

Emission Inventory for Ship Main Engines and Boilers



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Sacramento, CA



Overview

- ◆ Activity Data
- ◆ Emissions Calculation
- ◆ Main Engine Emissions
- ◆ Boiler Emissions
- ◆ Growth
- ◆ Results
- ◆ Next Steps

Activity Data

- ◆ State Lands Commission: default activity
 - 10,514 port calls in 2006
 - Arrival port, arrival date, prev/next port, vessel name/type
- ◆ Wharfinger data
 - Reconciled with State Lands
 - Arrival port, berth number, time at dock
- ◆ Marine Exchange
 - Anchorage
 - Vessel name, date, time anchored
 - LA-LB: 1,549 in 2006
 - Vessel Speeds in LA/LB
 - Vessel name, date, speed in VSR zone
- ◆ VTS – Bay Area
 - 549 anchorages in 2006

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Emissions Calculation

Emissions =

Engine Power * Time * Load Factor* Emission Factor

Time = Distance/Speed

Load Factor = (Actual Speed/Max Speed)³

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Main Engine Power

- ◆ Ship-Specific Data:
 - Lloyds-Fairplay PC Register

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Time

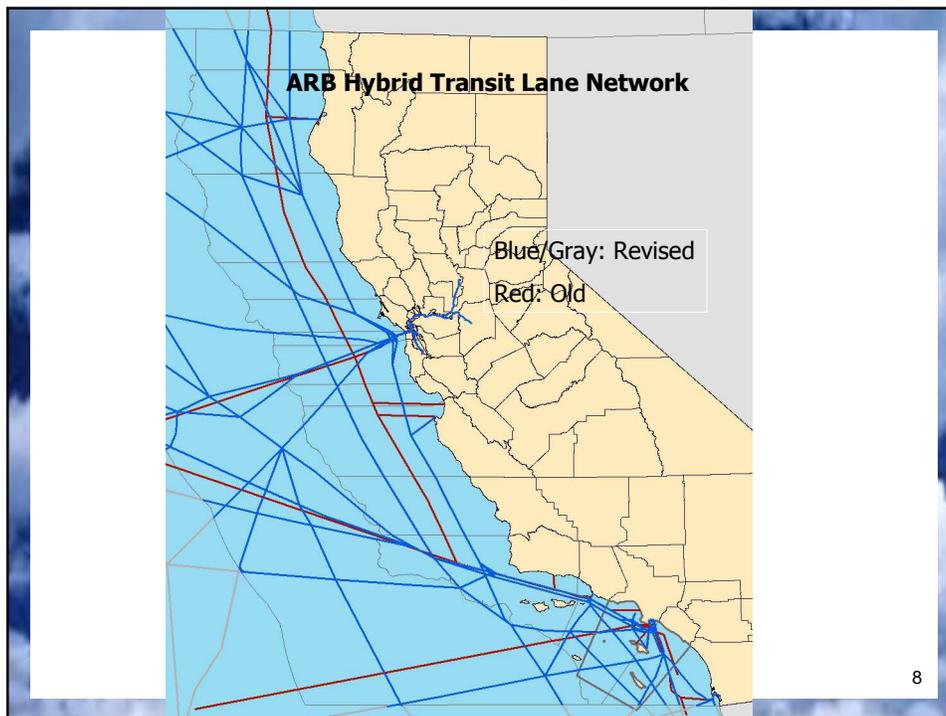
- ◆ Distance/Speed
- ◆ Distance:
 - Transit Lanes – optimal route
 - Berth Location
- ◆ Speed depends on where:
 - VSR
 - Speed Limitations
 - Cruise Speed
 - Maneuvering:
 - 5/7 knots inbound, 8 knots outbound

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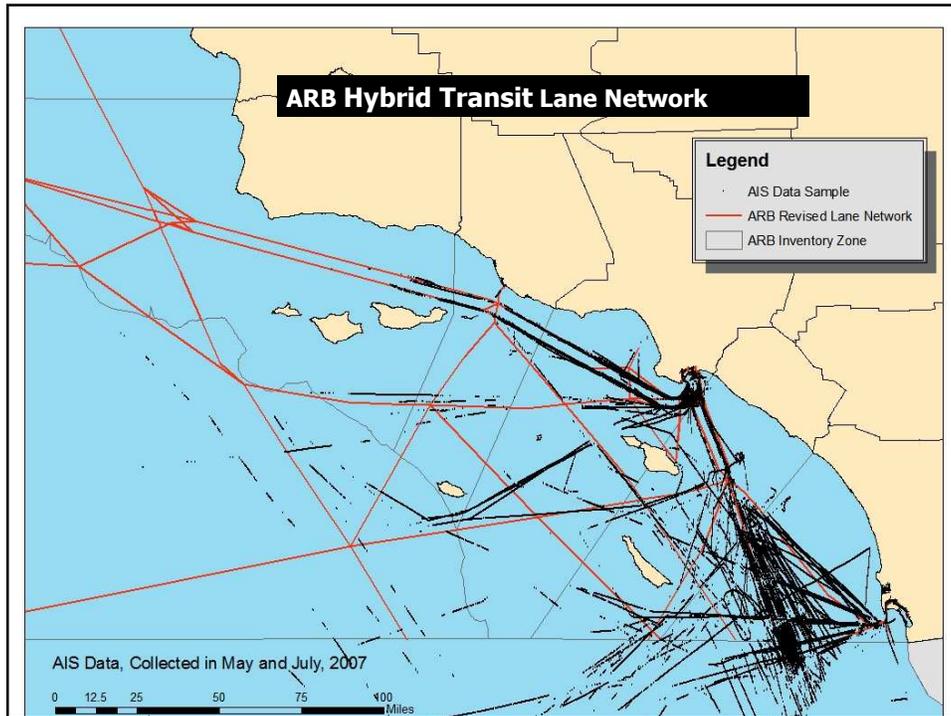
Transit Lanes

- ◆ Hybrid Approach
 - Army Corps for near port (~50 miles offshore)
 - Corbett/Wang STEEM Network (~50-200 miles offshore)
 - Using AIS data to verify
- ◆ Previously used Army Corps National Waterway Network

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Load Factors

- ◆ Transit & Maneuvering
 - Propeller Law: $(\text{actual}/\text{max speed})^3$ cubed
 - At cruise, 82.5% load
 - Example:
 - $(12 \text{ knots actual}/22 \text{ knots max})^3 = 16\%$

Transit Emission Factors (gm/kw-hr)

Main Engine

Pollutant	Slow	Medium
NOx	18.1/17*	14
PM10	1.5	1.5
CO2	620	677

* Ships built after 1999

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Maneuvering Emission Factors (gm/kw-hr)

Main Engine

Pollutant	Slow	Medium
NOx	14.5	11.2
PM10	1.5	1.5
CO2	682	745

- Low Load Adjustment Factors:
 - <10% Load: 1-10x

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Boiler Emissions

- ◆ Fuel Use Rates from Starcrest/POLA-LB
 - Vessel Boarding Program
 - 10x previous rates
 - Converted to equivalent kilowatts
- ◆ Emission Factors from Entec
- ◆ Assume use during hotelling and maneuvering
- ◆ May add 1 hour use during transit during entrance/clearance

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Growth

- ◆ Current rates pretty good
 - SECA/RTI
- ◆ Revised Growth factors
 - Port, Engine, and Type Specific
 - Larger data set: USACE 1994-2005 NRT
- ◆ Completion in 2-3 weeks

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Growth from 2006: Container

	2006	2014	2020	2025
CA Total	1.0	1.7	2.4	3.3
LA/LB	1.0	1.7	2.5	3.5
Oakland	1.0	1.6	2.2	2.9

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Growth from 2006: Passenger

	2006	2014	2020	2025
CA Total	1.0	1.5	2.1	2.8
LA/LB	1.0	1.4	1.7	2.1
San Diego	1.0	1.5	2.0	2.6
SF	1.0	1.8	2.7	3.8
Hueneme	1.0	2.0	3.2	4.9

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Growth from 2006: Reefer Vessel

	2006	2014	2020	2025
CA Total	1.0	0.8	0.7	0.6
LA/LB	1.0	0.5	0.3	0.2
San Diego	1.0	2.0	3.5	5.4
Hueneme	1.0	1.1	1.3	1.4

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Statewide Emissions 2006 Base Year

Engine	NOx	PM10	ROG	SOx
Auxiliary	46.4	4.0	1.1	29.4
Boiler	2.8	1.1	0.1	21.8
Main	176.7	15.4	5.2	105.3
Total	225.9	20.5	6.3	156.4

Mode	NOx	PM10	ROG	SOx
Anchorage	2.4	0.3	0.1	4.9
Hotelling	23.3	2.6	0.6	30.3
Maneuvering	5.8	0.6	0.2	3.1
Transit	194.4	17.0	5.5	118.1

100 nautical mile zone, inc. all air basins, incl. OCS

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Statewide Emissions 2006 Comparison

100 nautical mile zone, inc. all air basins, incl. OCS

Inventory	NOx (tpd)	PM10 (tpd)
Revised	225.9	20.5
Current ARB	238.5	19.9

* 2004 base year grown to 2006

Draft Results – Subject to Change

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Next Steps

- ◆ Schedule
 - Cold Ironing Regulation, Dec. 2007
 - Main Engine Reg., April 2008
 - Vessel Speed Reduction, 2008
- ◆ Inventory is still being evaluated
 - QA is on-going
- ◆ District/Port/Stakeholder Outreach
- ◆ CEIDARS/CEFS Update
 - Future

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For More Information

- ◆ **Contact**
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