

# Evaluation of Ship Auxiliary Boilers for Inclusion in the Proposed Regulation for Ship Main Engines



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## Overview

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- ◆ Why Regulate Auxiliary Boilers?
- ◆ Background
- ◆ Estimated Emissions and Potential Emission Reductions
- ◆ Feasibility of Using Distillate Fuel
- ◆ Costs and Cost Effectiveness
- ◆ Next Steps

## Why Regulate Auxiliary Boilers?

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- ◆ Significant source of emissions – mostly at dockside or close to shore
- ◆ Large potential reductions in PM & SO<sub>x</sub>
- ◆ Use of distillate fuel is feasible and cost-effective
- ◆ Practical to include boilers in main engine rule rather than separate rule

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## What is an Auxiliary Boiler?

- ◆ Closed vessel in which water is heated to produce steam
- ◆ Ship auxiliary boilers used for a variety of purposes (not ship propulsion)
  - Heat residual fuel
  - Heat viscous cargo
  - Hot water for crew/passengers
  - Space heating for cabins
  - Generate fresh water
  - Drive steam turbines pumps



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## Boiler Types

- ◆ Boilers, economizers, and composite units
  - Boilers are fuel-fired, economizers use exhaust heat (not covered), composite units do both
- ◆ Most boilers are fire-tube, water-tube, or a hybrid of both types
- ◆ Rated in terms of wt. steam/hr
- ◆ Different burners used
  - pressure jet
  - steam atomizing
  - rotary cup



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## Auxiliary Boiler Operation

- ◆ Cargo Ships
  - Boilers used in or near port when main engine is off or at low loads (economizer used at sea)
- ◆ Cruise Ships
  - May use boilers at all times due to passenger needs for hot water, space heating, etc.
- ◆ Tankers
  - Boilers used mostly in or near port
  - High loads when discharging cargo if equipped with steam turbine discharge pumps

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## Auxiliary Boilers are a Significant Source of Emissions

| 2010 Uncontrolled Emissions (tons/day) |      |     |     |
|--|------|-----|-----|
| Ship Emissions Source                  | PM   | NOx | SOx |
| Main Engines                           | 11.3 | 130 | 76  |
| Auxiliary Engines                      | 4.8  | 55  | 35  |
| Auxiliary Boilers                      | 1.3  | 3.3 | 26  |

Source: ARB Emissions Inventory. **Emissions within 24 nm of coastline.** Assumes all auxiliary boilers use heavy fuel oil at 2.5% sulfur and there are no boiler emissions during transiting.

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## Auxiliary Boilers Emissions by Vessel Type

| 2010 Uncontrolled Emissions (tons/day) |            |            |             |
|--|------------|------------|-------------|
| Vessel Type                            | PM         | NOx        | SOx         |
| <b>Auto Carrier/Roro</b>               | 0.02       | 0.05       | 0.38        |
| <b>Bulk/General Cargo</b>              | 0.03       | 0.07       | 0.55        |
| <b>Container Ship</b>                  | 0.32       | 0.85       | 6.7         |
| <b>Passenger/Cruise</b>                | 0.04       | 0.10       | 0.79        |
| <b>Reefer</b>                          | 0.02       | 0.05       | 0.41        |
| <b>Tanker</b>                          | 0.83       | 2.2        | 17.1        |
| <b>Total</b>                           | <b>1.3</b> | <b>3.3</b> | <b>25.9</b> |

Source: ARB Emissions Inventory. Emissions with 24 nm of the California shoreline.

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## Potential Auxiliary Boiler Emission Reductions

| Emissions and Reductions | PM (tpd) | NOx (tpd) | SOx (tpd) |
|--------------------------|----------|-----------|-----------|
| 2010 Emissions           | 1.3      | 3.3       | 26        |
| Percent Reduction*       | 83%      | 6%        | 96%       |
| Emission Reduction       | 1.1      | 0.2       | 25        |

\* Emission reduction percentages based on change from 2.5% sulfur HFO to 0.1% sulfur MGO, and same reductions used for diesel piston engines.

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## Feasibility of Using Distillate Fuel - Input from Operators

- ◆ Most operators report few concerns with using distillate fuel in auxiliary boilers
- ◆ Tanker operators report the need for technical evaluations and possible modifications
  - Tankers using boilers for steam turbine discharge pumps have larger, higher pressure boilers
  - Modifications include new burner systems, controls, tanks and piping
  - Modifications more likely with older boilers

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## **Feasibility of Using Distillate Fuel - Input from Manufacturers**

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- ◆ Existing boilers can use distillate fuels subject to certain technical considerations
- ◆ May need manual burner adjustment for optimal efficiency
- ◆ Fuel pumps on some older boilers may need to be replaced if fuel viscosity is too low, or fuel cooling installed to control viscosity
- ◆ Modifications to burners or control systems for some boilers

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## **Using Distillate Fuel in Boilers would be Cost-Effectiveness**

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- ◆ Overall cost-effectiveness is expected to be similar to the ship auxiliary engine rule for SO<sub>x</sub>, but higher for PM (but still favorable)
- ◆ Most ship operators will not need to modify auxiliary boilers
  - Costs and cost-effectiveness will be driven mainly by the higher incremental cost of distillate fuel
- ◆ Tanker operators expected to incur higher costs
  - Costs for some vessels expected to include boiler or vessel modifications in addition to higher fuel costs

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## Typical per Visit Cost to Use Distillate Fuel in Auxiliary Boilers

| Vessel Type      | Boiler Use per Visit (hrs) | Fuel Use Rate (tonne/hr)    | Fuel - MT per visit | HFO Cost (\$) | MGO Cost (\$) | Extra Fuel Cost (\$) |
|------------------|----------------------------|-----------------------------|---------------------|---------------|---------------|----------------------|
| <b>Container</b> | 48 (dock)<br>2(at sea)     | 0.15                        | 7.5                 | 2,933         | 5,175         | 2,242                |
| <b>Cruise</b>    | 11 (dock)<br>1 (at sea)    | 0.31                        | 3.7                 | 1,447         | 2,553         | 1,106                |
| <b>Tanker</b>    | 38 (dock)<br>2 (at sea)    | 0.9 ( dock)<br>0.11(at sea) | 34.4                | 13,450        | 23,736        | 10,286               |

Notes: Boiler use based on average ship time in mode (hotelling and maneuvering only) from the ARB Ship Auxiliary Engine Rule Staff Report. Fuel use rates from Starcrest 2005 POLA/POLB Emissions Inventory. Fuel prices from Bunkerworld.com on Sept. 18, 2007 averaging IFO-380 and MGO prices for Singapore, Houston, Rotterdam, and Fujairah -- \$391/tonne HFO and \$690/tonne MGO.

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## Next Steps

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- ◆ Continue discussions with ship operators and boiler manufacturers
- ◆ Additional emissions testing of boilers
- ◆ Refine emissions inventory and emission reduction estimates
- ◆ Include auxiliary boilers in the regulatory process for the Ship Main Engine Rule

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## Contact Information

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