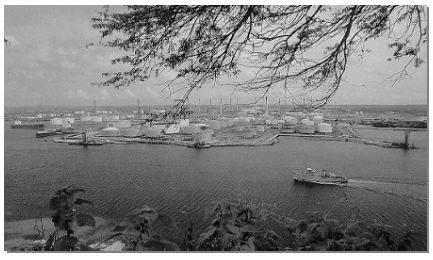
Module 4:
Emission Inventory Planning, Quality Assurance and Quality Control

Emission Inventory Compilation Steps

- Planning
- Gathering information
- Estimating Emissions
- Compiling the Database
- QA/QC
- Data Augmentation
- Documentation
- Providing Access to Data



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Emissions Inventory Planning

- Planning is needed to ensure that the inventory objectives are met
- Step #1 is to define the inventory uses and users
- The end uses of the inventory determine:
  - > The required staffing and resource allocation
  - > The structure of the inventory
  - > The data quality objectives (DQOs)
  - > The source types, categories, and pollutants to be included
  - > Necessary level of spatial and temporal resolution

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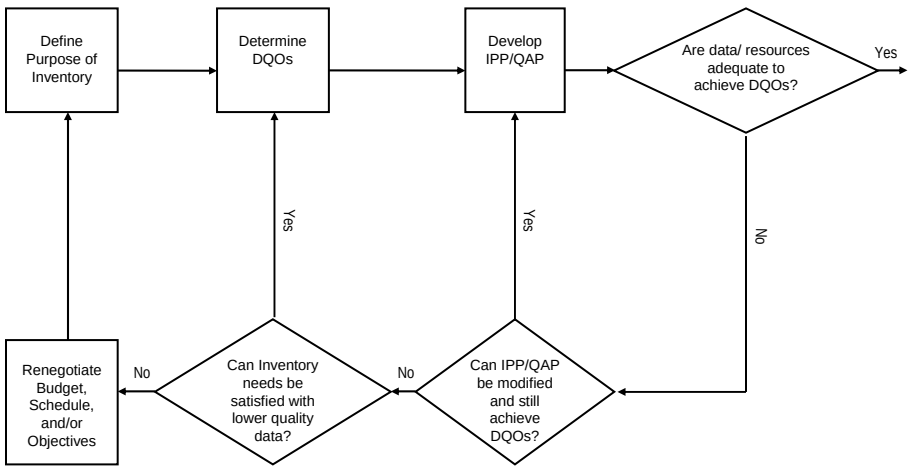
Emissions Inventory Development Process



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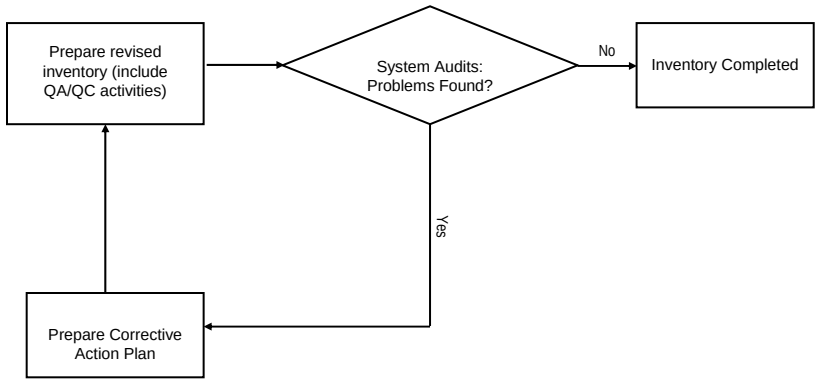
Process (continued)



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Preliminary Planning Activities

- Define the scope of the proposed inventory
  - > Base year and geographical area
  - > Pollutants
  - > Source types and categories
  - > Spatial and temporal resolution
- Staff and resource considerations
- Interagency communication

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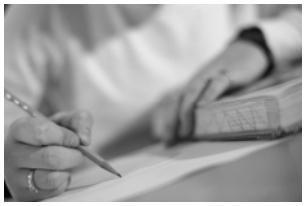
Inventory Preparation Plan

- A concise, prescriptive document that declares how an inventory will be developed and reported
- Important sections of an IPP:
  - > Introduction
  - > Inventory Scope
  - > Description of all steps in compiling inventory
  - > Emission Estimation Methodology
  - > Data Management and Reporting
  - > Quality Assurance Plan
  - > Documentation
  - > Staffing and Resources



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Inventory Preparation Plan

- Introduction
  - > Define uses of inventory and acceptable data quality for uses of inventory
  - > Define Data Quality Objectives (DQOs)
- Inventory Scope:
  - > Identify pollutants and source categories, geographic area, and time interval to be included in inventory

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Inventory Preparation Plan

- Description of be all steps in compiling emissions inventory
- Emission Estimation Methodology - Define all procedures that will be used to estimate emissions
  - > Data collection
  - > Emission estimation methodology
    - – Methods should be selected for each category
    - – Selection of methods is based on several factors
      - Resources available to develop the inventory
      - Data availability
      - Time schedules
      - Priority of the category
      - DQOs and Intended uses of the inventory
    - – Preferred" and "Alternative" methods

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Inventory Preparation Plan

- Data Management and Reporting
  - > Objectives:
    - – To provide a reliable and systematic procedure to record, report, and manage emissions inventory data
    - – To ensure inventory results are developed in appropriate format
    - – To lead to selection of a data management system that will facilitate the appropriate reporting format needed to transfer, share, and store emissions inventory data
  - > Select inventory data management and reporting system
    - – Facilitate data backup and revision
    - – Allow tracking of changes to the inventory
    - – Includes: Input, Output and Management of data
  - > Summarize data reporting and documentation
    - – Complete files with all data fields
    - – Data summaries
    - – Documentation

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Inventory Preparation Plan

- Quality Assurance Plan
- Documentation
- Staffing and Resources
  - > Establish resource requirements and schedule
  - > Identify partners and develop communication plan
    - – Industry
    - – Trade Associations
    - – Agencies
    - – Community groups

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Selection of Emission Estimation Methods

- Methods should be selected for each category
- Selection of methods is based on several factors
  - > Resources available to develop the inventory
  - > Data availability
  - > Time schedules
  - > Priority of the category
  - > DQOs
  - > Intended uses of the inventory
- "Preferred" and "Alternative" methods

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Emissions Data Management Strategy

- Objectives:
  - > To provide a reliable and systematic procedure to record, report, and manage emissions inventory data
  - > To ensure inventory results are developed in appropriate format
  - > To lead to selection of a data management system that will facilitate the appropriate reporting format needed to transfer, share, and store emissions inventory data
- Electronic spreadsheets and databases
  - > Facilitate data backup and revision
  - > Allow tracking of changes to the inventory

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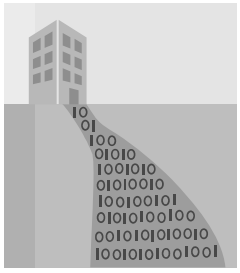
Emissions Data Format

- Electronic submittals of data facilitate use of inventory by various entities
  - > Facility-to-agency reporting
  - > Agency-to-agency reporting
- Many options for reporting data:
  - > U.S. EPA's National Emissions Inventory Format (NIF)
  - > U.S. EPA's Central Data Exchange (CDX)
  - > Others available to South Africa (e.g., HEAT)



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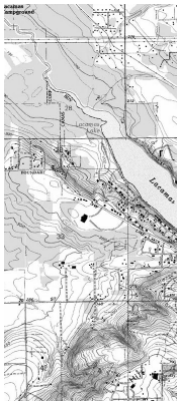
Emissions Data Elements



- Emission data elements to be collected within a database system and could include:
  - Standard Industrial Classification (SIC) codes
  - Source Classification Codes (SCCs)
  - Emission rates (tons/year, kg/day, g/second)
  - Geographic location
    - Universal Transverse Mercator (UTM)
    - Latitude/longitude
    - Country, province, city, district, grid cell

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Emissions Inventory Documentation

- A comprehensive document that provides adequate detail on data, methods, and calculations to duplicate the inventory results
  - Clear, concise text
  - Tables and graphs to illustrate results
  - Appropriate level of commentary related to conclusions and recommendations
- Include an outline of the inventory report within the IPP/QAP to facilitate early-feedback on content

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Emissions Inventory Report Outline

- Executive Summary
  - > Overview of scope, uses
  - > Inventory summaries
- Introduction
  - > Background, objectives, uses
  - > Scope, inventory characteristics
  - > Data management approach
- Point Source Inventory
  - > Categories
  - > Methods, data, assumptions
  - > QA/QC steps, corrective actions
  - > Results by source category
- Area Source Inventory
- Motor Vehicle Inventory
- Nonroad Inventory
- Natural Source Inventory
- Results by Pollutant
- References
- Appendices
  - > Sample calculations
  - > Additional tables, graphs

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Summary: Emission Inventory Planning

- Inventory characteristics (e.g., year, pollutants, sources) are determined by the uses of the inventory
- Inventory Preparation Plan describes how and why the inventory is being developed
- Data management strategies address the elements needed to record and manage the inventory data and results
- Estimation methods are determined by the DQOs, resources, and data available
  - > Least resource/data intensive methods yield most uncertain results (extrapolation)
  - > Most resource/data intensive methods yield least uncertain results (source sampling)
- Proper inventory documentation allows reproduction of the emissions estimates

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Questions
or
Comments?

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Quality Assurance/Quality Control (QA/QC)

- QA versus QC
- QA Plan
- QA/QC Activities
- QA/QC Tools
- Uncertainty Analysis

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QA vs. QC

- External review and audit process
- Independent review by a third party to assess
  - > Effectiveness of QC program
  - > Overall quality, completeness, accuracy, representativeness of the inventory
- Conducted by person not involved in inventory development

- Routine technical activities to measure and control the quality of the inventory *as it is being compiled*
- Accuracy checks
- Uses standardized procedures
- Includes use of good documentation
- Carried out by members of the inventory team

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Quality Assurance (QA)

- Quality assurance is the system of procedures used to ensure that inventory meets a specified level of quality
- Purpose is to ensure development of a complete, accurate and consistent inventory that meets the defined need

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Quality Control (QC)

- Quality control is the system of routine technical activities designed to measure and control quality
- Example QC activities
  - > Comparing emissions to previous inventories
  - > Using checklists to ensure that all inventory development requirements are met
  - > Determining outliers by using computer-aided, graphical, or other reviews

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Quality Assurance Coordinator

- Individual responsible for all QA activities
- One person for entire inventory for each major section

- Individual not involved in actual inventory work

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Data Quality Objectives (DQOs)

- Qualitative and quantitative descriptors to interpret the degree of acceptability of data
  - > Accuracy
  - > Comparability
  - > Completeness
  - > Representativeness
- Ensures that the final inventory meets intended uses
- DQOs must be realistic and achievable to be useful

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Example DQOs Table

DQO	Inventory Target Values
Accuracy/Uncertainty	• Achieve Data Attribute Rating System (DARS) score of ≥ 0.7 for all area sources contributing >10% of total emissions of VOC or NO_x • Achieve DARS score of ≥ 0.8 for all point sources ≥ 100 metric tons/yr • Quantify variability of all emissions based on source test data or surveys • Use expert judgement method to estimate uncertainty for all sources >5% of emissions of any pollutant
Completeness	• Include 100% of all point sources equal to or greater than 100 metric tons/yr • Include 90% of all other point sources • Include top 20 emitting area source categories from the 1999 inventory
Representativeness	• Provinces A, B, C, and D • 2004 daily ozone season
Comparability	• Results to be compared with the 1999 base year inventory

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Quality Assurance Plan (QAP)

- A description of specific QA and QC procedures and responsibilities
- Generally accompanies an IPP
- Initial QA/QC planning
  - > Identify a Quality Assurance Coordinator
  - > Restate the DQOs
  - > Determine resources needed to implement the QA plan
  - > Determine authority and responsibility for QA/QC plan implementation

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Components of a Comprehensive QAP

- Policy Statement
  - > Declares agency commitment
- Introduction
- QA Program Summary
  - > Data flow
  - > Points where QC procedures will be applied
- Technical Work Plan
  - > Resources, documentation, schedule
- QA/QC Procedures
  - > Techniques, checkpoints
- Inventory Preparation and QA/QC Activities
  - > Roles and responsibilities of agencies, personnel
  - > Reality checks, peer review, sensitivity checks, audits, etc.
- Corrective Action Mechanisms
- References

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Primary QA/QC Methods

Method	Reasonableness of Emissions, Data	Validity of Methods, Assumptions	Mathematical Correctness	Validity of Data	Accuracy of Estimates
Reality checks	✓				
Peer review	✓	✓			
Sample calculations			✓	✓	
Computerized checks	✓		✓	✓	
Sensitivity analysis		✓			
Statistical checks	✓		✓		
Independent audits	✓	✓	✓	✓	
Emissions validation	✓	✓			✓

Primary QA/QC Methods

- Reality checks
  - Is this number reasonable? Does it make sense?
  - You should never use the reality check as the sole criterion of quality
- Peer review
  - An independent review of calculations, assumptions, and/or documentation by person with a moderate to high level of technical experience
- Sample calculations – Replication of Calculations
  - Most reliable way to detect computational errors
  - General rule, a minimum of 10% of calculations is checked depending on:
    - Complexity of calculations
    - Inventory DQOs
    - Rate of errors encountered

Primary QA/QC Methods

- Computerized checks
  - > Automated data checks can be built-in functions of databases, models, or spreadsheets or can be designed as stand-along programs
  - > Automate to
    - – Check for data format errors
    - – Conduct range checks to ensure data falls within specified min/max
    - – Provide look-up tables to define permissible entries
- Sensitivity analysis
- Emission estimation validation

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Primary QA/QC Methods

- Statistical checks
  - > Descriptive statistics
  - > Statistical procedure to identify outliers
  - > Statistical tests
- Independent Audit
  - > Identify staffing issues
  - > Evaluate the effectiveness of the technical and quality procedures
  - > Provide confidence in the accuracy and completeness of the emission data
  - > Determine if DQOs are being met
  - > Identify the need for additional QC measures

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What QC Procedures Should I Follow?

- Best implemented through standardized checklists
- Use checklist to monitor
  - > Data collection
  - > Data calculations
  - > Evaluation of data reasonableness
  - > Evaluation of data completeness
  - > Data coding and recording
  - > Data tracking

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What Types of Errors Are Typically Found During QC?

- Missing facilities
- Duplicate facilities
- Closed facilities
- Improper facility locations
- Missing operating or technical data
- Erroneous technical data
- Inconsistent point and nonpoint source size designation
- Double counting
- Errors in calculations
- Data entry and transposition errors; data coding errors

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QA/QC Tools

- *Emissions Inventory Improvement Program, Volume VI: Quality Assurance/Quality Control*, U.S. EPA, 1997 (http://www.epa.gov/ttn/chief/eiip/techreport/volume06/index.html)
- QA/QC Checklists
- Computer software
  - > Automated QC tools available
    - – Format
    - – Emissions

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QA/QC Tools

See Appendix A, B, and C included in your student handbook notebook.

- Appendix A – Sample QA/QC Corrective Action Form
- Appendix B – Sample QA/QC Checklists
- Appendix C – Sample QA Audit Checklist

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QA/QC Documentation

- QA/QC documentation should include records of QA/QC activities, especially changes made as a result of these activities
  - > Any calculation sheets and QA/QC checklists
  - > Responses to QA/QC audits

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QA/QC Documentation: How Do I Document QA/QC Procedures?

- QA/QC must be documented and reported
- Report should include
  - > Procedures used
  - > Technical approach used to implement QA plan
  - > Dates of each audit, and the names of the reviewers
  - > Results of QA activities, including problems found, correction actions and recommendations
  - > Discussion of the inventory quality

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Uncertainty in Emissions Inventories

- Two types of errors cause uncertainty in emissions inventories:
  - > Bias = Systematic difference between a measurement and its true value
  - > Imprecision = Random fluctuations between a measurement and its true value
- Factors introducing uncertainty in emissions data
  - > Variability
    (spatial and temporal uncertainty)
  - > Parameter uncertainty
  - > Model uncertainty

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When Should Uncertainty in Emissions Inventories be Estimated?

- Overall objective of an uncertainty analysis is to develop confidence limits (e.g., 90-95%), about the mean of emission estimates from each source type analyzed.
- A needs analysis can help determine:
  - > Degree of acceptable uncertainty
  - > Appropriate statistical approach
  - > Resources needed to implement the approach

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Methods and Relative Time to Estimate Emissions Uncertainty

- <100 Hours
  - > Qualitative discussion
  - > Subjective Data Quality Ratings
- <500 Hours
  - > Data Attribute Rating System (DARS)
  - > Expert Estimation
  - > Propagation of Errors
- <1,000 Hours
  - > Direct Simulation
- >1,000 Hours
  - > Direct or indirect measurement
  - > Receptor modeling (source apportionment)
  - > Inverse air quality modeling

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Summary: Quality Assurance and Quality Control

- QA/QC is conducted external/internal to the emissions inventory development process
- A QA Plan implements QA/QC procedures and establishes DQOs for:
  - > Accuracy
  - > Comparability
  - > Completeness
  - > Representativeness
- EIIP, Volume VI is a good reference
- Uncertainty analysis can help establish level of quality of an inventory, can be resource intensive

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Questions
or
Comments?

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END

Module 4:
Emission Inventory Planning,
Quality Assurance and
Quality Control

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