



Improved Commercial Harbor Craft Emissions Inventory

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Outline

- Major Improvements
- Review of Methodology
- Model Inputs
 - Population
 - Emission factors
 - Activity
 - Regulation
- Emissions Inventory
 - Compare with previous version
- Next Steps

Feb. 16, 2007 2



Major Improvements

- Incorporated EPA's anticipated future tier 3 & 4 standards
- Adjusted fishing fleet growth rate based on fish landings
- Redefined engine useful life to match engine age distribution
- Modified spatial allocation based on survey
- Deteriorated emission factors over entire engine life

Feb. 16, 2007 3



Review of Methodology

- Assume ARB survey engine data representative
 - ~ 410 auxiliary & ~1,031 main sample engines
 - ~ 16% (Aux.) & 18% (main) of the statewide engine population
- Estimate average emission rates using survey data
- Scale up to statewide population
- Allocate emissions to counties, districts, air basins based on homeports & where activities take place
- Project future emissions based on growth, engine turnover & proposed regulation

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4



Model Inputs

- Vessel & engine population
 - Number of vessels by region
 - Number of engines per vessel
 - Fleet growth rate
 - Engine turnover
- Emission factors
 - Based on OFFROAD emission factors
 - Adjusted for marine cycles
 - EPA future tier 3 & 4 standards included
 - Account for engine deterioration
 - Correct for benefits of cleaner fuels
- Activity
 - Annual hours of operation by vessel & engine type
 - Vessel & engine type specific load factor

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5



Vessel Population

- Data sources
 - U.S. Coast Guard registration data
 - California Fish & Game registration data
 - ARB 2002 Commercial Harbor Craft Survey
 - Port of LA emission inventory
- Nine vessel types
 - Charter Fishing, Commercial Fishing, Crew & Supply, Ferries, Pilot Vessels, Tow Boats, Tug Boats, Work Boats, Others
- ~ 4,185 vessels in 2004
- Reality check by contacting ports & marinas

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6

Engine Turnover

- Attrition Curve (ARB's OFFROAD Attrition Curve)
- Redefined engine useful life
 - Age distribution asymmetric
 - Total life when 90% of engines retire
 - Useful life as half of total life
- New engines added with growth & engine turnover
 - New engines are cleaner
 - Emissions decrease with fleet turnover

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10

Engine Useful Life

Vessel Type	Old Useful Life		New Useful Life	
	Main Engine	Auxiliary Engine	Main Engine	Auxiliary Engine
Commercial Fishing	21	13	21	15
Charter Fishing	7	5	16	15
Ferries	10	12	20	20
Crew and Supply	22	22	22	22
Pilot Vessels	13.5	25	19	25
Tug Boats	21	22.5	21	22.5
Tow Boats	21	25	26	25
Work Boats	13	23	17	23
Others	14	22	23	22

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11

Emission Factor Sources

- Power-based emission factors
- Data evaluated
 - ARB OFFROAD Model emission factors
 - U.S. EPA (AP-42)
 - Lloyd's Register of Ships
 - U.S. EPA Category 1 marine engine emission factors
 - U.S. EPA Marine Engine Certification data
 - Actual emission testing results
- Based on ARB OFFROAD tier 0 emission factors
 - Harbor craft engines are marinized OFFROAD engines
 - OFFROAD emission factors table is the most complete

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12

Emission Factor Adjustments

- Adjusted to "E3" marine cycle for main engines
 - 1.18 for NOx, no adjustment for HC, 0.73 for CO, 0.95 for PM
- Adjusted to "D2" marine cycle for auxiliary engines
 - No adjustment for NOx, 1.19 for HC, 1.03 for CO, 0.84 for PM
- Adjusted to MARPOL & EPA Standards if they are lower

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13

Deterioration Factors

HP	HC	CO	NOx	PM
25-50	0.51	0.41	0.06	0.31
51-120	0.28	0.16	0.14	0.44
121-250	0.28	0.16	0.14	0.44
>250	0.44	0.25	0.21	0.67

Notes: Adopted from ARB's OFFROAD model; deterioration factor represents % increase of emission factors over one useful life (half of total life); useful life derived from survey data which is different from OFFROAD's useful life.

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14

Fuel Correction Factors

A fuel correction factor of 0.72 is applied to all diesel-powered engines HC emissions beginning with the 1994 calendar year.

Model Year	Calendar Year 1994-2006		Calendar Year 2007+	
	NOX	PM	NOX	PM
1980-1996	0.93	0.75	0.93	0.72
1997-2010	0.948	0.822	0.948	0.8
2011-2026	0.948	0.822	0.948	0.852

Notes: represents benefit of in-use fuel when compared to the certification fuel

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15

Engine Activities

Vessel Type	ME Load	ME Annual Hrs	AE Load	AE Annual Hrs
Commercial Fishing	0.27	1,250	0.43	1,633
Charter Fishing	0.52	1,622	0.43	2,077
Ferries	0.76	1,843	0.43	1,254
Crew and Supply	0.45	788	0.43	3,036
Pilot Vessels	0.51	1,031	0.43	994
Tug Boats	0.50	2,274	0.31	2,486
Tow Boats	0.68	1,993	0.43	2,965
Work Boats	0.45	675	0.43	750
Others	0.52	779	0.43	805

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16

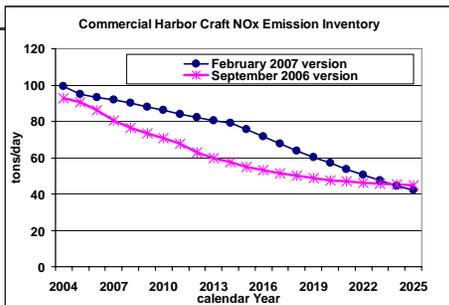
Emission Estimation

- Estimate emissions based on population, zero hour emission factors, engine deterioration, load factor, hours of operation
- Scale survey emissions to statewide population
- Estimate emissions under different control scenarios

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17

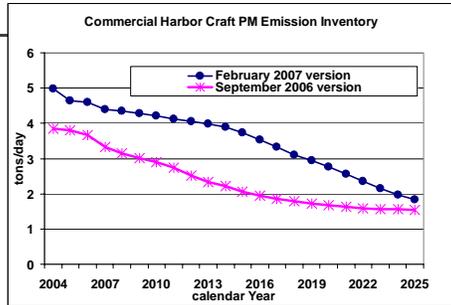
NOx Baseline Emission Inventory



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18

PM Baseline Emission Inventory



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19

Spatial Allocation

- Allocate emissions to home ports
- Allocate between land-based air basin & Outer Continental Shelf based on survey
- Adjust using engineering judgment
- Agree well with districts' allocation

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20

Spatial Allocation by Distance from Shore

Vessel Type	Land-based Air Basin (0-3 nautical miles)	Outer Continental Shelf Air Basin (3-100 nautical miles)
Commercial Fishing	12%	88%
Charter Fishing	15%	85%
Ferries	59%	41%
Crew and Supply	33%	67%
Pilot Vessels	39%	61%
Tug Boats	36%	64%
Tow Boats	43%	57%
Work Boats	42%	58%
Others	35%	65%

Feb. 16, 2007

21



Next Steps

- Continue QA Process
- Finalize emissions inventory
- Document methodology

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22

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Previous presentations on Commercial Harbor Craft Regulation can be found at :
<http://www.arb.ca.gov/msprog/offroad/marinevess/harborcraft.htm>
