A STACKED DECK:

AIR POLLUTION FROM LARGE SHIPS

BLUEWATER NETWORK

JULY 17, 2000

EXECUTIVE SUMMARY

Large oceangoing vessels are one of the largest pollution sources in the United States. Despite the fact that ships are more energy efficient than other forms of transportation such as trucks or rail, lack of emissions control regulations by the US EPA and international regulatory agencies have allowed ships to become one of the top dischargers of nitrogen and sulfur oxides and diesel particulate matter in the world.

Ninety-five percent of commercial goods imported to the US arrive aboard ships. Between 1983 and 1998, world seaborne trade rose 70 percent, from 12.6 trillion to 21.4 trillion ton miles. Commercial vessel traffic – and vessel-related emissions – are expected to double or triple in the next 20 years as a consequence of global accords that reduce future obstacles to international trade.

Ship emissions are far more significant than previously estimated and represent a major contributor to global nitrogen (14 percent) and sulfur (16 percent) emissions from all petroleum sources. Both of these pollutants have been implicated in global warming.

Marine engines operate on extremely dirty fuels with high sulfur and aromatic content. This contrasts sharply with fuels used by land- and air-based forms of transportation. The sulfur content of marine diesel fuel ranges from 5,000 parts per million (ppm) to over 50,000 ppm. By contrast, diesel fuel used by on-road vehicles in the US is capped at 500 ppm and will soon be reduced to 15 ppm by new regulations.

The largest category of ships, which carry most of the world's cargo, are termed Category 3 vessels by EPA. Category 3 vessels are fueled by bunker oil, the dirtiest and least expensive form of fuel available. As high-grade petroleum products such as jet fuel, gasoline, and diesel fuel are produced, the refining process removes undesirable chemicals. The residue from the production of these higher grade fuels is collected and sold as bunker oil. Bunker oil contains high concentrations of toxic fuel compounds banned from use in most other industrial and consumer applications.

The pollutants emitted from burning this dirty fuel leads to acid rain, global climate changes, particularly over oceans, and damaging health effects for

communities living near major port areas. As commercial vessel operations increase, so also does the threat to marine ecosystems and the health of Americans, especially in coastal regions.

A 1996 international agreement intended to control ship emissions (Annex VI of the International Convention on the Prevention of Pollution from Ships — MARPOL) has not entered into force, and is unlikely to be ratified by the world's shipping nations. Even in the highly unlikely event of ratification, the U.S. EPA projects that US emissions from large ships will continue to increase by six percent by 2020 and 13 percent by 2030. Absent ratification, these emissions could grow to 22 and 35 percent, respectively.

Therefore, the clear obligation is upon the US EPA to independently regulate ships emissions to protect the environment and public health and safety, according to the Clean Air Act Amendments of 1990.

1. LARGE VESSEL EMISSIONS

Ninety-five percent of commercial goods imported to the US arrive aboard ships, primarily Category 3 vessels which operate on low grade bunker fuel.[1] Between 1983 and 1998 world seaborne trade rose 70 percent, from 12.6 trillion to 21.4 trillion ton miles. Commercial shipping – and vessel-related emissions – will accelerate rapidly as trade barriers continue to fall. Yet ship engines, which are one of the highest polluting combustion sources per ton of fuel consumed, have been left almost entirely unregulated by US EPA and the International Maritime Organization (IMO).

Until recently, interest in air pollution generated by vessels had been limited to its impact on local air quality in ports such as Los Angeles, Boston, or New York. However, recent studies by Carnegie Mellon University demonstrate that ship emissions are concentrated along the heaviest ocean trade routes, particularly in the Northern Hemisphere, and are equivalent to the domestic nitrogen and sulfur inventories of the world's largest trading nations. Researchers also found that ship emissions are far larger than previously estimated and are a highly significant contributor to global nitrogen (14 percent), and sulfur (16 percent) emissions from all petroleum sources.[2] Both of these pollutants have been implicated in global warming. In California, more than 30 percent of the total sulfur inventory may be attributable to ship emissions.[3]

CLIMATE CHANGE

Sulfur Emissions

Further analysis by Carnegie Mellon and Duke Universities suggests that smokestack emissions from ships may account for half the sulfur found over the world's oceans, and 60 percent of the airborne sulfur in the North Pacific and North Atlantic. Worldwide, ship sulfur emissions rival the sulfur emissions of

[1] These fuels contain high levels of sulfur, ash, asphaltenes, and metals. As a result of improved fuel oil refining techniques, the above contaminant concentrations have increased.

[2] James Corbett and Paul Fischbeck, Science, October 31, 1997

the world's largest economies, resulting in staggering proportions when compared to sulfur generated on land. Total worldwide ship sulfur emissions equals 43 percent of the sulfur produced by the US and 53 percent of that produced by OECD Europe. Researchers conclude that ship emissions are a critical and overlooked element in the global climate change debate and in emissions modeling.

Adding to these concerns, groundbreaking results from the Indian Ocean Experiment in 1998-1999 suggest that aerosol emissions from ships, power plants and industrial sources may be trapping solar heat by "burning away" clouds through emissions of sulfates, nitrates, soot and ash. Such an effect would increase global warming through loss of heat-reflecting cloud cover.[1]

The role of increased sulfates from human activity in climate change is not clearly understood, and there is speculation that vessel-generated sulfates and other aerosols may be increasing, rather than decreasing, cloud formation. This would serve to mask and underestimate the anthropogenic effect of global warming by falsely attributing it to natural sources over oceans. In this scenario, the eventual reduction of sulfur fuel levels to protect public health would "unmask" the hidden role of ship-caused interference with climate change models.

However, it is now clear that sulfur emissions from the rapidly expanding worldwide vessel fleet play a very important role in climate change, weather, and the modeling of global warming. While further research is needed regarding the specific role of ship emissions upon cloud-forming behavior, a reduction of sulfur levels in ship fuels will substantially reduce the environmental dangers represented by such uncontrolled pollution of the troposphere.

NITROGEN OXIDE EMISSIONS

Ships emit significant global levels of nitrogen oxides (NOx), and contribute heavily to ozone, which is a global warming gas. As mentioned above, ships account for 14 percent of worldwide nitrogen emissions from fossil fuels. Global ship NOx emissions equal 42 percent of all US NOx emissions, 87 percent of emissions from US stationary sources, and are equal to all emissions from US mobile sources.[2] According to Sypros Pandis, a chemical engineer at Carnegie Mellon, "NOx levels are a lot higher than what anyone expected over the oceans."[3]

According to EPA, marine diesel engines contribute one million tons of NOx per year nationally, representing 8.1 percent of mobile source NOx and 4.8 percent of total NOx emissions nationally. Further, "emissions from marine diesel engines tend to be concentrated in specific areas of the country (ports, coastal areas, and rivers), and so local levels of these pollutants can be much higher." Category 3 marine diesel engines contribute 27 percent of this NOx inventory, or 273 thousand tons per year nationally (or 748 tons per day). Foreign flag vessels

[1] Science, 2000.

[2] Corbett and Fishbeck, Op. Cit.

[3] Environmental Science and Technology, Feb. 1, 2000, p. 65.

account for 45 percent of Category 3 NOx emissions, i.e., 123 thousand tons per year, or 339 tons per day.

Ozone, a product of nitrogen emissions, impacts the environment in many ways, from damage to urban grass, flowers, shrubs and trees, to reduced yield in tree seedlings in forests and commodity crops. It further increases susceptibility of plants to pests, reduces visibility, and damages buildings and monuments. Nitrogen emissions also increase nitrogen deposition into sensitive, already nitrogen-saturated coastal estuaries and ecosystems resulting in increased growth of algae and plants.[1]

Texas, California and the US East Coast – Significant NOx Effects

In many states and regions, NOx control is essential for achieving compliance with federal ozone standards. In Texas, for example, which recently claimed the national spotlight as the worst smog-standard violator, Houston must eliminate up to 85 percent of NOx emissions to come into compliance with Clean Air Act ozone standards. The Texas Natural Resource Conservation Commission is currently devising aggressive NOx control measures, including measures requiring a 90 percent reduction in NOx emissions at all industrial facilities in the Houston-Galveston area.[2] Because Texas is one of the nation's busiest ports-of-call, controlling NOx from marine diesel engines in Texas ports is important to that state's NOx reduction efforts. EPA found that marine diesel engines contribute approximately 15 percent of the NOx on a summer day for Beaumont-Port Arthur.[3]

California is the nation's second-busiest port-of-call destination, with approximately 9,300 ship arrivals in per year. EPA has found that the marine diesel engines entering California ports are a significant contributor to regional NOx inventories, making up approximately 17 percent of the NOx on a summer day in San Diego and 12 percent in San Francisco. In Santa Barbara, the Air Pollution Control District has stated that ship NOx emissions are equivalent to the NOx emissions from all of the motor vehicles operated in their county of 400,000 people.

EPA has also stated that NOx reductions are required "to bring major East Coast cities into attainment of the ozone standard," and to reduce ozone in rural areas of the eastern U.S., where ozone is generally "limited by the availability of NOx rather than hydrocarbons."

ACID RAIN

Acid rain is caused when sulfur and nitrogen oxides – pollutants released primarily from the burning of coal, oil and other fossil fuels – chemically react with other substances in the atmosphere to form acidic compounds. When these acids are carried down from the atmosphere in rain, fog or snow, they can harm fish, damage forests and contribute to the deterioration of buildings and historical monuments. The pollutants that cause acid deposition have also been

[1] EPA, Prevention of Air Pollution From Ships, Marine Environment Committee, December, 1999.

[2] Houston Chronicle, Oct. 28, 1999

[3] Note that unless these facts specifically state that a statistic relates to Category 3 marine engines, it refers to marine engines generally. Based on the finding cited in the preceding sentence, Category 3 engines may account for 27 percent of the amounts indicated for marine engines generally.

known to worsen asthma and other lung ailments and to impair visibility in many regions of the nation, including the scenic vistas of National Parks.

While there has been progress nationally in reducing the production of acid rain, EPA acknowledges that additional controls on sulfur and nitrogen emissions will be needed to achieve further improvement in the health of lakes and forests.

In a coastal context, this may result in weather impacts, increased levels of acidity in rainfall, decreased agricultural production, and damage to aquatic wildlife.

PUBLIC HEALTH

The Effect of NOx Upon Public Health

Numerous studies provide evidence of associations between ozone exposures and health effects ranging from respiratory symptoms and decreased lung functions to increased hospital admissions for respiratory causes. Mortality studies have suggested a possible association between ambient ozone levels and an increased risk of premature death.

Particulate Matter and Impacts to Communities

Particulate matter (PM) emissions are directly correlated with the amount of sulfur in fuel stocks. Communities throughout the US are threatened by high levels of PM emissions from diesel-powered ships, trucks and locomotives. According to EPA, smog and particulate matter (PM) account for 15,000 premature deaths, one million respiratory problems, 400,000 asthma attacks, and thousands of cases of aggravated asthma, especially in children, in the United States every year.[1]

For this reason, the EPA has reduced sulfur levels for virtually all categories of transportation, except large vessels. The EPA has not yet regulated Category 3 ship emissions, despite the fact that marine diesel engines represent the third largest source of PM in the US after the categories of non-road diesel and aircraft.[2] By 2010, EPA projects such uncontrolled PM emissions to grow significantly. Especially threatened are children, communities living near port loading terminals, shipyard workers, crews, and passengers in the immediate vicinity of marine diesel engines.

Due to the direct relationship between fuel sulfur and particulate emissions, decreasing the former will decrease the latter, *even without any other form of emissions control*, such as improved engine technologies. Therefore, it is essential to set standards for marine diesel sulfur levels in order to reduce public health risks from PM exposure.

California

According to the EPA Office of Mobile Sources, the coast of California is one of the highest sulfur oxide (SOx) emissions areas in the US due to its substantial

[1] EPA Press Release "EPA Proposes Reduced Sulfur Content in Diesel Fuel to Ensure Clean Heavy-Duty Trucks and Buses." May 17, 2000.

[2] In California, the Air Resources Board has stated that ships are the number three source of diesel particulate matter after the categories of trucks and construction equipment.

shipping traffic.[1] Ships account for approximately 31 percent of the total sulfur inventory in California's South Coast Air District,[2] but may represent even higher percentages of California's total sulfur inventory due to prevailing westerly wind patterns which blow vessel air emissions ashore. (Ship emissions have residence times of one to three days, and are believed to substantially contribute to pollution 250 to 750 miles inland).[3]

Most large vessel docks and shipyards in California are located in or near communities of color. Concerns about disproportionate PM exposure were highlighted in an Environmental Working Group Report, which analyzed 161 monitoring stations in California. This study demonstrated that residents of communities of color are nearly three times more likely to breathe dangerous levels of airborne PM than predominantly white communities.

According to the California Air Resources Board (CARB), the best regulatory measures to reduce PM attack the problem at both ends of the engine – sulfur levels in the fuel and PM emissions as controlled at the tailpipe. Both CARB and EPA have successfully taken this approach in the case of on-road standards, and this will have beneficial corollary effects for other categories of mobile sources as well.

REGULATORY ACTIONS

Ironically, ships employ less energy transporting goods than other forms of transit such as truck and rail, yet their emissions of sulfur and NOx are proportionately far higher. This is because ship engines and their fuels have been left almost entirely unregulated by US EPA and the International Maritime Organization (IMO).

Inexplicably, US EPA has delegated authority for regulating large ship emissions to the International Maritime Organization (IMO), in apparent violation of section 213 of the Clean Air Act, which requires EPA to achieve the greatest degree of emission reduction achievable given certain cost constraints.

New regulations passed by the IMO in 1996, known as MARPOL Annex VI, will slightly reduce nitrogen oxide levels by new ship engines, but will not affect older engines. Moreover, they will not go into force until the national legislatures of 15 nations, representing half of the world's shipping tonnage, ratify the agreement. By May 2000, only two countries – representing only five percent of the world's shipping tonnage – had ratified Annex VI, and the world's biggest shipping nations, Liberia, Mexico, Panama, and Malta appear unlikely to do so.

Bluewater believes it is incumbent upon the US EPA to reduce ship emissions to the maximum extent afforded by Section 213 of the Clean Air Act. Given recent technological advances, a 90 to 95 percent decrease in NOx emissions appears well within reach; sulfur limits should be established to meet similar levels

[1] Conversation with Director of EPA Office of Mobile Sources, Margo Oge, and staff, 1999.

[2] Charlotte Pera, Acurex report for South Coast Air District, 1996. Ship sulfur was 25 tons out of inventory of 79 tons/day. CARB's total sulfur inventory for California is 260 tons. Totals gathered from Bay Area, South Coast, and San Diego Air Districts yields 46 tons/day for vessels, or 18 percent of total sulfur inventory. Including other areas and offshore impacts may double these values.

[3] Environmental Science and Technology, Feb. 1, 2000, p. 65.

already achieved by Sweden, which has a cap of 1.5 percent by weight. Establishing such standards will significantly reduce vessel emissions worldwide.

EPA's Mandate to Require Best Available Technology

Considering that low-cost technology and cleaner fuels exist today that could substantially reduce both sulfur and NOx emissions, Bluewater believes that EPA has violated its mandate under Section 213 of the Clean Air Act, which requires it to "establish emissions standards that achieve the greatest degree of emission reduction achievable through the application of technology which the Administrator determines will be available...giving appropriate consideration to the cost of applying such technology."

In addition, EPA erred by delegating its authority to regulate large vessel emissions to the IMO, an international body subject to the whims of flag-of-convenience nations, many of which have shown utter disregard for appropriate environmental protection efforts.

Bluewater Network provided extensive official comments regarding the dangers posed by large vessel emissions during EPA's public comment period in early 1999. Despite this, EPA has failed to act. Consequently, Earthjustice Legal Defense Fund, representing Bluewater Network, has filed suit against the US EPA to protect the US from damaging environmental consequences. Hopefully, this action will compel the US EPA to enact much needed regulations to control vessel emissions, thereby better protecting air quality and public health.

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[5] Corbett and Fishbeck, Op. Cit.

[6] Environmental Science and Technology, Feb. 1, 2000, p. 65.

[7] EPA, Prevention of Air Pollution From Ships, Marine Environment Committee, December, 1999.

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