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U.S. Department  
of Transportation

United States  
Coast Guard



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Mr. Jon Kessler  
U. S. Environmental Protection Agency  
Regulatory Reinvention Pilot Projects  
FRL-5197-9, Water Docket, Mail Code 4101  
401 M Street, SW  
Washington, DC 20460

Dear Mr. Kessler:

The Coast Guard is pleased to submit a "Regulatory Reinvention (XL) Pilot Project" proposal for your consideration. We hope you find it acceptable for one of your initial six projects as it ties in nicely with the Coast Guard's Environmental Technology Initiative (ETI) proposal which Mr. Brandon Doyle of your agency is working on.

Sincerely,

J. M. Murphy  
Captain, U. S. Coast Guard  
Chief, Research and Development Staff,  
Office of Engineering, Logistics  
and Development

Encl: (1) XL Project Proposal

1p + 9 ATT (56pp)

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ATT 1

EPA Regulatory Reinvention (XL) Pilot Project Proposal Cover Sheet

1. Type

XL Projects For Government Agencies Regulated by EPA.

2. Project Title

**Federal Ship Fleet Atmospheric Pollution Prevention With Fuel Cell Power/Propulsion Plants - A "Facility" Demonstration Project.**

3. Abstract

This Coast Guard-led government agency "facility" Project is focused on a particular ship type now owned by a number of agencies. The ship type is the electric drive (former Navy owned) single hulled T-AGOS survey ship. The agencies are Navy, NOAA, Coast Guard, USGS and MarAd. The EPA has also recently considered acquiring a T-AGOS from the Navy as a possible longer term replacement for the ANDERSON. Fuel cell propulsion of a Coast Guard owned T-AGOS will demonstrate the atmospheric pollution prevention approach to ship powering so as to "...achieve environmental performance that is superior to what would be achieved through compliance with current and reasonably anticipated future regulation." (*Per EPA evaluation criterion 1*).

This XL Project Proposal is complementary to an earlier EPA (July 1994) Environmental Technology Initiative (ETI) Solicitation to which a Proposal was submitted by a Coast Guard Partnership in September 1994 under the "Domestic Diffusion" Topic and within the Focus Area of "Promoting Federal Purchases of 'Green' Technologies". It is titled "*Marine Atmospheric Pollution Prevention With Ship Fuel Cell Power Plants Using Federal Agencies Fleet*".

The program objectives of the EPA ETI Solicitation under the "Domestic Diffusion" Topic, where government agencies are the users of the technology to be demonstrated, are very similar to the program objectives of the "XL Projects for Government Agencies Regulated by EPA", where the agencies would be the users of the technologies to be demonstrated.

Therefore, the logical approach for EPA is to tie this XL Pilot Project Proposal to the September 1994 ETI Coast Guard Proposal.

4. Submitting Agency and Contact Person

United States Coast Guard  
Mr. Russ Doughty  
202-267-0989

# Federal Ship Fleet Atmospheric Pollution Prevention With Fuel Cell Power/Propulsion Plants - A "Facility" Demonstration Project.

## 5. Background

### 5.1 Fuel Cell Technology

The electric utility industry, the DOE and EPRI have been supporting the development and demonstration of fuel cell technologies for a number of valid commercial reasons. The fuel cell type receiving the most substantial support is the molten carbonate type, particularly using internal fuel reformation, the so-called direct fuel cell (DFC) configuration. In this industry the fuel being considered is municipal natural gas or a low heating value synthetic methane made from coal. The beneficial electric utility result will be far lower fuel consumption than with heat engine generator systems plus essentially no atmospheric pollution. Secondary dispersed site utility advantage include the lack of noise, the long periods before plant maintenance and the production of potable water. A 1.8 MW demonstration "shopping center sized" natural gas fueled DFC power plant will begin operation in late summer 1995 in Santa Clara, CA. It is made up of 14 of the 125 kW stacks of fuel cells. Exhibit 1 shows one of these stacks.

For marine/naval application the fuel choice is diesel not methane. Recognizing this the Naval Sea Systems Command (NAVSEA) sponsored work in 1990 to demonstrate [on a small laboratory scale limited by the available funding under a small business innovation research (SBIR) Phase II project] the internal reformation of diesel type fuel. This 400 hour demonstration work was successfully completed in August 1992. The EPRI also co-sponsored the work for an additional 200 hours. Exhibit 2 shows the two Final Reports.

Since that time efforts have been made to secure the necessary Navy funding to raise the power level of the demonstration to 10 kW and higher. In 1994 the ARPA separately funded work to demonstrate the technique at 32 kW in a military land application focused DFC stack. This will be done in the summer of 1995. Efforts continue, in a now "congressionally compressed" R&D budget environment, to secure the necessary funds to demonstrate marine-design DFCs for ship propulsion. A new, more compact and higher performance DFC stack design at 180 kW was offered and proposed as an SBIR Phase III effort to the NAVSEA in the autumn of 1994. This work has not yet been funded. 14 of these stacks would provide the necessary 2.4 MW for the T-AGOS ship propulsion requirement. The Coast Guard September 1994 ETI Proposal referred to in the Abstract is the EPA means to get this Project underway.

### 5.2 Ship Applications of Fuel Cell Propulsion

The federal government operates large numbers of ships, both large and small. The agencies include: Navy, Army, Army Corps of Engineers, Air Force, Coast Guard, NOAA, USGS and EPA. At present all are heat engine powered and produce significant levels of atmospheric pollution. Some are electric drive, most are diesel engine driven and some combatants are gas turbine powered. Recent efforts by the NAVSEA to develop electric drive approaches for future ships indicate the propulsion trend.

Using the Coast Guard fleet as an example, approximately 1.5% of this agency's annual operating budget, or \$40 M per year, goes for ship fuel. If high energy conversion efficiency fuel cell propulsion is gradually phased in to Coast Guard cutters, buoy tenders etc. the agency's ship fuel budget would be cut by half. Many of the present Coast Guard cutters are over 30 years old or older and will soon need replacement. The Coast Guard obtained two of the former Navy T-AGOS ships to evaluate them as replacements for some of its oldest cutters. One is the VINDICATOR, WMEC-3. Because these ships are electric drive and relatively modestly powered, a complete changeover from the four 600 kW diesel engine generators to 14 of the 180 kW DFC stacks could be readily and rapidly

## Federal Ship Fleet Atmospheric Pollution Prevention With Fuel Cell Power/Propulsion Plants - A "Facility" Demonstration Project.

accomplished, as was described in the Coast Guard September 1994 FTI Proposal to EPA. Once the pollution prevention fuel cell technology is demonstrated in this government agency "facility" the other agencies can incorporate this superior technology. In addition, the cost per kW will have been driven down, due to mass production driven by electric utility conversion to DFC power plants, making new installation on Federal agency and commercial ships a practical economic alternative. At that point the EPA Regulatory Reinvention (XL) Project objective will have been amply met in every respect.

### 5.3 Local and Regional Stakeholders' Interests

The atmospheric degradation of the southern California coastal air basin of greater Los Angeles has spawned the creation of the regional body South Coast Air Quality Management District (SCAQMD). The California Air Resources Board (CARB) and the EPA, operating under the Clean Air Act (CAA) have been recently discussing a draft Federal Implementation Plan (FIP) with regard to the atmospheric pollution caused by the non-road heavy duty transportation sector which includes ships offshore. SCAQMD and CARB have a vision of fuel cell powered ships operating in the Los Angeles/Long Beach area. They are eager to assist with demonstrated reduction in the air pollution (or more precisely, the air pollution prevention qualities of this ship "facility"). Whatever the long term fate of this project's prototype vessel, its attributes will be self evident to all the stakeholders, "...communities near the project.", states and the federal EPA's Region IX. Exhibit 3 is a copy of a May 15, 1995 letter from Region IX on the subject of the Proposal.

## 6. Project Criteria

### 6.1 Environmental Results

This ship "facility" project will "be able to achieve environmental performance that is superior to what would be achieved through compliance with current and reasonably anticipated future regulation." Exhibit 4, a Navy Chart, shows the NO<sub>x</sub> atmospheric pollution levels of heat engines versus fuel cells.

### 6.2 Cost Savings and Paperwork Reduction

Fuel cell ship propulsion on federal ships will dramatically reduce the cost of the fuel required over the typical ship's operational life of 30 or more years. Fuel cells will produce real operating cost savings to the ship operators due to the dramatic reduction in the rate of fuel consumption. The simplicity and reliability of the fuel cell power plant also permits a reduction in the crew for a further operating cost saving. Thus "...The project should produce cost savings... ." (*Per EPA evaluation criterion 2*).

### 6.3 Stakeholder Support

The southern California coastal area in which the South Coast Air Quality Management District (SCAQMD) is the major regional "stakeholder" is tied to this proposal. SCAQMD, along with the EPA Region IX and the California Air Resources Board (CARB) have all been directly involved in the generation of air quality regulations and plans such as the Federal Implementation Plan (FIP) under the Clean Air Act (CAA). Offshore ships currently contribute to the degradation of the Los Angeles Air Basin as monitored by SCAQMD. Fuel cell propelled ships will effectively eliminate this air pollution, not just reduce it to the so called "CARB" proposed levels. Furthermore the diesel fueled ship

## Federal Ship Fleet Atmospheric Pollution Prevention With Fuel Cell Power/Propulsion Plants - A "Facility" Demonstration Project.

propulsion fuel cell power plants are very similar to needed power plants for heavy duty road and non-road transportation applications. SCAQMD staff agree that demonstrating fuel cell ship propulsion at, for example, 2.5 megawatts (MW) power level on a T-AGOS ship, will also prove such power plants for other diesel fueled land applications such as 2.5 MW locomotives. Exhibit 5 is a copy of a June 15, 1995, supportive letter from SCAQMD. Exhibit 6 is a copy of a similar letter from CARB, dated May 30, 1995.

### 6.4 Innovation/Multi-Media Pollution Prevention

The Solicitation says, under Criterion 4: "EPA is looking for projects that test innovative strategies for achieving environmental results." and "EPA has a preference for protecting the environment by preventing the generation of pollution rather than by controlling pollution once it has been created." The proposed Coast Guard project meets these two tests under this evaluation criterion description. The proposed project of demonstrating fuel cell propulsion on a federal agency ship is a "... test of an innovative strategy...". Over time the strategy will be repeated until all federal ships which can be made electric drive and fitted with fuel cell propulsion are so equipped.

Furthermore, the proposed pilot project speaks directly to the EPA "... preference for protecting the environment by preventing the generation of pollution ...". Fuel cell ship propulsion using diesel fuel eliminates the atmospheric  $\text{SO}_x$  by removing the sulfur before the fuel is used. It eliminates  $\text{NO}_x$  by the fact that no fuel is "burned" in the presence of air, because the fuel is fully thermochemically reformed (in the presence of catalysts) to  $\text{H}_2$  and  $\text{CO}_2$ . Half as much exhaust  $\text{CO}_2$  is formed because of the much higher energy conversion efficiency of fuel cells. There are no unburned hydrocarbons in the exhaust of fuel cell power plants whether onboard ships or on land, again because of the thermochemical reformation step.

### 6.5 Transferability

The fifth evaluation criterion says: "EPA is therefore most interested in pilot projects that test new approaches that could one day be applied more broadly." The proposed pollution prevention ship fuel cell propulsion demonstration on a federal "facility" ship will prove the applicability of the multi-module approach. Individual fuel cell stack modules of, typically, 180 kW power level can be used in smaller craft (boats), in multiple units in larger boats and in tens of units in still larger ships, for both ship service power and for main propulsion.

For example, in the California coastal FIP draft the EPA has considered a strategy for diesel engined tug boats of requiring that their diesel engines to be shut off entirely when the tugs are not being used. The term "cold iron" is used to refer to this atmospheric "non polluting" condition. Upon starting up diesel engines are notorious sources of atmospheric pollution, as is true when these engines are at idle or at the pier in a "standby" condition (providing only "hotel" loads). In the case of future fuel cell powered electric drive tug boats the atmospheric pollution at full, partial throttle, idle or "standby" is essentially non-existent. If a shore electric power connection (for the hotel loads) were to be used by the present diesel tug boat in the FIP proposed "cold iron" condition the shoreside electric utility might actually create more air pollution to produce this electricity than will the future fuel cell powered tug boat with its very fuel efficient and atmospherically benign power plant. This is an example of the "new approach" to EPA thinking in regulating air polluting emissions from heavy duty transport systems such as ships, or locomotives. In other words, leaving the "squeaky clean" fuel cell power plant on the ship ON (to produce onboard hotel load power in standby conditions at the pier) is a more "common sense"

## **Federal Ship Fleet Atmospheric Pollution Prevention With Fuel Cell Power/Propulsion Plants - A "Facility" Demonstration Project.**

approach than the present EPA FIP thinking of turning the tug's diesel engine power plant OFF and thereby obliging the tug owner to rely on shore connection power while at the pier in order to meet shoreside air quality regulations.

The Coast Guard is committed to developing and operating non polluting ships in exchange for relief from Clean Air Act Federal Implementation Plan (FIP) future fines for non-compliance. Fuel cell ship powering provides the pollution prevention answer, plus the advantages of lower costs of operation.

The transferability of the ship fuel cell powering demonstration to the commercial maritime sector is great in regard to the reduction in the capital cost of the fuel cell power plant technology occasioned by the mass production needed to meet the federal ship fleet requirements. Driving down the cost per kW installed is beneficial to both government agencies as well as the commercial users.

### **6.6 Feasibility**

The key question is: Does the federal government have the will to carry out the proposed pilot project as it clearly has the "financial capability" to carry it out? The technical feasibility will soon be demonstrated on land at the power levels being discussed. The ship application demonstration needs to involve as many federal ship operating agencies as possible, as was the case during the Coast Guard partnership approach of the September 1994 ETI Proposal. Thereby as many as possible of the federal agency stakeholders will be committing to the Solicitation's objectives.

At the present time the Coast Guard, by itself, is inadequately funded to perform the entire Project XL demonstration work on this topic. However, by supplying leadership, \$500 K per year (starting in FY97) and by making the T-AGOS ship available it is providing a significant contribution.

The EPA ETI process can provide significant funds to move the work forward, assuming the Coast Guard partnership project is selected for ETI implementation. The SCAQMD is prepared to consider a significant stakeholder co-funding of the work under the above ETI selection scenario. See Exhibit 7, a copy of a November 14, 1994, SCAQMD letter to the Coast Guard, third paragraph.

Coast Guard discussions with NAVSEA, ARPA and ADUSD(ET) continue to secure DOD cost sharing as well.

### **6.7 Monitoring, Reporting and Evaluation**

This Project proposal responds to the Criterion No. 7 as follows:

a. Data on the federal agency ship fuel cell powering demonstration Project will be shared with a number of the peer agencies via regular coordination meetings, chaired by the Coast Guard. Once the ship is fitted with fuel cell power and is sent to sea, performance data will be shared with all of the stakeholders. Ship riders will be able to join the Coast Guard crew to see and witness the ship perform. The T-AGOS ship type is well equipped with quarters and common spaces to take EPA staff, commercial fuel cell propulsion prospective users, dignitaries and others on day or longer cruises.

b. The time frame for the Project to be accomplished is between mid 1995 and the year 2000 depending on the level of funding made available both in the near term and the out

## Federal Ship Fleet Atmospheric Pollution Prevention With Fuel Cell Power/Propulsion Plants - A "Facility" Demonstration Project.

years. The technology of fuel cell power plants is sufficiently far advanced for the engineering and naval architecture to be done in 1995 so that by 1997 the mass produced fuel cell stacks will be available and can be installed in the ship by 1998. Onboard checkout and acceptance testing could occur in 1999 and the ship shakedown cruise completed in 1999 or early 2000. In 2000 the ship would then transit to the southern California offshore operating area and be put in service as a Coast Guard cutter.

### 6.8 Shifting the Risk Burden

The Project will be consistent with Executive Order 12898 on Environmental Justice. As a federal agency asset the fuel cell propelled T-AGOS ship operating offshore will protect worker safety. It will also prevent any unjust or disproportionate environmental impacts on third parties. The Coast Guard is the offshore uniformed "law enforcement agency" which will carry out EPA FIP and other regulatory provisions on offshore coastal polluters, serving ship operators with citations as necessary. It is therefore natural that the Coast Guard should develop and deploy modified and new ships that are environmentally benign.

This project meets and/or exceeds all 8 of the evaluation criteria.

### 7. Cooperation with EPA on Project

This Coast Guard-led Pilot Project on a fuel cell powered federal "facility" ship is designed to be accomplished in close cooperation with EPA headquarters and its regions and cognizant laboratories. First, the Project has sought inputs from Region IX in San Francisco, CA, whose staff helped to prepare the draft FIP. See the previously mentioned Exhibit 3, the copy of the May 15, 1995, letter from EPA Region IX to the Coast Guard.

Second, we sought the involvement of the Mobile Sources Laboratory in Ann Arbor, MI, as shown by Exhibit 8, a copy of the June 2, 1995, letter from this facility. Staff of the laboratory have been and continue to work on the regulatory aspects of ship produced air pollution in conjunction with Coast Guard regulatory staff (Comdt G-MTH) and the International Maritime Organization (IMO). The IMO involvement occurs because ship created air pollution is recognized to be prevalent around the world.

Third, we sought the involvement of the State of California Air Resources Board (CARB) and the southern California regional air quality entity South Coast Air Quality Management District SCAQMD. The California coastal environment is the geographic focus of the draft Federal Implementation Plan (FIP) under the Clean Air Act (CAA) with regard to the non-road mobile sources which, by definition, includes locomotives, heavy equipment and ships.

Fourth, we sought the involvement of the Department of Defense (DOD) with whom the EPA has formulated the program Memorandum of Understanding (MOU) with regard to the Solicitation and means to move forward with federal i.e. DOD "facilities" (or in this case ships) as the focus of the initial demonstration to be carried out.

Current DOD difficulties in funding environmental aspects of its work have been magnified by recent FY1995 Congressional rescission actions but the issues remain: How to prevent DOD facility pollution, and how to use less fuel and fewer personnel to perform the missions? Fuel cell ship propulsion will uniquely do all three, and the DOD (Navy, Army, Air Force,) operates large numbers of ships in the performance of its many missions.

Fifth, this Coast Guard Project is working closely with the ship operating part of EPA itself, with the National Oceanic and Atmospheric Administration (NOAA) Corps, with the



## **Federal Ship Fleet Atmospheric Pollution Prevention With Fuel Cell Power/Propulsion Plants - A "Facility" Demonstration Project.**

Maritime Administration (MarAd) and with the US Geologic Survey (USGS) in an interagency coordination role. Because of the substantial similarity in power plant types, fuels and power levels between ships and railroad locomotives (for freight, passenger and commuter rail applications) the Department of Transportation's (DOT), Federal Transit Administration (FTA) and the Federal Railroad Administration (FRA) are part of this Coast Guard-led interagency coordination group.

In Summary, it is important for the various ship operating federal agencies, including EPA itself, "... to work cooperatively with the project proponents to develop and define acceptable approaches".