Shore Power (Cold-Ironing) Regulation

Shore Power Workgroup Meeting

March 20, 2007

California Environmental Protection Agency

Air Resources Board

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Topics

- Preliminary Results of Staff Analysis
- Emission Reduction Goals
- Regulatory Options
- Emission Reduction Technologies
- Next Steps

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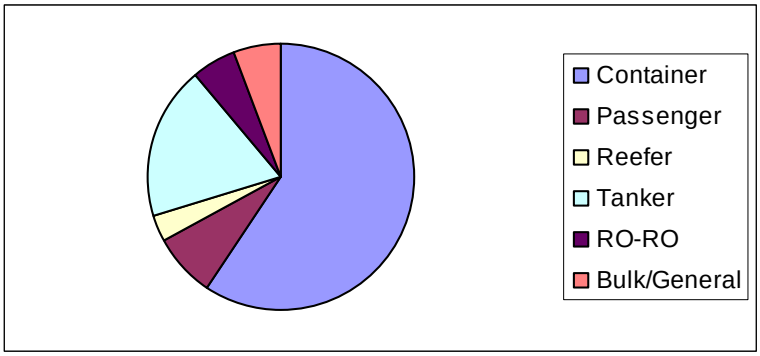
Ship Calls to California Ports, 2004, By Ships Making 3 or More Visits



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Good Shore Power Candidate

- Frequent Visitor
- Long Hotelling Times
- Significant Power Needs

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Data Overview

- Wharfinger Data for Ports of Hueneme, Long Beach, Los Angeles, Oakland, San Diego, and San Francisco
- Ship Descriptions
  - Internet
  - ARB 2005 ship survey
- Port Staff

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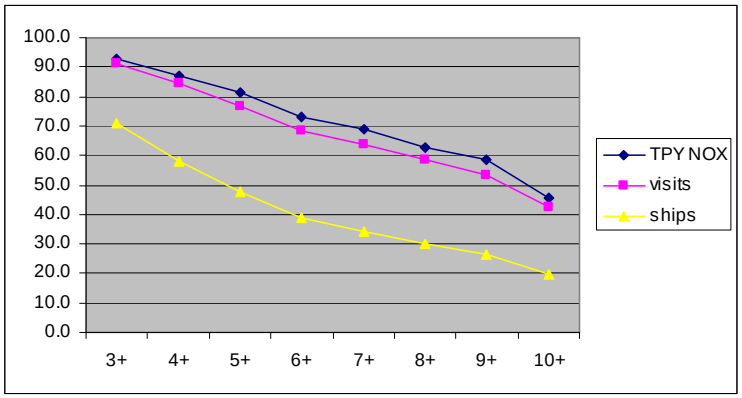
Emissions vs Container Ship Visits, POLA/POLB, 2005



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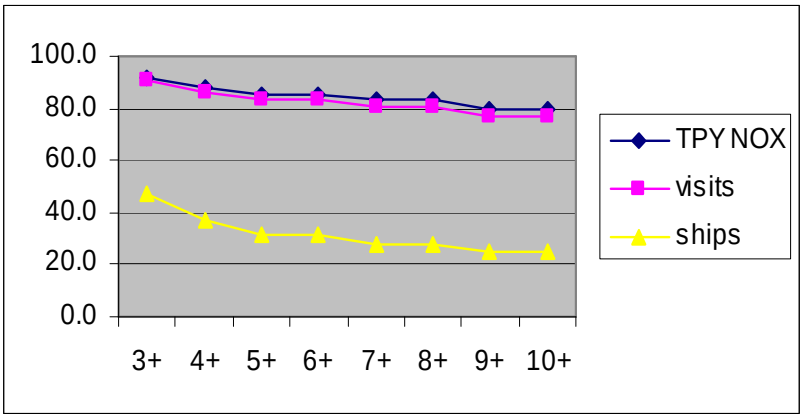
Emissions vs Passenger Ship Visits, San Diego, 2005



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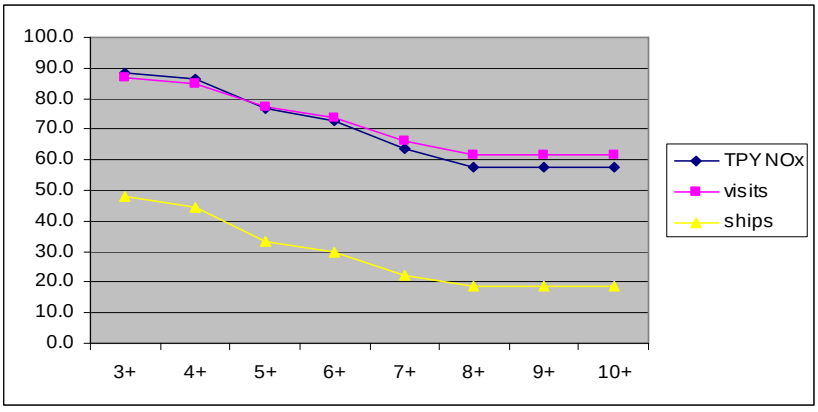
Emissions vs Reefer Ship Visits, Hueneme, 2005



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Ship Movement for Container Ships

- 2003-2005 Period
  - 730 ships visited POLA/POLB
  - Only 216 or 30 % of Ships visited POLA/POLB all three years
  - These ships made 58 percent of the ship visits to POLA/POLB

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Hotelling Times

- Determined hotelling times from port wharfinger data
- Hotelling times vary by port and ship type

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Hotelling Times
(Continued)

- Container Ships
  - POLA & POLB
    - Range: 5 hours to 150 hours per visit
    - 5000 TEU and less: 37 hours per visit (average)
    - Greater than 5000 TEU: 77 hours per visit (average)

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Hotelling Times
(Continued)

- Container Ships
  - Oakland
    - Range: 3 hour to 80 hours per visit
    - 21 hours per visit (average)
- Passenger Ships
  - Range: 5 hours to 48 hours per visit
  - 10-12 Hours Per Visit (average)

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Hotelling Times
(Continued)

- Reefer Ships
  - Hueneme
    - Range: 9 hours to 111 hours per visit
    - 71 hours per visit (average)
  - POLA
    - Range: 3 hours to 140 hours per visit
    - Reefer berths: 42 hours per visit (average)
    - Container berths: 8 hours per visit (average)

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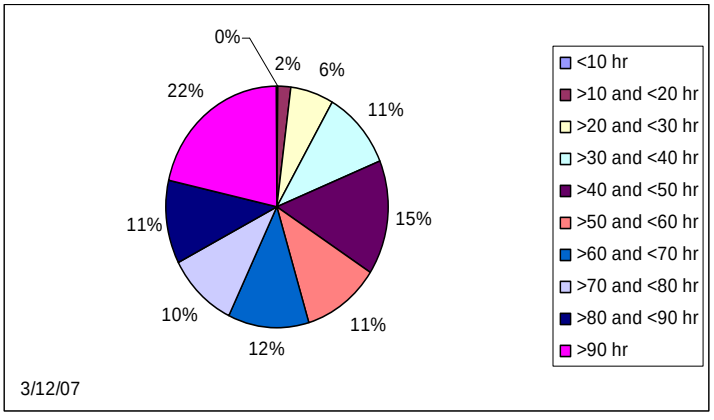
Emissions vs Hotelling Time For Container Ships Visiting POLA/POLB, 2005



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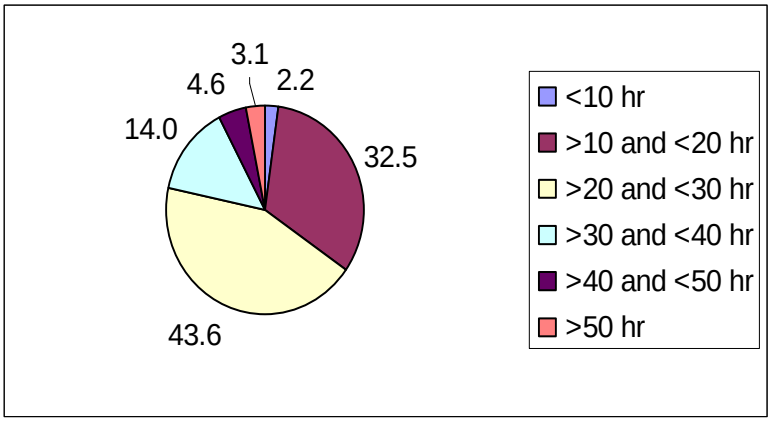
Emissions vs Hotelling Time For Container Ships Visiting Oakland, 2005



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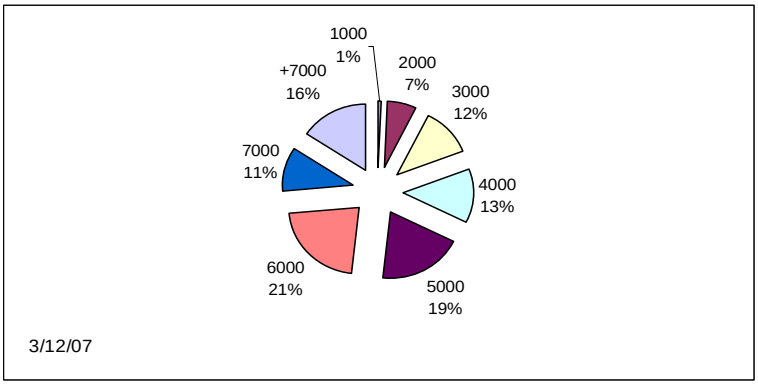
Emissions vs Size of Container Ship for Ships Visiting POLA/POLB, 2005



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Power Needs

- Container Ships
  - 1 to 6 MW
- Passenger Ships
  - 6 to 15 MW
- Reefer Ships
  - 3 MW

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Topics

- Preliminary Results of Staff Analysis
- **Emission Reduction Goals**
- Regulatory Options
- Emission Reduction Technologies
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Emission Reduction Goals

- General Approach
  - Port specific
  - Shore power or equivalent for container, passenger, and reefer ship categories
  - Reductions using alternative controls for: auto/ro-ro, bulk, general, and tanker ship categories

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Emission Reduction Goals
(Continued)

- Container Ships
  - 2015:
    - Ships larger than 4000 TEU and making 5 or more calls
    - Ships less than 4001 TEU and making 12 or more calls
  - 2020: Ships making 4 or more calls
  - Exemption for ships calls less than 10 hours

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Emission Reduction Goals
(Continued)

- Passenger Ships
  - 2015: ships making 3 or more calls to a port
- Reefer Ships
  - 2015: ships making 4 or more calls to a port
- Provisions for infrequent visitors

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Emission Reduction Goals
(Continued)

- Ship Categories Subject to Alternative Approach
  - 50 percent reduction

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Emission Reduction Goals
(Continued)

- Draft Proposal Based on Emission Reduction Goals
  - 80% reduction in hotelling emissions
- Proposal May Change
  - Cost Effectiveness Analysis
  - Health Risk Assessment

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Topics

- Preliminary Results of Staff Analysis
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Regulatory Options

- Shutting Down Auxiliary Engines
- Alternative Controls
- Fleet Average
- Auxiliary Engine Emission Limit

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Shutting Down Auxiliary Engines

- Concept:
  - Auxiliary engines are shut down within one hour
  - Applies to ships making X visits to a port
  - Phased in to apply to more ships over time with full implementation by 2020

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Shutting Down Auxiliary Engines
(Continued)

- Pro:
  - Simple compliance
  - Maximum emissions reduction
- Con:
  - Limits ship operation
  - Shore side infrastructure for shore power must be available
  - Identifying ships making X visits may be difficult

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Alternative Controls

- Concept:
  - Apply the control technique that achieves the maximum emission reduction
  - Phase in requirement by percentage of fleet affected (For example, 20% of ships by 2010) with full implementation by 2020

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Alternative Controls
(Continued)

- Pro:
  - Alternative controls can be implemented quickly
  - Overall cost, as compared to shore power, is lower
- Con:
  - Defining fleet may be difficult
  - Limited availability of control techniques for marine engines

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Alternative Controls
(Continued)

  - Less reductions generated, as compared to shore power
  - Multiple control techniques will be necessary
  - Periodic emission testing and monitoring
  - Significant residual emissions

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Fleet Average

- Concept:
  - An emission standard would apply to all auxiliary engines in a fleet visiting one port
  - Emission rate of all engines in the fleet would be averaged together and compared to standard
  - Individual engine emission rates could be lowered by using shore power, alternative controls, or engine repower
  - Emission standard would become more stringent over time

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Fleet Average
(Continued)

- Pro:
  - Maximum flexibility
  - Best option to deal with ship movement issue
  - May generate more early reductions as compared to shore power

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Fleet Average
(Continued)

- Con:
  - Defining a fleet may be difficult
  - Difficult to enforce
  - Requires extensive recordkeeping
  - Periodic emission testing and monitoring

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Engine Emission Limit

- Concept:
  - By specified dates, a certain percentage of fleet's auxiliary engines must comply with a specific emission standard
  - Full compliance by 2020, with interim goals

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Engine Emission Limit
(Continued)

- Pro:
  - Ship owners/operators, engine and control technology manufacturers would have clear goals to satisfy
  - New ships can be built to satisfy standard
  - Flexibility to meet standard

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Engine Emission Limit
(Continued)

- Con:
  - Defining fleet may be difficult
  - With current available technology, difficult to achieve high level of emission reduction
  - Difficult to enforce
  - Requires extensive recordkeeping
  - Periodic emission testing and monitoring

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Topics

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Ship-Side Emission Reduction Technologies

- NOx
  - Selective Catalytic Reduction
- PM
  - Oxidation Catalyst
  - Diesel Particulate Filter
- Both
  - Fuel / water emulsions
  - Biodiesel

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Selective Catalytic Reduction

- Description:
  - Catalytic reduction of NOx using a reducing agent
- Pro:
  - Extensive application on stationary and mobile applications
  - Some application on marine engines
  - High NOx reduction (80-95%)

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Selective Catalytic Reduction
(Continued)

- Con:
  - High capital and operating costs
  - Because of temperature and chemistry requirements, difficult to implement on engines with variable loads
  - Retrofit difficult
  - Ammonia slip can be issue
  - Higher sulfur in marine fuels may affect catalyst life and system performance
  - Testing and monitoring may be required

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Oxidation Catalyst

- Description:
  - Catalytic oxidation of particulate matter (PM)
- Pro:
  - Inexpensive

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Oxidation Catalyst
(Continued)

- Con:
  - Modest PM reduction
  - Higher sulfur in marine fuels may affect catalyst life and system performance
  - Testing and monitoring may be required
  - Not demonstrated for marine engines

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Diesel Particulate Filters

- Description:
  - Filtration to capture PM
  - Regeneration system to dispose of PM
- Pro:
  - High PM reduction (85%)

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Diesel Particulate Filters
(Continued)

- Con:
  - Expensive
  - Retrofit may be difficult
  - Higher sulfur in marine fuels may affect catalyst life and system performance
  - Testing and monitoring may be required
  - Not demonstrated for marine engines

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Fuel / Water Emulsion

- Description:
  - Mixture of fossil fuel with water and emulsification agent
- Pro:
  - Both NOx and PM reductions
  - Can be combined with post combustion controls

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Fuel / Water Emulsion
(Continued)

- Con:
  - Modest NOx reductions
  - Fuel penalty
  - Operational concerns
  - Not demonstrated for marine engines

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Biodiesel

- Description:
  - Fuel derived from vegetable oils or animal fats
- Pro:
  - Modest PM reduction
- Con:
  - May increase NOx
  - Availability may be limited

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Summary

- Most control techniques not demonstrated on marine engines
- Sulfur content of marine fuel may be a concern
- Multiple control techniques will need to be used to obtain significant PM and NOx reductions

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Next Meeting

- Next Workgroup Meeting on May 30 in Sacramento
  - Discuss regulatory language

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- **Webpages:**
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  www.arb.ca.gov/ports/shorepower/shorepower.htm
  Goods Movement Emission Reduction Plan:
  www.arb.ca.gov/planning/gmerp/gmerp.htm

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