Module 5:

Point Source Emission Inventory Development

Point Source Definition

- Stationary industrial sources
- Located at specific geographic “points” (latitude and longitude or UTM coordinates)
- Industrial facilities and their internal activities for which individual source records are maintained
- Point source inventories include detailed, site-specific information on operating parameters, throughputs, schedules, processes, etc.

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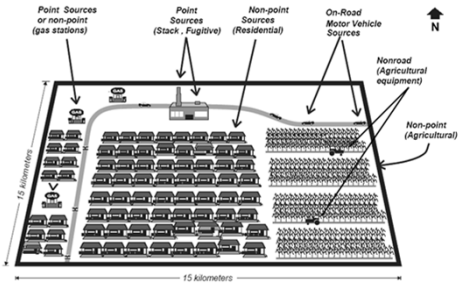
Point or Nonpoint?

- "Nonpoint" sources are activities where aggregated sources and emissions are maintained for the source category instead of individual information (e.g., petrol stations, dry cleaners).



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Point or Nonpoint?

- Classification of sources as point or nonpoint vary inventory-to-inventory and agency to agency
  - May be driven by end uses of data
  - May use thresholds (e.g., 10 metric tons/year) of specific pollutants to distinguish between "point" versus "nonpoint" sources
  - Can be driven by type of inventory – e.g., GHG national inventories use nonpoint approaches for many combustion sources
  - May be driven by available emission estimation methods
  - May be driven by available resources

- Need to reconcile point source and nonpoint source data within the same source category (see Module 6)

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Point or Nonpoint?

- Determine Point Source Threshold based on uses.
  - For modeling
    - Report as many facilities as possible, both large and small, as point sources
    - Report all large sources as point sources
    - Report all regulated sources as point sources
- Document decisions on point source thresholds

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How Are Point Sources Typically Categorized?

- Electric Utilities
- Chemical Manufacturing
- Petroleum Refining
- Primary/Secondary Metal Production
- Cement Production
- Mining and Quarrying
- Mineral Products
- Waste Disposal
- Automotive Industry
- Wood Pulping Operations
- Oil and Gas Production
- Printing and Publishing
- Surface Coating
- Bulk Fuel Terminals
- Wood Products Manufacturing
- Food and Agriculture Industry

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Air Pollutants Typically Emitted by Industry Type

Industry	VOC	PM	CO	NOx	SO2	Pb	Air Toxics
Electric Utilities		X	X	X	X	X	X
Chemical Manuf.	X						X
Petroleum Refinery	X	X					X
Primary/ Secondary Metal Production		X			X	X	X
Cement Production		X			X	X	X
Mining/ Quarrying		X				X	X
Mineral Products		X				X	X
Waste disposal	X	X				X	X

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Air Pollutants Typically Emitted by Industry Type

Industry	VOC	PM	CO	NOx	SO2	Pb	Air Toxics
Automotive Industry	X	X					X
Pulp/ Paper		X			X		X
Oil/Gas Production	X						X
Printing and Publishing	X						X
Surface Coating	X						X
Bulk Fuel Terminals	X						X
Wood Products Manuf.	X						X
Food and Ag Industryl	X						X

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Subcategories of Point Sources

- Combustion Emissions
- Process Emissions
- Fugitive Emissions
- Storage Tank Emissions
- Miscellaneous Solvent Usage

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Point Source Inventory Development Steps

- Planning
- Data Gathering
- Estimating Emissions
- QA/QC
- Data Augmentation
- Compiling the Database

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Point Source Inventory Planning

- Need to consider end uses of inventory
- What are data quality objectives?
- Inventory scope:
  - Define sources and categories to be included
  - Are there any emission thresholds for inclusion as point sources?
  - Define temporal resolution
- Describe all steps in compiling inventory
- Define structure of the inventory
- Define emission estimation methodology
- Data management and reporting
- Quality Assurance/Quality Control
- Documentation
- Determine available budget and existing resource constraints

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Point Source Inventory Planning: Inventory Scope

- How do I identify source categories?
  - Usually dictated by the pollutants of interest
  - Prepare list of potential categories associated with pollutant
    - Past inventory efforts
    - Historical knowledge of the inventory area
    - Permit files
    - Source tests and compliance tests
    - Other inventories created by other agencies
    - Emission characterization documents
    - Emission factor and emission estimation tools

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Point Source Inventory Planning: Inventory Scope

- How do I identify source categories?
  - Eliminate any source categories not found within inventory area
  - Decide which categories to inventory as point and nonpoint sources
  - Prioritize remaining categories
    - May choose to prioritize base on factors such as magnitude of emissions or risk
    - Eliminate any categories for which no emission estimation methods are available
    - Consider time and budget constraints
  - Document your decisions for the benefit of future preparers

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Point Source Inventory Planning: Emission Estimation Methodology

- Select emissions estimation method
  - Choice will be influenced by data quality objectives
  - Method selection can have large impact on resource requirements (e.g., direct measurements can be costly)
- Identify data that needs to be collected based on emission estimation method
  - Direct reported emissions data
  - Activity data
  - Emission factors
  - Extrapolation
- Identify process to collect data
  - Identify stakeholders to assist in data collection
  - Identify methods to collect point source data to estimate emissions
    - Surveys and questionnaires
    - Permit , compliance, or inspection files
    - Existing Inventories

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Point Source Inventory Planning: Data Management and Reporting

- Establish a platform for data collection, processing, and reporting
- Assess computer system capabilities and capacity
- Determine software requirements
- Determine whether internet-based applications will be required
- Determine what format end-users will need the data in and choose platforms that will meet those needs
- Carefully document the data flow path to allow for independent verification and review

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Point Source Inventory Planning: Quality Assurance/Quality Control

- QA/QC is particularly critical to point source inventories due to the quantity and detail of the data
- Need to plan for point source QA/QC ahead of time
- Large databases will require strategic QA/QC to isolate calculation errors, mis-reported data, and unreasonable values
- Will typically require both automated and manual type checks to assess overall quality
- Use of third party verification is desirable and sometimes required

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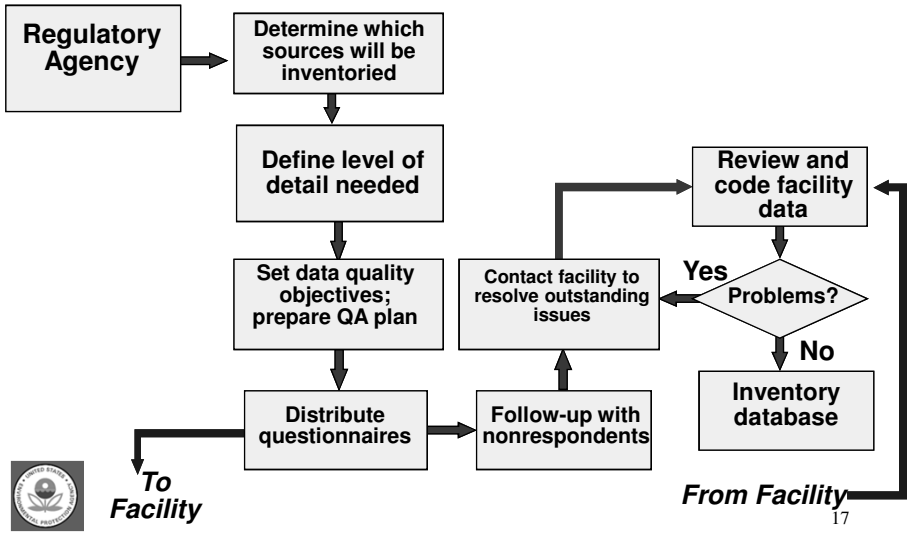
Point Source Inventory Development Process



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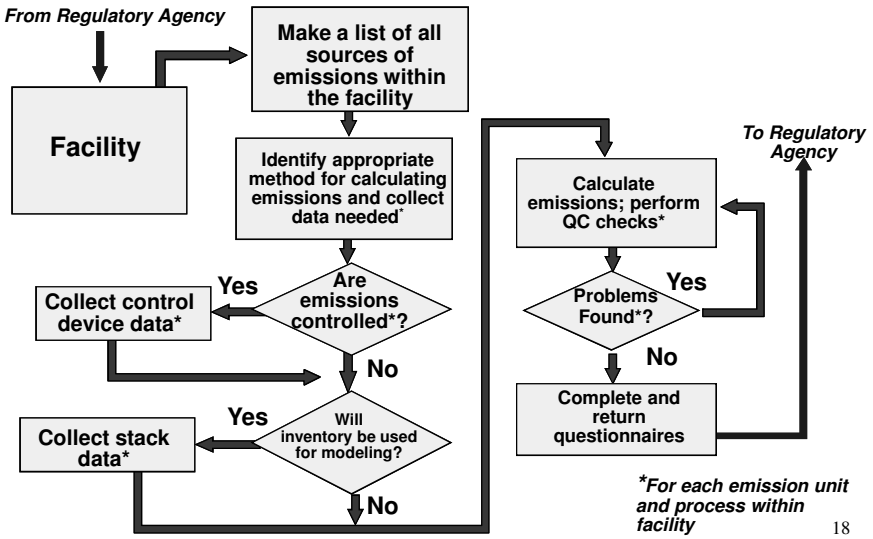
Point Source Inventory Development Process



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How Do I Identify Specific Facilities within a Geographic Area?

- Compile a list of facilities
  - Name and address, size and source category
- Sources useful for identifying point sources
  - Existing inventories
  - Permits, compliance reports, inspection reports
  - Source tests and compliance tests
  - Local information
    - Telephone directories
    - Business license databases
  - Professional Associations
    - Trade association membership
    - Chamber of Commerce membership
  - Academic institutions

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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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At What Level of Detail Are Point Source Inventories Compiled?

- Plant = Secondary lead smelter
- Unit = Boiler
- Process = Surface coating operation, coal-fired boiler
- Stack (emission release point)

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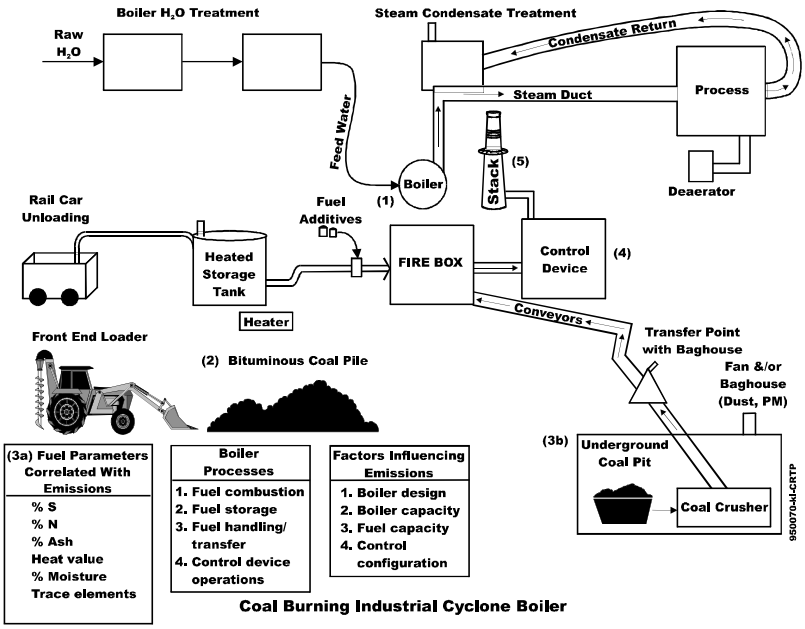

Coal Burning Industrial Cyclone Boiler

Plant Level Data Elements

- Source Identification
  - Facility Name and Identifier
  - Plant contact (phone number, e-mail address)
- Plant Location
  - Latitude, Longitude or UTM coordinates
    - Coordinates in decimal degrees
    - Accuracy and Reliability of Coordinates
  - Physical Address
    - Country, province, city, district, grid cell
- Plant Description
  - Type of Industry (example: refinery, utility coal boiler, etc.)
- Normal operating schedule
- Plant emissions By Pollutant Species (CAS number) if no stack/process/unit emissions needed
  - 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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Unit Level Data Elements

- Facility identifier
- Emission unit identifier
- Emission unit description
- Emission unit data
  - Design capacity
  - Normal operating schedule
- Unit 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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Process Level Data Elements

- Facility and Emission Unit identifiers
- Emission process identifier
- Emission process description
- Emission process level data
  - Operating rate data (design capacity)
  - Fuel parameters
  - Control equipment and efficiencies
  - Percent annual throughput (seasonal)
  - Normal operating schedule
- Process 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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Emission Release Point Level Data Elements

- Facility, Emission Unit, and Emission Process identifiers
- Emission process description
- Stack identifier
- Geographic location of stack
- Temporal data
  - Percent annual throughput (seasonal)
  - Normal operating schedule
- Control equipment and efficiencies
- Stack parameter data
- Stack 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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Typical Stack Data Required for Atmospheric Modeling

- Stack location
  - Latitude/Longitude or
  - UTM coordinates
  - Fence line distance
  - Accuracy and Reliability of Coordinates

  Stack characteristics
  - Height
  - Diameter
- Exhaust gas characteristics
  - Temperature
  - Exit velocity
  - Flow rate

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Factors Influencing Emissions

- Combustion characteristics influenced by firing configuration, operating conditions, fuel specifications
- Equipment age
- Operating practices
- Control equipment
- Raw materials used in processes or stored
- Meteorological data

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Typically Overlooked Processes

- In-process fuel use
- Process additives
- Fugitive VOC component emissions
- Devices that act as control devices and emission sources
- Miscellaneous solvent usage
- Fugitive dust sources
- Accidental releases
- Upset and Start-up emissions

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Control/Capture Efficiency

- Capture efficiency
  - The percentage of the emission stream that is directed to the control equipment
- Control efficiency
  - The percentage of the air pollutant that is removed from the emission stream by the control equipment before release to the atmosphere

Overall efficiency =
Capture efficiency × Control efficiency

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Bases to Estimate Capture Efficiency

- Equipment tests performed at the facility or from tests done on similar equipment at other facilities
- From manufacturer's specifications or literature values
- Engineering judgment

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Bases for Estimating Control Efficiency

- Source tests
- Manufacturer's design or guaranteed performance specification
- Literature values

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Typical PM Control Device Efficiencies

Control Device Type	CE Range – Minimum (%)	CE Range – Maximum (%)
Mechanical Collector	20	98
Wet PM Scrubber	50	99.9
Electrostatic Precipitator (ESP)	85	99.9
Fabric Filter (FF)	93.4	99.9
Scrubber General	--	99
Thermal Incinerator	79	96
Wet PM Scrubber with ESP	85	99
Hot ESP	20	80
Mechanical Collector with FF	--	99

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Rule Effectiveness (RE)

- A measure of the ability of a regulatory program to achieve emissions reductions possible by full compliance with applicable regulations by all sources at all times
- Reflects the assumption that regulations typically are not 100% effective
- Addresses reduced effectiveness due to malfunctions and shutdowns

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Rule Effectiveness (RE)

- Rule effectiveness for uncontrolled sources = 0%
- Rule effectiveness for irreversible process changes that eliminate use of a pollutant (e.g., VOCs) = 100%
- Methods for calculating inventory RE
  - Use a default value (e.g., 80%)
  - Use a study specific to a category and geographic area

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What Should I Consider in Estimating Rule Effectiveness

- Nature of the regulation
- Nature of the compliance procedures
- Performance of the source in maintaining compliance over time
- Performance of the implementing agency in assuring compliance

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What Is the Basic Rule Effectiveness Equation?

$$E_C = E_U \times (1 - (CE \times RE))$$

where:

E_C	=	Emissions after control
E_U	=	Uncontrolled emissions
CE	=	Estimated control efficiency (expressed as a fraction)
RE	=	Rule effectiveness (expressed as a fraction)

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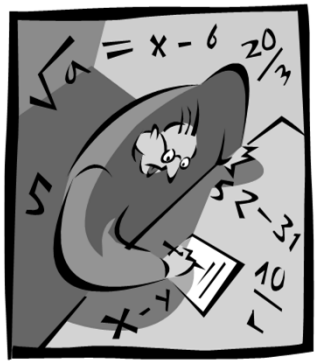
Emission Estimation Methods

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

Source sampling (CEM and Source tests)

- Preferred approach for many of the most important, larger point sources
- Most resource intensive
- Should be based on nationally and/or internationally-recognized measurement standards and testing protocol
- Source testing plan should be well designed to account for changing operating conditions and equipment performance
- Results should be clearly documented and subject to QA/QC procedures

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Emission Estimation Methods

- Material balance
  - Can be a very accurate and cost-effective method for certain pollutants and sources (e.g., VOC emissions from solvent usage)
  - Relies on process-specific throughput data (e.g., amount of cleaning solvent used)
  - Limited applications to sources that have predictable consumptive or evaporative losses
  - QA/QC should focus on accurate record keeping of material usage and consistency of make-up

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Emission Estimation Methods

- Survey data and emission factors
  - Depending on the source type, emission factor-based approaches can provide reliable and cost-effective estimates
  - Most used method
  - Emission factors need to be carefully developed and selected to match the conditions of the facility being inventoried
  - Surveys can produce critical site-specific information that improve the estimate (e.g., presence and type of controls in place)
  - Important to quantify the uncertainty of the emission factor to properly report on the quality of the estimate

$E = EF \times A$

Where :

E is Emissions

EF is Emission Factor

A is Activity

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Emission Estimation Methods

- Mechanistic models
  - Attempt to model the actual physical and biological process that result in emissions
  - Rely on algorithms and input variables that model the process
  - Emissions can be modeled for changing input parameters (e.g., raw material consumed) and conditions (e.g., temperatures)
  - Often limited by the number of verification studies that have been conducted to validate results
  - Can be very effective for processes that are well known and for which there are means to verify results

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Example Calculation: Source Test Data

- Estimate PM_{10} and NO_2 emissions from a cement plant given:
  - Plant operates 16 hrs/day, 312 days/yr
  - Flow rate (Q_f) = 283.29 standard cubic meters per minute (scmm)
  - Controlled PM_{10} collected on filter (C_f) = 0.0096 grams
  - Volume of gas sampled (V_m) = 0.57 scm at standard temperature and pressure (STP)
  - NO_2 concentration (C_{NO2}) = 40 ppm

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Example Calculation: Source Test Data

- PM_{10} concentration (C)

  $C = PM_{10}$ collected/gas sampled
  $C = C_f / V_m$
  $C = (0.0096\ g/0.57\ scm)$
  $C = 0.017\ g/scm$

- PM_{10} Emissions (kg/hr)

  = concentration $\times$ flow rate
  $= C \times Q_f \times 60$ min/hr
  = (0.017 g/scm) $\times$ 283.29 scmm $\times$ 60 min/hr x 1kg/1000g
  = 0.288 kg/hr of PM_{10}

- Annual PM_{10} emissions (Mg/yr)

  = 0.288 kg/hr $\times$ 16 hr/day $\times$ 312 days/year
  = 1,437.7 kg/yr $\times$ 1Mg/1000 kg
  = 1.44 Mg/yr of PM_{10}

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Example Calculation: Source Test Data

- NO_2 data:
  - C_{NO2} = 40 ppm
  - Molecular weight (MW) of NO_2 = 46 kg/kg-mole
  - Volume (V) of 1 mole of ideal gas at STP = 24.07 m^3/kg-mole
- NO_2 emissions (kg/hr)
  - = $(C \times MW \times Q_f \times 60 \text{ min/hr})/(V \times 10^6)$
  - = $(40 \text{ ppm} \times 46 \text{ kg/kg-mole} \times 283.29 \text{ scmm} \times 60 \text{ min/hr})/(24.07 \text{ m}^3\text{/kg-mole} \times 10^6)$
  - = 1.30 kg/hr NO_2
- Annual NO_2 emissions
  - = 1.30 kg/hr × 16 hr/day × 312 days/year
  - = 6,490 kg/yr = 6.5 Mg/yr NO_2

Example Calculation: Emission Factors

- Estimate CO, NO_2 PM10 and SO_X emissions from a coal-fired power plant using data from plant survey
- Survey data:
  - 1.68×10^6 metric tons coal/year throughput
  - Pulverized coal, dry bottom boiler, wall fired
  - Bituminous coal characteristics
    - 11% ash
    - 3% sulfur
- Emission factors from AP-42 Chapter 1.1
  - CO emission factor = 0.25 kg/Mg coal burned
  - NO_2 emission factor = 10.85 kg/Mg coal burned
  - PM_{10} emission factor = 2.3 × 5Ash × 0.5 = kg/Mg coal burned, where A = % ash in coal
  - SO_x emission factor = 38 × %Sulfur × 0.5 = kg/Mg coal burned, where S = % sulfur in coal , 0.5= metric conversion

Example Calculation: Emission Factors

- Uncontrolled CO emissions
  - CO emissions = EF x A
  - CO = 0.25 kg/Mg coal burned $\times$ (1.68 $\times$ 10^6 Mg coal burned/yr)
  - CO = 420,000 kg/yr

- Uncontrolled NO_2 emissions
  - NO_2 emissions = EF x A
  - NO_2 = 10.85 kg/Mg coal burned $\times$ (1.68 $\times$ 10^6 Mg coal burned/yr)
  - NO_2 = 18,200,000 kg/yr

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Example Calculation: Emission Factors

- Uncontrolled PM10 emissions
  - PM10 emissions = EF x A
  - PM10 = (2.3 $\times$ %Ash $\times$ 0.5 = kg/Mg coal) x Mg/yr coal burned
  - PM10 = (2.3 $\times$ 11 $\times$ 0.5 = kg/Mg coal) x (1.68 $\times$ 10^6 Mg coal burned/yr)
  - PM10 = 21,300,000 kg/yr

- Uncontrolled SO_X emissions
  - SO_x emissions = EF x A
  - SO_x = (38 $\times$ %Sulfur $\times$ 0.5 kg/Mg coal burned) x Mg/yr coal burned
  - SO_x = (38 $\times$ 3 $\times$ 0.5 kg/Mg coal burned) $\times$ (1.68 $\times$ 10^6 Mg coal burned/yr)
  - SO_x = 95,800,000 kg/yr

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Example Calculation: Material Balance

- Estimate annual and daily VOC emissions from a commercial dry cleaning plant given:
  - No existing regulation applies (rule effectiveness is not applicable)
  - 13 metric tons of Stoddard petroleum solvent are used in a separate, uncontrolled dry cleaning system annually
  - 1.2 metric tons of solvent is recovered/recycled annually
  - All solvent components are VOCs
  - Operating schedule
    - 5 days/week
    - 52 weeks/year

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Example Calculation: Material Balance

- Annual emissions from Stoddard Solvent (VOC)

  VOC emissions = Solvent used - Solvent recovered

  VOC = 13 metric tons/year – 1.2 metric tons/year

  VOC = 11.8 metric tons per year emitted

- Daily emissions

  VOC Daily emissions = Annual emissions × (days/week × weeks/yr)

  VOC Daily emissions = (11.8 metric tons/yr × 1000 kg/metric tons)/(5 days/week × 52 weeks/yr)

  VOC Daily emissions = 45.4 kg VOC/day

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Data Collection

- Surveys (questionnaires)
- Plant inspections
- Other inventories
- Permit applications or compliance files
- Other emission data
  - Departments of Commerce and Labor statistics
  - Data compiled by private research and development companies and Universities
  - Trade and professional associations

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Planning a Point Source Survey

- Identify sample size needed to provide reliable results (e.g., 10 to 20%, 100% of population)
- Screen facilities to confirm location, willingness to cooperate
- Collect data using methods commensurate with resources available
  - Telephone, e-mail, internet-based forms
  - On-site visits
  - Mail-out questionnaires and/or in-person interviews

Types of Questionnaires

- General questionnaire
  - Collect data on the location and points of contact at a facility
  - Facilitate comments by the facility staff
  - Capture overall plant-level data (operational hours, overall production, overall fuel usage)
- Specific questionnaire
  - Process level (e.g., boilers, storage piles)
  - Control device form
  - Industry focus (e.g., fertilizer manufacturing, power generation)

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General Facility Information

Year: 2002

OWNERSHIP INFORMATION

Company Name:_____

Industrial Association:_____

FACILITY CONTACT/RESPONSIBLE PERSON

Person Name:_____

Person Title/Role:_____

FACILITY DESCRIPTION

Facility Name:_____

Number of employees working at the Facility:

Administrative, technical and executive:_____ Workers, helpers, and other:_____

Description of product(s) produced:_____

GEOGRAPHIC LOCATION

Location Street and Number:_____

Between:_____ and_____

City/District:_____ Mail Code:_____ Telephone Number:_____

FACILITY OPERATING SCHEDULE

			Approximate Percent Operation by Month												
Hours/Day	Days/Week	Weeks/Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
8	5	44	5	9	9	9	9	9	9	9	9	9	9	5	100%
															100%

Name of Surveyor(s):_____

Date of Survey:_____

Notes (on reverse):_____

Boilers and Heaters

Year: 2002

FACILITY DESCRIPTION/LOCATION (From General Facility Information Form)

Facility Name: _____

Location Street and Number: _____ City, District: _____

EQUIPMENT IDENTIFICATION

ID of this equipment: _____

Your name for this equipment: _____

Air emissions from this equipment go into:

The atmosphere: ***OR*** Stack Device ID: _____ ***OR*** Control Device ID: _____

EQUIPMENT CHARACTERISTICS

Manufacturer: _____

Burner Type: _____ Number of Burners: _____

Maximum Heat Rating (e.g., Btu/hr): _____ Firing Method: _____

Describe what this boiler/heater is used for: _____

OPERATING SCHEDULE BY FUEL TYPE

Input Fuel * (list)	Hours/Day	Days/Week	Weeks/Year	Approximate Percent Operation by Month											
				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Natural Gas	*24*	*7*	*20*	*20*	*20*	*20*								*20*	*20*	*100%*

FUEL CHARACTERISTICS

Input Fuel (list*)	(Required) 2002 Fuel Usage	Fuel Heat Content	Fuel Sulfur Content	Fuel Ash Content
Natural Gas	*100 kl (kg or kl)*	*3.8×10^{10} (J/kg or J/kl)*	*(%)*	*(%)*
	(kg or kl)	(J/kg or J/kl)	(%)	(%)
	(kg or kl)	(J/kg or J/kl)	(%)	(%)

* Common name of fuel

Name of Surveyor(s): _____

Date of Survey: _____

Notes (on reverse): _____

Compiling an Inventory from Existing inventories

- Compile composite facility list from previous inventories
  - Facility Name, Address
  - Facility IDS
  - Coordinates
  - Stack parameters
  - Emissions Units and Processes
- Delete closed facilities
- Revise existing information
  - Facility configuration
  - Operating schedule
  - Emissions
    - Survey information
    - Extrapolation

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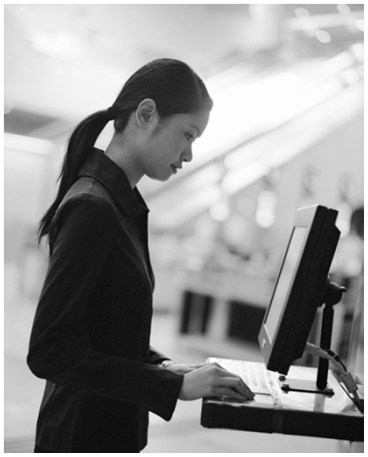
Data Coding for Point Sources

- Data coding uses unique codes will ensure that data are properly maintained
  and easily retrievable
- Coding scheme should be developed prior to collecting any data
- A useful data coding system should allow for identification of the different types of facilities, processes, controls



Data Coding for Point Sources

- Facility Identifiers: A unique facility identification code should be assigned to each facility
  - Use a predetermined number of characters in the identification code
  - Keep the facility identification code short
  - Use of letters within the code significantly increases the number of unique combinations
    - CEM_001, DRYC_003, CONV_001, ESP_001
- Source Category Descriptors: Codes to link emissions data to specific technology types
  - Each code represents a unique process or function within a source category
  - Examples include Source Classification Codes and SNAP codes

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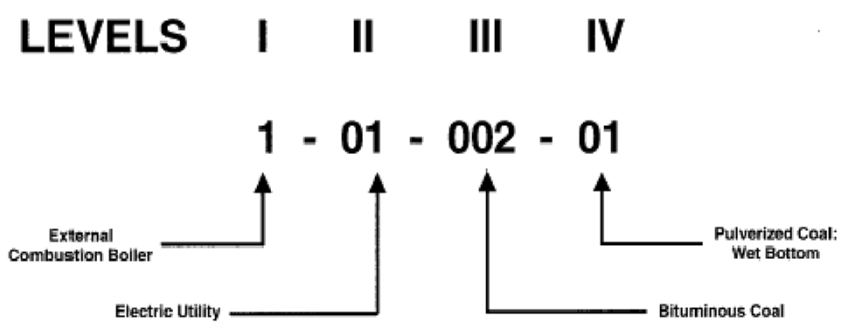
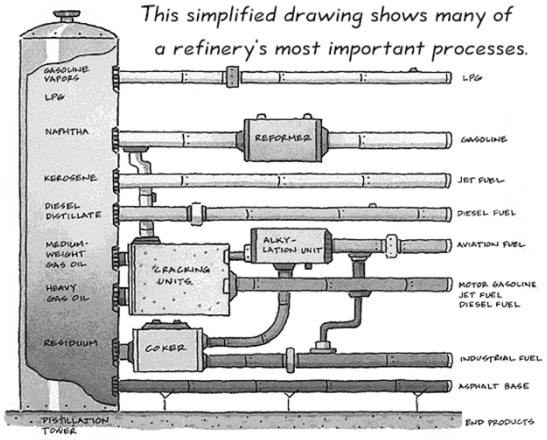
Source Classification Code System



Refinery Example



Drawing from Chevron's Web Site

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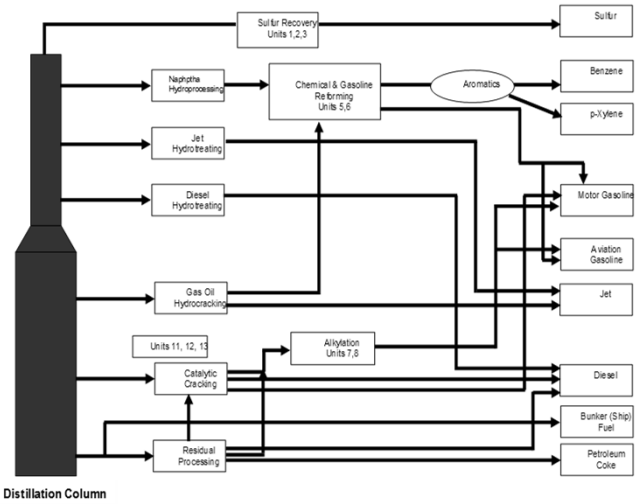
Petroleum Refinery Example



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Petroleum Refinery Emission Sources and Pollutants

- Boilers, Process Heaters, and Catalytic Cracking Unit
  - PM, NO_X, SO_X, CO_2
  - Ar, Cd, Cr, HCl, HF, Pb, Mn, Hg, Ni
- Regeneration Vent on Catalytic Reforming Unit
  - NO_X, CO_2, PM
  - HCl, Cl_2
- Sulfur Recovery Unit
  - SO_X
  - Carbonyl Sulfide, Carbon Disulfide
- Catalyst Changeovers and Cokers
  - PM
- Equipment Leaks, Wastewater Collection and Treatment, Cooling Towers, Storage Tanks, Product Loading and Handling
  - VOC
  - Benzene, Toluene, Xylene, Hexane, 2,2,4 – Trimethylpentane, Cresols, Ethylbenzene, Methyl Ethyl Ketone, Methyl Tert Butyl Ether, Naphthalene, Phenol
- Flares
  - SO_X

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Petroleum Refinery Emission Survey Example

Facility Information:

ID: 15

Facility Name: Chevron USA

City: El Segundo

State: CA

County: Los Angeles

Latitude: 33.5443

Longitude: 118.2448

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Petroleum Refinery Emission Survey Example*

Emission Unit ID	Unit Description	Process Description	Emission Release Point Type	Pollutant Name/ CAS #	Emissions (ton/yr)	Control Device	Stack Height (ft)	Stack Diameter (ft)	Temperature (F)	Velocity (ft/sec)
CRU05	Catalytic Reforming Unit	Continuous CRU	Vertical Stack	Hydrochloric Acid 7647010	30.3	None	40	1	500	10
CRU06	Catalytic Reforming Unit	Continuous CRU	Vertical Stack	Hydrochloric Acid 7647010	25.7	None	40	1	500	10
FCCU11	Catalytic Cracking Unit	CCU Catalyst Regeneration	Vertical Stack	Formaldehyde 50000	5.4	Low Excess Air Firing	100	10	500	70
SRU01	Sulfur Recovery Unit	Desulfurization	Vertical Stack	Carbon disulfide 75150	3.1	Wellman Lord Sodium Sulfite Scrubber	60	4	800	70

For each unit and process, information for all pollutants would be needed

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Petroleum Refinery Emission Survey Example*

Emission Unit ID	Unit Description	Process Description	Emission Release Point Type	Pollutant Name/ CAS #	Emissions (ton/yr)	Control Device	Stack Height (ft)	Stack Diameter (ft)	Temperature (F)	Velocity (ft/sec)
TNK1	Floating Roof Tank	Gasoline RVP 10: Standing Loss (67000 Bbl.)	FUGITIVES	Benzene 71432	0.001	None				
TNK1	Floating Roof Tank	Gasoline RVP 10: Withdrawal Loss (67000 Bbl.)	FUGITIVES	Benzene 71432	0.000001	None				
CSE1	Compressor Seals	Fugitive Emissions	FUGITIVES	Benzene 71432	0.000005	None				
VRV01	Vessel Relief Valves	Fugitive Emissions	FUGITIVES	Benzene 71432	0.004	None				

For each unit and process, information for all pollutants would be needed

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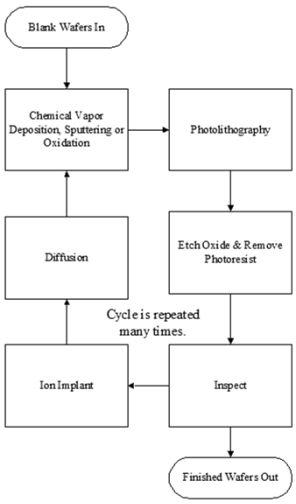
Wafer Tech Example

Use information in the air permit (WaferTech, permit ID = 97- 2040R8TSD.doc) to create an emission inventory.

WaferTech, LLC (WaferTech) produces integrated circuits (ICs) on eight-inch wafers using advanced Complementary Metal Oxide Semiconductor (CMOS) technology with circuit widths ranging from initial production at 0.35 microns down to 0.15 microns and less.



Wafer Tech Example: Data Sources

1. Air emissions permit
2. Lookup Tables
3. 1999 NEI
4. Internet

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Data Sources – Air Emissions Permit

1. Facility-level emissions
2. Facility information
3. Additional Information
   - Emission Unit Information
   - Emission Factors
   - Fuel Characteristics

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Wafer Tech Permit Information

Facility Information:

ID:	SWCAA1978
Facility Name:	Wafer Tech
Address:	5509 NW Parker Street
City:	Camus
State:	WA
Zip Code:	98607
County:	Clark
Latitude:	45.6175
Longitude:	122.455
SIC Code:	3674
Primary Process:	Semiconductor Manufacturing
Contact Person:	Judy Schramm

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Data Sources – Facility-level Emissions

1. Emissions by unit type: boilers, emergency generators, oxidizer/concentrator, acid scrubber, wastewater treatment, and plant scrubber
2. Pollutant Name: criteria, air toxics, and ammonia
3. Control Device Information: device and control efficiency
4. Maximum Emissions

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Data Sources: Facility-level Emissions

Emission Unit	Pollutant Name	Maximum Emissions (lb/yr)	Control Device	Control Efficiency
Boiler	NOx	50400	Low NOx Burner	
	CO	47600		
	VOC	19000		
	SO2	4600		
	PM	12400		
	Benzene	2.2		
	Formaldehyde	74.8		
Emergency Generators	NOx	109400	Uncontrolled	
	CO	28000		
	VOC	3400		
	SO2	1800		
	PM	3400		

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Data Sources: Facility-level Emissions

Emission Unit	Pollutant Name	Maximum Emissions (lb/yr)	Control Device	Control Efficiency
Oxidizer/ Concentrator	NOx	24000	Thermal Oxidizer	95
	CO	52600		
	VOC	38000		
	SO2	60		
	PM	200		
	Acetonitrile	1		
	Catcecol	890		
	Cresol	41		
	Diethanolamine	9		
	Glycol ethers	5180		
	Formaldehyde	16		
	Methanol	105		
	2-Methoxyethanol	28		
	Xylene	2		

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Data Sources: Facility-level Emissions

Emission Unit	Pollutant Name	Maximum Emissions (lb/yr)	Control Device	Control Efficiency
Acid Scrubber	Ammonia	15000	Scrubber	90
	Arsine	42		
	Chlorine	500		
	Chromic Acid	0.5		
	Chromium Trioxide	0.5		
	Hydrofluoric acid	3700		
	Hydrochloric acid	6310		
	Phosphine	2		
	Potassium chromate	0.3		
	Potassium dichromate	0.3		
	Sodium dichromate	0.3		

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Data Sources: Facility-level Emissions

Emission Unit	Pollutant Name	Maximum Emissions (lb/yr)	Control Device	Control Efficiency
Wastewater Treatment	Ammonia	100	Scrubber	
	Hydrofluoric acid	400		
	Hydrochloric acid	115		
Plant Scrubber	Hydrochloric acid	17	Scrubber	90

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Data Sources: Facility Information

Option 1: Facility level emissions only

- Plant ID
- Location Address
- SIC, NAICS, and SCC Codes
- Facility level emissions only

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Wafer Tech – Option 1-Limitations

However, just using these facility data only has limitations:

- No activity data, hours of operation
- No emission factor data
- No fuel characterization data
- Emissions lumped by grouped units
- No stack parameter data
- No emission calculation method

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Data Sources – Additional Information

1. Fuel characterization data
2. Activity and hours of operation data
3. Detailed SCC processes
4. Stack parameter data
5. Emission factors per process
6. Emission calculation method code

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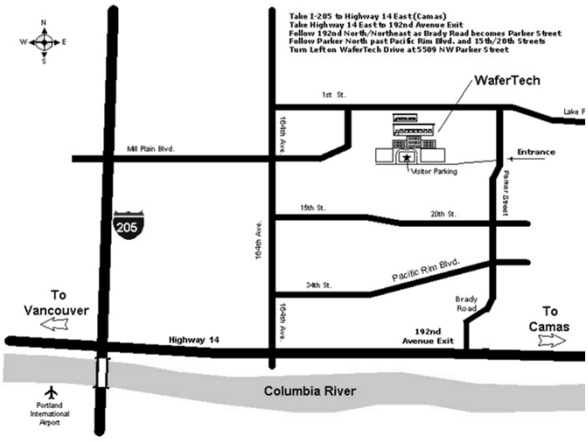
Determining Facility Lat/Lon (1)

1. WaferTech Website (www.wafertech.com)



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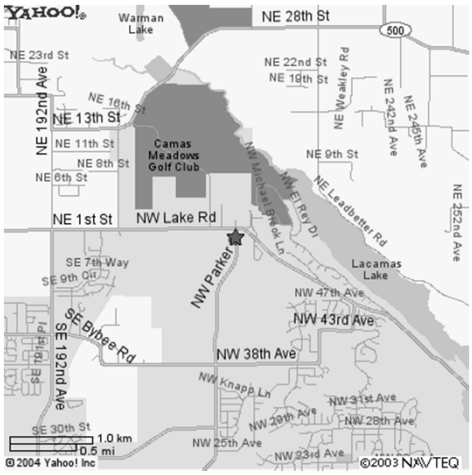
Determining Facility Lat/Lon (2)

2. Yahoo Maps (www.yahoo.com)



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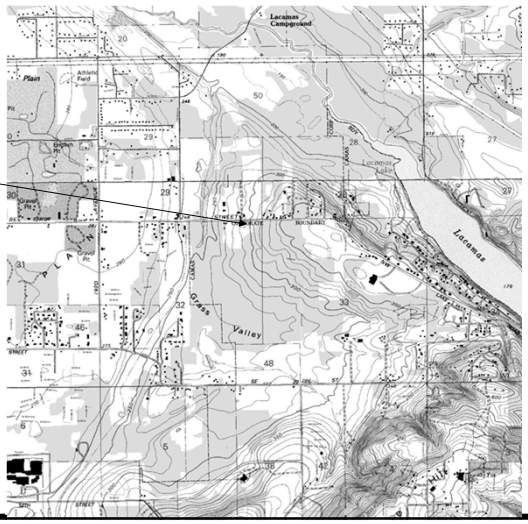
Determining Facility Lat/Lon (3)

3. Topozone Maps (www.topozone.com)



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Determining Facility Lat/Lon (4)

4. TRI (www.epa.gov/enviro/)

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Wafer Tech: Option 2

1. Boiler and generator-specific emissions can be created.

2. Used the grouped unit emissions of acid scrubbers, wastewater treatment, oxidizer/concentrator, and plant scrubber and spread evenly across each unit.

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Wafer Tech Option 2 – Diesel Boiler EFs

Pollutant	NEI Pollutant Code	Emission Factor	Factor Numerator	Factor Denominator	EF Type	Sulfur wt%
CO	CO	0.07	LB	E6BTU	Controlled	
SO2	SO2	0.052	LB	E6BTU	Controlled	0.05
VOC	VOC	0.03	LB	E6BTU	Controlled	
PM(total)	PM-PRI	0.025	LB	E6BTU	Controlled	

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Wafer Tech Option 2 – Natural Gas Boiler Emission Factors

Pollutant	NEI Pollutant Code	Emission Factor	Factor Numerator	Factor Denominator	EF Type
CO	CO	0.04	LB	E6BTU	Controlled
NOX	NOX	0.035	LB	E6BTU	Controlled
SO2	SO2	0.001	LB	E6BTU	Controlled
VOC	VOC	0.016	LB	E6BTU	Controlled
PM(total)	PM-PRI	0.01	LB	E6BTU	Controlled
Benzene	71432	0.00000206	LB	E6BTU	Controlled
Formaldehyde	50000	0.00007	LB	E6BTU	Controlled

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Wafer Tech Option 2 – Emergency Generator Emission Factors

Pollutant	NEI Pollutant Code	Emission Factor	Factor Numerator	Factor Denominator	EF Type
CO	CO	2.4	G	HP-HR	Uncontrolled
NOX	NOX	9.4	G	HP-HR	Uncontrolled
VOC	VOC	0.3	G	HP-HR	Uncontrolled
PM(total)	PM-PRI	0.3	G	HP-HR	Uncontrolled

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Wafer Tech Option 2 - Limitations

1. However, emissions are still maximum. Need actual hours of operation.

2. Lat/lon only available for facility, not at individual emission release points

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Summary: Point Sources

- Point sources are stationary, industrial
- Inventory characteristics are based on end uses
- Level of detail
  - Plant, point/stack, process
  - Data coding considerations
- Capture, control, and rule effectiveness may be considered
- Selecting appropriate estimation methods depends on end uses, and available resources and data
  - Source sampling
  - Emission factors with activity data
  - Material balance
  - Mechanistic models

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Questions or Comments?

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