Module 7: Steps for Designing and Implementing an Air Monitoring Program

Objectives:
- Develop an air monitoring plan and quality assurance project plan
- Understand the components of the air monitoring plan and quality assurance project plan

Set Objectives For the Air Monitoring Program
- Why are we conducting an air monitoring program?
- What air pollutants are we monitoring?
- Who will conduct the air monitoring?
- How will we maintain quality in our measurements?
- How can we create an air monitoring program that will be long-term and sustainable?

Components of an Air Monitoring Plan
- Air monitoring responsibilities
- Training requirements and certifications
- Site selection and identification
- Decide air pollutants to assess
- Method of sampling
- Develop sample collection operation
- Develop laboratory capabilities
- Quality assurance (QA) and quality control (QC)
- Data management
- Communicating data
Air Monitoring Responsibilities

- Agency
- Personnel
- Cost concerns

Training Requirements and Certifications

- Field operators
- Laboratory technicians

Select Sites for an Air Monitoring Plan

- Where to sample?
- How many sites to establish? Give reasons for site selection
- How should sampling be implemented?
Site Identification

- Type of sites
  - Permanent locations
  - Roadside locations
  - Temporary location
- Criteria for siting

What Air Pollutants to Assess?

- Particulate matter
- Ozone
- Sulfur dioxide
- Nitrogen dioxide
- Carbon monoxide
- Lead

Meteorological Data Needs

- Wind direction and speed
- Location and siting of meteorological sensors
- Representativeness of data
Wind Speed and Direction—Wind Rose

Method of Sampling

- Manual
- Passive
- Continuous

Select Methods of Sampling

- PM10 and PM2.5 sampling
  - Filtration
  - Impaction
  - Other methods
- Gaseous pollutant sampling
  - Absorption (Ogawa passive diffusion/reaction badges)
  - Adsorption (Draeger diffusion tubes)
  - Grab sampling (Grab bag or canisters)
  - Continuous automated monitoring
- Other sampling needs (On-site meteorology)
Particulate Matter Collection

- Filtration
  - Health Impact
- Impaction
  - Health Impact

Gaseous Pollutant Collection

- Absorption
  - Ogawa passive badges
- Adsorption
  - Draeger diffusion tubes
- Grab Sampling
  - Grab bags
  - Canisters

Grab Sampling
Select Sampling Instrumentation to be Used in the Air Monitoring Program

- Fit equipment to program objectives
- Consider costs to run network
- Efficiency of samplers
- Sampler requirements
  - Calibration standards
  - Electrical power
  - Shelter and fencing to contain and protect equipment
  - Initial and maintenance costs for samplers
  - Cost to train field operators

Develop Sample Collection Operation

Objectives

- Begin sampling in stages by site or by pollutant
- Begin sampling entire network at once
- Developing a sampling schedule
- Determine sampling frequency

How Should I Begin Sampling?

- Begin sampling in stages by site or by pollutant
- Begin sampling entire network at once
Developing a Sampling Schedule

- Standardized sampling schedule
- Independent sampling schedule

Example of Sampling Schedule Used in Accra, Ghana and Dar es Salaam, Tanzania

<table>
<thead>
<tr>
<th>Date</th>
<th>PM10 (co-loc.)</th>
<th>SO2 (co-loc.)</th>
<th>NO2 (co-loc.)</th>
<th>NOx (co-loc.)</th>
<th>O3 (co-loc.)</th>
<th>CO (co-loc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-22-05</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>5-28-05</td>
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<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>6-3-05</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>6-13-05</td>
<td>X</td>
<td>X</td>
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<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>6-21-05</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>6-27-05</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

RTI will conduct analysis of SO2, NO2, and O3, Ogawa passive badges at RTI laboratory for all sampling to 4-27-05. Based on the results, the frequency and method of sampling for SO2, NO2, O3, and CO will be determined.

Example of Short-Term Study Schedule of CO at a Roadside Site in Accra, Ghana

<table>
<thead>
<tr>
<th>Date/Time of Reading</th>
<th>Date/Time of Reading</th>
<th>CO Tube “A” Reading</th>
<th>CO Tube “B” Reading</th>
</tr>
</thead>
<tbody>
<tr>
<td>11 Aug 05</td>
<td>72 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 Aug 05</td>
<td>24 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Aug 05</td>
<td>8 hours later</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8 Aug 05</td>
<td>Start</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 July 05</td>
<td>72 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 July 05</td>
<td>24 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 July 05</td>
<td>8 hours later</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 July 05</td>
<td>Start</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 July 05</td>
<td>72 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 July 05</td>
<td>24 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29 June 05</td>
<td>8 hours later</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27 June 05</td>
<td>Start</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26 June 05</td>
<td>72 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24 June 05</td>
<td>24 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22 June 05</td>
<td>8 hours later</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22 June 05</td>
<td>Start</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21 June 05</td>
<td>72 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19 June 05</td>
<td>24 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 June 05</td>
<td>8 hours later</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17 June 05</td>
<td>Start</td>
<td></td>
<td></td>
</tr>
<tr>
<td>15 June 05</td>
<td>72 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 June 05</td>
<td>24 hours</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 June 05</td>
<td>8 hours later</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11 June 05</td>
<td>Start</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

PPM-Hour    PPM-Hour    PPM-Hour    PPM-Hour

Accra CO 3-Day Study

Roadside Site No._________
Parameters for Designing Your Sampling Schedule and Measurements

- Length of time to sample (hourly, daily, monthly, seasonally) and frequency of sample
- Length of time to conduct program (consider seasonal sampling too)
- Availability of general meteorological data
- Quality assurance requirements (standards, collocation, reviews)

Factors Affecting Sampling Frequency and Schedule

- Design frequency of sampling
- Limitations due to cost for conducting sampling
- Limitations due to cost for sample analyses in laboratory
- Factor in time and materials to conduct quality assurance sample collocation
- Allow time to train field operators and laboratory technicians

Develop Laboratory Capabilities

- Certification
- Equipment
- Staff development
Infrastructure

- Laboratory
  - Clean room for weighing PM filters and preparing passive samplers with temperature and relative humidity control
  - Laboratory instrumentation and bench space for continuous monitoring (for example: metal analysis, calibration of samplers)
- Field Equipment
  - Repair facility (replacement parts)
  - Storage of calibration gas cylinders
  - Shelter and fence to contain air monitors

Quality Assurance (QA) and Quality Control (QC) Considerations

- Field operations quality control
- Laboratory operations quality control
- Quality assurance oversight

Calibration Equipment and Procedures for Particulate Matter (PM)

- Certified weights to check balance
- Certified resistor plate orifice for SSI PM10 sampler
- Traceable flow rate, ambient temperature, and barometric pressure measuring devices to check filter-based samplers
Calibration Equipment and Procedures for Gaseous Pollutants

- Traceable NO, SO2, and CO standard cylinders
- O3 generator
- Dynamic dilution system if cylinder gas must be diluted
- Zero air supply or device
- Analytical measuring device (ion chromatograph for Ogawa passive badges)
- Traceable flow rate, ambient temperature, and barometric pressure measuring devices
- Grab bags
- Canisters

Data Management

- Entering data from field and laboratory forms
- Database for storage of information and data
- Central data repository location with controlled access to all data storage (central files)

Data Management Methods

Paper

- Data forms for field and laboratory
- Chain-of-custody form
- Field and laboratory notebooks
Example of Data Form Entries for the SSI
PM10 Sampler Used in Accra and Dar es Salaam Programs

Copy of the SSI PM10 Section from the Basic Field Operation Form

<table>
<thead>
<tr>
<th>PM10 (mg/m³)</th>
<th>SI</th>
<th>MinVol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of Start</td>
<td>Time of Start</td>
<td></td>
</tr>
<tr>
<td>Date of Stop</td>
<td>Time of Stop</td>
<td></td>
</tr>
<tr>
<td>Pre-weighted Filter and Bag (g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Differential Pressure (mbar)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Differential Pressure (mbar)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight of PM10 (mg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SSI PM10 Concentration (mg PM10/m³)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Example of Data Form Entries for the MiniVol PM10 Sampler Used in Accra and Dar es Salaam Programs

Copy of the MiniVol Section from the Basic Field Operation Form

<table>
<thead>
<tr>
<th>MiniVol</th>
<th>SI</th>
<th>MinVol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of Start</td>
<td>Time of Start</td>
<td></td>
</tr>
<tr>
<td>Date of Stop</td>
<td>Time of Stop</td>
<td></td>
</tr>
<tr>
<td>Pre-weighted Filter and Bag (g)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Flow Rate (L/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Final Flow Rate (L/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MiniVol Sample Flow (L)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MiniVol PM10 (mg)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MiniVol PM10 Concentration (mg PM10/m³)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Example of Data Form Entries for Ogawa Passive Badges Used in Accra and Dar es Salaam Programs

Ogawa Passive Badges: Operation and Forms

- Operation
- Forms

Copy of the SO₂, NO₂, and O₃ Section from the Basic Field Operation Form

<table>
<thead>
<tr>
<th>SO₂</th>
<th>NO₂</th>
<th>O₃</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date of Start</td>
<td>Time of Start</td>
<td>Date of Stop</td>
</tr>
</tbody>
</table>
Example of Data Form Entries for Draeger Tubes Used in Accra and Dar es Salaam Programs

CO Draeger Diffusion Tubes: Operation and Forms

- Operation
- Forms

CO Draeger Tubes

<table>
<thead>
<tr>
<th>Sample Duration (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
</tr>
</tbody>
</table>

Date of Start: ___________________ Time of Start: ___________________
Date of Stop: ___________________ Time of Stop: ___________________

Reading on diffusion tube: ___________________ ppm-hour

Divide tube reading by the sample duration: ___________________ ppm Carbon monoxide: Time-Weighted Average (TWA)

Example of Chain-of-Custody Signature and Date Section on the Request for Analysis Form Used in the Accra and Dar es Salaam Programs

IN:

Field Operator (sign and initial): ___________________ Date: ____________
Lab Technician (sign and initial): ___________________ Date: ____________

OUT:

Lab Technician (sign and initial): ___________________ Date: ____________
Field Operator (sign and initial): ____________________ Date: ____________

(Original Field Operation Form, Original Request for Analysis Form, and result of analysis to field operator; copies of the Field Operation Form, Request for Analysis Form, and results remain with the laboratory technician.)

RAF Version 12/31/04

Copy of Site Sketch Used in Accra and Dar es Salaam Programs
Type of Field Notebook Entries Used in the Accra and Dar es Salaam Programs

- Record initial and final weights of PM_{10} samples
- Record any information that would not fit into the Field Operation Form
- Record important details that need immediate responses
- Use as a means of communicating with other Field Operators

Type of Field Notebook Entries (Cont’d)

- Record Sample ID and Site Location of air samples collected during the sampling period
- Record dates and results of maintenance checks, verification checks, and calibration checks of sampling equipment
- Record dates of replacement of equipment and parts and identify problem
- Account for missing samples or invalidated samples in more detail

Electronic Data Management Methods

Direct electronic download
- Floppy disk
- Flash card/memory stick
- Hard drive
- Analog and digital input/output
Data Acquisition Systems

Ambient/Calibration Manifold Interface

Centralized Data Management Methods

Central data repository location with controlled access to all data storage:

- Field data
- Laboratory data
- Backup copies (2 minimum sources)
Data Compilation

- Chain-of-custody
- Unique labeling system
- Program effectiveness

Communicating Data

- Summary reports and displays to decision-makers
- Reports to general public
- Communication among air monitoring team members

Case Study Exercise
Quality Assurance Project Plan (QAPP)

- Project management
- Measurement/data acquisition
- Assessment/quality assurance oversight
- Data validation and usability
- General information

QAPP: Project Management

Key Items:
- Discuss roles and responsibilities of individuals and organizations participating in the project
- Develop data quality objectives (DQOs) and measurement quality objectives (MQOs)
- Identify special training needs for personnel
- Discuss how data and records are stored and reported

QAPP: Measurement/Data Acquisition

Key Items:
- Outline sampling design, sampling frequencies, and measurement parameters of interest
- Sampling collection method
- Describe method for sample labeling and assurance of chain-of-custody
- List equipment to be used for sample collection and laboratory analysis
- Discuss quality control (QC) procedures, maintenance checks, calibration frequency
- Outline data management system
QAPP: Assessment/Oversight

Key Items:
- Describe assessment activity for the project
- Identify frequency, content, and distribution of reports to keep stakeholders informed

QAPP: Data Validation and Usability

Key Items:
- Quality criteria to accept or reject data
- Discuss process to validate and verify data
- Describe steps to evaluate that the data quality objectives have been met

QAPP: General Information

Key Items:
- List all references
- List all Standard Operating Procedures (SOPs) and Operator's Manuals
- Identify all tables, figures, or exhibits
Module 7 Review

- Developed an air monitoring plan and quality assurance project plan
- Discussed the components of the air monitoring plan and quality assurance project plan

Case Study Exercise