	Record values on log sheet. Call contract laboratory to determine cause.
	New cartridge missing or mislabeled	Call contract laboratory to receive a new box of cartridges or to determine correct labeling.
	Field Documentation	
IMPROVE Sampler	Log sheet missing	Call contract laboratory to receive a new log sheet.
	Log sheet improperly completed or incorrect	Laboratory staff searches out the correct values and flags the data as questionable. If values are unknown, the sample is discarded.

Section 12

REPORTS

12.1 Reports

This section contains a description of program/project deliverables (electronic databases, summary statistics, illustrative materials, interim and final reports, etc.) and schedule for completion.

An ambient air monitoring network report is submitted to EPA Region VII by 30 June of each year. This report provides the results of a network review and what changes are planned in the immediate future.

A Kansas air quality report will be published each year. This report provides information to the general public on air pollution activities and trends.

A quality assurance program evaluation of the air monitoring program is conducted covering the calendar year. This report is submitted to the Division of Environment QA Officer by 15 February of each year. The Monitoring and Planning Section Chief directs this evaluation.

Section 13

TRAINING

13.1 Training

Personnel will meet the educational, work experience, responsibility, and training requirements for their positions. Records on personnel qualifications and training will be maintained in personnel files.

On-the-job training is an important part of the training program. For this, an employee reads and studies all relevant material (e.g., operator's manual, SOPs, federal regulations, and QA manuals) before performing an operation. Then the employee performs the operation while being observed by an experienced technician. When the experienced technician is satisfied that the employee is doing the operation correctly, the employee then may do the operation independently.

Site Operators are specifically trained in equipment operations, sample collection, and log recording. A training session will be conducted by IMPROVE program personnel during new site installation and repeated during the annual maintenance visits to sites. These training sessions will cover all the steps needed to change filters, and procedures for changing the date and time recorded by the IMPROVE sampler. Operators are currently not trained to calibrate the IMPROVE samplers.

Any conferences or workshops on IMPROVE protocol aerosol sampling will be attended if funding can be arranged. Usually only one person will attend such events (he/she relays the information to applicable personnel after returning to the office) in order to conserve resources.

Training procedures are described in the IMPROVE Protocol Sampling SOPs (Section 8).

Appendix A

REFERENCES

1. *IMPROVE Particulate Monitoring Network Procedures for Site Selection*; Crocker Nuclear Laboratory, University of California; Davis, CA; February 24, 1999.

2. *IMPROVE Protocol Sampling Standard Operating Procedures (SOPs*); Kansas Department of Health and Environment; Topeka, KS; Revision 1; January 2006.

3. *Version II IMPROVE Sampler Operating Procedures Manual*; Crocker Nuclear Laboratory, University of California; Davis, CA; v02.01.01: January 2001.

4. *IMPROVE Standard Operating Procedure, SOP201-3: Sampler Maintenance by Site Operators*; Crocker Nuclear Laboratory, University of California; Davis, CA; June 28, 2005.