Air Pollution in the Santa Barbara Channel

*Presentation for the Channel Islands Naturalist Corps*

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Air Pollution in the SB Channel

- Air Quality (AQ) regulatory framework
- Pollutants of concern/ Health effects
- Ozone AQ trends/ Meteorology
- Shipping in the Santa Barbara Channel
  - Our case study
  - Planning process/ Emissions
  - Regulatory efforts
  - Demonstration project
  - Port Hueneme/ Cabrillo port project
  - Ship types
3-Tiered Regulatory Framework

- Federal – U.S. Environmental Protection Agency
- State – California Air Resources Board
- Local – Air Pollution Control & Air Quality Management Districts
Regulatory Framework: Federal

Federal Clean Air Act

– National Ambient Air Quality Standards
– Attainment deadlines and progress requirements
– Planning requirements
– Permitting and enforcement standards
– Performance standards for:
  • new sources
  • sources of hazardous air pollutants
  • fuels and engines
– Federal pre-emption of certain actions
Regulatory Framework: State

- California Clean Air Act
- California Health & Safety Code
  - More restrictive ambient standards (must protect children and sensitive groups)
  - No set deadlines; “as expeditiously as practicable”
  - Planning, rulemaking, enforcement, public outreach, and transport mitigation requirements
  - Additional programs including: ag sources, portable equipment, toxics, emission banking, & incentives
  - Separate programs for stationary sources (air districts), & mobile sources and fuels (state board), but some cross-over
Regulatory Framework: Local

APCD Plans, Rules, Policies, Programs

- Air monitors determine whether ambient standards have been achieved
- Plans guide local efforts to achieve state & federal standards
- Rules are adopted consistent with plans, and also to implement policies of the Board of Directors
- Authority to Construct permits are required for new air pollution sources and for modifications to existing sources; large emission sources must use best available control technology and must offset emissions increases with emission reductions
- Operating permits are required for existing sources, and require monitoring and records that ensure compliance; some permits are federally enforceable
APCD Plans, Rules, Policies, Programs

- Toxic Risk Management programs reduce or mitigate exposure to toxic air pollution, and notify members of the public about potential exposures.
- Field inspections verify compliance, and investigate complaints.
- Incentive programs reduce emissions from other sources: motor vehicles, heavy duty diesel engines, agricultural equipment, commercial fishing vessels.
- Public outreach provides information to, and gathers information from, the communities, businesses, local governments, and others within the district.
California Air Districts & Counties

Santa Barbara County Air Pollution Control District

California Environmental Protection Agency
Air Resources Board
Air Pollution in Santa Barbara County

• Ozone, a.k.a. smog
  – Oxides of Nitrogen (NOx)
  – Reactive Organic Gases (ROG, or VOCs)

• Particle Pollution
  – Inhalable Particulate Matter (PM10)
  – Fine Particulate Matter (PM2.5)
    • Primary and secondary formation

• Toxic Air Contaminants
  – Identified by state or federal government
  – Classified for cancer or non-cancer effects
  – Effects can be from short term (acute) exposure, or long term (chronic exposure)
Ozone Formation

Ozone formation

Sunlight

Oxygen (O₂) + Volatile Organic Compounds (VOC) + Nitrogen Oxides (NOx)

Ozone (O₃)

Santa Barbara County Air Pollution Control District
Air Pollution & Health

- **Ozone**
  - Irritates eyes, nose, throat and lungs
  - Exacerbates and can cause asthma
  - Contributes to heart and lung disease and early death

- **Particle Pollution**
  - All of the above, and
  - Can have serious effects on those with heart ailments
  - Penetrates lung tissue; small particles cannot be removed by body’s defenses, disrupt lung cell function
  - Cause or contribute to poor pregnancy outcomes
  - Have additional and very serious adverse effects on children

- **Toxic Air Pollution**
  - Acute (short term) and chronic (long term) effects
  - Some cause cancer
  - Some have non-cancer effects, such as causing birth defects, sterility, nerve or brain damage, or damage to eyes, skin, organs and organ systems
Air Pollution and Children

*Southern California Children’s Health Study* showed pollutants from fuel combustion:

- Slow lung growth in children
- Decrease lung function in children
- Increase asthma rates in children
- Some effects could not be reversed (will effect children for life)
- Other effects included increased hospital admissions, more missed school days, and greater care costs for affected children
Our Air Quality
Bad Ozone Days 1988-2005

California 1-Hour Standard (0.09 parts per million)
National 8-Hour Standard (0.08 parts per million)
National 1-Hour Standard (0.12 parts per million)
Ventura County
Days Over Federal & State Ozone Standards

Days Exceeding Ozone Standard

Fed 1-hr.  State 1-hr.  Fed 8-hr.  State 8-hr.  Population


Days

Population

Sources: California Air Resources Board and California Department of Finance.
Eastern Pacific High

Sea-Level Pres Analysis (GFS model) and Surface Obs

GOES—West Infrared Image at 1200Z 3 MAY 2004

LO: 985.6   HI: 1035.5
2003 Socal Fires
Ventura County Fire
Shipping in the SB Channel
Santa Barbara Case Study

• Over 7,200 annual traverses
• 130 miles of coastline
• Large 2-stroke engines
• Vessels burning heavy bunker fuels
• Slow turnover rates
• Majority of the vessels are foreign flagged
• Trade volumes expected to continue increasing
Great Circle Route
Clean Air Planning Process

• Attainment state and federal standards
• Develop emission inventories
• Evaluate emission control measures
• Forecast emissions
• Marine shipping contribution: Large and growing
• June 2007 – Next Clean Air Plan
ROC & NOx Emission Sources *

2000 Santa Barbara County ROC & NOx Emissions
122 Tons per day

- Stationary Sources: 13%
- OCS- Marine Shipping: 27%
- OCS Other Mobile Sources (Excluding Ships): 1%
- OCS Stationary Sources: 2%
- Other Mobile Sources: 17%
- Area-Wide Sources: 7%
- On-Road Motor Vehicles: 33%

2020 Santa Barbara County ROC & NOx Emissions
120 Tons per day

- Stationary Sources: 15%
- OCS- Marine Shipping: 56%
- OCS Stationary Sources: 2%
- Other Mobile Sources: 9%
- Area-Wide Sources: 9%
- On-Road Motor Vehicles: 9%
- OCS Other Mobile Sources (Excluding Ships): <1%

* Includes both Onshore & OCS Emissions
Santa Barbara County NOx * Emissions Comparison

2000 Santa Barbara County NOx Emissions
- On-Road Motor Vehicles: 31.17%
- OCS- Marine Shipping: 42.71%
- Area-Wide Sources: 0.61%
- Stationary Sources: 7.13%
- Other Mobile Sources: 17.25%
- OCS Stationary Sources: 1.05%
- OCS Other Mobile Sources (Excluding Ships): 0.08%

2020 Santa Barbara County NOx Emissions
- On-Road Motor Vehicles: 7.62%
- OCS- Marine Shipping: 74.88%
- Area-Wide Sources: 1.36%
- Stationary Sources: 7.10%
- Other Mobile Sources: 8.02%
- OCS Stationary Sources: 0.92%
- OCS Other Mobile Sources (Excluding Ships): 0.10%

* NOx = Onshore + OCS
Santa Barbara County
NOx * Emission Forecast

* Percentage of total emissions from foreign and US vessels in transit

* NOx = Onshore + OCS
Platform Gilda
Natural Oil and Gas Seeps
Installation of a Seep Tent
Seep Containment Devices -- 1982
2005 Marine Shipping Inventory

- Over 7,000 transits
- 10% of vessels = 56% NOx emissions
- 76 vessels over 50 tons of NOx
- 92% of NOx from foreign flagged vessels
- About 19 transits per day
- About 40 tons of NOx and 3 tons of PM emitted daily
Ship Type Analysis

2005 Total NOx by Vessel Type
(Total NOx = 14,918 Tons)

- Container Ship: 83.0%
- Bulk: 4.5%
- Tanker: 2.8%
- Tug/Barge: 1.2%
- RO/RO: 1.2%
- Cargo/General: 2%
- Other (8): 1.0%

2005 Total Transits by Vessel Type
(Total Transits = 7,086)

- Container Ship: 61.2%
- Bulk: 9.0%
- Auto Carrier: 9.3%
- Cargo/General: 3.7%
- Tug/Barge: 6.7%
- RO/RO: 2.1%
- Other (8): 1.2%
- Tanker: 6.9%

Santa Barbara County Air Pollution Control District
Regulatory Efforts

IMO

- MARPOL Annex VI
  - Entered into force on May 19, 2005
  - Sets limits for SOx and NOx from vessels built or modified after 1/1/2000
  - Currently 35 countries have ratified
  - US, Canada & Mexico have **NOT** ratified treaty yet
  - By 2007 revisions that will be considered include:
    - PM, VOC, GHG limits & tougher NOx & SOx limits
    - In-use engine applicability

US EPA

- Category 3 Engine Rulemaking
  - Tier 1 standards = IMO standards
  - Tier 2 standards expected 2007
- SECA application development
Regulatory Efforts

California Air Resources Board (ARB)
– Air Toxic Control Measures (ATCM)
  • Adopted aux. engine ATCM
  • Cargo handling equipment ATCM
  • Cruise ship on-board Incineration ATCM
  • Frequent flyer vessel ATCM

– Research
  • CA ocean-going vessel emission inventory
  • Modeling & Health / Ecological impact
  • SECA development collaboration with EPA
Demonstration Project

Objectives

• Demonstrate emission controls
• Develop support for potential economic incentive programs
• Develop in-use testing protocol

Participants

• U.S. EPA, MARAD
• ARB, Ports, CA Air districts
• Ship operator
• Engine manufacturer
• UC Riverside
Demonstration Project (cont’d)

- Emission Control Technologies
  - Fuel-water emulsification
  - Slide Valves
- Detailed Emissions Testing
- Project Costs
  - About $780,000 for hardware
  - About $100,000 for emissions testing
- Annual Emissions Reductions in CA Waters
  - 66 Tons of NOx
  - 4 Tons of PM
- Project to be complete by July 2007
- Challenges
Port Hueneme

• “Niche” Port
  – #1 port in nation for citrus exports
  – Top ten in imports of autos & bananas
• Nearly tripled cargo weight and value between 1990 & 2001
• 35' depth limits vessel types
• Vessel types: Reefer, ro-ro, older containerships
• About 340 calls in 2004
• About 7% of total US vehicle carrier port calls and capacity (DWT x calls) in 2004
Common Ship Types

2004 Port Hueneme Calls

- Ro-ro 62%
- General Cargo 34%
- Tankers 3%
- Container 1%

Santa Barbara County
Air Pollution Control District
Proposed Cabrillo Port Project
# Containership Evolution

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<th>Generation</th>
<th>Length</th>
<th>Draft</th>
<th>TEU</th>
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<tr>
<td><strong>First Generation (1956-1970)</strong></td>
<td>135 m</td>
<td>&lt; 9 m</td>
<td>500</td>
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<tr>
<td>Converted Cargo Vessel</td>
<td>200 m</td>
<td></td>
<td>800</td>
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<td>Converted Tanker</td>
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<td><strong>Second Generation (1970-1980)</strong></td>
<td>215 m</td>
<td>10 m</td>
<td>1,000 – 2,500</td>
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<td>Cellular Containership</td>
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<td><strong>Third Generation (1980-1988)</strong></td>
<td>250 m</td>
<td>11-12 m</td>
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<td>Panamax Class</td>
<td>290 m</td>
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<td><strong>Fourth Generation (1988-2000)</strong></td>
<td>275 – 305 m</td>
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<td>Post Panamax</td>
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<tr>
<td><strong>Fifth Generation (2000-?)</strong></td>
<td>335 m</td>
<td>13-14 m</td>
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<td>Post Panamax Plus</td>
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Containerships
General Cargo Ships
Ro-Ro Ships
Tankers
LNG Tankers

135,000 cubic metre LNG carrier with membrane tanks.

137,000 cubic metre LNG carrier with type B tanks.
~ 30 MW (~40,000 hp)
2-stroke main engine
Questions ?