



February 28, 2006

Catherine Witherspoon  
Executive Officer  
California Air Resources Board  
P. O. Box 2815  
Sacramento, CA 95812

RE: Comments on the *Air Resources Board Draft: Emission Reduction Plan for Ports and International Goods Movement in California* (Release Date: December 1, 2005)

Dear Ms. Witherspoon,

Bluewater Network – a division of Friends of the Earth – appreciates the opportunity to comment on the Draft Emission Reduction Plan for Ports and International Goods Movement in California. Overall, we believe this is a strong framework for taking action to reduce emissions from ports and goods movement in California. Once again, the California Air Resources Board is leading the nation, and probably the world, in tackling significant and growing air pollution sources.

Bluewater Network works to stop environmental damage from vehicles and vessels, and to protect human health and the planet by reducing dependence on fossil fuels. Bluewater Network is a division of Friends of the Earth – the U. S. voice of the world's largest network of environmental groups with one million supporters in 100 countries across five continents.

In general, we support the goals of the plan to reduce emissions to 2001 levels by 2010, continuing reductions until attainment of applicable standards is achieved, reducing diesel-related health risks 85 percent by 2020 and eliminating localized risk in affected communities.

However, we are concerned that this timeline may be too slow for affected communities who are already suffering high rates of asthma, cancer and premature death due to goods movement. Please consider accelerating these timelines as much as possible and making a priority of working on the ground with community groups to immediately reduce health and other impacts.

At last night's community hearing in Oakland on February 2<sup>nd</sup> we heard from a number of people who live near ports, railroad tracks and freeways who were experiencing first-hand the negative effects of goods movement in the Bay Area. One woman told of a three-engine train idling behind her neighborhood for five days. She asked for enforcement of idling laws and a complaint line that she could call after-hours to get immediate response. Another spoke of getting cancer probably due to lifelong exposure to diesel exhaust from rail, trucks and other goods movement sources. She suggested that the state should include in the Goods Movement Plan a fund to pay for medical and hospital costs for disadvantaged people who are directly suffering from the pollution from ports. The state should seriously consider these requests.

As Bluewater Network's Clean Vessels Campaign is focused on preventing and reducing air and water pollution from ships and harborcraft, our comments from this point on will be confined to the marine sector of the ports emission reduction plan.

Overall, we urge the Air Resources Board to emphasize regulation over voluntary or market-based approaches to reduce shipping and harborcraft emissions. We also urge the ARB to be as aggressive as possible with timelines

on reducing ship and harborcraft emissions, as they comprise one of the largest, if not the largest, portion of air emissions coming from ports. We will support in every way we can ARB's efforts to move the shipping industry toward cleaner fuels, engines and technologies in an accelerated manner.

Last night, Cynthia Marvin mentioned that the ARB would be conducting emissions estimates and public health risk assessments on a regional level to expand the port emissions reduction plan to more ports. We very much support this approach as much of the focus until now has been on Southern California – and rightfully so considering the dire air quality needs of that area.

However, other California ports are expanding rapidly without adequate air quality mitigations, if any, and avoiding environmental scrutiny due to lack of regulatory and political pressure.

As part of the port emissions reduction plan and the goods movement plan, we urge the ARB to consider adding requirements that every major commercial port in California conduct an emissions inventory, implement an air quality and emissions reduction plan modeled on the ARB timeline and goals, and establish a Community Advisory Community that has oversight over port air quality programs and related activities.

The Port of Oakland provides a good example of why such additional state requirements are urgently needed. Ships currently produce 65 percent of PM emissions and 48 percent of NOx emissions at the Port of Oakland, according to port documents. Yet the port has no plan, and has never had a plan, to address shipping emissions, claiming it has no authority. While it is the fourth largest container port in the country, it lags far behind other large ports such as Los Angeles and Long Beach in addressing shipping emissions. These and other ports have shown that various approaches can be accomplished at the port level to require or incentivize international ships to use cleaner fuels, install shoreside power and reduce shipping speeds to reduce emissions.

Unlike the Ports of Los Angeles and Long Beach, or even San Francisco, the Port of Oakland has very little public participation or oversight, lacking a Community Advisory Community. The port was sued by neighborhood groups and settled in 1999, committing to spend \$9 million on air quality mitigation. To date, only \$3 million has been spent and most of it was to pay port staff and consultants. Last year, the port gave back a \$1.5 million Carl Moyer grant because it was unable to implement a program to reduce truck emissions. These failures demonstrate the lack of accountability that the port has to the community or to any political body or regulatory agency when it comes to initiating or following through on air quality programs.

We would also urge the state and the ARB to require that all port expansion activities receive environmental review in a public process. Currently, state environmental law is only triggered when a new terminal or other project is proposed or built. When shipping or cruise line traffic increases at existing facilities, a port is not required to evaluate or mitigate the added air and water pollution. This is a huge concern because it allows degradation of air and water quality without public knowledge. Significant increases in shipping or cruise traffic to a port warrants a full environmental review in a public process.

One good example is the Port of Oakland's recent takeover of the Port of Sacramento with the intention of moving cargo and containers through the Delta on barges instead of by truck or rail. Essentially, this would turn the Delta's main channels into a marine highway. This should not be allowed to go forward without a full environmental review of the air, water quality, and public health, safety and security impacts in a public process.

### **Following are more specific comments on measures proposed for ships**

**Shoreside Power:** We propose that the timeline for shoreside power for ships be accelerated as much as possible, depending on the feasibility study that the ARB is planning to release soon. Based on existing installations and power capacity in California, we believe that it is reasonable to set a threshold of 10 to 80 percent of ocean-going ships hooking up to shoreside power by 2015.

The Port of San Francisco has determined that shoreside power for cruise ships at a new terminal is technically feasible and a funding program is underway. The Port of San Diego recently announced its plans to study and implement shoreside power for cruise ships as it expands. And, of course, you are well aware of the Port of Los

Angeles "AMP" program and its intention to electrify as many ships and terminals as possible. With these developments, it seems that other ports could follow suit to reduce dockside ship emissions as soon as possible.

**Cleaner Fuels for Ships:** We commend ARB for its recent rule to require marine distillate fuels in ship auxiliary engines within 24 nautical miles of the coast. We support ARB's intention to require cleaner fuels in main engines. We urge the ARB to consider requiring marine distillate fuels in main engines within the same distance of the coast as soon as possible to reduce ship emissions quickly and cost effectively. Some ships may need to modify its engines and tankage to safely burn such fuels, but we believe that going straight to distillate fuels instead of low-sulphur bunker fuels is not only better for air quality, may be more feasible.

Currently, marine distillate fuel is in good supply and oil refineries in California and elsewhere produce this type of fuel routinely. Low-sulphur bunker fuel of 1.5 percent or less is far less common and is not likely to be in ample supply in the immediate future. We urge the ARB to research the availability and feasibility of mandating marine distillate fuels instead of low-sulphur marine bunker fuel for large ships along the California coast before finalizing any recommendations in this plan or in the SIP.

Also please consider that although Sulphur Emissions Control Areas established under MARPOL Annex VI are capped at 1.5 percent sulphur, treaty does not set the sulphur limit at that level. It could be less. It may even be possible that if and when the U. S. ratifies Annex VI and joins with Canada and perhaps Mexico to petition the IMO to establish a North American SECA, that the sulphur limit may be set lower than 1.5 percent in order to achieve the best emissions reductions. Please consider these possibilities before finalizing your marine fuel recommendations.

**Cleaner Engines and MARPOL Annex VI:** We appreciate the fact that ARB recognizes the limitations of international regulations and that the current marine engine emissions standards provide little, if any, air emissions benefits. However, we did note that the ARB mentions on Page III-9 that "Engine standards by the IMO could become an important component." This concerns us since it is unlikely that the IMO will set any stronger standards for ship engines in the near future.

As you probably know, negotiations on strengthening Annex VI begin this spring at IMO subcommittee meetings in London. The IMO moves very slowly and we expect that the shipping industry and the nations who represent maritime interests will be resisting any meaningful change. Bluewater Network plans to be there to help progressive nations lobby for stronger standards, so we hope that ultimately we will see results, but probably not for five years or more at the soonest.

In the meantime, we urge ARB to pressure the US EPA to take action regulating large marine engines from foreign-flagged ship when it takes up the issue again this year or next. And to be aggressive with alternative approaches to getting ships to install cleaner engines.

**Clean Ships in California Service:** ARB's plan to promote the use of the cleanest ships in California service makes sense. We urge you to consider revenue-neutral port fee incentive programs that would provide financial benefits to ships that invest in the cleanest technology. Such a program has been successful in Scandinavian countries and there is really no reason why it can't work here. Awards programs may also be worth considering.

The Port of San Francisco recently instituted an "environmental award" program for cruise ships that meet a number of environmental standards that go beyond state and federal law. It rewards ships for achieving emissions standards below IMO and for using cleaner fuels. So far several ships have applied and earned awards. Perhaps California could consider a similar statewide program, provided it rewards true emissions reductions and does not simply give ships recognition for what they are already doing to meet laws or regulations.

California could also establish a "green shipping standard" with input and oversight from environmental groups to push ships towards overall environmental excellence. Of course, any awards or green standard has the risk of becoming "greenwash" if industry has too much influence over the specifications and enforcement.

**Emissions trading:** We share the concern of environmental and community groups who wrote in a Jan. 10, 2006, comment letter on the goods movement plan that market-based, industry created emissions trading plans

"have serious environmental justice implications." In addition, we share the concern that the program forwarded by shipping interests is "not just confined to goods movement sources of pollution, but stationary sources as well."

We would also like to quote further from that letter: "Most importantly, the goods movement industry has long remained unregulated, has not chosen voluntarily to reduce its impacts on nearby communities, and has externalized health and environmental costs, placing these costs instead on local communities."

With these concerns in mind, we would urge the ARB to use extreme caution in considering emissions trading for the ports sector and to only consider it at all if the plan achieves emissions reductions beyond what is achievable through regulation, berth and lease agreements, port incentive programs or any other feasible option – and does not increase the emissions burden on any community. Any emissions trading program should be fully reviewed and supported by impacted communities and the environmental community in a public process before ARB considers adding it to its port emissions reduction plan or SIP.

**Harborcraft** Regarding the section on harborcraft, I will attach comments that we submitted last year along with several other groups relating to the proposed regulation in its previous form. We urge you to move quickly on the new harborcraft rule this year and to consider use of biodiesel by the fishing fleet to achieve compliance in older engines that are not easily repowered or replaced.

Thank you so much for accepting these comments and considering them in your port emissions reduction plan. We look forward to future drafts and to commenting in more detail as the proposal develops.

Sincerely yours,

A handwritten signature in black ink that reads "Teri Shore". The signature is written in a cursive, flowing style.

Teri Shore  
Clean Vessels Campaign Director

# **Public Comments on California Air Resources Board Regulatory Concepts for Commercial Harbor Craft**

By:

Diane Bailey, Natural Resources Defense Council  
Teri Shore, Bluewater Network  
Tom Plenys, Coalition for Clean Air  
Don Anair, Union of Concerned Scientists

Our organizations strongly support the California Air Resources Board's (ARB) initiative to develop new air quality regulations for harborcraft that operate in state coastal waters. We agree that the regulations should apply to all in-use commercial harbor craft having engine model years 2007 and older that do not meet EPA Tier II standards for marine engines, 2004-2007.

In addition, we recommend that the ARB consider standards for new marine engines in the event that the US EPA's new regulatory process for commercial marine vessels does not produce satisfactory results. The state would then be in a position to quickly implement state regulations.

Below are specific comments and recommendations on the draft regulatory concepts followed by a review of current literature pertaining to cleaner fuels and technologies in the commercial marine sector.

## **Performance Requirements**

We urge ARB to develop regulatory language requiring harbor craft to meet EPA Tier II standards with an implementation schedule based on engine model year and the type of vessel operation (similar to option 1 in the Draft Regulatory Concepts). In addition, ARB should develop an implementation schedule for moving beyond Tier II by requiring further reductions of nitrogen oxides and particulate matter from specific types of harbor craft.

## **Meeting Tier II**

We believe requiring harbor craft engines to meet Tier II standards will be more protective of public health and more effective at reducing harmful particulate matter than allowing the use of level 1 or level 2 retrofit technology. Currently, there are no verified emission control technologies for harbor craft and there is no guarantee that level 1, 2 or 3 devices will be available for a wide range of vessel types and model years. Even if a level 1 retrofit device such as a diesel oxidation catalyst were verified, it still would not achieve nearly the same amount of PM reductions as would be achieved by a rebuild or repower to US EPA Tier II standards. The relatively small number of engines affected by

this proposed regulation may also present a challenge for getting companies to verify retrofit technology with the ARB.

## **Beyond Tier II**

We urge ARB to incorporate measures that go beyond the Tier II standards for harbor craft with newer engines and those that present the greatest health risk to individuals. These vessels may include passenger ferries, excursion vessels, charter fishing vessels, or other vessels which operate almost exclusively near the shore and carry groups of people. The more stringent measures could also apply to engines year 2000 and newer and those that have been repowered within the last five years. Suggested options are listed below.

- **Tier III Engine Standards** EPA is expected to develop Tier III standards for marine engines within the next two years. ARB could require engines to meet EPA Tier III standards, once they are adopted. If EPA does not set Tier III standards, or they are inadequate, then ARB should adopt its own set of emissions standards for new marine engines operating in California, and require post-2000 engines to meet the standard within a reasonable timeframe.
- **Retrofit Technologies** Fuels and technologies are commercially available to reduce emissions up to 15 percent below EPA Tier II standards. A number of technologies and fuels could be employed to go beyond EPA Tier II including use of non-diesel fuels, installation of particulate matter traps and/or oxidation catalysts, water injection, selective catalytic reduction, conversion to battery-electric and other methods (see literature review). In particular, use of emulsified fuels combined with exhaust gas recirculation and an oxidation catalyst was recommended by marine engineers as a viable and immediate option for quickly reducing ferry emissions.<sup>1</sup>

To ensure the availability of retrofit technology, ARB should require large fleets to conduct at least one control technology demonstration project beginning in 2006 and implement that control technology throughout the fleet upon successful completion of a demonstration. Upon an unsuccessful demonstration of technology, that fleet should be required to test a new type of technology and apply it to their fleet, or install technology demonstrated successfully on another fleet. The fleets should be restricted to a limit of two consecutive demonstration projects before applying a proven technology to their fleet.

- **Commuter Ferries** Commuter ferries represent a unique type of harbor craft vessel in that a large number of individuals may be exposed daily to the vessels' harmful diesel emissions. ARB should identify vessels that operate frequently and expose large numbers of people to diesel exhaust, such as commuter ferries, and require them to meet more stringent standards, sooner. The fact that the San Francisco Bay Area Water Transit Authority has set an emissions standard of 15 percent below EPA Tier II for its new fleet demonstrates that greater emissions standards can be achieved. In addition, the new MV Solano built by the city of

Vallejo is operating successfully with Selective Catalytic Reduction on board, achieving 50 to 60 percent nitrogen oxide emissions reductions beyond EPA standards. Other technologies are now available to achieve similar reductions on the existing fleet as retrofits.

- **Non-Diesel Alternative Standard for Ferries** The ARB should also consider including a non-diesel alternative standard in the regulations that would differentiate between vessel classes. Specifically, we urge you to consider a non-diesel alternative standard for passenger commuter ferries that would require or incentivize conversion to natural gas and/or pure biodiesel (B100), particularly for existing engines that have not been repowered and lag far behind EPA Tier 2 standards. Charter ferries that clock significant operation hours should also be required to switch to non-diesel fuels.

## **Fishing Fleets**

We believe that the commercial fishing fleet should be given additional consideration. Most of the fishing fleet is operated by individuals who may have more difficulty meeting the requirements of the regulation than others.

We recommend that the fishing fleet be given the option of utilizing pure biodiesel (B100) to meet the regulations. While a marine biodiesel fueling station is not currently available, we believe that supplies are adequate and growing in California. In addition, the fuel is expected to become more affordable due to a new federal excise tax incentive for fuel distributors that could reduce the per-gallon price of B100 by \$1.00 per gallon.<sup>2</sup>

Biodiesel provides significant reductions in particulate matter, air toxics, sulfur oxides and greenhouse gases. Biodiesel is also less toxic to aquatic life in the event of a spill, making it a good alternative to petroleum diesel fuel in marine environments. Nitrogen oxide emissions can be reduced with use of additives and controls. See literature review for details.

## **Exemptions**

### **Vessels that use non-diesel fuel**

We support an exemption for vessels that use non-diesel alternatives. We suggest that staff develop a detailed list of fuels that would trigger the exemption. For example, pure biodiesel (B100) should be allowed as a means to meet the regulations, particularly for older marine engines and fishing vessels (as noted above), but with the requirement that any increase in NOx be mitigated or avoided. (See attached technology review for more detail.)

Exemptions should also be considered for vessels that operate primarily on wind, solar, batteries, diesel-electric, gas turbines, fuel cells or other alternative power systems that provide significant air quality benefits. For example, a commercial vessel that runs on biodiesel using a diesel-electric battery power plant for main propulsion and solar power

for auxiliary engines or on-board electricity should qualify for an exemption. Other vessels that might qualify would be commercial charter vessels that operate mainly with sails, such as the Adventure Cat.

**Low-Use engines**

Additionally, we urge staff to pay close attention to exemption language for low use engines as this rule is developed. While we agree that an exemption may be appropriate for engines operating less than 100 hours per year, staff must ensure that any vessels using this exemption adhere to the usage limit. ARB must specify that any exempt harbor craft also record hours of operation for both auxiliary and main engines.

**Suggested Compliance schedule**

Below is a suggested compliance schedule for meeting the Tier II emission standards. For reasons outlined above, we recommend expediting the compliance schedule for passenger ferries and passenger fishing vessels. Conversely, we recommend allowing additional time for commercial fishing vessels and research vessels. For all other harborcraft we have slightly expedited the compliance schedule with an emphasis on ensuring the oldest model years are addressed as soon as possible.

**Compliance Dates for Passenger Ferries & Passenger Fishing Vessels**

Annual Hours of Operation	Pre-1900 MY	1900-1909 MY	1990-1999 MY	2000-2003 MY
< 500*	2009	2009	2010	2011
500 – 1500	200□	200□	2009	2010
> 1500	2007	2007	200□	2009

\* Similar proposal to ARB draft regulatory concepts

**Compliance Dates for Commercial Fishing Vessels & Research Vessels**

Annual Hours of Operation	Pre-1900 MY	1900-1909 MY	1990-1999 MY	2000-2003 MY
< 500*	2014	2014	2014	2014
500 – 1500	2011	2011	2012	2013
> 1500	2010	2010	2011	2012

\* Similar proposal to ARB draft regulatory concepts

**Compliance Dates for all other Harborcraft**

Annual Hours of Operation	Pre-1900 MY	1900-1909 MY	1990-1999 MY	2000-2003 MY
< 500*	2009	2011	2011	2013
500 – 1500	200□	2009	2009	2011
> 1500	2007	200□	200□	2010

\* Similar proposal to ARB draft regulatory concepts

## Definitions

We recommend adding the definition for ‘Annual Hours of Operation’ to the list of key definitions. A clearly defined method of calculating hours of operation should be included in the regulation to ensure proper and consistent record keeping across all vessel types and uses. Additionally, if the definition of ‘Oceangoing Ships’ is being included solely to help define ‘Harbor Craft’ we suggest it be moved within the ‘Harbor Craft’ definition.

## REVIEW OF MARINE VESSELS USING ALTERNATIVE FUELS, CLEANER FUELS, AND TECHNOLOGIES TO REDUCE AIR EMISSIONS

### Natural Gas and Dual-Fueled Engines

Innovations in engine technology have allowed natural gas to be used successfully in marine settings.<sup>3</sup> Compressed natural gas (CNG) is often used in dual fuel systems, so that different marine gas engines can be used together to optimize energy production to conform to power, efficiency, emissions, complexity, time and cost requirements. Two similar dual fuel systems, Combined Diesel and Gas (CODAG) and Combined Diesel Electric and Gas (CODLAG) allow for diesel to be used on open ocean stretches and less polluting gasoline to be used in coastal or environmentally sensitive areas. It should be noted, however that fuel consumption can increase when a vessel is operated on gas.<sup>4</sup>

A number of ferry companies have purchased new vessels using combined diesel and gas systems or have converted older ferries to the newer system.<sup>5</sup> In Greece, a 1,000 passenger CODAG powered ferry has been running since the summer of 2001.<sup>6</sup> A 1,116 passenger ferry based in Nice, France has been operating with a CODAG engine system since 2000.<sup>7</sup> For the past 12 years, two large passenger ferries in Italy have operated reliably using CODAG engines. Two additional ferries have been running with the same setup since 1999.<sup>8</sup> Finally, in Vancouver, Canada, two car and passenger ferries have been running CNG in dual fuel engines since the late 1980's. These ferries were reported to have recouped all investment costs within the first 5 years of operating.<sup>9</sup>

Large shipping vessels can particularly benefit from CNG because, though requiring more space than LNG, CNG systems do not require the advanced retrofits that LNG requires. Cruise lines and other large ships with highly varying power demands have shown increasing demand for combined diesel and gas engines in recent years. Cunard Cruise Lines, which operates the Queen Mary II, and Princess Cruises use CODLAG technology in their ships.<sup>10</sup> In Australia, a bulk carrier has been using CNG in a dual fuel system since 1982.<sup>11</sup> In Norway, two cargo ships are operating on natural gas and have a ten-year charter with a major energy company.<sup>12</sup>

Natural gas is also used as the sole propulsion fuel source in a wide range of marine applications, including many large passenger ferries.<sup>13</sup> HR Transit in Norfolk, Virginia has operated a large CNG powered passenger ferry safely and efficiently, since it was

converted in 1995.<sup>14</sup> In Dhaka, Bangladesh, a ferry has been running on compressed natural gas since 1996.<sup>15</sup> Seven small canal boats are currently operating in Amsterdam on CNG and two of them have been running since the early 1990's.<sup>16</sup> In Moscow and St. Petersburg, Russia, two tourist boats have been running on CNG for the past five years.<sup>17</sup> Florida research and restoration group Tampa Bay Watch has been using CNG in one of their 23-foot research boats since 1996.<sup>18</sup>

Liquefied natural gas (LNG), though apparently not as common in commercial vessels as CNG, is still used in some instances. In Norway, a 300 passenger, LNG powered ferry has been operating since 2000 and has experienced no major problems. The same company who built this one has plans to build an additional LNG ferry.<sup>19</sup> Also, for some time, LNG carriers have used the boil off gas from the cargo tanks as fuel for ship propulsion, which helps reduce fuel consumption and prevents the gas from being released into the atmosphere.<sup>20</sup>

### Biodiesel

Marine vessels, which tend to utilize longer lasting, but more polluting engines, could particularly benefit from biodiesel, as pure biodiesel (B100) is biodegradable, non-toxic, causes no visible emissions or offensive fumes, and considerably reduces or eliminates SOx, Hydrocarbon, CO, and PM emissions.<sup>21</sup> NOx emissions, however, tend to increase with biodiesel, but can be mitigated with additives, engine tuning and add-on controls such as water injection. Use of biodiesel in marine settings is increasing, due to growing demand from recreational boaters and certain commercial segments. Municipal ferries, water taxis, ecotourism boats, and research vessels have demonstrated the greatest demand for biodiesel, in both B20 (20% biofuel/ 80% conventional diesel) and B100 (100% biofuel) blends.<sup>22</sup> B100 has the best overall environmental and life-cycle benefits compared to diesel fuel.<sup>23</sup>

The following chart provides a summary of US EPA estimates on the air quality benefits of biodiesel versus petroleum diesel.<sup>24</sup>

Emission Type	B100	B20
<b>Regulated</b>		
Total Unburned Hydrocarbons	-67%	-20%
Carbon Monoxide	-48%	-12%
Particulate Matter	-47%	-12%
<b>Non-Regulated</b>		
Sulfates	-100%	-20%*
PAH (Polycyclic Aromatic Hydrocarbons)**	-80%	-13%
nPAH (nitrated PAH's)**	-90%	-50%***
Ozone potential of speciated HC	-50%	-10%

\* Estimated from B100 result

\*\* Average reduction across all compounds measured

\*\*\* 2-nitrofluorine results were within test method variability

The biodiesel industry is currently testing additives to bring NOx emissions down. When blended with B20, a new additive designed by Clean Diesel Technologies showed NOx reductions of 5 percent compared to on-highway diesel fuel.<sup>25</sup> A product being tested in Port Hueneme, CA, claims to counter any negative NOx increases.<sup>26</sup> Other additives are undergoing testing. The National Park Service has converted a portion of their marine fleet to run on biodiesel.<sup>27</sup> The Channel Islands National Park, near Santa Barbara, CA, currently has two B100 powered boats in their fleet. The first boat, which was converted to run on B100 in 2000, also uses electrical generation from a set of batteries and has had its hull modified with a “bulbous bow,” both of which have increased fuel efficiency and reduced emissions. Reportedly, however, it should be noted that one boat has had a few minor problems including a bad fuel line and failed fuel tank gaskets; the other boat has been running trouble-free since 2001. Channel Islands NP is also planning on running two additional vessels, a crew boat and landing craft, on biodiesel in the coming months.<sup>28</sup>

Mammoth Cave National Park in Kentucky has been operating two ferries using B20 Biodiesel since 2001 with no incidents.<sup>29</sup> At Voyageurs National Park in Minnesota, a barge has been operating on B20 since 2001, and has significantly reduced visible emissions and fumes. Concerns that the barge, which goes unused during the winter months, would have trouble starting in the spring were proved unwarranted by the barge’s efficient and reliable operation.<sup>30</sup> Two boats have been operating on B20 Yellowstone National Park since 2001.<sup>31</sup>

A number of tour boat operators have also adopted biodiesel as a fuel source. Na Pali Eco Adventures in Maui, Hawaii has been operating two 40’ catamarans on B100 since 2001.<sup>32</sup> The Pacific Whale Foundation, also in Maui, uses biodiesel in varying blends in their research vessels, as well as in their 149 passenger ecotourism boat.<sup>33,34</sup> Two other tourism companies in Hawaii use biodiesel in their boats: Prince Kuhio Charters and Maui Diamond Sea Sports.<sup>35</sup> Western Prince Whale Watching & Wildlife Tours near San Juan Island, Washington uses B20 in one of their observation boats.<sup>36</sup>

Several commuter ferries have been testing biodiesel, including San Francisco, Ca, Blue & Gold ferry operators, which ran one of their ships on B100 for a year, without any problems.<sup>37</sup> Washington States Ferries will be testing B20 with low sulfur diesel on a heavily used route during the next year.<sup>38</sup> Finally, the Delaware Shoreline and Waterway Management Section has been operating two dredges with associated marine equipment, a sand bypassing system, and two aquatic weed harvesters on B20 since 2002.<sup>39</sup>

### **Engine Repowers, Retrofits and New Builds**

Engine retrofits and upgrades can be beneficial, in terms of emissions reduction, and these emission reductions will be greater now that low sulfur fuel will be required. Many commercial vessel operators have opted for this route or simply purchased newer, more efficient engines in order to meet certain emissions standards, whether set internally or by an outside agency.<sup>40</sup>

Purchasing new engines and retrofitting old ones are common, particularly for commuter ferries. New ferries are being built to higher air quality standards, such as in San Francisco Bay, where state law mandates that all vessels built by the Water Transit Authority will meet an emissions standard that is 5 percent more stringent than the US EPA 2007 requirements for Category 1 and 2 vessels.<sup>41</sup> This mandate will advance the commercial availability of cleaner engines and advanced air pollution controls.

Ferry operators New York Waterway, the largest of the private ferry companies along the Hudson River, installed newer, more efficient engines on three-quarters of their fleet and planned to renew the rest by the end of 2004.<sup>42</sup> Blue & Gold Ferries in San Francisco, California replaced eight of its older two-stroke diesel engines with more efficient electronically controlled four-stroke diesel engines in 2003.<sup>43</sup> Washington State Ferries' fleet of 20 vessels have been running on low sulfur diesel since May of 2004 and, in conjunction, have been upgraded and retrofitted to run more efficiently—reducing fuel consumption.<sup>44</sup>

In Vancouver, British Columbia, ferry operator SeaBus replaced their older, inefficient diesel engines eight years ago with Detroit Diesel Series 92 engines featuring smoke sensing and more efficient fuel injection. SeaBus is looking to replace their current engines with DD Series 60 engines, which are even less polluting than the 92 Series, as they are 4 stroke engines instead of 2 stroke.<sup>45</sup>

Marine applications of Selective Catalytic Reduction (SCR) units have become more common due to reduction in cost of the technology together with increasingly stringent regulations of marine vessels in Europe. Since April 2004, a Vallejo, CA based 301 passenger ferry has been running with urea-based SCR.<sup>46</sup> Staten Island Ferry in New York, New York retrofitted one of their ferries with SCR and diesel oxidation catalysts and is anticipating substantial reductions in NOx and PM emissions.<sup>47</sup> Swedish SCA Graphic Paper uses SCR with urea injection on their fleet of ships and has experienced few problems with the systems since they were installed in the spring of 1999.<sup>48</sup> In San Diego, California, a 149 passenger commuter ferry ran on ultra low sulfur diesel with a water injection system for more than half a year until the ferry route was discontinued. During its tenure, PM emissions were reduced by 40% under load and 70% at idle.<sup>49</sup>

Add-on controls currently in use in other sectors, such as in off-road equipment, may soon be available for use in marine applications. For example, the ARB-certified Clearaire “Longview” reduces particulate matter by 5 percent and nitrogen oxides by 25 percent in non-road construction equipment.<sup>50</sup>

### **Solar (Photovoltaic)**

Though solar power requires significant initial capital outlay, it can potentially pay for itself in reduced or eliminated fuel costs.<sup>51</sup> At least a dozen solar powered vessels are currently in operation worldwide, some of which are in areas that are not traditionally associated with having large amounts of sunlight. Often used in conjunction with other alternative fuels, such as biodiesel or natural gas, solar power is also a very effective supplementary power source.<sup>52</sup>

Several passenger ferries have adopted solar power and photovoltaic cells as their main source of power. One of the most celebrated solar powered boats is the “Solar Sailor,” a 100 passenger ferry operating in Sydney Harbor. The vessel combines sails and photovoltaic cells, to harness maximum natural power.<sup>53</sup> Three different solar ferries are in operation in Germany, including a 100 passenger ferry in Hamburg, a Lake Constance solar ferry that has been operating since 1999, and a 10 person solar ferry that has been operating in Berlin for several years<sup>54, 55, 56</sup> On Lake Geneva, Switzerland, three other solar ferries are currently running. A small solar passenger ferry has been operating for some time in Norfolk, Great Britain and at least four other solar ferries are known to be operating in Central Europe.<sup>57</sup>

### **Electric/Hybrid Technology**

Electricity as a source of power for vessels is neither a novel idea nor a very complex one. The range and speed of electric boats are somewhat limited by the battery capacity, however, a number of ferry operators have successfully used electric power, including two larger ferries.<sup>58</sup> A 13 passenger sightseeing boat in Strasbourg, France is running well off electricity, though it is reported to have cooling problems due to its “greenhouse” design. In Newport Beach, California, a converted 100 passenger old-time river boat runs off of electricity stored in a host of batteries.<sup>59</sup>

In Tybee Island, Georgia, two 4 passenger electric canal boats are currently operating.<sup>60</sup> False Creek Ferries in Vancouver, British Columbia has been operating a fleet of electric boats since 1982, currently numbering 10 ferries.<sup>61</sup> In Phoenix, Arizona, Rio Lago Cruise Company has been operating a fleet of charter boats on high capacity batteries since 1999.<sup>62</sup> A water taxi company in Broward County, Florida uses hybrid technology in its vessels, which are powered by stored electricity or on a diesel-electric engine using B20, depending on the circumstances.<sup>63</sup>

Though fuel cell technology is still developing a few commercial vessels have employed fuel cells to date. A 22 passenger fuel cell powered boat has operated in Hannover, Germany without any major problems for the past four years. In Italy, a 90 passenger fuel cell boat was created for commercial usage, but was never commissioned because of safety concerns over hydrogen. Iceland is taking an important lead in the field of marine fuel cell technology, as they are planning on converting all their 2500 fishing vessels to hydrogen by 2030, with a prototype due by early 2006.<sup>64</sup>

### **Hull Modification Technology**

Significant fuel savings and therefore emission reductions can be had through evaluating the hull shape and size of a vessel to determine if they are causing avoidable friction. The shape of a vessel’s hull can be modified to best fit its operational and size characteristics, achieving fuel savings of up to 15%. The drawbacks are that hull modifications can be costly, depending on the nature of the work.<sup>65</sup>

Bulbous bows have been used for decades on large vessels and their effectiveness is well proven in those applications. In recent years, however, using computer design technology, the bulbous bow has been fitted to smaller boats and fuel consumption has decreased markedly in many cases.<sup>66</sup> The science behind the improvement is that the bulbous bow, which is essentially a ball attached to the front of the hull, reduces wave resistance through the “interference effect”—decreasing friction.<sup>67</sup>

Many large commercial vessels use the bulbous bow, including an 11 deck car and passenger ferry in Sweden, which has been operating since 1996.<sup>68</sup> The 50’ boat in the Channel Islands National Park that was fitted with a bulbous bow, mentioned earlier, saw fuel consumption improvements nearing 10%.<sup>69</sup>

Dynamic lift devices are another technology that could be utilized to reduce friction and increase fuel economy. These devices reduce friction by putting enough lift on the boat to reduce the submerged portion of the hull. A passenger ferry in Seattle, Washington saw its speed increase by 3 knots with an optimized wedge design that provided some overall dynamic lift.<sup>70</sup> Generally, increases in speed suggest a proportional increase in fuel economy if the normal speed is maintained. Thus, emissions could potentially be reduced by some margin.<sup>71</sup>

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