Chapter Overview

- Introduction to Air Quality Monitoring
- Introduction to Network Design
- Monitoring Criteria Pollutants
- Monitoring Non-Criteria Pollutants
- National Monitoring Strategy Committee

Introduction to Air Monitoring

- Temporal and Spatial Variations
- Complexities in the dynamics
- Uses of Air Monitoring
- Purpose of Air Monitoring
Introduction to Ambient Air Quality Monitoring

- Temporal and Spatial Variations
  - Changes in Pollutant Sources
  - Changes in meteorology and topography

- Complexities in the dynamics

Introduction to Ambient Air Quality Monitoring - Uses

- Determine Compliance
- Document progress
- Establish Baselines
- Policy Development
- Establish Relationships
- AQI reporting
- Model Evaluation
- Health/Environmental Effects
- Assess Trends

The NAAQS

- Covered in earlier sessions
## Design of Air Quality Monitoring

1. Set Objectives
2. Choose Parameters
3. Select Sites
4. Scheduling
5. Select Methods
6. Equipment Selection
7. Calibration Procedures
8. Recoding Methods
9. Data Analysis
10. Reporting Results

## Network Design

- Network Design Objectives
- Spatial Scales
- Elements of Network Design

## Network Design Objectives

- The design should determine one of the following:
  1. Highest Concentrations
  2. Representative Concentrations
  3. Impact
  4. Background Concentration Levels
  5. Regional Pollutant Transport
  6. Welfare-related Impacts
Spatial Scales

• The Scales

• Matching Objectives to a Scale

• Application of the Scales

The Spatial Scales

• Microscale (1-100 meters)
• Middle scale (100m-0.5 kilometers)
• Neighborhood scale (0.5-4.0 kilometers)
• Urban scale (4-50 kilometers)
• Regional scale (tens to hundreds of kilometers)
• National and global scales (nation and globe as a whole).

Matching Objectives to a Scale

<table>
<thead>
<tr>
<th>Monitoring Objectives</th>
<th>Appropriate Siting Scales</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highest concentration</td>
<td>Micro, Middle, neighborhood or urban</td>
</tr>
<tr>
<td>Population</td>
<td>Neighborhood, urban</td>
</tr>
<tr>
<td>Source Impact</td>
<td>Micro, middle, neighborhood</td>
</tr>
<tr>
<td>General/Background</td>
<td>Neighborhood, urban, regional</td>
</tr>
<tr>
<td>Regional transport</td>
<td>Urban, regional</td>
</tr>
<tr>
<td>Welfare-related impacts</td>
<td>Urban, regional</td>
</tr>
</tbody>
</table>
Application of the Scales

<table>
<thead>
<tr>
<th>Scale Applicable to SLAMS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SO2</td>
</tr>
<tr>
<td>Overall Scale</td>
</tr>
<tr>
<td>Minor</td>
</tr>
<tr>
<td>Neighborhood</td>
</tr>
<tr>
<td>Tile</td>
</tr>
<tr>
<td>Regional</td>
</tr>
</tbody>
</table>

Types of Air Monitoring Networks

- SLAMS -- State and Local Monitoring Stations
- NAMS -- National Air Monitoring Stations
- PAMS -- Photochemical Assessment Monitoring Stations
- SPMS -- Special Purpose Monitoring Stations

Elements of Network Design

- Particulate Matter Collection
- Gaseous Pollutant Collection
- Reference Methods Equivalents
- Averaging Times
- 40 CFR 58 Appendices
- Air Quality Index
Particulate Matter Collection

• Filtration
  – Health Impact

• Impaction
  – Health Impact

Gaseous Pollutant Collection

• Absorption
• Adsorption
• Grab Sampling

Averaging Times

- Instantaneous
- One-Hour Average
- Four-Hour Average
**Reference Methods Equivalents**

- Federal Reference Methods
  - 40 CFR part 50 Appendices A through M

- Equivalent Methods
  - 40 CFR Part 53, Subparts A through F

- [http://www.epa.gov/tnn/amtic](http://www.epa.gov/tnn/amtic)

**40 CFR 58 Appendices**

- Appendix A: QA Requirements for SLAMS
- Appendix B: QA Requirements for PSD Air Monitoring
- Appendix C: Ambient Air Quality Monitoring Network
- Appendix D: Network Design for SLAMS and NAMS
- Appendix E: Probe Siting Criteria
- Appendix F: Annual SLAMS Air Quality Information
- Appendix G: AQI and Daily Reporting

**Monitoring Non-Criteria Pollutants**

- Visibility

- Hazardous Air Pollutants (HAPs)
Beer's Law

As particle size gets smaller, reflective surface area increases

Visibility

- National Visibility & PSD Programs
- IMPROVE- Interagency Monitoring of Protected Visual Environments
- CASTNET- Clean Air Status and Trends Network

National Visibility & PSD Programs
Visibility

- National Visibility & PSD Programs
- IMPROVE- Interagency Monitoring of Protected Visual Environments
- CASTNET- Clean Air Status and Trends Network

CASTNET

Hazardous Air Pollutants (HAPs)

- Introduction
- Regulations
- Monitoring Programs
HAPs Introduction

- What is a HAP?
- What is the Danger?
- Where do they come from?
- Does the CAA Address this?
- How Many are there?

HAPs Regulations

- Two Phases
  - Development of technology based standards
  - Evaluate remaining issues (187)
- National Air Toxics Program
  - Quantify the impacts
- Development of a Monitoring Network

HAPs Monitoring Program
Air Quality Index

<table>
<thead>
<tr>
<th>Air Quality Index Values</th>
<th>Ozone Levels (ppb, 8-hr avg.)</th>
<th>Air Quality Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-50</td>
<td>0-64</td>
<td>Good</td>
</tr>
<tr>
<td>51-100</td>
<td>65-84</td>
<td>Moderate</td>
</tr>
<tr>
<td>101-150</td>
<td>85-104</td>
<td>Unhealthy for Sensitive Groups</td>
</tr>
<tr>
<td>151-200</td>
<td>105-124</td>
<td>Unhealthy</td>
</tr>
<tr>
<td>201-300</td>
<td>125 and up</td>
<td>Very Unhealthy</td>
</tr>
</tbody>
</table>

National Monitoring Strategy Committee (NMSC)

- A Holistic Review of Air Monitoring
- A New Strategy
- 6 Essential Components
- Revised Strategy is on the web
  - http://www.epa.gov/tnn/amtic
- Ncore – network design proposal

NCore

- A New Direction in Monitoring
- National and local objectives
- Objectives of NCore
- NCore Structure
NCore Objectives

- Provide timely reporting of data to public by supporting AIRNow, air quality forecasting and other public reporting mechanisms.
- Support the development of emission strategies through air quality model evaluation and other observational methods.
- Support long-term health assessments that contribute to ongoing review of National Ambient Air Quality Standards.
- Evaluate compliance with NAAQS through better establishment of nonattainment/attainment areas.
- Support scientific studies ranging across technological, health, and atmospheric process disciplines.

NCore Structure

Level 1: 3-10 Master Sites
- Comprehensive Measurements
- Advance Methods Serving Science and Technology Transfer Needs

Level 2: ~75 Multi-pollutant (MP) Sites
- “Core Species” Plus Leveraging from PAMS, Speciation Program, Air Toxics

Level 3: Single Pollutant Sites (e.g. >500 sites each for O₃ and PM 2.5)
- Mapping Support

Traditional Air Monitoring Paradigm

- Expensive instruments (> $20K/unit)
- Specialized training required
- Large physical footprint
- Large power draw
- Lifetime of 10+ years

- Government-provided data
- Air Quality Index (AQI) provided on broad time and spatial scales
Typical Low Cost Monitor

- Inexpensive instruments ($100-5,000)
- Highly portable and easy to operate
- Does not require specialized training to operate
- Low operation costs (replace or recharge batteries)
- Lifetime between 1-2 years

What does this all mean?

Current Approach

- Limited reliance to governments, industry, and researchers
- Why is data collected?
- Compliance Monitoring, Enforcement, Trends, Research
- How is data accessed?
- Government Websites, Permit Records, Research Databases

New Paradigm

- Expanded use by communities and individuals
- New applications and enhancement of existing applications
- Increased data availability and access

Snyder et al., 2013

New Technologies

- Technology advances support a shift towards new ways of measuring and communicating air quality information
- Smartphone/Tablet in widespread use
- e.g., Fitbit activity tracker
- Miniaturized environmental sensors
- e.g., Arduino microprocessor
- Introduction of low cost controllers and communications
- Crowd funding supporting do-it-yourself (DIY) innovation
Chapter Summary

- Introduction to Air Quality Monitoring
- Monitoring Criteria Pollutants
- Monitoring Non-Criteria Pollutants
- Network Design
- National Monitoring Strategy Committee
Chapter Overview

- Measurement of Pollutant Emissions
- Source Sampling Methodology
- Continuous Emission Monitoring
- Compliance Assurance Monitoring
# Measurement of Pollutant Emissions

- Goal of Testing
- History of Testing
- Codification of Testing

## Eight Methods

1. Distributed Sampling Points
2. Sampling Distributed Over Time
3. Isokinetic Sampling
4. Separation of Gas Constituents
5. Sample Recovery and Analysis
6. Data Recording
7. Calculation of Results
8. Expression of Results

## Goal of Testing

1. The gas being sampled from a source should represent either the total or a known portion of the emissions from the source.
2. Samples of the emissions collected for analysis must be representative of the gas stream being sampled.
3. The volume of the gas sample withdrawn for analysis must be measured accurately in order to calculate the concentration of the analyzed constituents in the sampled gas stream.
4. The gas flow rate from the source must be determined in order to calculate emission rates for the various constituents.
History of Testing

- Performance Test Code 21-1941
- U.S. EPA Reference Methods (FRM) 1-8
- Subsequent Reference Methods

Codification of Testing

- Emission Measurement Center – OAQPS
- Method Numbers and the CFR
- http://www.epa.gov/tnn/emc
Source Sampling Methodology

• Overview
  – Federal Reference Method

• Methods

Distributed Sampling Points

Eight Methods

1. Distributed Sampling Points
2. Sampling Distributed Over Time
3. Isokinetic Sampling
4. Separation of Gas Constituents
5. Sample Recovery and Analysis
6. Data Recording
7. Calculation of Results
8. Expression of Results
Isokinetic Sampling

Gas Stream

Nozzle

Over-Isokinetic Sampling

Gas Stream

Nozzle

Under-Isokinetic Sampling

Gas Stream

Nozzle
Separation of Gas Constituents

Basic Test Methods
- Method 1 - Sampling Point Location
- Method 2 - Stack Gas Velocity
- Method 3 - Dry Molecular Weight
- Method 4 - Moisture Content of Stack Gases
- Method 5 - Particulate Emissions
- Method 6 - Sulfur Dioxide Emissions
- Method 7 - Nitrogen Oxide Emissions
- Method 8 - Sulfur Dioxide and Sulfuric Acid
- Method 9 - Opacity
- Method 10 - Carbon Monoxide Emissions
Eight Methods (cont.)

1. Distributed Sampling Points
2. Sampling Distributed Over Time
3. Isokinetic Sampling
4. Separation of Gas Constituents
5. Sample Recovery and Analysis
6. Data Recording
7. Calculation of Results
8. Expression of Results
Hazards

- What are the Stack Emissions?
- What Heat & Gas Hazards Exist?
- What are the Facility Health & Safety Procedures?
- Are Entry, Confined Space, or Other Permits Required?
Saturated Exhaust

Stack Access

Source Test  Enforcement Cycle

Permitting

Source Test

Facility Inspections

Continued Compliance
Continuous Emission Monitoring

- Why CEM?
- Opacity monitors
- CEM Classifications
- EPA Requirements

Purpose of CEMS

Regulators View

- Determine emission compliance
- Identify periods of excess emissions
- Assess control equipment efficiency
- Monitor operating parameters
- Validate emission credits
- Public perception reports
  - Haz. Waste Incinerators
  - Municipal Waste Combustors
Purpose of CEMS

Industry View

- Comply with regulations
- Demonstrate compliance
- Monitor control equipment
- Monitor process parameters
- Validate emission credits
- Complaint protection
- Plant safety

Federal Guidance

- Standards Setting
- Test Methods
- Performance Specifications
  - 40 CFR 60, Appendix B
  - 40 CFR 75, Appendix A
- Quality Assurance Criteria
  - 40 CFR 60, Appendix F
- Enforcement Guidance

Performance Specs: Gauge

- PS 1 - Opacity Monitors
- PS 2 - SO₂, NOₓ Monitors
- PS 3 - CO₂, O₂, Monitors
- PS 4 - CO Monitors
- PS 5 - Total Reduced Sulfur (TRS) Monitors
- PS 6 - Rate (Velocity) Monitors
- PS 7 - Hydrogen Sulfide (H₂S) Monitors
- PS 8 - VOC Monitors
- PS 9 - Gas Chromatograph Systems
CEMS Monitors

- Opacity
- Sulfur Dioxide
- Nitrogen Oxides
- Carbon Dioxide
- Carbon Monoxide
- Oxygen
- VOC
- Hydrogen Chloride
- Ammonia
- Total Reduced Sulfur
- Hydrogen Sulfide
- Gas Velocity
- Mercury
- VOC
- Hydrogen Chloride
- Ammonia
- Total Reduced Sulfur
- Hydrogen Sulfide
- Gas Velocity
- Mercury
- VOC
- Hydrogen Chloride
- Ammonia
- Total Reduced Sulfur
- Hydrogen Sulfide
- Gas Velocity
- Mercury
- VOC
- Hydrogen Chloride
- Ammonia
- Total Reduced Sulfur
- Hydrogen Sulfide
- Gas Velocity
- Mercury
- VOC
- Hydrogen Chloride
- Ammonia
- Total Reduced Sulfur
- Hydrogen Sulfide
- Gas Velocity
- Mercury

Systems Classifications

- Extractive Systems
  - In-Stack
  - Out-of-Stack
  - Dry
  - Wet
  - Single Pass
  - Double Pass
- In-Situ Systems
  - Point
  - Path
- Source Monitoring Systems
- Predictive Systems
Opacity Monitors

CEM Classifications

SOURCE MONITORING SYSTEMS

EXTRACTIVE SYSTEMS
- Dilution
- Direct

IN-SITU SYSTEMS
- Point
- Path
  - Single Pass
  - Double Pass

Compliance Assurance Monitoring

- Background
- Main Components
CAM Background

- Title V
- Operating Permits
- Title VII
- Next Generation of Enhanced Monitoring

Effect of Title V

- Required “continuous” monitoring of many sources
- Standard CEM is impractical for most small sources.
- No CEM exists for pollutants
- This forced a new approach to monitoring

CONCEPTS BEHIND CAM

- If the emissions control system is working properly, there is "reasonable assurance of compliance".
- Monitoring the control system is more practical than monitoring emissions - e.g. instruments for temperature, flow, volts, etc. are much cheaper and more reliable than CEM systems. ☑ FLEXIBILITY
- So - relate control system indicators to compliance.
- Many sources with no active emission controls can be monitored in other ways.
CAM Background

- Targets facilities with add-on control devices
- "assure that control measures...are properly operated and maintained so that they do not deteriorate to the point where the owner/operator fails to remain in compliance..."
- "long-term, significant loss of control efficiency that can occur without complete failure of a control device"

Part 64 (CAM) design principles

Monitoring sufficient to also ensure operators pay the same level of attention to pollution control measures as to production activities.

Part 64 (CAM) design principles...

Requires source owners to design monitoring to fit site and incorporate into permits
Who will be affected by CAM (§64.2)

- An emission unit (except some backup utility power emission units) &
- With an emission limit or standard
- With a control device &
- With pre-control emissions greater than major source thresholds &
- At a major source subject to title V permitting

Who is exempt from CAM?

- Post-1990 NSPS and NESHAP emission limits (does not include rules amended after Nov 15, 1990)(example)
- CFC rules
- Acid Rain requirements
- Emissions trading programs
- Emission caps
- Title V permit requiring continuous compliance determination method (CEM)

Recap: Elements of CAM

| §64.4 (a) | Describe indicators to monitored process to set indicator ranges Describe performance criteria |
| §64.4 (b) | Provide justification for the proposed elements of the monitoring |
| §64.4 (c) | Provide control device operating/test data Provide engineering & manufacturer’s recommended ranges |
| §64.4 (d) (e) | Test plan and implementation plan, if monitoring requires installation, testing or other activities |
| §64.4 (e) | Expeditiously correct control device performance problems |
CAM Rule Components

• Establishes Criteria
• Title V Compliance Certification
• Exemptions
• Monitoring Requirements
• Control Device Specifications

Chapter Summary

• Measurement of Pollutant Emissions
• Source Sampling Methodology
• Continuous Emission Monitoring
• Compliance Assurance Monitoring

World-Wide Web Environmental Resources

• Air Resources Board - www.arb.ca.gov
• Cal EPA - www.calepa.ca.gov
• US EPA - Technology Transfer Network www.epa.gov/ttn
• Air & Waste Management Association - www.awma.org/links.htm
• US EPA - Technology Transfer Network www.epa.gov/ttn
Chapter Overview

- Emissions Inventory Introduction
- Purpose of Emissions Inventories
- Elements of an Emissions Inventory
- Quality Assurance and Quality Control Procedures for an Emissions Inventory
Emissions Inventory Introduction

• What is an Emissions Inventory?

• Emissions Inventory Activities

• Estimation of Emissions

What is an Emissions Inventory?

• Detailed listing of pollutants emitted from specific sources in a defined area.

Emissions Inventory Activities
Identification of Objectives
• Pollutants
• Emission Sources
• Source Categories
• Geographical Boundaries

Defining Point/Area Categories
• Point Sources
• Area Sources
• Mobile Sources
• Biogenic Sources

Estimation of Emissions
• Top-Down Approach
• Bottom-Up Approach
Top-Down Approach

- Definition
- Benefits
- Drawbacks

Bottom-Up Approach

- Definition
- Benefits
- Drawbacks

Methods of Estimating Emissions

- Continuous Emission Monitors
- Source Testing
- Material Balance
- Emission Factors
- Fuel Analysis
- Emission Estimation Models
- Surveys and Questionnaires
- Engineering Judgment
- US EPA CHIEF
- Locating & Estimating (L&E) Documents
Continuous Emission Monitors
• Description

Source Testing
• Description

Material Balance
• Description
Emission Factors

- Description
- Uses
  - US EPA AP-42
  - Emission Estimation Equations

US EPA AP-42

- Provides published emission factors
- [http://www.epa.gov/ttn/chief/](http://www.epa.gov/ttn/chief/)
- Emission factors are not EPA recommended limits

Emission Estimation Equations

\[ E = A \times EF \times (1 - ER/100) \]

Where:
- \( E \) = Emissions,
- \( A \) = Activity Rate,
- \( EF \) = Emission Factor, and
- \( ER \) = overall Emission Reduction Efficiency, %.
Fuel Analysis

- Description
- Uses

Emission Estimation Models

- Description
- Uses

Surveys and Questionnaires

- Description
- Uses
Engineering Judgment

• Description

• Uses

US EPA CHIEF

• Description

• Uses

Locating & Estimating Documents

L & E
Purpose of Emissions Inventories

- Historical Records
- Temporal and Spatial Distribution
- Emission Reactivity
- Compliance
- Policy Development
- Ambient Air Monitoring
- Agency Requirements

Historical Records

- Uses

Temporal and Spatial Distribution

- Uses
Emission Reactivity
• Uses

Compliance
• Uses

Regulatory Development
• Uses
Ambient Air Monitoring

- Uses

Agency Requirements

- Uses

Elements of an Emissions Inventory

- Geographical Area
- Spatial and Temporal Characteristics
- Source Specific Data
- Pre-existing Inventory Data
- Data Handling
Geographical Area

• Boundary Considerations

Spatial and Temporal Characteristics

• Definition

• Universal Transverse Mercator (UTM)

Source Specific Data

• Location

• Parameters

• Control Devices

• Other Physical Characteristics
Pre-existing Inventories

- Uses

Data Handling

- Manual Data Recovery
- Computer-assisted Data Recovery

QA and QC Procedures for Emission Inventories

- Quality Control
- Quality Assurance
Chapter Summary

- Emissions Inventory Introduction
- Purpose of Emissions Inventories
- Elements of an Emissions Inventory
- Quality Assurance and Quality Control Procedures for an Emissions Inventory

Questions?

APTI Course 452
Principles and Practices of Air Pollution Control
Chapter 9:
Control of Stationary Sources (Particulate Matter)
Chapter Summary

• Introduction to Stationary Sources
• Control Procedures
• Control Devices for Particulate Emissions

Introduction to Stationary Sources

• Process Operations Groupings
• Air Release Emissions Points

Process Operations Groupings

• Process Operations
• Atmospheric Releases
• Auxiliary Losses
• Waste Emissions
Air Release Emissions Points

Industrial Process Operation Air Emission Points and Categories

<table>
<thead>
<tr>
<th>Industrial Process Operation</th>
<th>Fugitive Sources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reactor vents</td>
<td>Valves</td>
</tr>
<tr>
<td>Distillation systems</td>
<td>Pipe seals</td>
</tr>
<tr>
<td>Vacuum systems</td>
<td>Flanges/connections</td>
</tr>
<tr>
<td>Combustion stacks</td>
<td>Compressors</td>
</tr>
<tr>
<td>Blow molding</td>
<td>Open-ended lines</td>
</tr>
<tr>
<td>Spray drying and washing</td>
<td>Pressure relief devices</td>
</tr>
<tr>
<td>Exhaust machines</td>
<td>Equipment cleaning/maintenance</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Surface Area Sources</th>
<th>Handling, storage, loading</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pond evaporation</td>
<td>Storage tank storage</td>
</tr>
<tr>
<td>Cooling tower evaporation</td>
<td>Loading/unloading</td>
</tr>
<tr>
<td>Wastewater treatment</td>
<td>Line venting</td>
</tr>
<tr>
<td>Land disposal</td>
<td>Packaging and container loading</td>
</tr>
</tbody>
</table>

Control Procedures

- Exhaust Stacks
- Plant Operations
- Control Technology

Exhaust Stacks

- Benefits
  - Reduce effects
  - Cheap
  - Transfer pollution to another location
**Plant Operations**
- Pre-Treating
- Cleaner Fuels
- Improved Plant Maintenance

**Control Technology**
- Exhaust Gas Characteristics
- Process or Site Characteristics
- Use of Control Devices

**Exhaust Gas Characteristics**
- Total Exhaust Flow Rate
- Exhaust Gas Temperature
- Required Control Efficiency
- Particle Size Distribution
- Particle Resistivity
- Composition of Emissions
- Corrosiveness of Exhaust Gas
- Moisture Content
- Stack Pressure
- Exhaust Gas Combustibility and Flammability
Process or Site Characteristics

- Reuse/Recycling of Collected Emissions
- Availability of Space
- Availability of Additional Electric Power
- Availability of Water
- Availability of Wastewater Treatment Facilities
- Frequency of Startup and Shutdowns
- Environmental Conditions
- Anticipated Changes in Control Regulations
- Anticipated Changes in Raw Materials
- Plant Type – Stationary or Mobile

Let’s Discuss PM Control

- Cyclones
- Baghouses
- ESPs
- Scrubbers
- Particulate Filters
- Settling Chambers
Cyclones: Collection Efficiency

• Typical Efficiency
  – Single cyclone: 30-95% pm10
  – Single cyclone: 0-70 pm% 2.5
  – Multiple cyclone: 80-99%

• Determining Factors for Efficiency
  – Particle size and/or density
  – Inlet duct velocity
  – Cyclone body length and design

Cyclones: Advantages

• Low Capital Cost
• No Moving Parts
• Few Maintenance Requirements
• Low Operating Costs
• Relatively Low Pressure Drop
• Dry Collection and Disposal
• Relatively Small Space Requirements

Cyclones: Disadvantages

• Relatively Low PM Collection Efficiencies
• Unable to Handle Sticky or Tacky Materials
• High Efficiency Units May Experience High Pressure Drops
Let’s Discuss Fabric Filters

Fabric Filters

- Method of Operation
- Cleaning
- Collection Efficiency
- Benefits / Drawbacks

Fabric Filters: Method of Operation

- Mechanical Design
Fabric Filters: Cleaning

- Shaking
- Reverse-air
- Pulse-jet
Pulse Jet Baghouse

Inside a Pulse Jet Baghouse

Pulse Jet Bag
Pulse Jet Baghouse Advantages

- Have high collection efficiency for respirable dust
- Can have high air-to-cloth ratio (6 to 10 ft/min)
- Have increased efficiency and minimal residual dust buildup due to aggressive cleaning action
- Can clean continuously
- Can use strong woven bags
Pulse Jet Baghouse Disadvantages

- May not be used readily in high temperatures unless special fabrics are used
- Cannot be used if high moisture content or humidity levels are present in the exhaust gases

Baghouse Design Considerations

- Pressure Drop
- Air-To-Cloth Ratio
- Collection Efficiency
- Fabric Type
- Cleaning
- Temperature Control
- Bag Spacing
- Compartment Design
- Space and Cost

Fabric Filters: Collection Efficiency

- Typical Efficiency
  - 95-99.9% (old equipment)
  - 99-99.9% (new equipment)

- Determining Factors for Efficiency
  - Gas Velocity
  - Particle characteristics
  - Fabric characteristics
  - Cleaning mechanism, intensity, frequency
Fabric Filters: Benefits / Drawbacks

- Simplicity
- Sensitivity
- Installation
- Cleaning and Maintenance

Let’s Discuss Electrostatic Precipitators

Bio Mass Power Plant

Electrostatic Precipitator
Electrostatic Precipitator

- General Description
  - Two types
    - Dry type use mechanical action to clean plates
    - Wet type use water to prequench and to rinse plates

Magnetic Impulse Rappers
**ESP: Design Factors Affecting Performance**

- Specific Collection Area
- Aspect Ratio
- Collection Plate Spacing
- Sectionalization
- Power Requirements/Spark Rate

**Electrostatic Precipitators: Collection Efficiency**

- Typical Efficiency
  - 99% <10 microns

- Determining Factors for Efficiency
  - ESP size and retention time
  - Electric field strength
  - Process factors

**Electrostatic Precipitators: Benefits / Drawbacks**

- Benefits
  - Removal efficiency

- Drawbacks
  - Cost
  - Installation
  - Operating Range
  - Treatment and Maintenance
Let's Discuss PM Scrubbers

Packed-Bed Wet Scrubber

Clean Gas
Mist Eliminator
Liquid Spray
Packing
Dirty Exhaust
Dirty Scrubber Liquid
Venturi Scrubbers: Method of Operation

- Mechanical Design

Venturi Scrubbers: Collection Efficiency

- Typical Efficiency
  - 70 to 99% removal
  - 0.5 to 5 microns

- Determining Factors for Efficiency
  - Pressure drop and energy consumption
## Venturi Scrubbers: Advantages

- Capable of Handling Flammable and Explosive Dusts
- Can Handle Mists in Process Exhausts
- Low Maintenance
- Simple in Design and Easy to Install
- Variable Collection Efficiency
- Provides Cooling for Hot Gases
- Neutralizes Corrosive Gases and Dusts

## Venturi Scrubbers: Disadvantages

- Water Pollution
- Wet Waste Product
- High Corrosion Potential
- Requires Protection Against Freezing
- Final Exhaust Must Be Reheated
- Collected PM May be Contaminated
- Disposal of Waste Sludge is Very Expensive

Let's Discuss Diesel Particulate Filters
Diesel Particulate Filter (DPF)

- High temperature regeneration (600-650 °C)
- Catalytic regeneration (~375 °C)
- Oxidize NO to NO₂ → adsorbs → reduces regeneration temperature
- Fuel-borne catalyst
- Ceramic coatings
- Engine adjustments necessary

Let's Discuss Settling Chambers
### Settling Chambers

- Method of Operation
- Collection Efficiency
- Advantages
- Disadvantages

#### Settling Chambers: Method of Operation

- Mechanical Design
- Cleaning

![Settling Chamber Diagram](image)

#### Settling Chambers: Collection Efficiency

- Typical Efficiency
  - Effective for large and/or dense particles
- Determining Factors for Efficiency

![Efficiency Diagram](image)
Settling Chambers: Advantages

- Low Capital Cost
- Very Low Energy Cost
- No Moving Parts
- Few Maintenance Requirements
- Low Operating Costs
- Excellent Reliability
- Low Pressure Drop Through Device
- Device Not Subject to Abrasion
- Provides Incidental Cooling of Gas Stream
- Dry Collection and Disposal

Settling Chambers: Disadvantages

- Relatively Low PM Collection Efficiencies
- Unable to Handle Sticky or Tack Materials
- Large Physical Size
- Trays in Multiple-Tray Settling Chamber may Warp

Chapter Summary

- Introduction to Stationary Sources
- Control Procedures
- Control Devices for Particulate Emissions
Chapter Summary

- Control Devices for Gaseous Emissions
- Sulfur Dioxide Emission Controls
- Nitrogen Oxide Emission Controls
Combustion Considerations

3 T's of Combustion
- Residence Time
- Temperature
- Turbulence (mixing)
- Increase 3T's = more NOx
- Decrease 3T's = more CO and uncontrolled pollutant

Control Devices for Gaseous Emissions
- Thermal Incinerators
- Catalytic Incinerators
- Flares
- Boilers and Process Heaters
- Adsorbers
- Absorbers
- Condensers
Thermal Incinerators

- Method of Operation
- Collection Efficiency
- Advantages
- Disadvantages

Thermal Incinerators: Method of Operation

- Mechanical Design
  - Time, temperature, turbulence
Thermal Incinerators: Collection Efficiency

- Typical Efficiency
  - 98-99.99%

- Determining Factors for Efficiency
  - Design criteria: temperature, time, VOC concentration, compound type, mixing
Thermal Incinerators: Advantages

• High Efficiency
• Reusable Energy and Heat Produced

Thermal Incinerators: Disadvantages

• Not Well Suited to Streams with Highly Variable Flow
• High Operating Costs

Let's Discuss SCR
Catalytic Incinerators

• Method of Operation

• Collection Efficiency

• Advantages

• Disadvantages

Catalytic Incinerators: Method of Operation

• Mechanical Design
  – Catalyst increases oxidation reaction rate
  – Catalyst lowers temperature

Selective Catalytic Reduction (SCR)

• NOx control thru ammonia (NH₃) injection
• 4NO + 4NH₃ + O₂ → 4N₂ + 6H₂O
• 2NO₂ + 4NH₃ + O₂ → 3N₂ + 6H₂O
• 65-90% control

• Problems
  – Expensive
  – High maintenance
  – Ammonia “slip”
  – Catalyst replacement & disposal
Catalytic Incinerators: Collection Efficiency

- Typical Efficiency
  - 25-99%
- Determining Factors for Efficiency
  - VOC composition and concentration
  - Temperature
  - Oxygen concentration
  - Catalyst characteristics
  - velocity

Catalytic Incinerators: Advantages

- Lower Fuel Requirements
- Lower Operating Temperatures
- Little or No Insulation Requirements
- Reduced Fire Hazards
- Reduced Flashback Problems
- Less Volume/Size Required

Catalytic Incinerators: Disadvantages

- High Initial Cost
- Catalyst Poisoning is Possible
- Particulate Often Must First be Removed
- Disposal Problems for Spent Catalyst
### Catalytic vs. Thermal for VOC Control

<table>
<thead>
<tr>
<th>Catalytic</th>
<th>Thermal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Operating Temp. &amp; Lower Fuel Usage</td>
<td>Higher Operating Temp. &amp; Higher Fuel Usage</td>
</tr>
<tr>
<td>Higher Capital &amp; Maintenance Costs</td>
<td>Lower Capital &amp; Maintenance Costs</td>
</tr>
<tr>
<td>Catalyst Fouling &amp; Poisoning</td>
<td>No Catalyst Involved Here</td>
</tr>
</tbody>
</table>

### Flares

- Method of Operation
- Types of Flares
- Capacity
- Advantages
- Disadvantages
Flares: Method of Operation

- Mechanical Design
- Primary application in petroleum and petrochemical Industries

Flares: Types

- Steam-Assisted
- Air-Assisted
- Pressure-Assisted
- Non-Assisted

Flare at Landfill
Flares: Capacity

- Typical Capacity
  - 100,000 lbs/hr of hydrocarbon gases – ground flares
  - 2 million lb/hr elevated flares

- Determining Factors for Capacity
  - Type of configuration
  - Source of waste stream

Flares: Advantages

- Economical Way to Dispose of Gas
- Does Not Require Auxiliary Fuel
- Used to Control Intermittent or Fluctuating Waste Streams
- Can be used for almost any VOC stream

- Primary use: safety device

Flares: Disadvantages

- Produces Undesirable Noise, Smoke, Heat Radiation, and Light
- Source of SOx, NOx, and CO
- Cannot Treat Waste Streams with Halogenated Compounds
- Released Heat from Combustion is Lost
Let's Discuss Boilers and Process Heaters

Boilers and Process Heaters
• Method of Operation
• Collection Efficiency
• Advantages
• Disadvantages

Boilers and Process Heaters: Method of Operation and Efficiency
• Mechanical Design
• Typical Efficiency
  — 98% or greater
Boilers and Process Heaters: Collection Efficiency
• Typical Efficiency
  • 98 percent plus

Boilers and Process Heaters: Advantages
• Little Additional Capital Cost
• Reduces Fuel Costs
• Exhaust stream be used as supplementary fuel

Boilers and Process Heaters: Disadvantages
• Can Only Use Pollutants for Fuel That Do Not Affect the Performance of the Burner Unit
• Gas Streams with Low Heating Values Only Work in Small Burner Units
Let's Discuss Carbon Adsorption Systems

Adsorbers

• Method of Operation
• Capacity
• Advantages
• Disadvantages

Adsorbers: Physical Process

• Physical Process (pollutant held physically)
  – Adsorbent called absorbent carbon (i.e. activated carbon)
• Mechanical Design
• Regenerative or Non-regenerative
• Mass Transfer Zone
The Mass Transfer Zone (MTZ) exists in all adsorbents. In the MTZ, the concentration of VOCs in the gas phase from VOCs of lower vapor pressure goes to equilibrium with the adsorbed adsorbent.

The concentration in the MTZ is determined by the equilibrium between the gas phase and the adsorbed adsorbent.
Carbon Adsorbers at a Soil Remediation Site
Adsorber Design Considerations

- Porosity of Adsorbent
- Bed Cross-Sectional Area
- Bed Length
- Multiple VOC’s
- Steaming Requirements
- Fouling
- Timers/Monitors
- Channeling

Absorber/Condenser/Adsorber Unit at Marketing Terminal
Adsorbers: Capacity

- Capacity
  - Depends on adsorbent material, regeneration schedule, size of adsorbent bed

Adsorbers: Advantages

- Economical for controlling low concentrations of VOCs
- Recovery of VOC possible
- Can increase VOC concentration to allow the use of incineration or recovery by membrane or condenser

Adsorbers: Disadvantages

- Problems with solid waste disposal in non-regenerable adsorbers
Let's Discuss Absorbers

Absorbers
- Method of Operation
- Collection Efficiency
- Advantages
- Disadvantages
Absorbers: Method of Operation

- Mechanical Design
  - Removes gaseous pollutant by dissolving in liquid
- Packed-bed absorber (a.k.a Scrubbers)
  - Has column filled with inert substance and absorbing liquid

Absorbers: Collection Efficiency

- Typical Efficiency
  - >95%
- Determining Factors for Efficiency
  - Used to control inorganic fumes, vapors, and gases, VOC’s, PM, HAP’s in particulate form
  - Efficiency depends on properties of gas stream and liquid absorbent
  - Process temperature dependent – lower temperature favors absorption

Absorbers: Advantages

- Good for recovering products or purifying gas streams that have high concentrations of organic compounds.
- More cost effective than impingement plate towers.
Absorbers: Disadvantages

• Has Several Limiting Factors
  – Availability of suitable solvent
  – Availability of vapor/liquid equilibrium date of specific pollutant
• Requires Disposal of Wastewater
• High PM Concentrations Can Clog Bed
• Plugging

Let’s Discuss Condensers

Condensers

• Method of Operation
• Collection Efficiency
• Advantages
• Disadvantages
Condensers: Method of Operation

• Mechanical Design – removes gaseous pollution from air by lowering temperature such that gas condenses and become liquid

Condensers: Collection Efficiency

• Typical Efficiency
  — 50 – 95%

• Determining factors for efficiency
  — Design and application
Condensers: Advantages

- Allows Recovery of Valuable Waste Products from Gas Stream
Condensers: Disadvantages
- Requires Disposal of Wastewater
- Generally Used in Combination with Other Control Devices

Inorganic Gas Control
- Solvents
  - Water is most common
- Scrubbing Liquids
  - Caustic solution
- Acid gases absorbed into scrubbing solution form neutral salts

Any questions on control devices for gaseous emissions?
Sulfur Dioxide Control

Sulfur Dioxide Emissions Controls

- Flue Gas Desulfurization (FGD)
  - Wet FGD Technologies
  - Dry FGD Technologies
  - Performance

Wet FGD Technologies

In wet FGD processes flue gas contacts alkaline slurry in absorber
Wet FGD Technologies

- Limestone Forced Oxidation (preferred – minimizes oxidation)
- Limestone-Inhibited Oxidation (efficient with High sulfur coals)
- Lime and Magnesium Lime (more reactive than Limestone but more expensive)
Dry FGD Technologies

- Hot flue gas mixes in a spray dryer vessel with a mist of finely atomized fresh lime slurry resulting in series of reactions and a drying of process waste. To increase efficiency partial recycle occurs. Lime sorbent can be delivered to flue gas in an aqueous slurry form [lime spray drying (LSD)] or as a dry powder [furnace sorbent injection (FSI), and circulating fluidized bed (CFB)].

Dry FGD Technologies

- Line Spray Drying (LSD)
  - Used by sources that burn low to medium–sulfur coal
- Furnace Sorbent Injection (FSI)
  - dry sorbent injected
  - Directly into furnace w/temperature between 950-1000vC

Dry FGD Technologies

- Circulating Fluidized Bed (CFB)
  - Dry sorbent (hydrated lime) contacted with a humidified flue gas with long contact time provided
Dry FGD Technologies

- Line Spray Drying (LSD)
- Furnace Sorbent Injection (FSI)
- Circulating Fluidized Bed (CFB)

Regenerable FGD Technologies

- Only Marginal in Application
- High O&M Costs
- Five Processes in Use
  - 4 wet
  - 1 dry
FGD Technology Performance

- Performance
  - Medium: 90%
  - State of Art: >95%
- Performance Improvements
  - Large capacity module
  - Increase flue gas velocity
  - Buffering

Let's Discuss NOx Control

- Thermodynamic realities
- Low-NOx combustion techniques
- Ammonia injection (SCR & SNCR)
- Catalytic controls

Nitrogen Oxides (NOx) Emissions Control

- Types of Nox
  - 7 compounds
  - NO2 only regulated as a surrogate
- NOx Control Methods
Types of Nitrogen Oxides (NOx)

- **Thermal Nox**
  - Formed by combustion

- **Fuel Nox**
  - Formed from fuels that contain nitrogen (i.e. coal)

- **Prompt Nox**
  - Formed from molecular nitrogen in air combining with fuel in fuel-rich conditions

**NOx** is the most important reactant in Ozone formation

- **NOx** is primarily formed from 3 different sources:
  1. Atmospheric N2 in the combustion air: **Thermal NOx** (≥2800°F)
  2. N2 present in fuel: **Fuel Bound NOx**
     - NOx from coal burning boilers
  3. HC (in the flame) during combustion oxidize to form **Prompt NOx**

**NOx Control Methods**

- Reducing Temperature
- Reducing Residence Time
- Chemical Reaction of NOx
- Oxidation of NOx
- Removal of Nitrogen from Combustion
- Sorption (both Adsorption and Absorption)
- Combinations of Methods
NOx Control Methods

- Reducing Temperature
- Reducing Residence Time
- Chemical Reaction of NOx
- Oxidation of NOx
- Removal of Nitrogen from Combustion
- Sorption (both Adsorption and Absorption)
- Combinations of Methods

Thermal NOx
Fuel-bound NOx
Prompt NOx
NOx Creation
APTI 452

NOx vs. Temperature

Babcock & Wilcox Utility Boiler

Staged Combustion with Overfire Air
Ultra Low-NOx Burner (9 ppm)

Low-NOx Burner with Staged Fuel

Fire-Tube Boiler
NOx Reduction by Boiler Configuration

A: Low-NOx burner only, no overfire air (OFA)
B: Low-NOx burner with OFA
C: Low-NOx burner with OFA and FGR

Let’s Discuss SNCR

Boiler with SNCR
Selective Non-Catalytic Reduction

- NOx control through ammonia injection
- No catalyst necessary
- Temperature range 1400 °F – 2000 °F
- Injected upstream of convection section
- 30% - 50% control under normal conditions
- Problems:
  - Changing flue temperatures with changing load
  - Formation of ammonium salts
  - Ammonia slip

Comparison of NOx Control Technologies

<table>
<thead>
<tr>
<th>Technology</th>
<th>Approx. Reduction</th>
<th>Approx. lbs/MMBTU</th>
<th>Approx. ppmv @ 3% O2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard burners</td>
<td>Base case</td>
<td>0.14</td>
<td>120</td>
</tr>
<tr>
<td>Low NOx burners</td>
<td>60%</td>
<td>0.06</td>
<td>45</td>
</tr>
<tr>
<td>Ultra Low NOx Burners</td>
<td>80%</td>
<td>0.03</td>
<td>25</td>
</tr>
<tr>
<td>Ultra Low NOx Burners</td>
<td>95%</td>
<td>0.007</td>
<td>6</td>
</tr>
<tr>
<td>Ultra Low NOx Burners – 2nd gen.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FGR</td>
<td>55%</td>
<td>0.025</td>
<td>20</td>
</tr>
<tr>
<td>Compu-NOx w/ FGR</td>
<td>90%</td>
<td>0.015</td>
<td>12</td>
</tr>
<tr>
<td>SNCR</td>
<td>40%</td>
<td>0.033 - 0.085</td>
<td>27 - 70</td>
</tr>
<tr>
<td>Catalytic Scrubbing</td>
<td>70%</td>
<td>0.017 - 0.044</td>
<td>14 - 36</td>
</tr>
<tr>
<td>SCR</td>
<td>90 – 95%</td>
<td>0.006 - 0.015</td>
<td>5 - 12</td>
</tr>
</tbody>
</table>

Chapter Summary

- Control Devices for Gaseous Emissions
- Sulfur Dioxide Emission Controls
- Nitrogen Oxide Emission Controls
APTI Course 452
Principles and Practices of Air Pollution Control
Chapter 11: Control of Mobile Sources

Chapter Overview
- Mobile Sources
- Future Alternatives

Mobile Sources
- Automobiles
- Diesel Engines
- Off-Road Vehicles and Equipment
- Airplanes
- Railroad Locomotives and Marine Engines
Automobiles

- Milestones in Auto Emissions Control
- Automobiles and Emissions
  - Control of Automobile Emissions

Milestones in Auto Emission Control


Automobiles and Emissions

- Evaporative
- Exhaust
- Refueling
Automobiles and Emissions

- Evaporative
- Exhaust
- Refueling

Automobiles and Emissions

- Evaporative
- Exhaust
- Refueling

Automobiles and Emissions: Exhaust Breakdowns

- NO
- CO
- HC
Automobiles and Emissions
- Evaporative
- Exhaust
- Refueling

Control of Automobile Emissions
- Federal Emission Standards
- Control Devices
- Gross Emitters
- Reformulated Gasoline
- Alternative Fuels

Vehicle Emissions Certification
- TLEV
- LEV
- ULEV
- SULEV
- PZEV
What is Tier 3?

• Systems approach to reducing motor vehicle pollution: more stringent vehicle standards enabled by gasoline sulfur control
• Creates a harmonized vehicle program
  – Coordinated with California LEV III and Light-duty GHG standards finalized last year for model years (MY) 2017-2025
  – Enables auto industry to produce and sell one vehicle nationwide
• Part of comprehensive approach to create cleaner, more efficient vehicles
  – Begins phasing in with model year 2017
  – To allow coordinated compliance with LEV III and LD GHG

Why Tier 3: Air Quality and Public Health

• Tier 3 standards would have immediate health and air quality benefits
• Will help attain and maintain ozone and PM NAAQS
  – Provides cost-effective national reductions that avoid more expensive local controls
• Reduces pollution near roads
  – More than 50 million people live, work, or go to school near major roads

Why Tier 3: Harmonized Vehicle Program

• California finalized LEV III standards last year
  – EPA issued a waiver under CAA in December 2012
• The auto industry supports Tier 3 because they want to produce and sell one vehicle nationwide
• Tier 3 is harmonized with LEV III
  – Would begin in 2017 to allow coordinated compliance with GHG and LEV III
Why Lower Sulfur Gasoline?

- Both Tier 3 and LEV III vehicle standards depend upon lower sulfur gasoline
  - Sulfur at current levels degrades the performance of vehicle catalytic converters the primary emission control system on vehicles
- Tier 3 vehicle standards not achievable without lower sulfur
- Lower sulfur also provides immediate reductions in NOx and VOC emissions from the existing fleet
- California already has lower sulfur gasoline (as do Europe, Japan, S. Korea, and several other countries)
  - Other states prohibited from controlling gasoline sulfur on their own

Tier 3 Vehicle Standards

- Phase in between 2017 and 2025
- Tighter VOC and NOx tailpipe standards
  - 80% reduction from today’s fleet average
- Tighter PM tailpipe standard
  - 70% reduction in per-vehicle standard
- Evaporative emissions standards
  - Reduced fuel vapor emissions and improved system durability
- Revised certification test fuel to better reflect in-use gasoline expected in 2017
  - Current certification test fuel has no ethanol
- Regulatory streamlining/harmonization changes in response to the President’s Regulatory Review initiative

Tier 3 Fuel Standards

- Lower the average sulfur standard from 30 to 10 ppm starting January 1, 2017
  - California is already 10 ppm sulfur on average, and Europe and Japan have a 10 ppm cap
- Proposing to either maintain the current per-gallon sulfur caps (80 ppm at refinery gate, 95 ppm at retail) or lower them to 50 ppm and 65 ppm respectively
Impacts on Refiners

• Of the 111 refineries potentially impacted by Tier 3, EPA estimates that:
  — 29 are either already meeting the Tier 3 standard, or could do so with operational changes alone
  — 66 could meet the Tier 3 standard by modifying their existing equipment
  — Just 16 would have to install new equipment to comply with Tier 3

• Refiners would invest roughly $2.1 billion

Fuel Flexibilities

• Proposing the superset of flexibilities that have proven successful in past EPA fuel programs
  /* Annual average */ standard with a sufficiently high per-gallon cap

• Early credit program to phase in the sulfur standard from January 1, 2014 through December 31, 2019

• Relief for small refineries and refineries <75,000 barrels per day
  — Delay of 3 years through December 31, 2019, consistent with the end of the early credit phase-in for large refineries
  — Total of 35 refineries representing a total of 10% of gasoline production

• Economic and Technical Hardship provisions available to all refineries
  — EPA has granted hardship relief to over a dozen refineries under past fuel regulations; many more for RFS

Tier 3 Emission Impacts

<table>
<thead>
<tr>
<th>National Onroad Inventory Reductions</th>
<th>2017</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tons</td>
<td>Percent</td>
</tr>
<tr>
<td>NOx</td>
<td>284,000</td>
<td>8</td>
</tr>
<tr>
<td>VOC</td>
<td>55,000</td>
<td>3</td>
</tr>
<tr>
<td>PM 2.5</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>CO</td>
<td>747,000</td>
<td>4</td>
</tr>
<tr>
<td>Benzene</td>
<td>1,835</td>
<td>1</td>
</tr>
<tr>
<td>Total air toxics</td>
<td>35,000</td>
<td>3</td>
</tr>
</tbody>
</table>

• Emission reductions will continue to grow beyond 2030 as more of the fleet continues to turn over to Tier 3 vehicles
**Benefits of Tier 3**

- Total Ozone and PM-related Premature MortalityAvoided:
  - $20-2,400 in 2030 (based on range of ozone and PM mortality studies)

- Other PM- and ozone-related health impacts avoided in 2030:
  - Hospital admissions and asthma-related ER visits: 3,200
    - Asthma exacerbations: 22,000
  - Upper and lower respiratory symptoms in children: 23,000
  - Lost school days, work days, and minor restricted activity days: 1.8 million

- Total Monetized Benefits in 2030 (2010$):
  - $8 to $23 Billion

**Ozone Reductions in 2030 From Tier 3**

**PM$_{2.5}$ Reductions in 2030 From Tier 3**
Status of Tier 3

- EPA Proposes Tier 3 Tailpipe and Evaporative Emission and Vehicle Fuel Standards - 3/13
- Public Hearings on 4/24/12 and 4/29/13
- EPA published Proposed Rule - 5/21/13
- Notice of Extension of Comment Period to 7/1/13

Control of Automobile Emissions

- Federal Emission Standards
- Control Devices
- Gross Emitters
- Reformulated Gasoline
- Alternative Fuels
Control of Automobile Emissions

- Federal Emission Standards
- Control Devices
- Gross Emitters
- Reformulated Gasoline
- Alternative Fuels

Diesel Engines

- PM Emissions
- NOx Emissions

Highlights MY2014-2018

☑️ First ever Medium- & Heavy-Duty Standards
☑️ Will reduce oil imports, fuel consumption, CO₂ emissions, and operating costs for thousands of businesses
☑️ Allows manufacturers to produce a single fleet of vehicles to meet requirement

- 530 million barrels less oil
- 270 MMT lower GHGs
- $50 billion in fuel savings
- $8 billion in new hardware
- $42 billion in net savings
- $49 billion in net benefits
SmartWay Transport Partnership

- EPA program to improve freight transportation efficiency
- Encourages key technologies such as idle reduction, improved aerodynamics, & efficient tires

Unique Aspects of the Rule

- More complex than light-duty and regulates many entities for the first time
  - Traffic sector is incredibly diverse, serving a wide range of functions
  - Separate procedures for truck and engine performance, new metrics (g/ton-mile) to account for the work that trucks perform hauling freight
- Begins with Model Year 2014
  - 18 months from now for many products
  - Typically heavy-duty rules give 4+ years lead time
- Gets existing technology off the shelf and onto new trucks
  - As first-ever regulation of this sector, rule drives truck makers to apply fuel-saving technologies across all vehicles that will benefit
  - Flexible enough that fleet can get the right truck for their business
- Enjoy broad support from major stakeholders
  - Truck makers wanted a national program supported by California
  - American Trucking Association gets national fuel economy standards called for by ATA since 2008
  - Environmental stakeholders support early action on climate change

Key Elements of the Final Rule

- Begins with 2014 model year and increases in stringency through 2018
- Breaks diverse truck sector into 3 distinct categories
  - Line-haul tractors (“semis”) (largest heavy-duty tractors used to pull trailers, e.g., 18-wheelers)
  - Heavy-duty pickups and vans, less-than-truckload (LTL) and 3-ton trucks and vans made primarily by Ford, GM, and Chrysler
  - Vocational trucks (everything else, buses, refuse trucks, cement mixers, ambulances,)
- Sets separate standards for engines and vehicles, ensures improvements in both
- Sets separate standards for fuel consumption, CO2, NOx, CH4 and HFCs. Fuel consumption and CO2 standards are aligned.
- Provides incentives for advanced technologies (e.g. EVs and Hybrids)
- Manufacturer flexibilities, including averaging, banking and trading
- New compliance methods for heavy-duty hybrids and innovative technologies not contemplated in existing engine and vehicle test procedures
Vehicles Covered

- All on-highway vehicles that are not regulated by CAFE standards.
- Certain small businesses will not be covered in initial phase.

CA Waivers

- 6/19/13 – EPA issues waiver for CA State Nonroad Engine Pollution Control Standards
- 5/16/13 = EPA authorized CA emission regulations applicable to in-use, nonroad yard trucks and two engine sweepers.

Airplanes

- Emissions
- Commercial Aircraft Standards
- International Civil Aviation Organization
- Procedural Changes
Railroad Locomotives and Marine Engines

- Railroad Locomotives
- Marine Engines

Railroad Locomotives

- Emissions
- Tier 0
- Tier 1
- Tier 2

Marine Engines

- Gasoline-Fueled Outboard Engines and Personal Watercraft
- Switch out 2 stroke with 4 stroke
- Stern Driven and Inboard Gasoline Engines
- Marine Diesel Engines
Future Alternatives

- New Technology – Electric Cars
- Transportation and Air Quality Center (TRAQ)
  www.epa.gov/oms/traq

Chapter Summary

- Mobile Sources
- Future Alternatives