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Feasibility of Providing
Shore-Based Electrical Power to Ships while Docked

Environmental Perspective

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Summary

The environmental community strongly supports the California Air Resources Board's (ARB) initiative to conduct a comprehensive analysis of the feasibility of installing shoreside power for marine vessels at ports in California. All ocean-going vessels including cruise ships as well as harborcraft such as passenger ferries and tugboats should be included in the analysis as possible candidates for shoreside power. A look at existing shoreside power operations including those for military vessels should also be reviewed.

We recommend that ARB act on its findings by requiring that a certain percentage of all ship calls at outfitted terminals be connected to shoreside power and that for future expansions and during lease renewals that terminals be required to be equipped with shoreside hook-ups for marine vessels.

Our recommendation is that ARB propose and adopt a regulation as soon as possible requiring that at least 80 percent of ship calls utilize shoreside power at retrofitted and new terminals, providing a reasonable phase-in of five to 10 years. A goal should also be set for the number of terminals to be retrofitted, such as 50 percent in five years and 100 percent in 10 years.

Any cost/benefit analysis should include consideration of the health and environmental costs of exposure to diesel exhaust produced by marine vessels in California. Funding sources for shoreside power projects should also be considered, such as the feasibility of:

- private-public partnerships between ports, utilities, shipping lines, government agencies;
- incentive programs such as graduated harbor fees tied to emissions reductions
- container fees to help pay for projects, and
- a statewide fee-based funding program for shoreside power to ensure a level-playing field for all ports.

Collaboration with other West Coast ports on these initiatives would also be advantageous.

Please refer to the August 2004 report, *Harboring Pollution: Strategies to Clean Up U.S. Ports* , by Natural Resources Defense Council and Coalition for Clean Air for a more detailed discussion about reducing air pollution at ports from ships and other sources, including trucks, trains and cargo handling equipment. Also refer to Bluewater Network's report "Stacked Deck" about shipping emissions.

Window of Opportunity

As ports expand and new ships are built to accommodate increased global trade, an unprecedented window of opportunity exists to exert substantial influence on the international fleet and Western ports to plan for implementation of shoreside power. By focusing on port operations at this juncture, the state can guide the course of the marine industry toward improved air quality practices. If the state does not act soon, it may be decades before significant changes can be achieved in the way that ships and ports operate. This is true because turnover among vessel fleets is slow and infrastructure investments by ports typically occur after long intervals due to lengthy funding, approval and construction timelines. Expansion of ports and marine vessel fleets is occurring now.

Not only is the timing auspicious, but the ports and shipping industry appear to be more receptive than ever to addressing air emissions issues, as evidenced at several recent air quality meetings on port and shipping emissions. Several shoreside power projects are already established or underway along the West Coast and around the world, demonstrating the feasibility of the technology.

Marine Vessel Air Pollution

The U.S. EPA predicts that air pollution from ocean-going vessels alone will increase 150 percent by 2030 in U.S. waters.[1] This will occur even after an international treaty on air pollution from ships (Annex VI of MARPOL) enters into force. Cruise ship traffic and domestic ferry fleets are also growing, accelerating the overall impact of shipping and port operations on global warming and air pollution.

Marine diesel engines contribute significantly to air pollution in the U.S. These emissions are expected to grow from 7 percent in 1996 to 16 percent of the national mobile source NOx inventory by 2030.[2] Particulate matter emissions from marine engines are expected to grow from 6 percent to 10 percent of the mobile source PM inventory by 2030. Sulfur dioxide emissions from marine engines are expected to grow from 29 percent to 37 percent of the national mobile source SO2 by 2030.

Commercial diesel ships are expected to account for one-fifth of all diesel particulate generated by 2020, making them the second largest source of this toxic soot.[3] In ports, marine vessels contribute an average of 32 percent of NOx emissions and 43 percent of PM compared to other sources. [4]

In California, the commercial marine sector generates 9 tons per day of PM and 100 tons per day of NOx.[5] By 2010 emissions from these vessels will contribute 15 percent of the state's diesel PM, 5 percent of NOx and 28 percent SOx.[6] Emissions from ocean-going vessels are also considerable on a port-specific basis. For example, EPA made the following estimates[7]:

Los Angeles/Long Beach

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[1] U. S. Environmental Protection Agency, "Final Regulatory Support Document: Control of Emissions from New Marine Compression Ignition Engines at or Above 30 Liters per Cylinder," January 2003.
[2] Revelt, Jean Marie, U.S. Environmental Protection Agency, Presentation for Advancement of Clean Marine Diesel Engines Meeting, Washington D.C., January 29, 2004.
[3] "Harboring Pollution: Strategies to Clean Up U.S. Ports," National Resources Defense Council and Coalition for Clean Air, August 2004, p. 7.
[4] Ibid. p. 8
[5] California Air Resources Board, California Maritime Working Group presentation, Year 2000 Statewide Diesel PM and NOx Emissions from Ocean-going Ships and Harbor Craft.

[6] California Air Resources Board.
[7] Revelt, Jean Marie.

- NOx emissions from Category 3 ships will grow from 2 to 8. 6 percent of the mobile inventory by 2020.
- PM emissions from Category 3 ships will grow from 3.9 to 10.8 percent of the mobile inventory by 2020.

A single cruise ship on a 10-hour port call can generate emissions equal to more than 12,400 cars.[8] On entering San Francisco Bay from 12 miles outside the Golden Gate and hoteling for a half-day, one cruise ship produces daily NOx and PM emissions equal to the notoriously dirty Hunters Point Power Plant. The US EPA estimated that cruise ships calling on California ports produce 30 percent of the air emissions produced by the cruise industry in the U. S.

In any case, shipping emissions are significant and growing and need immediate remedies to protect public health and the environment.

Public Health and the Environment

Exposure to diesel exhaust is extremely harmful to human health and the environment, as detailed in the report *Harboring Pollution* and in numerous other reports and studies. As ARB and the US EPA have documented, diesel exhaust contributes to premature death of thousands of people each year.

Other hHealth effects include:

- Airway irritation and allergies
- Increased cancer risk
- Respiratory illness such as asthma
- Increased hospitalizations
- Decreased lung function

For a more in-depth discussion, please refer to Chapter 1 of Harboring Pollution, "Health and Environmental Effects of Port Pollution."

Air Quality Benefits

In California, electrical power generation is far cleaner than diesel combustion in marine diesel engines. Based on this fact, the primary benefit of shoreside power is that it can reduce shipping emissions from hoteling at the dock by nearly 100 percent as follows:

a. NOx emissions by 99 percent[9]
b. PM emissions by 83-97 percent[10]
c. Greenhouse gas emissions by two-thirds[11]
d. SOx emissions by nearly 100 percent[12]

According to the Port of Los Angeles, dockside power can reduce NOx and PM emission by over one ton per day, which is roughly equivalent to 69,000 diesel truck miles per call.[13]

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[8] Monterey Air Pollution Control District estimate.

[9] Environ for the Port of Long Beach, "Cold Ironing Effectiveness Study, Volume 1, Report," March 2004.

[10] Ibid.

[11] West Coast Governors' Global Warming Initiative, Emissions Reductions at Marine Ports, Working Group 2 Report.

[12] Power generation in California does not utilize bunker or other high-sulfur fuels

[13] Port of Los Angeles, Alternative Marine Power, 21 June 2004,

A new Port of Long Beach study found that installing shoreside power at new or existing docks is cost-effective for ships that require 1.5-1.8 million kilowatts of power per year while operating at the dock.[14] Of the 12 vessels studied, five qualified for the cost-effectiveness threshold of $15,000 per ton of emissions reduced. Vessels that qualified under these criteria included cruise, container, reefer and tanker vessels.

However, the Coalition for Clean Air and the Natural Resources Defense Council (based on joint comment letters sent to AQMD and Port of Long Beach in July) found that the Port of Long Beach actually underestimates the benefits of the PM emissions reductions achieved and have since asked the South Coast Air Quality Management District to review the Port's calculations. From its communications with SCAQMD staff, they share the opinion that cold ironing is more cost effective than the port study concludes. By taking into account PM's potency, we believe using a higher threshold of cost effectiveness, that 9 of the 12 ships analyzed in the cold ironing study (instead of 5 out of 12) would have been found to be cost-effecitve for cold ironing. ARB must take into account this fact in the shoreside power analysis.

Other examples of shoreside power installations in place or planned include:

- Port of Long Beach: BP has committed to two oil tankers hooking up by 2006
- Port of Los Angeles: working to outfit the NYK terminal with shoreside power, also, the China Shipping terminal which plugged in its first ship on June 21, 2004 and agreed to retrofit at least another 5 ships before January 2005
- Swedish port of Goteborg installed shoreside power for ferries and cargo vessels, achieving annual emissions reductions of 80 tons of NOx, 60 tons of SOx and 2 tons of PM.

Cruise ships

The cruise industry has proven that shoreside power is feasible in Juneau, AK, and recently announced that it would install dockside electricity for the Princess fleet at Pier 30 in Seattle. The landside cost for this project is estimated at $1.8 million, significantly less than the $2.5 million invested at the more challenging site in Juneau. Because the Princess fleet is already equipped to connect to shoreside power, no additional costs for ship retrofits are required.

The Port of San Francisco is conducting a study to determine the feasibility of installing shoreside power to serve cruise ships at a new terminal that will be built beginning in about 2008. The cruise industry is also considering shoreside power in Long Beach.

Here is a summary of cruise ship projects currently operating or planned:

- Juneau, AK, Princess cruise ships, $2.5 million dockside infrastructure to withstand extreme weather conditions
- Seattle, WA, Princess cruise ships, $1.8 million dockside project announced for 2005 cruise season
- San Francisco, CA, Port of San Francisco conducting $50,000 shoreside power feasibility study for Piers 30—32
- Port of Los Angeles investigating shoreside power for cruise ships (Cruise Industry News, Fall

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http://www.portoflosangeles.org/Environmental/AMP.htm (29 June 2004).
[14] Environ, ibid.

2004)
- Port of San Diego will consider shoreside power for cruise ships if/when terminal is expanded (Cruise Industry News, Fall 2004)

Cost of shoreside electricity

The cost of switching from burning bunker fuels in port to buying electricity from the grid is not likely to be significant compared to the overall costs of fuel on a voyage. The price of electricity negotiated and the power requirements will determine these costs.

In an analysis conducted last year by Bluewater Network to assess such costs for cruise ships, we found that using shoreside electrical power in port is expected to cost about the same as burning bunker fuel, and will cost far less than burning ultra-low sulfur diesel. A cruise ship spends $425-$450 per hour on bunker fuel when hotelling in port, about 2.5 tons per hour based on a 5MW per hour requirement for the average cruise ship.[15] The equivalent cost of burning CARB diesel would be $787 per hour.

Based on the 5-megawatt shoreside power requirement of an average cruise ship, the retail cost of shoreside power would be $450-$550 per hour.[16] That is based on a retail price of $90 to $110 per megawatt hour. The net cost increase would be minimal, if any, because it costs a cruise ship about $60 to $90 per megawatt hour to produce on-board electricity when fuel, maintenance and labor is considered. The air emissions and potential greenhouse gas benefits could be tremendous.

Infrastructure and Retrofitting

Some, or possibly all, of the costs of electric utility reinforcements and extensions required to serve shoreside power loads may be offset under standard utility line extension and service rules.[17] The cost may also be subsidized by private and public energy conservation and clean air programs such as those under Carl Moyer and the Department of Energy.

For new construction, shoreside power infrastructure can easily be built into the design, such as with the proposed new San Francisco Cruise Ship Terminal, a $246 million project being built on public trust lands. The additional cost to provide cruise ships with shoreside power would be small compared to the overall cost of the project.

In the case of a retrofit, we do not see evidence that a significant terminal shut-down would be required to retrofit existing wharves. For example, the Port of Los Angeles has successfully retrofitted at least two facilities (ie Terminal Island/Pier 400 and the China Shipping Terminal) and is planning on wiring a third (ie, the former Matson Terminal, Berths 206-209).

Modular Shoreside Hook-ups

The potential for modular shoreside power hook-ups could make the transition to shoreside power much

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[15] Wartsila Marine News, No. 2, 2001

[16] Cost estimates are based on PG&E's E-20 Industrial/General Rate Schedule see: http://www.pge.com/tariffs/IndustrialCurrent.xls Average Total Rate.

[17] PG&E Electric Rules 15 & 16 as approved by the California Public Utilities Commission. See the following links for the complete text of applicable rules.(http://www.pge.com/customer_services/business/tariffs/doc/ER15.doc and http://www.pge.com/customer_services/business/tariffs/doc/ER16.doc)

faster and more cost-effective if political, regulatory and financial incentives advance its development. While retrofits of ships and port facilities are possible, they are often more difficult and costly than when included at the time of construction.

A marine engineer who worked on the Juneau, AK, shoreside power facility for Princess Cruises has floated the idea of developing modular shoreside power hook-ups that would make it easier for vessels to use this power source. Instead of requiring a vessel to be retrofitted to accommodate power lines and new hook-ups, a modular unit would be stowed at the dock and then hoisted on board when the ship arrives.

This could reduce the cost per ship to as little as $150,000, according to Bob Maddison of Project Marine in Westlake, CA. However, no studies or demonstration projects have been conducted. Exploring this alternative could be a worthwhile use of state funding initiatives.

Another option for shoreside power generation is the installation of one or two fuel cell units at berths where smaller ships are hoteling and where natural gas is available as a fuel source.

A second fuel cell option could be a power barge equipped with fuel cells that can maneuver within a port to supply power at multiple locations. The fuel cell application might be particularly well-suited for cargo ships in berth where diesel generators producing auxiliary loads are in the 1-to-2 megawatt ranges, as opposed to cruise ships, for which the load can be an order of magnitude higher.[18]

However, fuel cell technology is not yet commercially developed, so should be considered in the long-term context.

Safety and interruptible power

The marine industry has routinely raised safety and energy-availability objections to shoreside power. While these are valid concerns, safety has never been an issue in Juneau, according to Princess Cruise executives and marine engineers. At a public forum, they have stated that if there were a need to immediately depart from a dock, a ship could quickly fire up its engines and even pull away with the electrical hook-ups still attached.[19]

In addition, the cruise line and its engineers have stated on numerous occasions that the power supply in Juneau is interruptible and should be so elsewhere. That means if there is a municipal power need or electricity shortage, the ship need only be given notice and it can easily switch back to diesel power.

As for power requirements, using LA DWP as an example, the utility currently has a 7200 MW capacity. The current peak demand is up to 5,600 MW. For the vast majority of time, significant excess capacity is available. But on the rare occasions when an electrical shortage or blackout is imminent, ships would simply run on their diesel engines as they do now.

Conclusion

Shoreside power for marine vessels is a feasible and potentially cost-effective way to significantly reduce marine emissions from vessels while docked in port. ARB should move quickly to analyze the feasibility of this technology, then act by proposing new regulations to require shoreside power in CA ports. These

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[18] Harboring Pollution, p. 22
[19] San Francisco Cruise Terminal Environmental Advisory Committee, Cruise Operations and Environmental Issues Workshop, January 2004.

regulations should set a threshold for the number of port calls that should utilize dockside electricity and establish a timeframe for phasing in shoreside power in California ports. Ultimately, the threshold for the number of port calls hooking up to shoreside power should approach as close to 100 percent as possible, but certainly at least 80 percent at existing or new terminals.

We believe that the facts show that shoreside power is far more effective than other options for reducing air emissions from marine vessels, such as cleaner fuels, engine controls and operational changes such as slowing speeds. However, all measures should be considered and undertaken in the effort to clean up shipping emissions.