Module 3:

Inventory Compilation Steps and Quality Assurance and Quality Control

What Does An Inventory Contain?

An inventory includes:

- Database with fields needed to support uses of the inventory
  - Mandatory fields
  - Non-Mandatory fields
- Background information needed to reproduce inventory

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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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Emission Inventory Compilation: Why is Planning Important?

- Every inventory requires extensive advanced planning
- Emission inventories are the foundation of many decisions
- Planning is needed to ensure that the inventory objectives are met.
- Mistakes early in the process interject errors in downstream calculations
- Redoing work is costly and embarrassing

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Emissions Inventory Planning

- 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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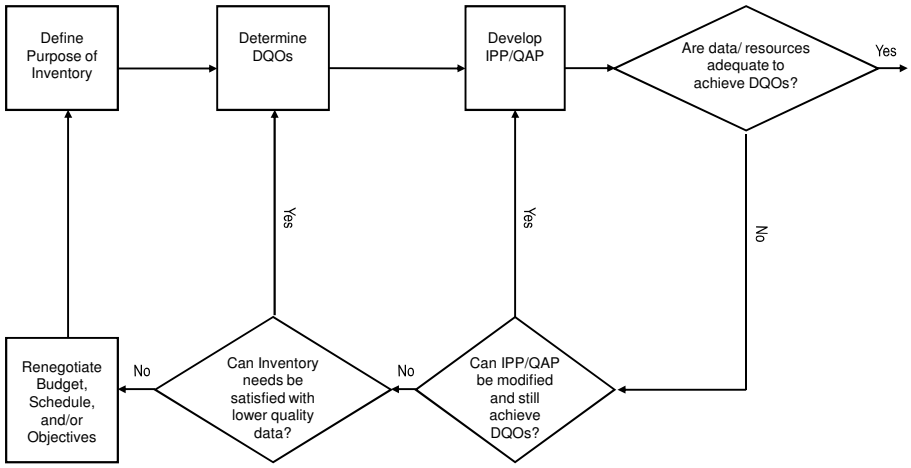
Emissions Inventory Development Process



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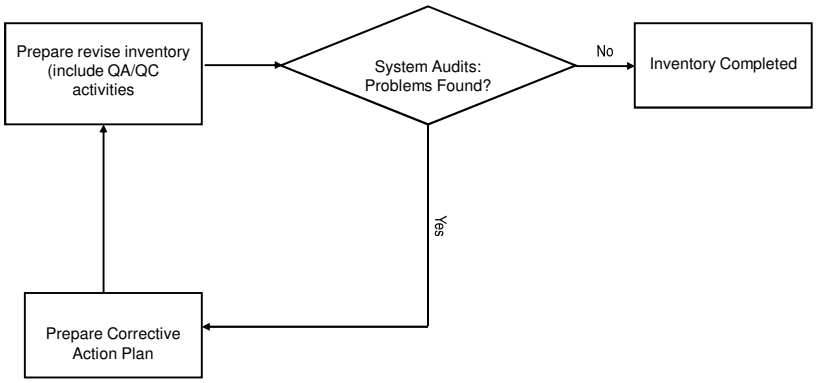
Process (continued)



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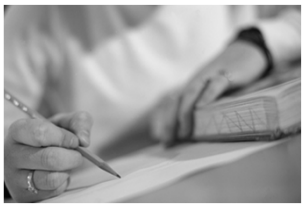
Inventory Preparation Plan

- 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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Inventory Compilation: Gathering Information - What Data Should I Gather?

- Inventory guidance
- Existing emissions data
- Preliminary screening studies – usually for nonpoint sources
- Emission factors and Models
- Source characterization documents
- Activity data references

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Gathering Information: How Do I Identify Source Categories?

- Usually dictated by the pollutant of interest
- Past inventory efforts and historical knowledge of the inventory area can help identify categories
- Inventories in other countries

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Gathering Information: How Should I Research Sources of Pollutants?

- Research all available resources to identify sources of pollutants
  - Documents and Tools
  - Existing inventories
  - Source tests
  - Compliance data
  - Permits
  - Risk assessments
- Eliminate any sources that are not found within the inventory area
- Prioritize the list of remaining categories
- Consider time and budget constraints
- Eliminate any categories for which no emission factors or acceptable methods have been developed
- Document your decisions for the benefit of future preparers

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How do I Identify Specific Point Sources in the Geographic Area?

- After identifying pollutants and source categories of interest for inventory, compile a list of facilities
  - Name and address, size and SIC
- Sources useful for identifying point sources
  - Commerce directories
  - Existing inventories
  - Others:

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Preliminary Screening Study for Nonpoint Sources

Conduct Preliminary Screening Study to:

- Determine pollutants emitted by source categories within a geographic area
- Determine which pollutants to inventory
- Identify source categories of pollutants.
- Determine which source categories to inventory as point vs. nonpoint sources in specific geographic areas.

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Where Do I Find Emission Factor and Models Information?

- Government agencies
- Industry
- Source test data for compliance purposes
- Professional societies - AWMA

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Where Do I Find Source Characterization Information?

- Emission estimation guidance from EPA, UNEP, etc.
- Emission factor documents such as AP-42
- Existing inventory documentation

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Where Do I Find Applicable Point Source Activity Data?

- Surveys and questionnaires
- Direct plant inspections
- Permit applications or compliance files
- Industrial directories
- Commerce and Labor statistics
- National directories of manufacturers
- Data compiled by private research and development companies, e.g. SRI
- Trade and professional associations

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Where Do I Find Applicable Nonpoint Source Activity Data?

- Government-sponsored surveys
- Industry data
- Dept of Commerce
  - Business Patterns
  - Census of Population
  - Census of Manufacturers
  - Census of Agriculture
  - City Data Book
  - Current Industrial Reports
  - Census of Retail Trade

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Where Do I Find Applicable Nonpoint Source Activity Parameters?

- Departments Of Labor
- Agriculture Offices
- Solid Waste Management agencies
- Fire marshals
- Port Authority
- Health Departments
- Miscellaneous statistical government & trade publications
- Departments of Transportation and Energy Offices
  - Energy Reports
  - Petroleum Marketing Annual
  - Natural Gas Annual

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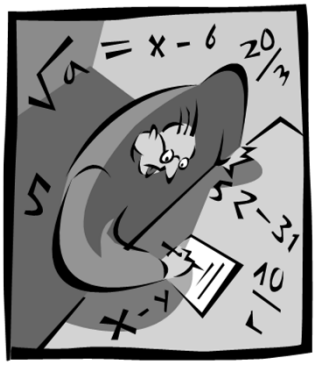
Inventory Compilation: Emission Estimation Methods - Point Sources

- Point Source Methods
  - Continuous Emission Monitor (CEM)
  - Source tests
  - Material balance
  - Emission factor x activity factors
  - Fuel analysis
  - Emission estimation models
  - Engineering judgment



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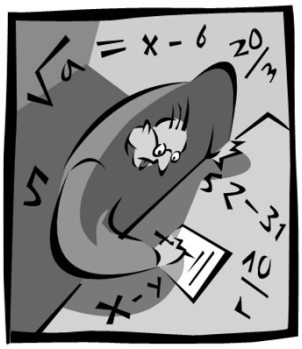
Emission Estimation Methods - Nonpoint and Mobile Sources

- Nonpoint Source Methods
  - Surveys and questionnaires
  - Material balance
  - Emission factor x activity factors
  - Emission models
- Mobile
  - Approved models



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How Do I Choose Emission Estimation Methods?

- Choice of methods depends on:
  - Pollutant and source category priorities
  - Intended use of the inventory
  - Resources
  - Availability of data
  - Compromise between method accuracy and cost to implement

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What Emissions Inventory Approaches Should I Use for Point Sources?

- Point source methods are generally bottom-up. Bottom-up methods include:
  - Surveys – most used method
    - Collect all information including emissions estimates and necessary data fields
    - Collect activity data and information about facility and its operations
      - If emissions are not included as part of survey, agency makes emission estimates
  - Source measurements – most resource intensive
    - CEM data
    - Source tests
    - Compliance tests
- Top-down approaches for point sources include:
  - Model plant calculations
  - Projections from previous inventories

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What Emissions Inventory Approaches Should I Use for Nonpoint Sources?

- Applying point source methods to nonpoint sources (bottom-up)
- Conducting local activity level surveys (bottom-up)
- Applying a top-down approach
  - Most common approach uses emissions factors and activity data

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Emission Estimation Methods: Temporal Allocation

- Emissions may be reported as seasonal, day of week, or hourly. Temporal allocation is need to adjust emission to time period of interest.
- Emissions estimates are adjusted to account for temporal differences by apportioning emissions to a particular time period using:
  - Activity level
  - Rate of emissions
- How do I make temporal adjustments?
  - Collect activity data for each specific time period represented by the inventory
  - Conduct a survey to collect source information (include seasonal emission rate variations)
  - Collect information from indirect sources such as business and labor statistics

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Emission Estimation Methods: Spatial Allocation

- Spatial Allocation is the adjustment of activity levels or emission estimates to a smaller or larger geographic area than the area for which the activity levels or emission estimates of nonpoint sources are prepared.
- How do I spatially allocate emissions? Make Adjustments based on:
  - Local activity level data
  - National data
  - Population data
  - Employment data

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Emission Estimation Methods: How Do I Maintain the Emission Inventory?

- Monitor and record changes in the total number of sources as well as changes in operation of existing sources
- Necessary to collect new data and information to calculate emissions to represent current conditions
- Existing inventories serve as the starting point for future inventories

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Inventory Compilation: Compiling the Data into a Database

- The emission inventory database should contain all data elements necessary to transfer, share, and store emissions inventory data
  - The term data element refers to any piece of information used in the inventory compilation process
  - Selection of data elements in the emission inventory database will be dependent on the uses of the data

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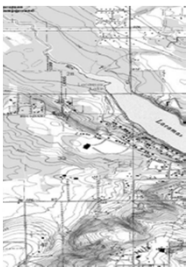
Compiling the Data into a Database : Point Source Data Elements



Data elements needed for modeling

- Source Identification
  - Facility Name and ID
- Source Location
  - Latitude, Longitude
    - Latitude and Longitude Measure in decimal degrees
    - Accuracy and Reliability of Latitude and Longitude Coordinates
  - Physical Address
    - Country, province, city, district, grid cell
- Source Category Description
  - Type of Industry (example: refinery, utility coal boiler, etc.)

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Compiling the Data into a Database : Point Source Data Elements

Data elements needed for modeling

- Process Description
  - Type of emitting process within a facility (example: petroleum refinery contains boilers, wastewater treatment, catalytic crackers, vents, etc.)
  - IDs for units and processes
- Emission Release Point Data
  - Release Type- Stack or Fugitive
  - Emission Release Point (stack) Parameters
    - Height
    - Diameter
    - Temperature
    - Velocity or flow rate
  - Capacity
  - Latitude and Longitude for each stack and fugitive release
  - Emission Release Point IDs

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Compiling the Data into a Database : Point Source Data Elements

Data elements needed for modeling

- Activity
  - Temporal Data:
    - Operating schedule: Start and end date and times
    - Seasonal throughputs
  - Throughput data for emissions
- Control Device
  - Equipment Type
  - Efficiency
- Emissions By Pollutant Species (CAS number)
  - Amount (tons/year, kg/day, g/second)
  - Estimation calculation methods
    - Include emission factor if this method is used
  - Emission Type - Actual, Allowable, Potential, Maximum
  - Emissions uncertainty

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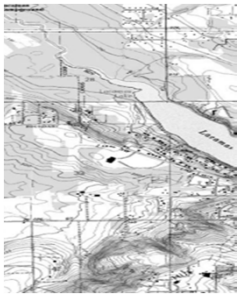
Compiling the Data into a Database : Nonpoint Source Data Elements

Data elements needed for modeling



- Source Identification
  - Source Category Description
- Source Location
  - Country, province, city, district, grid cell
- Activity
  - Temporal Data:
    - Operating schedule: Start and end date and times
    - Seasonal throughputs
  - Throughput data for emissions

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Compiling the Data into a Database : Nonpoint Source Data Elements

Data elements needed for modeling

- Control Device
  - Equipment Type
  - Efficiency
- Emissions By Pollutant Species (CAS number)
  - Amount (tons/year, kg/day, g/second)
  - Estimation calculation methods
    - Include emission factor if this method is used
  - Emission Type - Actual, Allowable, Potential, Maximum
  - Emissions uncertainty

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Compiling the Data into a Database : Mobile Source Data Elements

Data elements needed for modeling

- Source Location
  - Country, province, city, district, grid cell
- Source Category Description
  - Source Type – Onroad or Nonroad
  - Source Description:
    - Fuel type
    - Vehicle type or Nonroad equipment type
    - Exhaust or evaporative emissions

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Compiling the Data into a Database : Mobile Source Data Elements

Data elements needed for modeling

- Activity
  - Temporal Data:
    - Operating schedule: Start and end date and times
    - Seasonal throughputs
  - Throughput: VMT (example: vehicle miles traveled)
- Emissions By Pollutant Species (CAS number)
  - Amount (tons/year, kg/day, g/second)
  - Estimation calculation methods including model number
  - Emissions uncertainty

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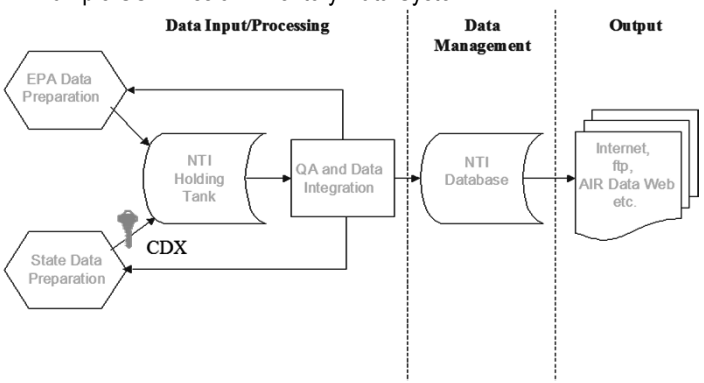
Compiling the Data into a Database : Emissions Data System

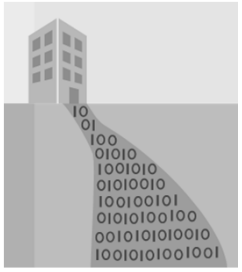
Emissions Data Systems should include: Input, Output and Management of Data

Example US Emission Inventory Data System: NEI



Compiling the Data into a Database : Emissions Data System

- Input of Data
  - Electronic submittals of data facilitate use of inventory by various entities
    - Facility-to-agency reporting
    - Agency-to-agency reporting
  - Considerations for electronic reporting of data:
    - Provide Single Point of Entry Move Data to from data providers to agency
    - Support Variety of Formats
      - User-Defined Flat Files
      - Extensible Markup Language (XML)
      - Web Forms
    - Automate and Secure Data Transfer With All Trading Partners



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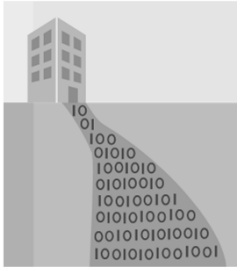
Compiling the Data into a Database : Emissions Data System

- **Management of Data**
  - Facilitate data backup and revision
  - Allow tracking of changes to the inventory
  - Transfer, share, and store emissions inventory data
  - QA QC of data



- **Output of Data**
  - Determine audience and their needs
    - Internal vs. External audience
    - Level of data needed
      - Full data base with all data elements
      - Summary data sets
  - Determine how to provide access to data
    - FTP site or web or CD-ROM/DVD
    - Raw data or Interactive query systems

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Inventory Compilation: Quality Assurance/Quality Control (QA/QC)

- QA/QC is not optional in emission inventory development
  - Integral part of emission inventory compilation
- Why do we need to conduct QC and QA?
  - Instills confidence in emission estimates and their uses
  - Improves accuracy of emission estimates
  - Improves assessment of emissions on air quality
  - Provides a better assessment of emission inputs to air quality models
  - Improves transparency of estimates and provides documentation
  - Lowers program costs for subsequent data base maintenance

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Quality Assurance/ Quality Control (QA/QC)

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

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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
- QA involves external review and audit procedures by a third party

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Quality Control (QC)

- Quality control is the system of routine internal 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
  - Conducting accuracy checks
  - Using approved standardized procedures for checking emissions calculations

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QA vs. QC

QA	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 internal 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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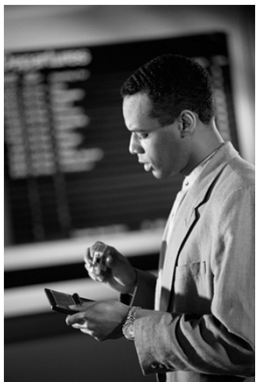
Quality Assurance Coordinator



- 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 statements to identify the level of uncertainty that a decision-maker is willing to accept
- DQOs ensure that the final inventory meets intended uses
- DQOs are Identified as part of the inventory planning process
- DQOs must be realistic and achievable to be useful

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DQOs : Example EPA NEI

- NEI will meet US Government's Office of Management and Budget Information Quality Guidelines to ensure transparency and reproducibility of NEI data. Because the NEI is considered an influential product , EPA will ensure maximum objectivity, utility and integrity of data.

- DQO will require NEI to:
  - Undergo scientific peer review
    - Must be capable of being reproduced by a qualified third party
  - Have a Quality Assurance Plan
  - Be transparent
    - Log and archive all original submittals
    - Archive holding tables which contain compiled revisions
    - Archive and index intermediate work products
    - Incorporate data elements in output files which allow user to determine source of record and nature of revision as well as origin of defaulted data
    - Prepare Emissions History Table to track changes over time in NEI
    - Assign data ratings for estimates
    - Prepare documentation including end users of inventory, purpose, data sources, submittal contacts and methodology

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Data Quality Indicators (DQIs)

- Data quality indicators - qualitative and quantitative descriptors used to interpret degree of acceptability or utility of the data
- Principal DQIs
  - Accuracy
  - Comparability
  - Completeness
  - Representativeness

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Example DQIs Table

DQI	Inventory Target Values
Accuracy/Uncertainty	• Quantify variability of all emissions based on source test data or surveys • Use expert judgment 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 of VOC • Include 90% of all other point sources • Include top 20 emitting nonpoint 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
- Every Inventory Preparation Plan should contain a QAP
- Initial QA/QC planning
  - Identify a Quality Assurance Coordinator
  - Restate the DQOs and DQIs
  - Determine resources needed to implement the QA plan
  - Determine authority and responsibility for QA/QC plan implementation

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Quality Assurance Plan (QAP)

Accurate and complete QAPs for inventories are necessary to:

- Ensure that the final compilation of the data accurately reflects the inventory effort
- Support QA/QC assessments of inventory
- Determine quality of emission estimates and data references
- Allow reproducibility of estimates
- Ensure inventory will be starting point for future inventories

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Components of a Comprehensive QAP

- Policy Statement
  - Declares organization's 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	Mechanical Correctness	Validity of Data	Accuracy of Estimates
Reality checks	✓				
Peer review	✓	✓			
Sample calculations			✓	✓	
Computational checks	✓		✓	✓	
Sensitivity analysis		✓			
Statistical checks	✓		✓		
Independent audits	✓	✓	✓	✓	
Emissions validation	✓	✓			✓

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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

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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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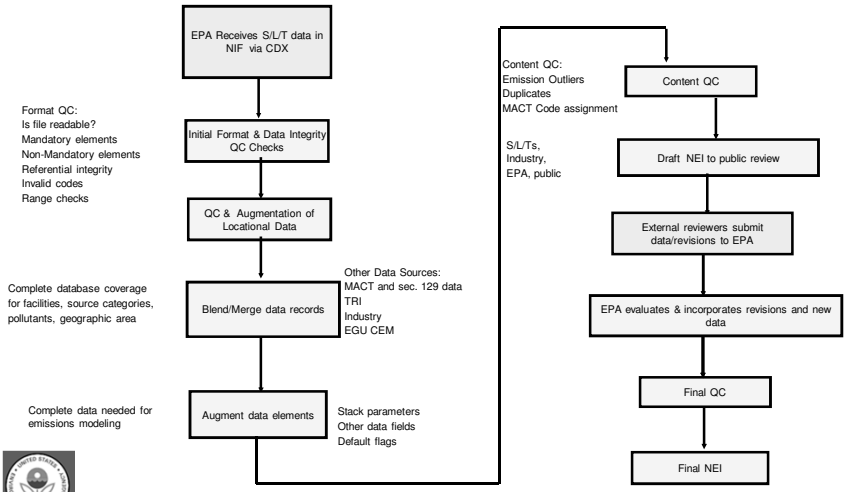
QA/QC: Example 1999 NEI for HAPs



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QA/QC: Example 1999 NEI for HAPs

- Goals of the 1999 NEI
  - Stick to schedule
  - Use standardized format for data inputs and outputs
  - Consistently use best data
  - Improve QA/QC
    - Reduce number of missing sources
    - Reduce errors in geographic coordinates
    - Reduce number of missing stack parameters
    - Improve consistency in nonpoint sources across nation
    - Improve quality of emission estimates
  - Reduce number of nonpoint source categories by increasing number of categories inventoried as point sources
  - Integrate criteria and HAP emissions where feasible

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QA/QC: Example 1999 NEI for HAPs

- Goals of QC/QA Program
  - Identify and correct duplicate facility, site, and emissions data
  - Identify and correct erroneous emissions data
  - Verify coordinate data
  - Review stack parameters
  - Identify and correct format errors
- Types of QC conducted by EPA
  - Format QC - identify potential errors with format
  - QC of Locational Data - verify facility locations
  - QC of stack parameters
  - Content QC - identify emission errors

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QA/QC: Example 1999 NEI for HAPs Format QC

- QC Activities include:
  - Checks data integrity (relational data base with required key fields)
  - Evaluate properties of data fields
    - Name
    - Data type (text, numeric types)
    - Length – maximum length of each field
    - Mandatory fields reported
  - Evaluate code values with acceptable values in code tables
  - Conduct range checks
    - Maximum and Minimum
- Corrective Actions resulting from QC include:
  - Referential integrity violations
    - Remove duplicate records and records with null and zero values
    - Work with agencies and tribes to correct records by creating needed records or removing records
  - Code Values
    - Correct invalid codes
    - Assign new codes not included in code table, e.g., additional HAPs that are not included in Pollutant Code Table
  - Range Checks
    - Contact agencies and tribes to verify that reported value is correct,
    - Correct values

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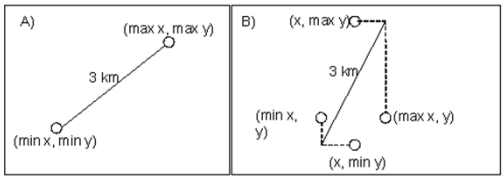
QA/QC: Example 1999 NEI for HAPs Location QC

QC Steps Include:

1. Convert UTM coordinates to latitudes/longitudes
2. Correct obvious errors in latitudes/longitudes (transcribed coordinates, etc.)
3. Examine coordinates for multiple stacks within a facility and verify all stacks are within 3 km of one another



4. Use a GIS program to plot latitude/longitude for each release point within reported county
   - Investigate points not within 5 km of an outside boundary of the county

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QA/QC: Example 1999 NEI for HAPs Stack Parameter QC

QC Steps Include:

1. Evaluate missing and invalid emission release point type
   - Emission Release Point Types
     - Fugitive
     - Non-Fugitive (stack):
       - Vertical, Horizontal, Goose Neck,
       - Vertical with Rain Cap, Downward Facing vent
   - QA using SCC/Emission Release Point Type Crosswalk
2. Evaluate missing and invalid parameters associated with fugitive emissions release points
   - Verify Stack Height is between 0.1 and 100 ft.
3. Evaluate missing, invalid, or inconsistent parameters associated with non-fugitive release points
   - Compare parameters to the following min/max values:
     - Height: 0.1 – 1200 ft
     - Temperature*: 50 – 1800 ˚F, Verify Temperature is greater than 250 ˚F for boilers and incinerators
     - Diameter: 0.1 – 50 ft
     - Velocity: 0.1 – 100 ft/sec
   - Determine if out of range value is acceptable for source category.
   - **Evaluate internal consistency between parameters**
     - **Stack Height < Stack Diameter**
     - **Reported Flow Rate and Calculated Flow Rate are within 10% of each other**
       - **Flow rate =((Pi)*(Diameter/2))2 *Velocity**

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QA/QC: Example 1999 NEI for HAPs Emissions Content QC

QC Activities:

- Identify duplicate emissions
  - Identify facilities having different IDs, but identical latitude and longitude
    - Similar names – missing coordinate data, addresses, etc.
    - Different names – change in ownership/name, use of subsidiary names, use of abbreviated names, etc.
  - List top emitters of each pollutant
    - Identify facilities with same reported emissions of each pollutant

County State	NTI Unique Facility ID	Facility Name	MACT Code	SIC Code	HAP	Emissions	Data Source
Person NC	NTI37037	Progress Energy	1808-1 – Utility Coal	4911	Mercury	0.6	MACT
Person NC	NTINC0592	Roxboro CP&L	1808-1 – Utility Coal	4911	Mercury	0.6	State

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QA/QC: Example 1999 NEI for HAPs Emissions Content QC

Corrective Actions

- Correct Duplicate Facilities and Emissions
  - Evaluate pollutant emissions at potential duplicate facilities
  - If all pollutants are duplicated, delete one facility
  - If only some pollutants are duplicated, delete only emission records for duplicated pollutants

County State	NTI Unique Facility ID	Facility Name	MACT Code	SIC Code	HAP	Data Source	Resolution
Person NC	NTI37037	Progress Energy	1808-1 Utility Coal	4911	Lead, Mercury, Nickel	MACT	Delete Lead. Merge under one Unique Facility ID
Person NC	NTINC0592	Roxboro CP&L		4911	Lead, Mercury, POM	State	Delete Mercury, Merge under one Unique Facility ID

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QA/QC: Example 1999 NEI for HAPs Emissions Content QC

- Identify Outliers and Missing Emissions
  - Significant changes between 96 and 99 emissions by facility, category, county, and state
  - Significant variation (high std deviation) within 99 draft data for facilities within source categories
  - Individual facility checks
    - Identify top emitters for each pollutant nationwide
    - Rank each facility based on emissions nationwide
    - List top emitters for each pollutant/source category combination
- Correct Outliers
  - Investigate outliers by contacting organizations who provided the data
  - Make corrections to emissions
  - Add missing facilities and source categories

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QA/QC: Example 1999 NEI for HAPs Emissions Content QC

Example Outlier QC:

Pollutant Name:	Mercury
# Facilities:	24660
99 Point Source Emissions (tpy):	5.35E+06
96 Point Source Emissions (tpy):	124
Max Site %:	99.9
Maximum Emissions (tpy):	5.35E+06
Minimum Emissions (tpy):	1.18E-012
Standard Deviation:	3.4E+04
Range:	5.35E+06
Maximum Emitter:	Transamerican Waste Central Landfill, Inc.
NTI Facility ID:	NTIMS1091185 (State data)

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QA/QC: Actions after New or Revised Data Changes to Inventory

Standard Checks on any corrected or new data:

- QC format of revised and new records
- Review documentation provided by reviewers
- Verify that no source category overlap exists between draft and revised data
- Review revised emission estimates by source category and pollutant to determine validity of revisions
- Check for and resolve duplicate records
- Run checksums after any manipulation
- Check for missing data fields

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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 Rating System
  - 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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What Is Role of Emission Uncertainty in Ambient Model Concentrations?

- Total Mass
  - Completeness of emission sources - facilities and source categories
  - Speciation of compound classes for grouping
- Geographic Distribution of Mass
  - Facility location data
  - Spatial allocation of nonpoint sources
- Vertical Distribution of Mass
  - Stack parameters
- Chemical/Physical Characteristics
  - Assignment of PM coarse/fine splits
  - Assignment of reactivity classes
- Temporal Resolution
  - Allocation of emissions from annual to 3 hr

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Inventory Compilation: Data Augmentation

- Latitude/longitude coordinates
- Stack parameters
- Emissions Data Gaps

2002 NEI QA and Augmentation Report

www.epa.gov/ttn/chief/emch/invent/

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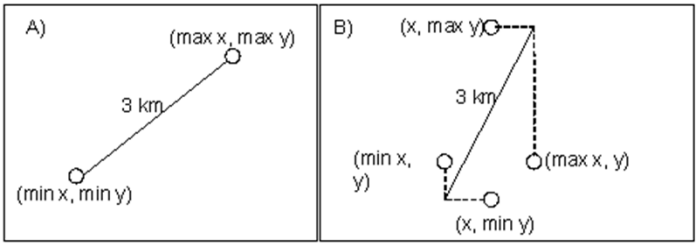
How Do I Augment Locational Coordinates? 1999 NEI for HAPs

1. Replace coordinates within a facility.

   For stacks where distance between points should not be > 3km, then:

   - Use average Site Latitude and Longitude calculated from valid points to replace outliers



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How Do I Augment Locational Coordinates? 1999 NEI for HAPs

2. Replace bad/missing coordinates outside of county boundary using the hierarchy below.

- Use Facility Specific Data
  - Average Site Latitude and Longitude calculated from valid points
- Use Geocoding software
  - First QA and correct address and zip codes
  - Then use Geocoder
    - Exact Matches
    - Near - match to single street block
    - Zip code +2 Zip code 5 (47% of GEOCODER matches)
    - Zip code 3 - match to 3 digit zip code
    - Ambig - match to one of possible multiple street segments

- Use data from previous inventory
- Use company website
- Use maps from the web
- Assign Site Release Point at County Centroid if coordinates cannot be found

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How Do I Augment Locational Coordinates? 1999 NEI for HAPs

3. Assign location coordinate default flags. Example from 2002 NEI.

Default Code	Description
Exact	Match is to within a unique intersection or within a single side of a single street block.
Near	Match is to a single street block but the correct placement within block is unknown.
Zip code+2	Match to a 5-digit zip code, plus the first two digits of the 4-digit extension.
Zipcode5	Match to a 5-digit zip code
Zipcode3	Match to multiple 3-digit zip codes based on postal service Sectional Center Facility (SCF).
Ambig	Match is to multiple street segments
Cntycent	County centroid.
NEI Fac Table	Coordinate found in the NEI Historical Facility Table
Site-Avg.	Average of accurate coordinates of other emission release points at the same site

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How Do I Augment Stack Parameters? 1999 NEI for HAPs

- Stack Parameters: height, diameter, temperature, velocity, and flow rate
- Procedure
  1. Replace missing and invalid emission release point type
  2. Replace missing and invalid parameters associated with fugitive emissions release points
  3. Replace missing, invalid, or inconsistent parameters associated with non-fugitive release points
  4. Assign stack parameter default flags

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How Do I Augment Stack Parameters? 1999 NEI for HAPs

1. Replace missing and invalid emission release point type
   - Emission Release Point Types:
     - Fugitive
     - Non-Fugitive (stack):
       - Vertical, Horizontal, Goose Neck,
       - Vertical with Rain Cap, Downward Facing vent
   - Replace invalid emission release point types based on source category
     - Fugitive
     - Non-fugitive
   - Proceed to Step 2 if Emission Release Point Type is fugitive and to Step 3 if Emission Release Point Type is non-fugitive

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How Do I Augment Stack Parameters? 1999 NEI for HAPs

2. Replace missing and invalid parameters associated with fugitive emissions release points
   - If Stack Height is between 0.1 and 100 ft, replace remaining parameters with defaults. Proceed to Step 4.
   - If Height is invalid, replace all parameters with defaults. Proceed to Step 4
   - Non-Fugitive Stack Parameter Defaults:
     - Height: 10 ft
     - Temperature: 72 ˚F
     - Diameter: 0.003 ft
     - Velocity: 0.0003 ft/sec
     - Flow: 0 ft3/sec

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How Do I Augment Stack Parameters? 1999 NEI for HAPs

3. Replace missing, invalid, or inconsistent parameters associated with non-fugitive release points

A. Compare parameters to the following min/max values:

Height:	0.1 – 1200 ft
Temperature*:	50 – 1800 ˚F, Verify T is greater than 250 ˚F for incinerators
Diameter:	0.1 – 50 ft
Velocity:	0.1 – 100 ft/sec

B. Determine if out of range value is acceptable for source category.

C. If all parameters are acceptable, proceed to Step D. If any parameter is missing or out of range, proceed to Step E.

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How Do I Augment Stack Parameters? 1999 NEI for HAPs

3. Replace missing, invalid, or inconsistent parameters associated with non-fugitive release points

D. Evaluate internal consistency between parameters

- Stack Height < Stack Diameter.
  - If Stack Height > Stack Diameter, replace all 5 parameters. Proceed to Step E.
  - If Stack Diameter< Stack Height, evaluate Flow Rate Consistency.
- Reported Flow Rate and Calculated Flow Rate are within 10% of each other

  Flow rate =((Pi)*(Diameter/2))2 *Velocity
- If internal consistency is met, process is complete. If internal consistency is not met, proceed to Step E.

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How Do I Augment Stack Parameters? 1999 NEI for HAPs

3. Replace missing, invalid, or inconsistent parameters associated with non-fugitive release points

E. Replace missing, invalid or inconsistent parameters using following hierarchy. Proceed to Step 4.

- Calculated flow rate or velocity.
- SCC default unless SCC is 39999999
- MACT Code default
- SIC Code default
- National default

Height:	10 ft
Temperature:	72 ˚F
Diameter:	1 ft
Velocity:	15 ft/sec
Flow:	12 ft3/sec

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How Do I Augment Stack Parameters? 1999 NEI for HAPs

4. Assign stack parameter default flags to indicate how stack parameters have been defaulted in the inventory. For example:

   0 = Original value (not a default)

   1 = SCC default

   2 = SIC Code default

   3 = National default

   4 = Calculated value

   5 = MACT Code default

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How Do I Identify and Fill Emission Data Gaps?

- Perform additional searches of databases to identify appropriate surrogate data
- Use the existing inventories to spatially allocate emissions
- Extrapolate emissions from other geographic areas
- Project emissions data from past inventories within the same geographic area. Includes both future growth and control.
  - Growth: Expected growth in an geographic region by industry sector
  - Control strategy: Expected impact of **modified or additional** control regulations

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How Do I Augment Emission for Pollutants?

How do I augment for individual compounds when a compound group is reported?

- Pollutants are often not speciated in original data submitted to agency. Examples include: PM2.5, PM coarse and fine, metals such as mercury and chromium
- Speciation methodology exists for some pollutant groups.
  - Mercury speciation factors
  - Chromium speciation factors for hexavalent and trivalent chromium
  - EPA NEI Data Augmentation Point Source Report
  - SPECIATE for PM coarse and fine

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Emission Inventory Compilation: Documentation

Why Is Documentation Important?

- Ensures that the final written compilation of the data accurately reflects the inventory effort.
- Supports QA/QC assessments of the inventory
- Ensures reproducibility of the inventory estimates
- Enables an inventory user or reviewer to assess the quality of the emission estimates and identify the data references
- Is a foundation for future inventories

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Documentation: What Records Must Be Kept?

- Documentation of all data collection and emission estimation activities
  - methods
  - assumptions
  - raw data
  - calculations (manual and electronic)

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What Documentation Procedures Should Be Followed?

- Procedures are established in Inventory Preparation Plan.
- It is important to record the **names** of persons responsible and the **dates** of **each** data manipulation activity
- Each project member should be assigned a numbered, project-specific, notebook for recording all calculations and assumptions
- All entries should be initialed and dated
- Calculations and documentation should be done in ink not pencil
- Errors should be corrected by drawing a single line through original and writing the correct value nearby. Corrections should be initialed and dated.

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Emission Inventory Documentation Report

- 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, DQOs
  - Inventory limitations
  - Scope, inventory characteristics
  - Data management approach
- Point Source Inventory
  - Categories
  - Methods, data, assumptions
  - QA/QC steps, corrective actions
  - Results by source category
- Nonpoint Source Inventory
- Motor Vehicle Inventory
- Nonroad Inventory
- Natural Source Inventory
- Results by Pollutant
- References
- Appendices
  - Sample calculations
  - Additional tables, graphs

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Emission Inventory Compilation: Access to Data

Distribution of product:

- Final emission inventory product includes both documentation and data files
- Data and documentation must meet the format and content requirements specified in the Inventory Preparation Plan
- You may want to consider developing a communication plan for emission inventory distribution.

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Summary: Inventory Compilation, Quality Assurance and Quality Control

- Inventory Compilation includes:
  - Planning
  - Gathering information
  - Estimating Emissions
  - Compiling the Database
  - QA/QC
  - Data Augmentation
  - Documentation
  - Providing Access to Data
- Inventory Preparation Plan describes how and why the inventory is being developed
- 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)
- Data management strategies address the elements needed to input, output and manage the inventory data and results

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Summary: Inventory Compilation, Quality Assurance and Quality Control

- A QA Plan implements QA/QC procedures and establishes DQOs for:
  - Accuracy
  - Comparability
  - Completeness
  - Representativeness
- Uncertainty analysis can help establish level of quality of an inventory, can be resource intensive
- After QA/QC is completed, data augmentation is necessary to address problems found in QA/QC of data in order to compile inventory that can meet DQOs
- Proper inventory documentation allows reproduction of the emissions estimates
- Thought should be given about final inventory products and their distribution

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Questions or

Comments?

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