The Need to Reduce Marine Shipping Emissions: A Santa Barbara County Case Study

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Ships in the SB Channel

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Overview

- The problem
- Clean air planning process
- 2004 marine shipping inventory
- Regulatory efforts
- Technologies and challenges
- Demonstration project
- Conclusions

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The Problem

- 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

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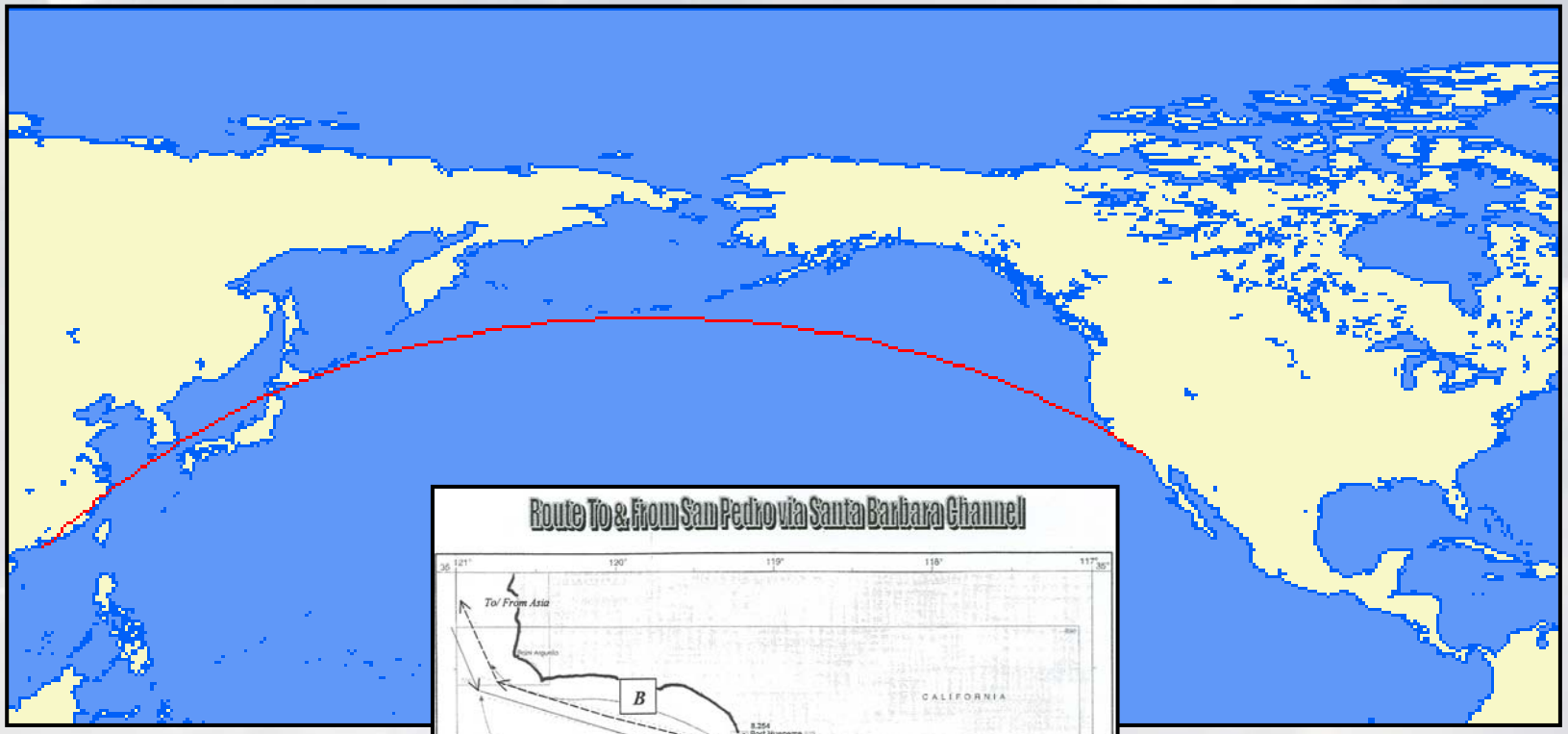
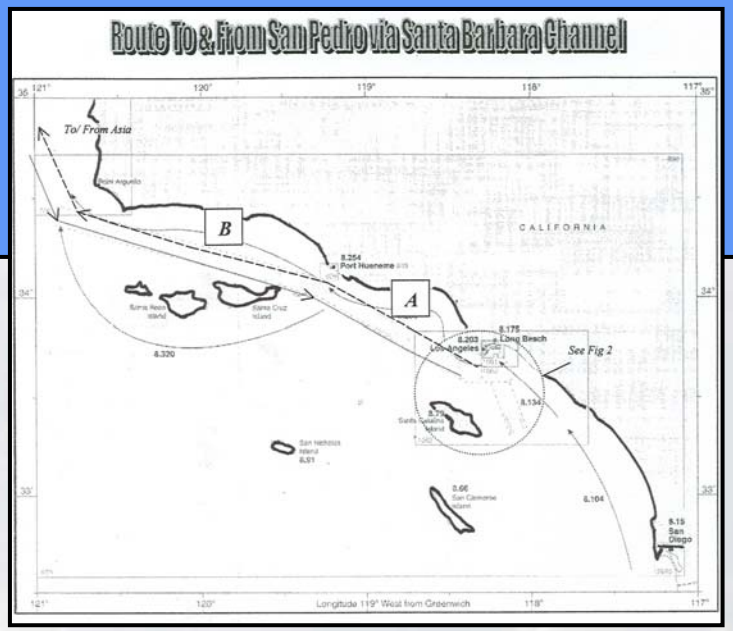
Typical Great Circle Route





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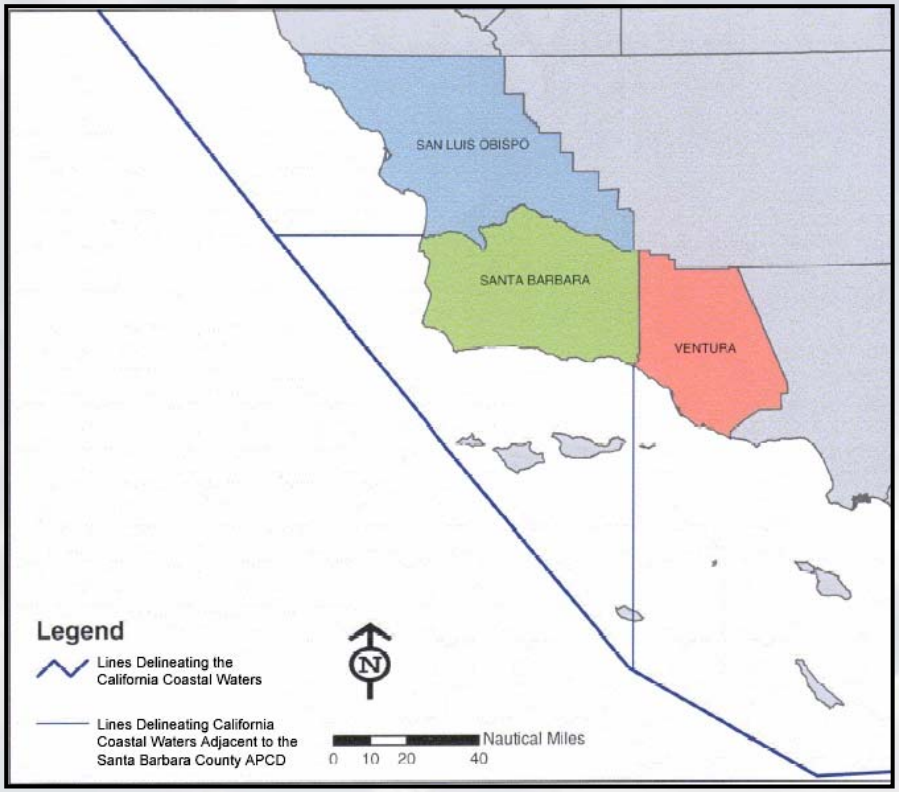
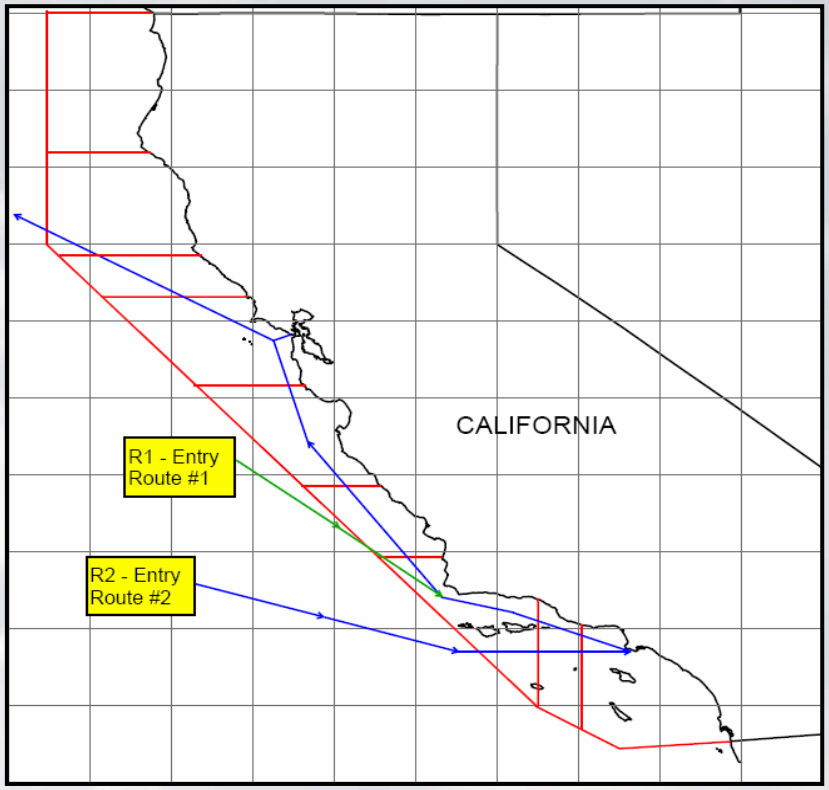
California Coastal Waters





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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

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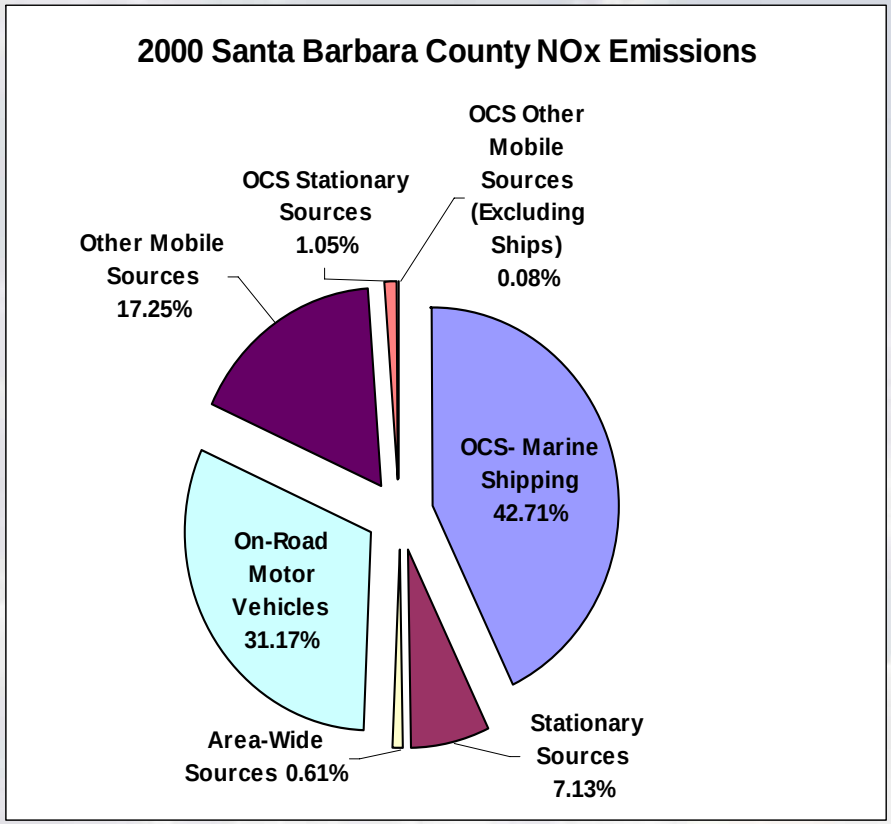
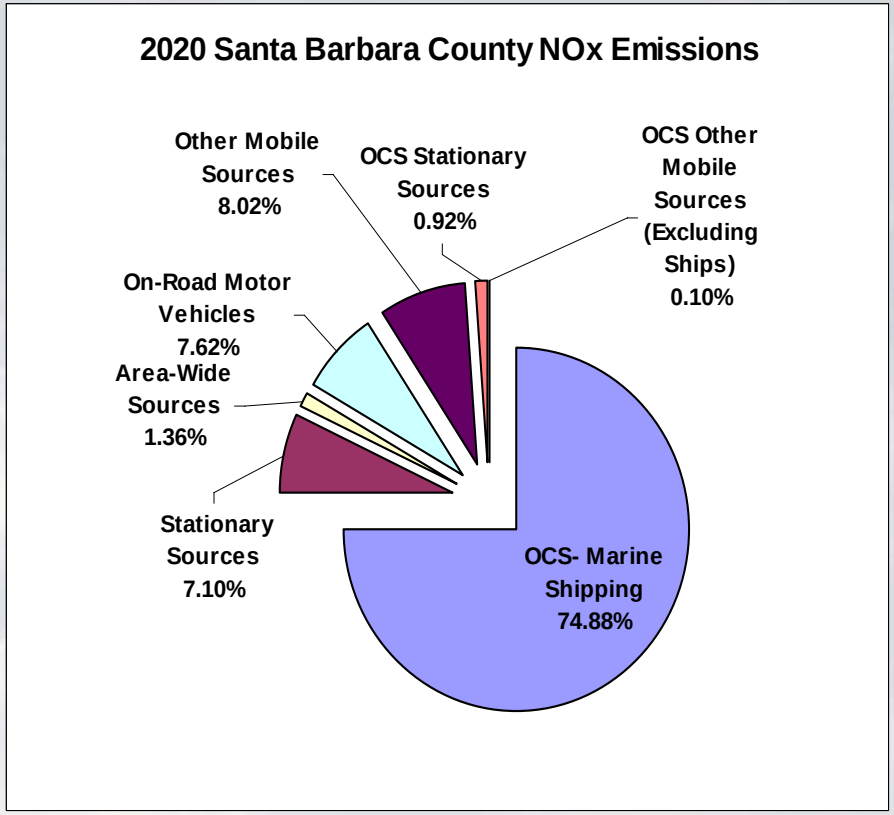
NOx * Emissions Comparison





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* NOx = Onshore + OCS

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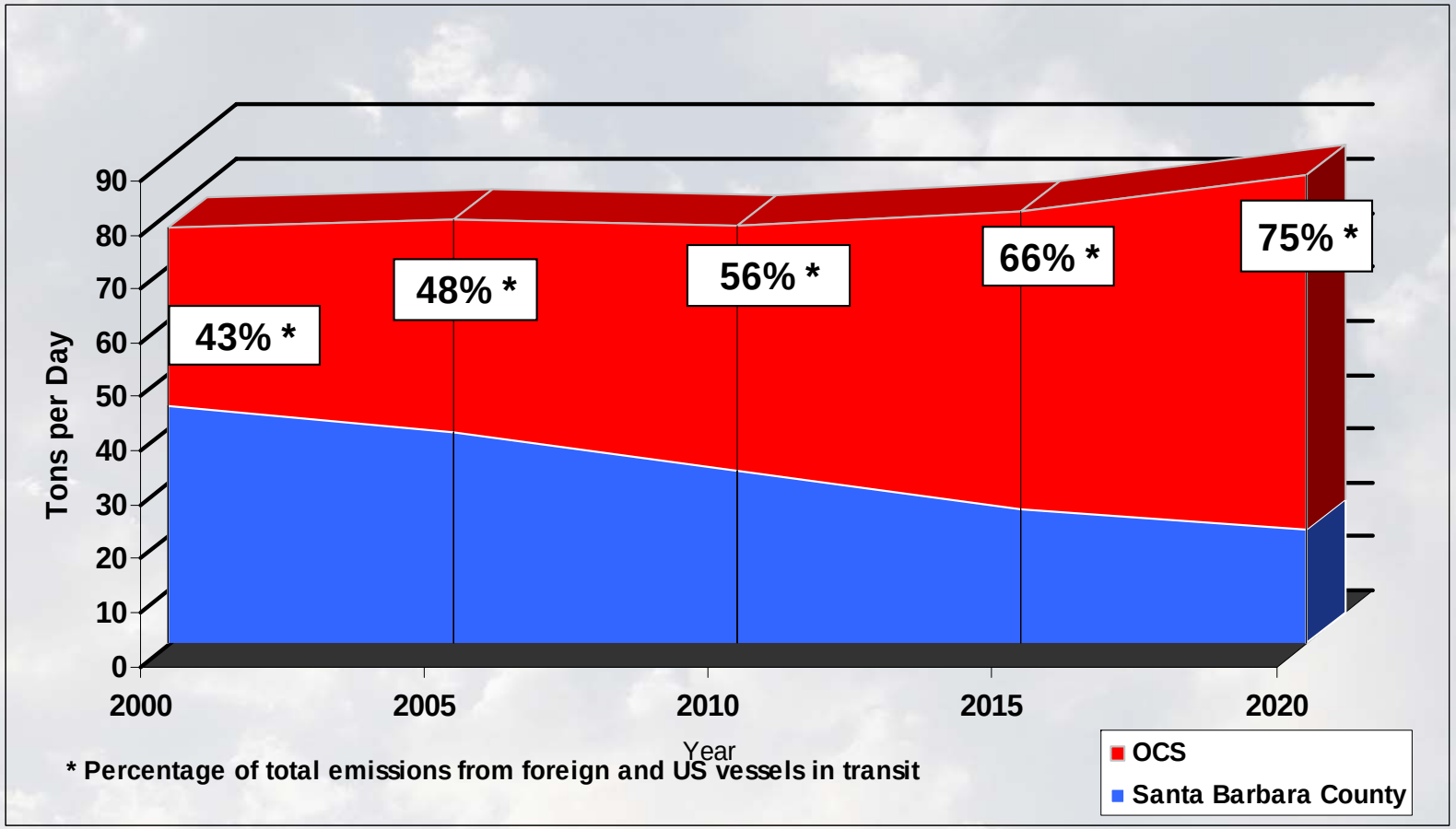
NOx * Emission Forecast



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* NOx = Onshore + OCS

2004 Marine Shipping Inventory

- Over 7,200 transits
- 9% of vessels = 50% NOx emissions
- 59 vessels over 50 tons of NOx in 2004
- 92% of NOx from foreign flagged vessels
- About 19 transits per day
- About 40 tons of NOx and 3 tons of PM emitted daily

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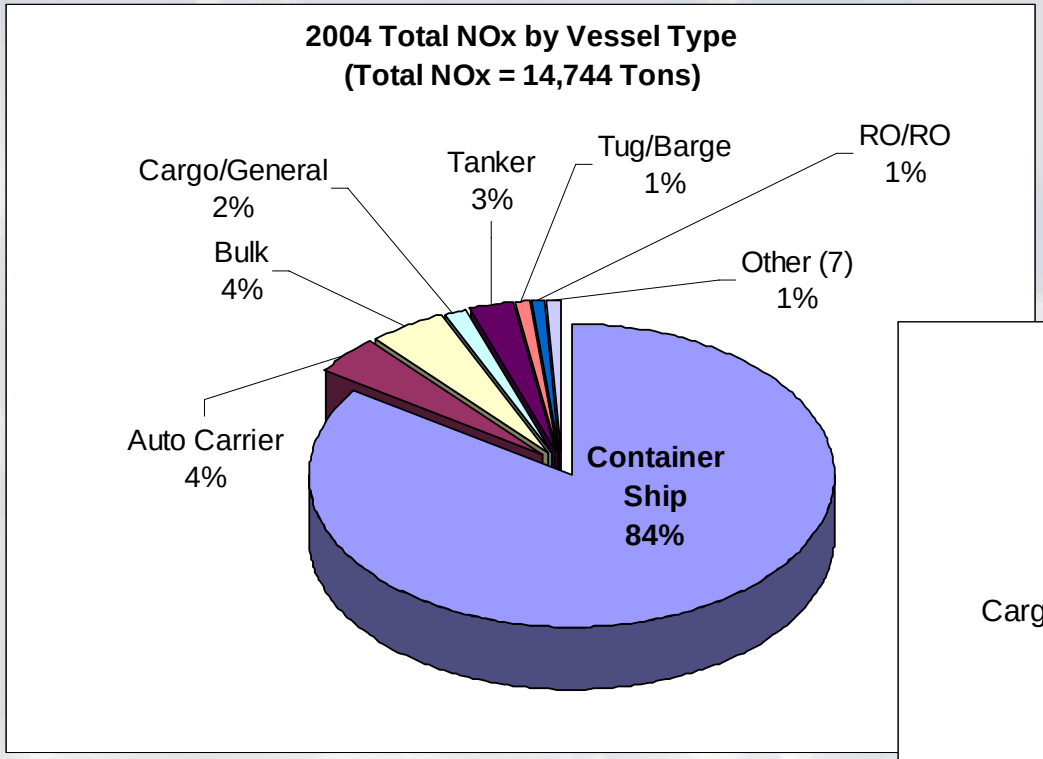
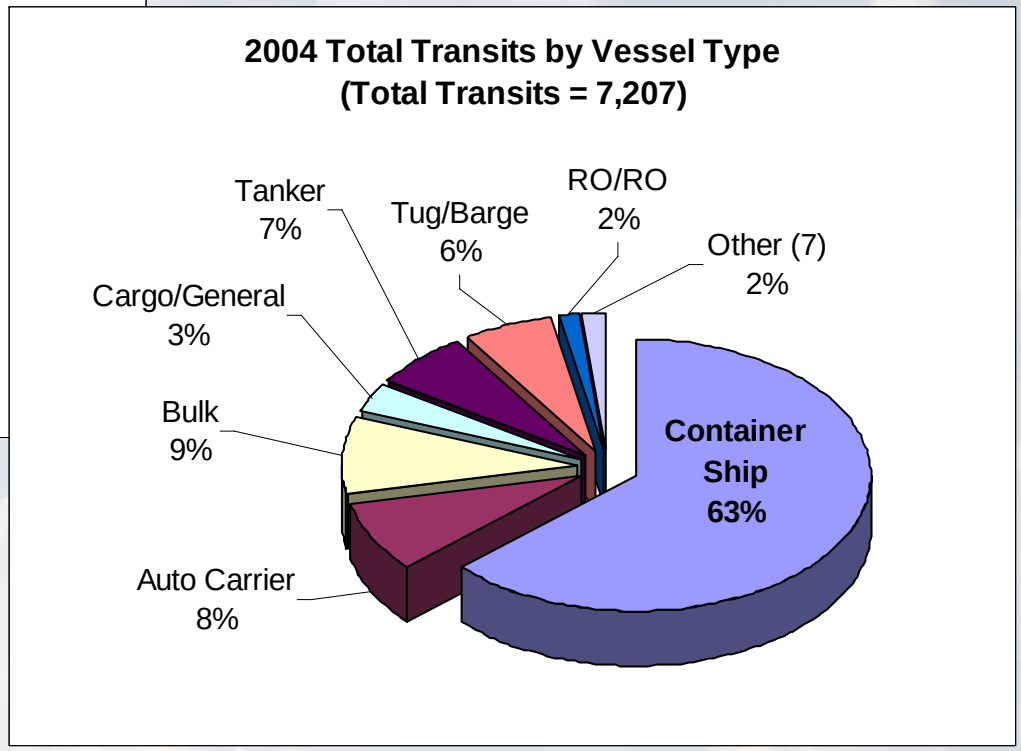
Ship Type Analysis





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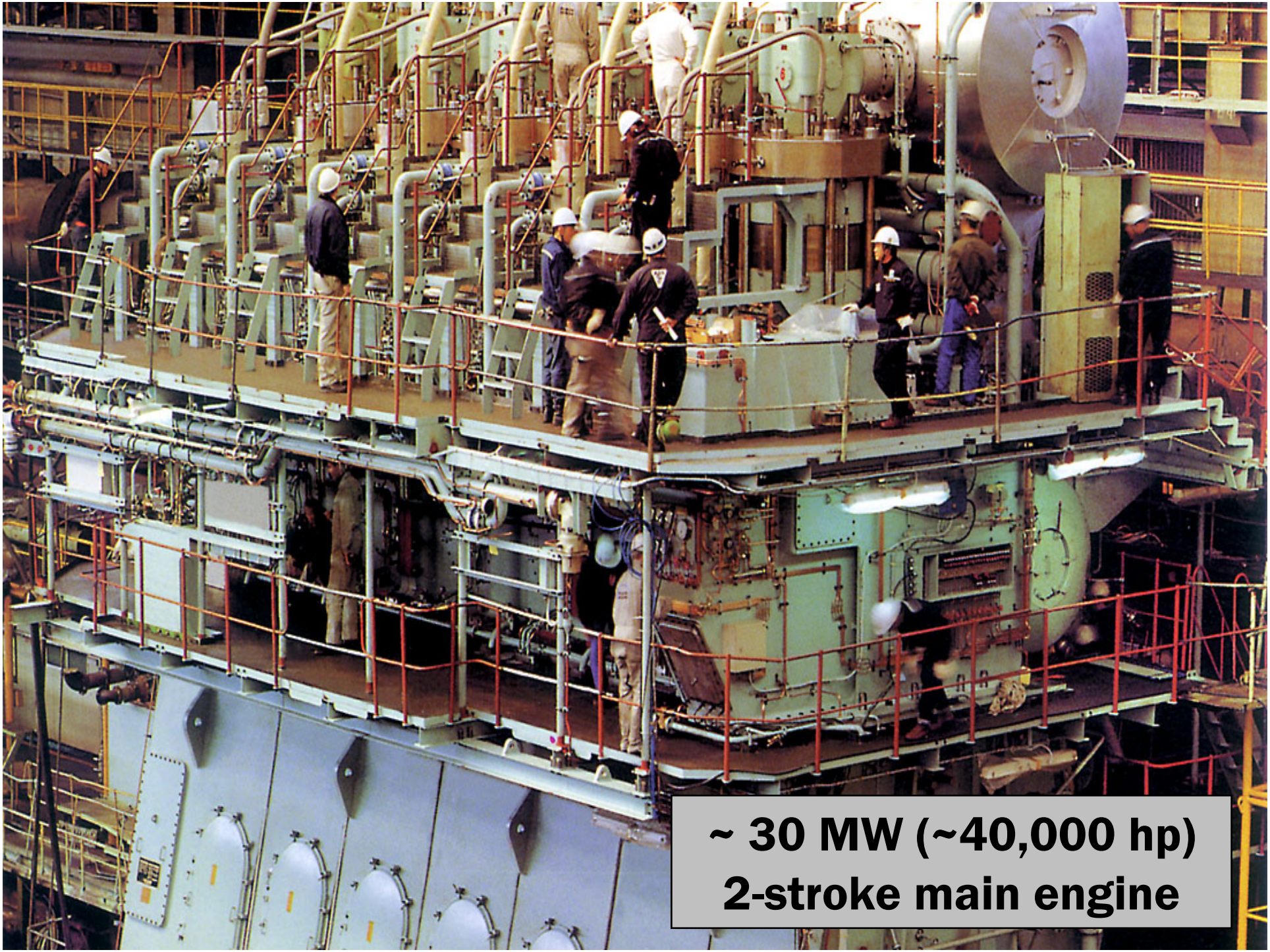
Container ship


~ 30 MW (~40,000 hp)
2-stroke main engine

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

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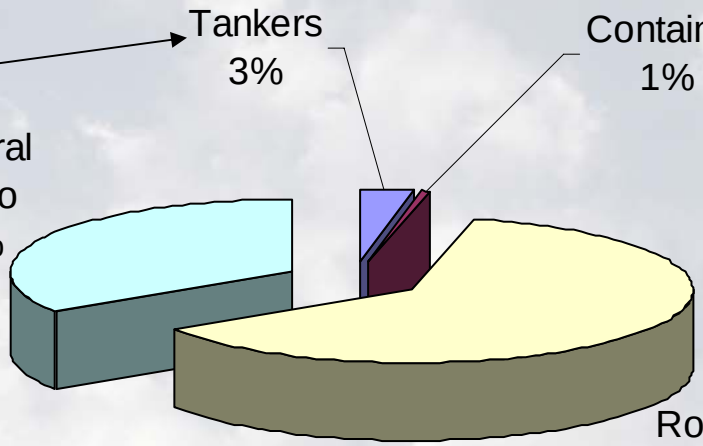
Common Ship Types



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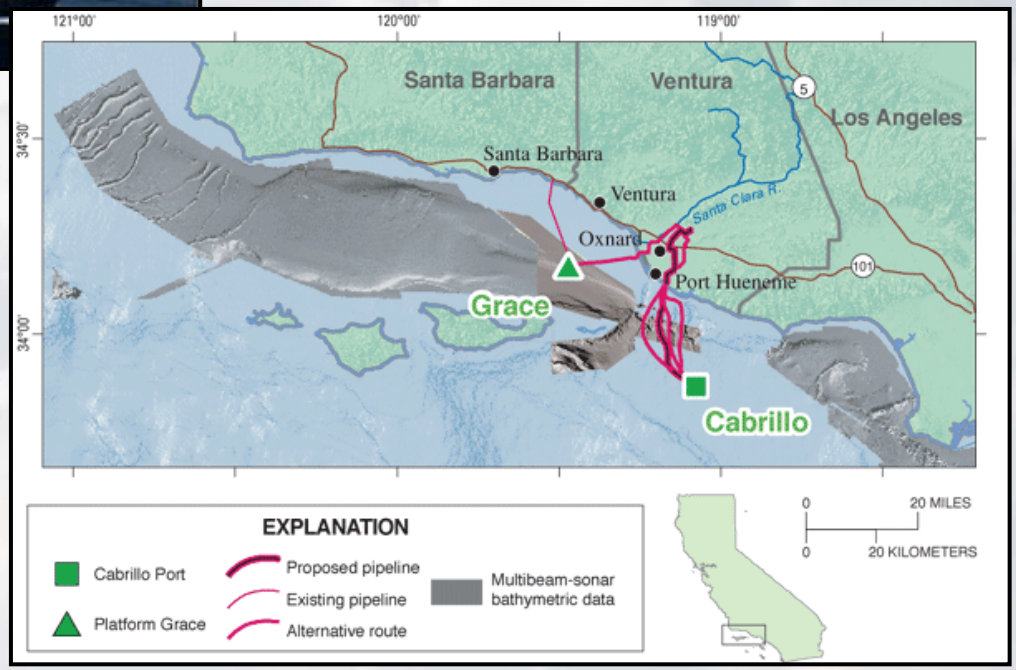
Future?

*MAP: USGS. ***Report on Hazards Offshore California's Ventura County Coast Compiled in Response to Congressional Request.*** Nov. 2004.



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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 27 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 (2007 submittal)

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Regulatory Efforts

California Air Resources Board (ARB)

- **Air Toxic Control Measures (ATCM)**
  - Developing aux. engine ATCM (Dec. 2005)
  - Cargo handling equipment ATCM (Dec. 2005)
  - Cruise ship on-board Incineration ATCM (Nov. 2005)
  - Frequent flyer vessel ATCM (2006)
- **Research**
  - CA ocean-going vessel emission inventory (Fall 2005)
  - Modeling & Health / Ecological impact (Spring 2006)
  - SECA development collaboration with EPA

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Potential Control Technologies

- Water based controls
  - Emulsified fuels
  - Water injection
  - Humidification
- Slide valves
- Exhaust gas recirculation
- Selective catalytic reduction
- Cleaner fuels, oxidation catalysts

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Technology Challenges

- Quick installation
- Reliability
- Low maintenance
- Safety
- Pollutant trade-offs
- Fuel consumption
- Industry buy-in

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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

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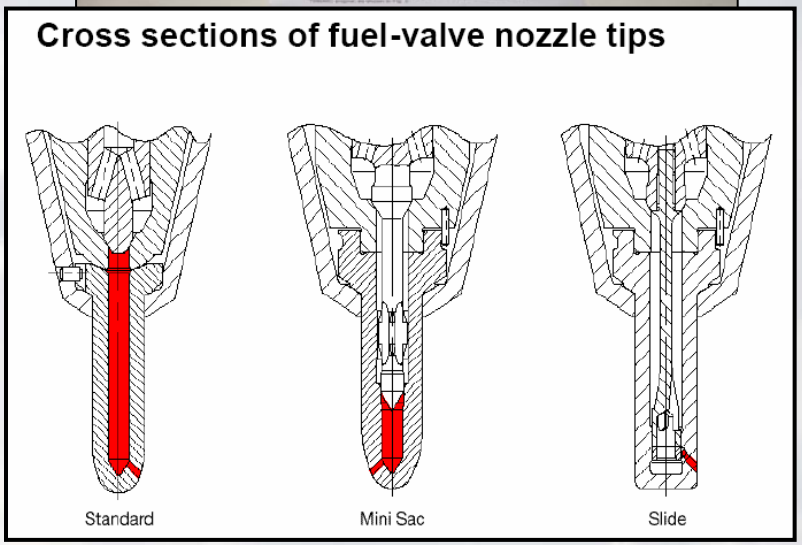
Technology: Slide Valves

- Already in use
- Reduce PM by 30 - 50%
- Fuel efficient design
- Cost-effective
- Easy to install
- $96,000 for 22 valves



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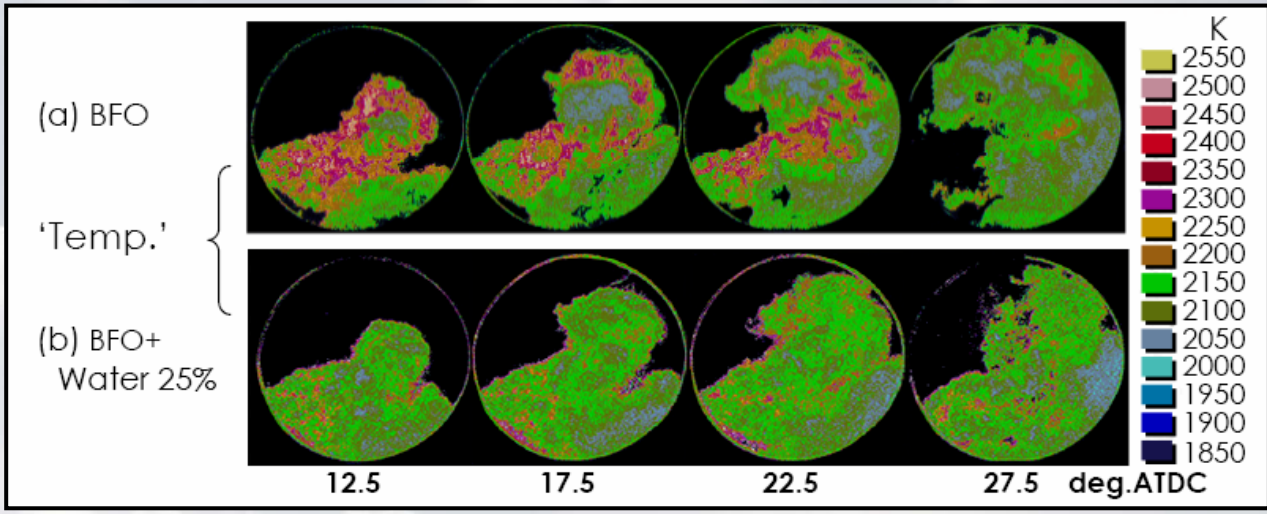
Technology: Water Emulsion System

- Reduce NOx up to 30%
- Being considered for Main engine
- Designed by engine manufacturer
- Small loss in power possible
- Approx. $555,000 for the system
- Cost-effective

In-cylinder temp. distribution*



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* ***Source:*** **Visual Study on Combustion of Low-Grade Fuel Water Emulsion,** Hiroshi Tajima, Koji Takasaki, Masayoshi Nakashima, Keiichiro Kawano Makoto Ohishi, Jun Yanagi and Shin-nosuke Osaf, 2001

Projects Evaluated

Ship Name	Ship type	Built	Power (hp)	DWT* / TEU	Engine	Control technology	Hardware Cost	NOx reductions	PM reductions
Matson/ R.J. Pfeiffer	Container	1992	34,160	28,555 / 2,319 TEU	MAN B&W 8L80MC	Seaworthy water emulsion system	~$400,000	25%-35%	n/a
APL CHINA	Container	1995	66,398	66,520 / 5,418 TEU	MAN B&W 11K90MC-C	MAN B&W water emulsion system and slide valves	$742,300	25%	25-35%
APL KOREA	Container	1995	66,398	66,520 / 5,418 TEU	MAN B&W 11K90MC-C	MAN B&W water emulsion system and slide valves	$742,300	25%	25-35%
APL JAPAN	Container	1995	66,398	66,520 / 5,418 TEU	MAN B&W 11K90MC-C	MAN B&W water emulsion system and slide valves	$742,300	25%	25-35%
SeaRiver Long Beach	Tanker	1987	31,650	214,682/ TEU_n/a	Sulzer 8RTA84	Seaworthy water emulsion system for engine + boiler	$442,500	25%-35%	30% (boiler)

* **Deadweight Tonnage (DWT)**: The weight in tonnes (1000 kg) of cargo, stores, fuel, passengers and crew carried by the ship when loaded to her maximum

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Challenges

- Ship owner participation
- Funding sponsors & cooperative agreements
- Project scope & priorities
- Limited emission test data available
- Vessel down time and schedule delays
- Vessel route stability
- Project life

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Conclusions

- Marine shipping emissions are significant & growing
- Regulatory efforts largely ineffective to date
- Cost effective control technologies available
- Significant capital expenditure
- Technology & implementation challenges
- Pursuing a partnership approach
- Once proven, additional partnerships and incentives programs needed

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Questions ?
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Photo by Steve Ringman, The Seattle Times