



# Air Pollution and Greenhouse Gas Emissions from Ships

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February 24, 2009

Congressional Research Service

7-5700

[www.crs.gov](http://www.crs.gov)

RL34548

## Summary

This report provides information regarding pollution from ships and port facilities; discusses some of the measures being implemented and considered by local, state, and federal regulatory agencies; discusses the efforts to ratify and to strengthen Annex VI of the International Convention for the Prevention of Pollution from Ships (MARPOL); and describes legislation in Congress to control emissions from ships by amending the Clean Air Act (CAA).

As pollution from cars, trucks, and land-based stationary sources has been more tightly controlled over the last 40 years, the contribution of ships and port operations to air pollution in port cities has become more important. In the same period, foreign trade has grown dramatically; thus, pollution from shipping and port operations would be growing as a percentage of total emissions, even if the emissions were regulated to the same degree as other sectors. In many cities, ships are now among the largest sources of air pollution. As Congress and the new Administration turn their attention to climate change, there is also a growing recognition that marine vessels are an important source of greenhouse gas (GHG) emissions.

Controlling these sources of both conventional and greenhouse gas pollutants is complicated by the fact that most ocean-going ships are not registered in the United States and may not even purchase the fuel they are using here. Thus, controlling such pollution would seem to lend itself to an international approach. To date, such efforts have been of little avail. In 1997, the United States and most countries signed an international agreement known as MARPOL Annex VI, setting extremely modest controls on air pollution from ships. The agreement did not enter into force until 2005, and the United States took until July 21, 2008, to enact legislation to implement it (P.L. 110-280). Negotiations to strengthen Annex VI accelerated in 2008, however, and discussions regarding GHG emissions have also begun.

While awaiting congressional action and international agreement, the Environmental Protection Agency (EPA), port cities, and states have begun to act on their own. In the 110<sup>th</sup> Congress, legislation was introduced (S. 1499 / H.R. 2548) to require EPA to dramatically strengthen ship emission standards under the Clean Air Act. S. 1499 was reported, but no further action was taken.

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## Introduction

Over the last 40 years, air quality in the United States has improved substantially. Since the passage of the Clean Air Act in 1970, annual emissions of the six most widespread (“criteria”) air pollutants have declined 160 million tons (53%), despite major increases in population, motor vehicle miles traveled, and economic activity.<sup>1</sup>

Emissions from shipping are a major exception to these trends. Although emission controls have reduced pollution from new cars and trucks by more than 90%, most ocean-going ships operate without any pollution controls at all. New and remanufactured engines on tug boats, ferries, and other smaller ships will be subject to emission controls beginning in 2008 and 2009, but most existing engines in vessels of these types remain uncontrolled.

Pollution from ships is also affected by the fuel they use. Marine vessels other than oceangoing ships have been required to use cleaner fuels, but ocean-going ships generally use bunker fuel, a fuel that contains a high level of contaminants: the average fuel used by oceangoing ships contains 27,000 parts per million (ppm) sulfur, for example—almost 2,000 times as much as would be allowed in trucks operating on U.S. roads.

In the Los Angeles-Long Beach area—which is both the nation’s busiest port<sup>2</sup> and the nation’s most polluted area<sup>3</sup>—the problem is particularly acute. According to the South Coast [L.A.-Long Beach] Air Quality Management District (AQMD):

- Oceangoing vessels are among the largest sources of nitrogen oxides (NO<sub>x</sub>) in the area, emitting more NO<sub>x</sub> than all power plants and refineries in the South Coast air basin combined. NO<sub>x</sub> reacts with volatile organic compounds in the atmosphere to produce ozone/smog.
- 70% of the area’s emissions of sulfur dioxide (SO<sub>2</sub>) come from ships. These emissions need to be cut by over 90%, according to the AQMD, if the area is to attain the national air quality standard for particulates by the 2014 deadline.
- Particulates from marine vessels also create significant cancer risks.
- More than 700 premature deaths are caused in the Los Angeles area annually by these emissions, according to the AQMD.<sup>4</sup>

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<sup>1</sup> See U.S. EPA, “Air Emissions Summary Through 2005,” at [http://www.epa.gov/air/airtrends/2006/emissions\\_summary\\_2005.html](http://www.epa.gov/air/airtrends/2006/emissions_summary_2005.html). The six criteria pollutants are ozone, particulate matter, carbon monoxide, sulfur dioxide, nitrogen oxides, and lead.

<sup>2</sup> According to the *Wall Street Journal*, Los Angeles and Long Beach ranked number 1 and number 2 in the value of cargo handled, with a combined total exceeding \$248.5 billion in 2003-2004. The port of New York and New Jersey ranked third with \$132.4 billion. See “The Busiest U.S. Ports,” March 9, 2006, at <http://americanfuture.net/?p=1447>.

<sup>3</sup> The Los Angeles South Coast Air Basin is the only area that EPA considers to be a “Severe” nonattainment area for ozone. The area also has the highest readings in the country for fine particulates (PM<sub>2.5</sub>), and is among only 8 areas classified as “Serious” nonattainment areas for larger particles (PM<sub>10</sub>). See U.S. EPA, “Green Book,” at <http://www.epa.gov/oar/oaqps/greenbk/index.html>.

<sup>4</sup> See testimony of Barry R. Wallerstein, Executive Officer, South Coast Air Quality Management District, at “Legislative Hearing on the Marine Vessel Emissions Reduction Act of 2007, S. 1499,” U.S. Senate, Committee on Environment and Public Works, February 14, 2008, p. 1.

While the Los Angeles-Long Beach area may be the most extreme example, the problem is not limited to L.A. or even to California. According to the Environmental Protection Agency (EPA), more than 40 U.S. ports nationwide are located in “nonattainment” areas<sup>5</sup> for ozone, fine particulates, or both.<sup>6</sup> In addition, according to EPA, “... the problem is not limited to port areas alone. Santa Barbara County, which has no commercial ports, estimates that by 2020, 67 percent of its NOx inventory will come from shipping traffic transiting the California coast...”<sup>7</sup>

Oceangoing ships are perhaps the largest source of port emissions, but they are not the only source. Ports make use of tug boats to guide ships entering and leaving the harbor. Ports make connections to land-based transportation networks, such as railroads, and they generally operate large truck terminals. Ships at rest in the port need a source of power, which often comes from running auxiliary engines. And, in many cases, a harbor is served by substantial local boat or barge traffic, sometimes including ferry service. Thus, addressing the sources of pollution in a port may require a multi-faceted approach.

## MARPOL Annex VI

Pollution from ships (not only air pollution, but pollution of all kinds) is governed by the International Convention for the Prevention of Pollution from Ships, first negotiated through the International Maritime Organization (IMO) in 1973. The Convention, known as MARPOL (for “MARine” “POLlution”) 73/78 (the dates referring to the 1973 Convention and its 1978 amendments), applies to all ships of the flag states that have ratified it. About 150 countries, representing over 98.7% of world shipping tonnage, have done so. The Convention also applies to ships of non-signatory states while they are operating in waters under the jurisdiction of parties to MARPOL. Six annexes to MARPOL 73/78 cover various sources of pollution from ships (oil, noxious liquids, sewage, garbage, etc.) and provide an overarching framework for implementation.

### Provisions of Annex VI

Annex VI of the Convention, which was adopted in 1997 but did not enter into force until 2005, addresses the Prevention of Air Pollution from Ships. The annex represents a small first step toward controlling such pollution, particularly if one compares it to pollution controls that the United States and other developed countries impose on land-based sources. Annex VI:

- limits the sulfur content of the fuel used in oceangoing ships (bunker fuel) to 4.5% (45,000 parts per million (ppm)). By comparison, highway diesel fuel in the United States is limited to 15 ppm;
- allows special sulfur oxide (SOx) Emission Control Areas (currently the Baltic Sea, the North Sea, and the English Channel), where the sulfur content of fuel is limited to 1.5% (15,000 ppm) or SOx emissions are limited;

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<sup>5</sup> That is, areas where air quality is worse than the health-based standard for ozone, particulates, or both.

<sup>6</sup> Testimony of Bryan Wood-Thomas, U.S. EPA, Office of Transportation and Air Quality, at “Legislative Hearing on the Marine Vessel Emissions Reduction Act of 2007, S. 1499,” U.S. Senate, Committee on Environment and Public Works, February 14, 2008, p. 2.

<sup>7</sup> Ibid.

- limits NO<sub>x</sub> emissions from new engines and engines that have undergone major conversions to a range of 9.8-17.0 grams per kilowatt-hour (g/kwh), depending on the rated engine speed. By comparison, power plants in the eastern United States are limited to 0.45-0.73 g/kwh;
- allows the regulation of emissions of volatile organic compounds (VOCs) from tankers by parties to Annex VI in their ports and terminals;
- prohibits emissions of ozone-depleting substances;
- prohibits the incineration on ships of polychlorinated biphenyls (PCBs, a class of toxic chemicals widely used in electrical transformers until the 1970s). In the United States, PCB production and use were banned in 1976, and disposal has been strictly regulated since then; and
- prohibits the incineration of garbage containing more than traces of heavy metals and of refined petroleum products containing halogen compounds.

## **Implementing Legislation (P.L. 110-280)**

The United States is a party to MARPOL 73/78 and most of its annexes, but did not enact legislation to implement Annex VI until the summer of 2008. The Senate gave its consent to ratification of Annex VI on April 7, 2006,<sup>8</sup> but Congress needed to enact implementing legislation before the United States could submit the instrument of ratification. The House passed H.R. 802 to implement the annex on March 26, 2007. The Senate passed the bill, with an amendment, June 26, 2008, and the House agreed to the Senate amendment July 8. The President signed the bill July 21, 2008 (P.L. 110-280).

The Annex VI standards apply to: any oceangoing vessel that is registered in the United States; ships of any registry in ports, shipyards, terminals, or the internal waters of the United States; ships of any registry bound for or departing from the United States, while they are located in the navigable waters of the United States or designated emission control areas; and ships bearing the flag of any country that has ratified Annex VI traveling through U.S. waters or designated emission control areas, even if they are not bound for or departing from a U.S. destination. To the extent consistent with international law, the Annex also applies to any other ship in the U.S. exclusive economic zone.

## **Amendments to Annex VI**

The United States has participated in negotiations to strengthen Annex VI, and more stringent limits on both fuels and emissions were approved by the IMO October 10, 2008. The new limits cut the allowable sulfur content of bunker fuel to 3.5% (35,000 ppm) starting January 1, 2012, with a further drop to 0.5% (5,000 ppm) on January 1, 2020. This provision will have little effect prior to 2020, since bunker fuel currently averages 27,000 ppm sulfur, substantially cleaner than the 2012 requirements. New limits will also apply in Sulfur Emission Control Areas—currently the Baltic Sea, North Sea, and English Channel, but potentially including other areas. Sulfur content in those areas, currently capped at 1.5% (15,000 ppm), will be capped at 1.0% (10,000 ppm) effective July 1, 2010, and 0.10% (1,000 ppm) effective January 1, 2015.

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<sup>8</sup> The Senate consented to ratification through Treaty Document 108-7.

IMO also agreed to reductions in nitrogen oxide (NO<sub>x</sub>) emissions from marine engines, with the new standards to be phased. For engines installed on ships constructed after January 1, 2011, but before 2016, NO<sub>x</sub> limits would be reduced about 20% to a range of 7.7 to 14.4 g/kWh, depending on the rated engine speed. For engines installed on ships constructed after January 1, 2016, the limits would be reduced about 80%, to a range of 2.0 to 3.4 g/kWh while ships are operating in designated emission control areas. Outside emission control areas, the prior (7.7 to 14.4 g/kWh) limit would apply.

These new Annex VI regulations will enter into force unless more than one third of the contracting parties to the convention or parties representing 50% of the gross tonnage of the world's merchant fleet notify IMO of their objection prior to January 1, 2010.<sup>9</sup>

## **EPA Regulations**

Before Congress enacted the Annex VI implementing legislation, EPA had already promulgated regulations under the Clean Air Act that were as stringent as Annex VI, and shipping companies were already generally meeting the standards. These so-called "Tier 1" standards were promulgated February 28, 2003, and went into effect in 2004.<sup>10</sup> In addition, in October 1999, EPA established a voluntary certification program so that engine manufacturers could show that their engines are compliant with Annex VI. EPA believes that all marine diesel engines sold in the U.S. since January 1, 2000, to which the annex applies (i.e., those rated above 130 kilowatts), meet Annex VI requirements.

## **Other Legislation**

In addition to the bill to implement Annex VI, other legislation on ship emissions saw committee action in the 110<sup>th</sup> Congress. S. 1499, reported by the Environment and Public Works Committee, July 10, 2008 (S.Rept. 110-413), would have amended the Clean Air Act to require oceangoing vessels entering or leaving U.S. ports and offshore terminals to use fuel that contains no more than 1,000 parts per million of sulfur (a 98% reduction from the requirement of Annex VI) beginning on December 31, 2010. The restrictions would have applied within 200 miles of the West Coast and within such distance of the East or Gulf coast or the shoreline of the Great Lakes or St. Lawrence Seaway as EPA determined to be appropriate.<sup>11</sup> The Administrator would have been allowed to provide an alternative mechanism of compliance if he determined that a vessel employed a control technology that reduced emissions of sulfur oxides and particulate matter to at least the same degree as the reduction that would be achieved through compliance with the sulfur content limitation.

In addition to the fuel standards, the bill would have required EPA to promulgate emission control standards for main and auxiliary engines on oceangoing vessels that enter or leave U.S. ports. The

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<sup>9</sup> "International Maritime Panel Sets Limits on Ships' Sulfur, Nitrogen Oxide Emissions," *Daily Environment Report*, October 14, 2008, p. A-6. For a copy of Annex VI as revised by the October 10, 2008 agreement, see the IMO website at [http://www.imo.org/includes/blastDataOnly.asp/data\\_id%3D23760/176%2858%29.pdf](http://www.imo.org/includes/blastDataOnly.asp/data_id%3D23760/176%2858%29.pdf).

<sup>10</sup> 68 *Federal Register* 9746, February 28, 2003.

<sup>11</sup> The Administrator may promulgate regulations that permit sulfur content as high as 2,000 ppm for a specified period if he determines that compliance with the 1,000 ppm limit is not technically feasible by December 31, 2010.

standards would have required the greatest achievable emission reduction for four pollutants (nitrogen oxides, particulate matter, hydrocarbons, and carbon monoxide) effective January 1, 2012. The standards could have taken into account the feasibility, benefits, and costs of specific technologies; could have distinguished new from in-use engines; and could have varied depending on the age of the engine.

A similar bill, H.R. 2548, was introduced by Representative Solis in the House, but no action was taken there.

## **Federal, State, and Local Measures**

Beyond Annex VI and the Senate and House bills of the 110<sup>th</sup> Congress, potentially more stringent actions are being taken at the federal, state, and local level to address emissions from marine engines.

### **EPA Regulations**

EPA has begun to regulate ship emissions under existing Clean Air Act authority. Thus far, the regulations are relatively weak, and it will be at least 2014 before the agency's regulations impose stringent requirements in most cases. Also, when the more stringent requirements do take effect, they will apply only to new and remanufactured engines, so improvements resulting from the standards will be gradual.

### **Category 3 Engines**

EPA categorizes ship engines in three categories. The largest of these engines—the main engines on oceangoing ships—are diesel engines with a per-cylinder displacement at or above 30 liters. These are referred to as “Category 3” engines. As noted, the agency has already promulgated regulations equivalent to Annex VI for these engines under the Clean Air Act. But, as the agency stated on its website, “There is an opportunity to gain large additional public-health benefits from Category 3 marine diesel engines through the application of advanced technology emission controls including high-efficiency catalytic aftertreatment.”<sup>12</sup> The agency began the process of developing more stringent regulations, by issuing an Advance Notice of Proposed Rulemaking December 7, 2007. It plans to finalize new Category 3 regulations by December 17, 2009.

Whether or not the agency promulgates more stringent Category 3 emission standards, they may have little effect on the overall level of pollution from Category 3 ships, since they will only apply to engines installed on vessels flagged or registered in the United States. In 2007, only 6.7% of the world's ships (and only 1.2%, if measured by carrying capacity) were registered in the United States.<sup>13</sup>

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<sup>12</sup> U.S. EPA, Office of Transportation and Air Quality, “Oceangoing Vessels,” at <http://www.epa.gov/otaq/oceanvessels.htm>.

<sup>13</sup> United Nations Conference on Trade and Development, *Review of Maritime Transport 2007*, pp. 32, 149-153 at [http://www.unctad.org/en/docs/rmt2007\\_en.pdf](http://www.unctad.org/en/docs/rmt2007_en.pdf).



## **Category 1 and 2 Engines**

By contrast, the Category 1 and 2 engines (those smaller than 7 liters per cylinder, and those from 7 to 30 liters per cylinder, respectively), are used in boats or ships that operate in U.S. waters—tugs, ferries, Great Lakes freighters, fishing boats, and recreational boats, for example—virtually all of which are registered in the United States. And, compared to Category 3, EPA is further along in regulating the emissions of these categories. Regulations that will reduce emissions of NO<sub>x</sub> from new or remanufactured engines by 24% and emissions of particulates by 12% when fully implemented, were promulgated in 1999 and began taking effect between 2004 and 2007. More stringent standards were promulgated May 6, 2008, and will take effect between now and 2014.<sup>14</sup> The final 2014 standards will require ultra low sulfur diesel fuel (15 ppm sulfur) and high efficiency catalytic emission controls capable of reducing particulate matter emissions by 90% and NO<sub>x</sub> emissions by 80%, along with “sizeable reductions” of hydrocarbon, carbon monoxide, and air toxic emissions, according to EPA.<sup>15</sup>

## **California Emission Reduction Measures**

California, being more adversely affected than most other areas, has played a leadership role in identifying and implementing emission reduction measures, as well. The state has focused on port activities, in addition to fuel and emission standards. California’s measures fall into four categories: (1) requiring the use of lower sulfur fuel; (2) requiring emission controls on harbor vessels and shore-side equipment; (3) providing alternative (electric) power to ships while they are docked at marine terminals ; and (4) providing grants for the re-powering of harbor craft and short-haul trucks with cleaner engines.

### **Low Sulfur Fuels**

The California Air Resources Board (CARB), at a July 24, 2008, meeting, approved regulations that would require both U.S.- and foreign-flagged vessels sailing within 24 miles of its coast to use low sulfur fuels in both main and auxiliary engines beginning July 1, 2009. Compliant fuels are marine diesel oil with 5,000 ppm or less sulfur or marine gas oil with 15,000 ppm or less sulfur. In January 2012, sulfur in both types of fuel would be limited to 1,000 ppm. The rules replace low sulfur fuel requirements that the state implemented in 2007, but which were overturned by the U.S. Court of Appeals for the Ninth Circuit in February 2008.<sup>16</sup> The original rules would have set a 1,000 ppm limit two years earlier, in 2010.

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<sup>14</sup> 73 *Federal Register* 25097, May 6, 2008.

<sup>15</sup> For information, see U.S. EPA, Office of Transportation and Air Quality, “Diesel Boats and Ships,” at <http://www.epa.gov/oms/marine.htm>.

<sup>16</sup> *Pacific Merchant Marine Ass’n v. Goldstene*, 517 F.3d 1108 (9<sup>th</sup> Cir. 2008). The court held that the state’s Marine Vessel Rules were preempted by the federal Clean Air Act because the regulations set emission standards for marine engines without California having received a waiver from EPA to do so. California has since asked EPA for a waiver to enforce the original rules, in addition to developing the rules applying only to fuels. If the waiver is granted, the original (2007) requirements would be enforced. See “California Air Board Seeks Federal Waiver to Enforce Ship Auxiliary Engine Rules,” *Daily Environment Report*, May 13, 2008, p. A-1. See also, CARB, “Advisory on Plans to Implement a Proposed ARB Regulation on Fuel Sulfur and Other Operational Requirements for Ocean-Going Vessels,” October 2008, at <http://www.arb.ca.gov/ports/marinevess/documents/advisory1008.pdf>.

## **Emission Controls**

California has, in general, led the nation in imposing more stringent requirements on diesel engines. In addition, the ports of Los Angeles and Long Beach have developed procedures to require that trucks serving the ports will be replaced by newer, less-emitting models. According to a description of the ports' plan:

... all pre-1989 trucks will be barred from entering the ports' terminals beginning Oct. 1 [2008]. Effective Jan. 1, 2010, all 1989-1993 trucks and any 1994-2003 trucks without certified pollution control equipment will be banned. By Jan. 1, 2012, all trucks entering the port must meet the 2007 federal standard for heavy-duty diesel trucks....

A \$35 gate fee for each 20-foot container unit that passes through the port will generate funds to help underwrite subsidies to upgrade and replace trucks.<sup>17</sup>

In addition, CARB has adopted regulations for harbor craft, including ferries, tugboats, and tow boats, which will require the replacement of unregulated engines beginning in 2009, and will accelerate the adoption of EPA's Category 1 and Category 2 marine engine pollution controls. These rules became effective November 19, 2008.<sup>18</sup>

## **Alternative Power**

In June 2004, the Port of Los Angeles opened the world's first Alternative Maritime Power (AMP) terminal for container ships, where cargo ships can plug in to power instead of operating auxiliary engines to generate electricity while at berth. The electrification project was the result of a lawsuit brought by the Natural Resources Defense Council and other groups, who sued the city claiming it failed to fully weigh air quality and other environmental impacts of the new container terminal. As a result of the suit, a state appeals court halted work on the terminal in October 2002, and Los Angeles subsequently agreed to electrify the terminal to cut diesel emissions while ships are at docks, among other measures.<sup>19</sup> A second terminal was outfitted with AMP capability in 2005. To encourage shippers to use the AMP facilities, in December 2004, the Los Angeles Board of Harbor Commissioners passed a policy resolution to help each existing Port customer underwrite the cost of building or retrofitting their first container or cruise ship to run on electrical power when docked, a cost estimated at \$320,000 - \$830,000 per vessel.<sup>20</sup> Cruise ship terminals in San Francisco and Seattle are also implementing AMP, and CARB obtained final approval of regulations to require the use of AMP at the state's six largest ports, in December 2008.<sup>21</sup>

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<sup>17</sup> "Los Angeles Harbor Commission Approves Program to Replace Older Diesel Trucks," *Daily Environment Report*, March 24, 2008, p. A-9.

<sup>18</sup> Information on these regulations can be found at <http://www.arb.ca.gov/regact/2007/chc07/chc07.htm>.

<sup>19</sup> *Natural Resources Defense Council v. City of Los Angeles*, 126 Cal. Rptr. 2d 615 (Cal. App. 2002).

<sup>20</sup> See Port of Los Angeles, "Alternative Marine Power," at [http://www.portoflosangeles.org/environment/alt\\_maritime\\_power.asp](http://www.portoflosangeles.org/environment/alt_maritime_power.asp). Also see "Alternative Maritime Power 'Off and Running,'" presented by Eric Caris, at <http://www.ffca2006.com/documents/presentations/marine/Eric%20Caris.pdf>.

<sup>21</sup> See California Air Resources Board, "Rulemaking to Consider Adoption of Proposed Regulations to Reduce Emissions from Diesel Auxiliary Engines on Ocean-Going Vessels While at Berth at a California Port," at <http://www.arb.ca.gov/regact/2007/shorepwr07/shorepwr07.htm>. The December 2008 regulation will require container vessels, passenger vessels, and reefers (refrigerated ships for perishable cargo) to reduce on-board power generation 50% by 2014, 70% by 2017, and 80% by 2020.

## Grants

CARB, the Ports of Los Angeles and Long Beach, and the South Coast Air Quality Management District also intend to provide substantial amounts of financial support for the replacement of older, high-emitting engines and the conversion to lower emitting power sources. CARB awarded \$247 million in FY2007-08 funds for “goods movement emission reduction” projects (about \$137 million of which was designated for ports) and another \$250 million has been appropriated in FY2008-09. CARB notes, however, that state funding for bond programs is suspended, pending “effective resolution of the current fiscal year budget crisis and a restoration of the state’s ability to access the bond market.” This affects FY2007-08 funds awarded to local agencies under the Goods Movement Program, as well as the FY 2008-09 funds that have not yet been awarded.<sup>22</sup> According to CARB, most requests for the funds have come from trucking companies, which would replace older engines or trucks with new models that reduce emissions as much as 90%.<sup>23</sup>

In addition to the CARB funding, the ports of Los Angeles and Long Beach, as noted earlier, will provide subsidies for truck and engine replacement from a fund generated by a \$35 to \$70 per container fee. The grants will provide \$20,000 for the cost of each truck compliant with EPA’s 2007 emission standards used by port concessionaires. The ports began distributing \$44 million in incentive checks in December 2008, for the first 2,200 low-emission trucks purchased under the program.<sup>24</sup>

These grants have also experienced funding problems. The per-container fees that are to fund the system were to have been collected beginning in November 2008, but implementation was delayed by the Federal Maritime Commission (FMC), which maintains that the ports’ program (referred to as the PortCheck Agreement) is anti-competitive and interferes with interstate commerce. FMC delayed implementation of the fees by requiring two 45-day review periods; the Commission has also filed suit in the U.S. District Court for the District of Columbia, where it seeks an injunction to block implementation of the fees.<sup>25</sup> These actions delayed the start of fee collection until February 18, 2009.

Besides state and local funding, U.S. EPA has become a source of funds for diesel emission reductions at ports. The stimulus package (the American Recovery and Reinvestment Act of 2009, P.L. 111-5) contained \$300 million for diesel emission reduction grants. This money may be used for purposes authorized under Title VII, Subtitle G of the Energy Policy Act of 2005 (P.L. 109-58), including retrofit of diesel trucks, marine engines, and cargo handling equipment, not only in California, but in other states as well. There is an additional \$60 million in diesel emission reduction grant money in H.R. 1105, the Fiscal Year 2009 Omnibus Appropriation bill, as introduced.

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<sup>22</sup> Although funds are appropriated to ARB as part of the state’s budget process, ARB must obtain the cash through the Pooled Money Investment Board. See CARB, “Prop 1B/Goods Movement Update” (e-mail to listserve on February 4, 2009), at [http://www.arb.ca.gov/bonds/gmbond/docs/2\\_4\\_2009\\_email\\_update\\_to\\_listserv.pdf](http://www.arb.ca.gov/bonds/gmbond/docs/2_4_2009_email_update_to_listserv.pdf).

<sup>23</sup> See CARB, “Emissions Reduction Plan for Ports and Goods Movement in California: *Update on Implementation*,” Staff Presentation, Air Resources Board Meeting, Oakland, CA, April 24, 2008 at <ftp://ftp.arb.ca.gov/carbis/board/books/2008/042408/08-4-7pres.pdf>.

<sup>24</sup> “Port of Los Angeles Begins Estimated \$44 Million Pay-Out Process to Clean Truck Program Concessionaires that Applied for Port’s 2007-Compliant Incentive Program,” Press Release, December 23, 2008, at <http://www.portoflosangeles.org/environment/ctp.asp>.

<sup>25</sup> Federal Maritime Commission v. City of Los Angeles, California, No. 1:08-cv-01895 (D. D.C. filed Oct. 31, 2008).

## Greenhouse Gases

Ships are also an important source of greenhouse gas (GHG) pollutants. Although there is a wide range of estimates, the International Maritime Organization's consensus is that international shipping emitted 843 million metric tonnes of carbon dioxide, 2.7% of global CO<sub>2</sub> emissions in 2007. Including domestic shipping and fishing vessels larger than 100 gross tonnes, the amount would increase to 1.019 billion tonnes, 3.3% of global emissions.<sup>26</sup> At these levels, only five countries (the United States, China, Russia, India, and Japan) account for a higher percentage of the world total of CO<sub>2</sub> emissions.<sup>27</sup>

In addition to the CO<sub>2</sub> emissions, the low quality fuel (bunker fuel) that ships use and the absence of pollution controls result in significant emissions of black carbon and nitrogen oxides, which also contribute to climate change. The refrigerants used on ships (hydrofluorocarbons and perfluorocarbons—HFCs and PFCs) are also potent greenhouse gases when released to the atmosphere. Thus, the total impact of ships on climate may be somewhat greater than 3%.

### International Efforts to Address GHGs

For the most part, these emissions occur in international waters, and the sources are vessels not registered in the United States. Addressing the emissions, therefore, is likely to require international agreement. On the international level, however, there has been disagreement over who should take responsibility to abate GHG emissions. Rather than cover these emissions under the Kyoto Protocol, nations agreed to look to the IMO for sector-specific provisions to reduce GHG emissions from shipping.<sup>28</sup>

The IMO's Marine Environment Protection Committee has begun negotiations on the issue, and has stated that the issue is "high on the Committee's agenda." According to the Committee's website:

the IMO is currently working in accordance with a work plan, due to culminate in 2009 with the adoption of a binding instrument. The Organization is working to have measures in place to control GHG emissions from international shipping before the first commitment period under the Kyoto Protocol expires at the end of 2011. The Committee is also expected to decide whether GHG regulations should form part of an existing convention or whether a new instrument should be developed.<sup>29</sup>

Final adoption of an IMO regime to control GHG emissions is planned for the 59<sup>th</sup> meeting of the Marine Environment Protection Committee in July 2009.

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<sup>26</sup> International Maritime Organization, *Updated Study on Greenhouse Gas Emissions from Ships*, Executive Summary of Phase 1 Report, 1<sup>st</sup> September 2008, p. 5 at [regserver.unfccc.int/seors/attachment/file\\_storage/6ep77qqvcujba7k.doc](http://regserver.unfccc.int/seors/attachment/file_storage/6ep77qqvcujba7k.doc). Both estimates exclude emissions from naval vessels. Cited below as "IMO 2008 Update."

<sup>27</sup> Oceana, *Shipping Impacts on Climate: A Source with Solutions*, p. 2, at [http://www.oceana.org/fileadmin/oceana/uploads/Climate\\_Change/Oceana\\_Shipping\\_Report.pdf](http://www.oceana.org/fileadmin/oceana/uploads/Climate_Change/Oceana_Shipping_Report.pdf).

<sup>28</sup> Under the UN Framework Convention on Climate Change, emissions from internationally used fuels (both ships and aviation) are calculated by countries but reported separately from national emissions, such as those subject to the United Nations Kyoto Protocol.

<sup>29</sup> "IMO Continues Work on Regime to Control GHG Emissions," Press Release, 07 October 2008, at <http://www.climate-l.org/2008/10/imo-continues-w.html>.

As with many other sectors, the European Union has been a driving force in getting international consideration of controlling the shipping sector's GHG emissions. The EU has considered adding the shipping industry to its cap-and-trade system, the EU Emissions Trading Scheme (ETS), but for now is deferring to the IMO. Approving a broad package of climate measures on December 17, 2008, the European Parliament left shipping out of the package, pending the outcome of the IMO discussions. Satu Hassi, a Finnish lawmaker from the Parliament's Green Group, who oversaw negotiations on emission reduction targets for non-ETS sectors, was quoted as saying the "EU will act unilaterally" should IMO discussions not produce sufficient results.<sup>30</sup>

## **Shipping vs. Other Transport Modes**

Ocean-going ships are already by far the most efficient means of goods movement. As noted by the United Nations Conference on Trade and Development (UNCTAD):

While in absolute terms GHG emissions from international shipping are significant, in relative terms maritime transport – in particular where larger ships are used – surpasses other modes of transport in terms of fuel efficiency and climate friendliness. On a per ton kilometre (km) basis and depending on ship sizes, CO<sub>2</sub> emissions from shipping are lower than emissions from other modes. For example, emissions from rail could be 3 to 4 times higher than emissions from tankers, while emissions from road and air transport could, respectively, be 5 to 150 times and 54 to 150 times higher. Equally, in terms of fuel consumption (kilowatt (kW)/ton/km), a container ship (3,700 twenty-foot equivalent units (TEUs)), for instance, is estimated to consume on average 77 times less energy than a freight aircraft (Boeing 747-400), about 7 times less than a heavy truck and about 3 times less than rail.<sup>31</sup>

But, in general, shipping does not compete with other modes of transport. Only in a small number of cases involving high value or perishable commodities, or relatively short distances between countries that also have land links, are mode shifts between shipping and air, truck, or rail transport possible. Ships move more than 80% of the volume of international trade, and are likely to continue doing so. As the overall volume of trade grows, GHG emissions from shipping are projected to be 2.4 to 3 times the current level by 2050 unless control measures are adopted.<sup>32</sup>

## **Measures to Reduce Ships' GHG Emissions**

A number of measures might be taken to reduce the shipping sector's GHG emissions. One of the more common suggestions is that ships operate at lower speeds. The IMO's 2000 study of GHG emissions from ships concluded that a 10% reduction in speed would result in a 23.3% reduction in emissions.<sup>33</sup> Slowing speeds is not without problems. According to the 2000 IMO report:

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<sup>30</sup> "European Parliament Gives Final Approval to Far-Reaching Climate Protection Strategy," *Daily Environment Report*, December 18, 2008, p. A-1.

<sup>31</sup> "Maritime Transport and the Climate Change Challenge," Note by the UNCTAD Secretariat, 9 December 2008, prepared for the Multi-Year Expert Meeting on Transport and Trade Facilitation, Geneva, Switzerland, 16-18 February 2009, at [http://www.unctad.org/en/docs/cimem1d2\\_en.pdf](http://www.unctad.org/en/docs/cimem1d2_en.pdf).

<sup>32</sup> IMO 2008 Update, op. cit., p. 5.

<sup>33</sup> Norwegian Marine Technology Research Institute – MARINTEK et al., for the International Maritime Organization (IMO), *Study of Greenhouse Gas Emissions from Ships*, March 2000, p. 17, at [http://unfccc.int/files/methods\\_and\\_science/emissions\\_from\\_intl\\_transport/application/pdf/imoghmain.pdf](http://unfccc.int/files/methods_and_science/emissions_from_intl_transport/application/pdf/imoghmain.pdf). This one measure (slow steaming) dwarfed the potential of any of the other technical and operational measures examined in the IMO study: in (continued...)

For most ship engines, running at reduced speed / slow steaming may ... cause problems. Such problems may be vibrations (critical RPM of engine / shaft) and accelerating sooting in the exhausted gas channel. Sooting problems are normally coincident with incomplete combustion and increasing GHG emission per fuel unit consumed. For ships permanently operating at slow speed, however, engine modifications / de-rating may be a solution.<sup>34</sup>

In addition, of course, cargo owners may consider the lost time in reaching the ship's destination to be more valuable than the fuel and GHG savings. Thus, in a competitive market with low fuel costs, ship owners will tend to offer as swift a service as they can safely provide. Nevertheless, it is possible without changes in technology or fuels to achieve significant GHG emission reductions.

Cleaner fuels and emission controls could also lower emissions, particularly if one focuses on emissions of black carbon and nitrogen oxides. Like slow steaming, these could be implemented without the need to replace ship engines or the ships themselves.

The use of alternative power in ports may also reduce GHG emissions, if the shore power is derived from low-carbon sources such as natural gas, or no-carbon sources (hydropower, wind, solar, or nuclear).

New ships may be able to reduce emissions further through better hull design, more efficient propulsion, and propeller coatings, among other options. A detailed discussion of options (in the context of Navy ships) is provided in CRS Report RL33360, *Navy Ship Propulsion Technologies: Options for Reducing Oil Use - Background for Congress*, by Ronald O'Rourke.

## Conclusion

As pollution from cars, trucks, and land-based stationary sources has been more tightly controlled over the last 40 years, the contribution of ships and port operations to air pollution in port cities has become more important. Simultaneously, foreign trade has grown dramatically, adding to the burden of pollution from these sources. Thus, pollution from ships and the port operations that serve them is now among the most important sources of sulfur oxides, nitrogen oxides, particulates, and other pollutants in numerous U.S. cities.

Controlling these sources of pollution is complicated by the fact that most oceangoing ships are registered in foreign countries. Thus, initial efforts at control were focused on international negotiations through the IMO, which established a basic structure (MARPOL Annex VI) that may be the basis of more stringent future controls. Negotiating, ratifying, and implementing MARPOL agreements is time-consuming, however, and thus far, has not resulted in more than token levels of regulation. Thus, EPA and state and local agencies (particularly those in California) have begun to address pollution from ships using the Clean Air Act and comparable state authorities.

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(...continued)

the short term (10 years), it accounted for nearly 60% of the total reductions identified; over a 20-year horizon, it still accounted for 43% of potential reductions.

<sup>34</sup> Ibid., p. 91.

Not all pollution from marine vessels comes from foreign ships. Smaller craft, such as ferries, tugboats, and fishing boats do tend to be registered in the United States, and are thus more amenable to control. Even for these smaller craft, the technical issues can be complex, as the vessels include a wide variety of engine sizes and ship configurations. Safety also poses important considerations, as ships must be able to depend on their sources of power in what may be extreme weather conditions and while dealing with a variety of navigational hazards.

Because ships and port operations are now such significant sources of air pollution, further regulatory and legislative efforts to control their emissions are likely. In addition, ships are a large and growing source of greenhouse gas emissions; how and whether to regulate these emissions are the subject of IMO discussions and may enter into the larger debate over legislation to address climate change.

Congress has begun efforts to address these problems, and enacted legislation to implement MARPOL Annex VI in July 2008. But this is likely to be just the start of Congressional attention to air pollution from ships. Action at the state level, in the courts, and at U.S. EPA will continue to bring the issue to Congress's attention, with numerous opportunities for oversight and legislation.

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