

Workshop on Alternative Fuels for Ferries and Other Vessels



Vessel Operator Desires for New Technology Demonstrations

Alameda, CA

November 1 & 2, 2000



Environmental Reality

- Increased focus on the Environmental Impact by industry, regulatory agencies and academia will be critical to success
- Prediction of emissions performance based on questionable calculation methods must be replaced by detailed data derived from actual exhaust stack testing
- Premature pressure for natural gas use in the U.S. domestic passenger segment before many questions are answered does not make sense



Environmental Reality

- A careful environmental analysis must be a strong component of system start-up or expansion
- Valid comparisons with other transit options must be made
- The dissemination of misinformation must be challenged
- A scientifically valid emissions study is needed - SNAME and others are considering and/or completing
- This conference is primarily about ferries yet many statistics discussed here refer to the total marine market - the actual impact of the ferry segment must be separated from the total impact picture to put the issues into perspective



Counterproductive Trends

- City and County of San Francisco Commission on the Environment resolution banning diesel ferries on the Bay is ill-conceived
- Other statements regarding the safety and environmental impact of ferries have been inflammatory
- Behind the scenes attempts to force the use of Natural Gas in a new Bay Area ferry are premature
- Overstatement of wake issues by industry players is unwise - U.S. domestic operating conditions/vessels are not the same as European wake wash woes



The CNG/LNG Alternative

- There is only one small passenger vessel (149 passenger) in the U.S. certified for CNG
- This vessel operates on a very short route in Norfolk, Virginia
- An elaborate fueling system had to be installed and the Tidewater Regional Transit Agency uses the boat primarily to back-up it's two diesel vessels
- Though some very impressive success stories have been told here, the installed unit base is still extremely small

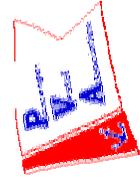


The CNG/LNG Alternative

- To our knowledge, no comprehensive risk assessment has been undertaken
- A serious analysis of logistics issues related to marine use has just begun here in the U.S.
- The assessment of risk and evaluation of feasibility must be totally customized for each operation, taking into account:
 - terminal locations
 - financial viability
 - route specific issues
 - vessel characteristics
 - fuel availability
 - earthquake preparedness
 - local sentiment
 - complex cost projections
 - cost/benefit analysis
 - plan review/design issues



Survivability



Validity in Question

- Two recent studies cast significant doubt as to the benefits and viability of CNG or LNG as a marine fuel:
 - Fueling Heavy Duty Trucks: Diesel or Natural Gas? *Harvard Center for Risk Analysis*
 - Relative Impact on the Environment and Health from the Introduction of Low Emission City Buses in Sweden *SAE Technical Paper Series*
Paper 2000-01-1882



The Harvard Study

- Compressed Natural Gas (CNG) is compressed to several thousand pounds per square inch
- Liquefied Natural Gas (LNG) is stored at temperatures around -260° Fahrenheit
- The magnitude of health risks of diesel has been questioned by the Health Effects Institute
- Major research efforts are currently underway to enhance the understanding of these health risks
- Little is known about the adverse health effects of Natural Gas emissions



The Harvard Study

- The combination of low sulfur fuel with after-treatment technology (green diesels) is proving to be very effective
- Though diesel emissions result in more mass, the “ultra fine” particles of Natural Gas emissions could prove to be more biologically harmful due to their ability to penetrate the body further
- Diesel engines possess a significant efficiency advantage over Natural Gas



The Harvard Study

Greenhouse Gas Potential

- Methane is 20 times more “potent” than carbon dioxide as a greenhouse gas
- Methane will escape during refueling and storage
- Regulators in California have apparently not taken the diesel greenhouse gas advantage into account



The Harvard Study

Relative Safety is an Important Consideration

- The National Fire Protection Association gives Natural Gas its highest hazard ranking for flammability (a 4 on a scale of 1 to 4)
- Diesel is rated as moderate (2 on the scale)
- Natural Gas leaks and spills must be treated with great care
- Natural Gas vapors at low temperatures can cause clouds of flammable vapor concentrations



The Harvard Study

Safety Concerns

- The extreme pressure or temperature condition of CNG or LNG pose significant additional hazard
- Very special care must be given to the transport, transfer and storage of CNG/LNG
- Methane poses “significantly higher safety hazards than diesel”
- Safety concerns about siting fueling facilities may be an obstacle to terminal locations



The Harvard Study

Significant Performance Issues

- Range limitations result from lower performance combined with storage parameters
- Complex refueling infrastructure limits routing
- A gallon of LNG contains about 60% of the energy in a gallon of diesel
- CNG contains considerably less energy than LNG
- Maintenance costs are significantly higher and downtime is predicted to be more problematic



The Harvard Study

Higher Cost

- Capital costs are significantly higher
 - ex: A diesel truck may cost about \$75,000 while a Methane truck would cost \$35,000 more = \$110,000
 - ex: Transit buses cost between \$45,000 and \$75,000 more
 - ex: A fueling facility for 8 transit buses cost \$350,000
 - ex: One large bus fleet had capital costs of \$2 million
- Maintenance facilities must be upgraded to include ventilation improvements and leak detection



The Swedish Study

- Considerable improvements in Diesel emissions performance have been possible by reformulating diesel in combination with the fitting of after treatment devices
- Particulate emissions are the most severe emissions component of diesel
- Particulate filters are available today
- It is expected that future developments of engine technology and after treatment will “diminish the advantage of alternative fuels”



The Swedish Study

- Ozone formation is highest for diesel but with catalyst or particulate trap level is same as natural gas
- No_x emissions can be reduced by 50% with EGR
- Particulate emissions can be reduced with trap to level similar from Natural Gas
- Diesel fuel with a particulate trap has the lowest acetaldehyde emissions - methane is higher
- The lowest cancer risk index is achieved with diesel fuel and a particulate filter



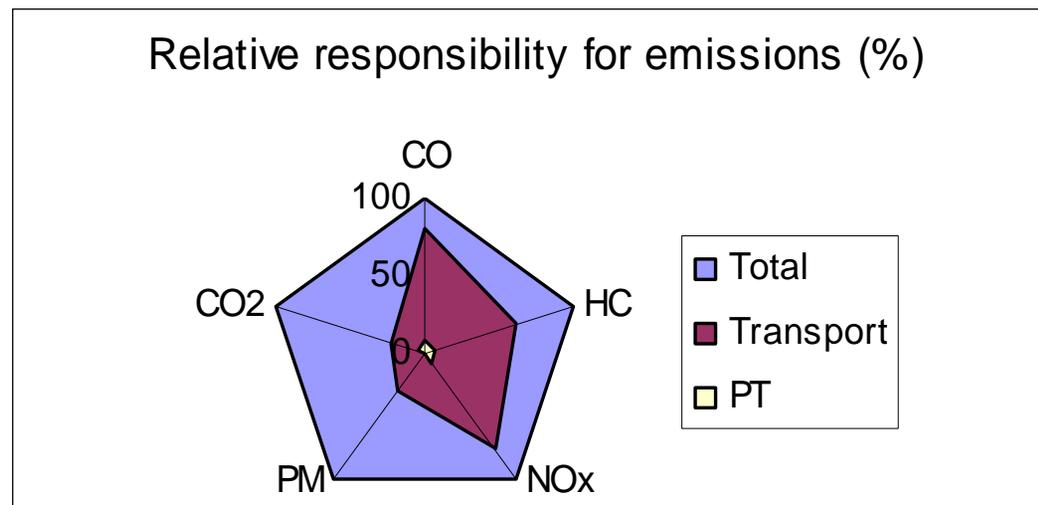
The Swedish Study

- CNG has higher Greenhouse Gas Emissions (GHG) than diesel fuel due to lower engine efficiency and higher GHG emissions
- Considerable improvements are possible by the reformulation of diesel in combination with after-treatment technology
- Continuing development of engines and after-treatment devices will diminish the advantage of alternative fuel



UITP Position Paper

- In the long term, electric traction will become commonplace (fuel cells) - hydrogen will be a widespread fuel
- Public transport is thought to cause high levels of pollution, but it is actually responsible for very little



UITP Position

- There are many different fuel types, however, experience shows that many of them cannot be considered because of intrinsic or extrinsic disadvantages
- The consumption and CO₂ emissions from natural gas-powered vehicles are higher than diesel
- CNG vehicles cost an additional 25%



UITP Position

- From an operator's perspective, the advantages of gas over modern diesel have become so small it is increasingly difficult to justify the extra expense of gas
- Recent scientific discoveries indicate that the toxicity of particles is linked more to their size than to their number or mass - the smaller they are, the more their carcinogenic impact.
- These particles are especially harmful for human health while, on the contrary, particulate filters used with diesel are demonstrated to be particularly effective for the "nano-particle" range



UITP Position

- Experts concur that the #1 issue to be resolved this century is CO₂ . . . on the other hand, excessive fuel consumption by natural-gas powered vehicles compared with diesel vehicles has an unfavorable impact on CO₂ levels
- Industry/operators must work together toward the use of hydrogen
- The debate is no longer centered on diesel vs. CNG, but on the best allocation of resources to obtain a clean fleet



Cost Issues

- A comprehensive Business Plan would be required to fully evaluate short and long range cost projections
- Given the higher capital costs how would total vehicle unit numbers be reduced?
- How are the R & D costs, in combination with the significantly increased capital and operating expense, be justified in light of the fact that this technology may be obsolete 5 or 10 years from now?

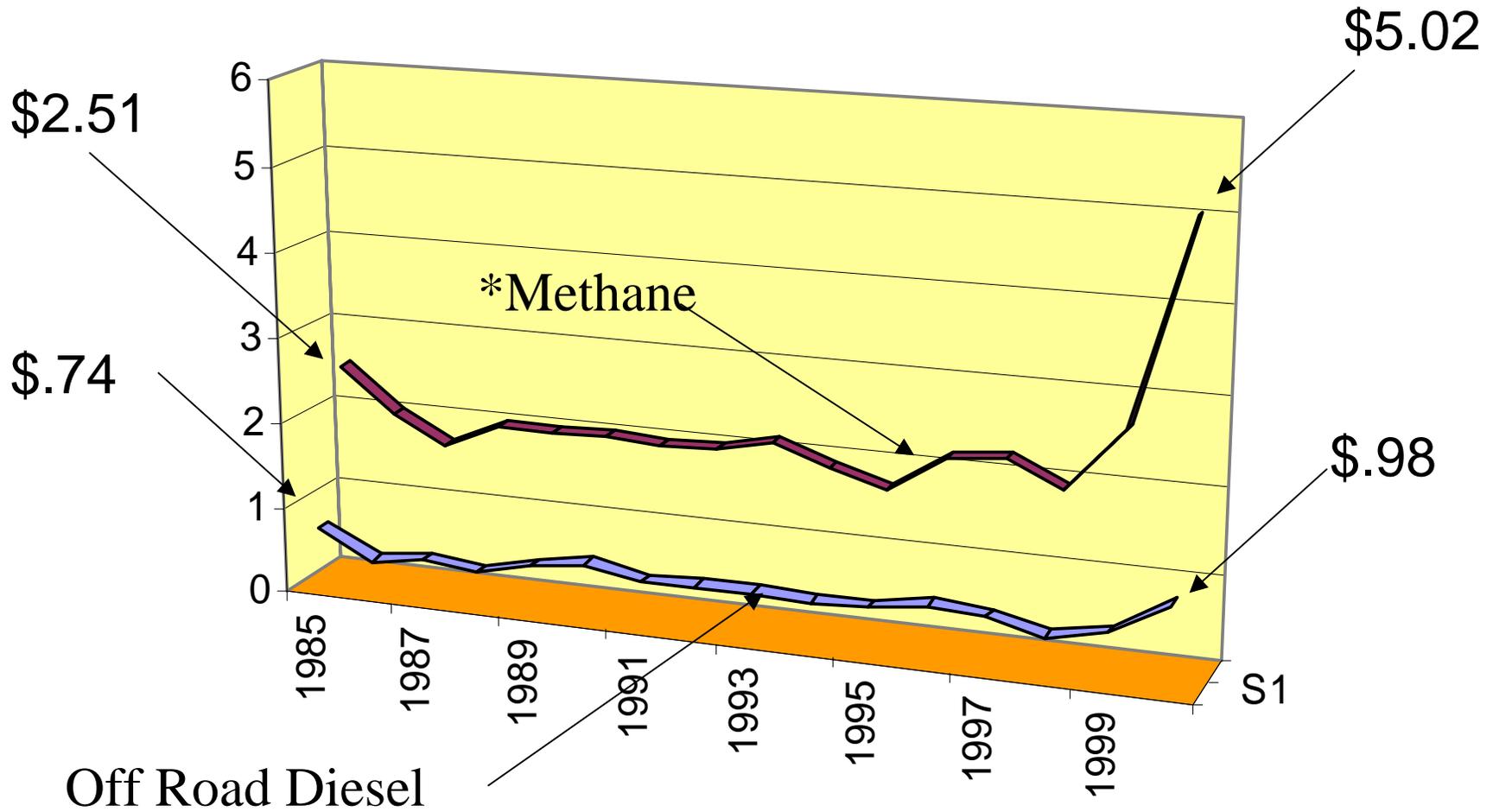


Cost Issues

- What is the potential for price volatility given the fact that this fuel is provided by few suppliers?
- Who will pay for this alternative given the fact that Bay Area ferries operate at a significant loss?
- Notwithstanding the success stories described here, can anyone assure us that cost savings will be available, given the total costs?
- How will insurance costs be effected?



Price Volatility



*Source: U.S. Department of Energy



Issues and Drawbacks

- Storage/weight/volume requirements
 - weight of pressure vessels and/or associated chilling/handling equipment
 - space required to store CNG and proximity to passenger spaces
 - the degraded power to weight ratio will be a significant challenge
 - vessels are moving aggressively toward lighter weight in combination with FRP hulls



Safety Concerns

- Explosion Potential
 - Ventilation requirements
 - Shoreside and vessel piping and coupling
 - Collision hazard and the potential for tank rupture and/or supercold fluid release
 - Integrity of aluminum when faced with high temperature explosion or reaction with LNG at -260°



Safety Concerns

- How would current lifesaving arrangements and apparatus perform under the potential explosion scenario?
- Would existing qualified refuge areas be adequate given the potential for a rapidly disintegrating hull?
- How would the time allotted for evacuation change?
- How would damage stability calculations be reevaluated in light of this potential?



Safety Concerns

- How would embarkation stations and apparatus deployment mechanisms be altered to allow for explosion?
- What fire detection and suppression system enhancements would provide an equivalent level of safety?
- Has anyone seriously analyzed the complexities of passenger vessel lifesaving apparatus/strategies to begin the process of considering this fuel?



Safety Concerns

- How would crews be trained to handle this fuel in a totally safe manner?
- How would manning be affected by the apparently necessary rapid evacuation scenarios?
- How will our public feel about the exposure to this additional risk?
- What inspection changes must be made to provide a proper level of safety?



Safety Concerns

- What might be the result of two high speed Methane powered vessels colliding?
- How soon will other, less hazardous, fuel technologies displace Natural Gas as the alternative of choice?
- How would the first serious casualty experience effect all other so-equipped vessels?



Other Issues

- Is the market base large enough in this segment to warrant the R & D investment given the risk?
- Is the passenger vessel segment the appropriate market niche to test this “alternative”?
- Who will be the first to own a Natural Gas powered passenger vessel of significant size, speed and range?
- What do underwriters think of the idea?



What Operators Want

- A fair and unbiased working relationship with other stakeholders
- A predictable future which includes progress toward better environmental performance
- A recognition that ferries provide a transit alternative and an environmental benefit - any calculations of impact must consider this
- A comprehensive, unbiased, assessment of all viable alternatives
- and, **most importantly:**



**Capital Grants
Programs**

**Operating
Subsidies**

SHOW ME THE MONEY!!!

**Tax
Incentives**

**Other Viable
Incentives**



Recommendations

1. An analyses of propulsive energy feasibility must be undertaken by the Naval Architect/Marine Engineering community in conjunction with industry
2. A working group consisting of members of industry, the USCG, academia, environmental organizations and Natural Gas suppliers should pursue this option in an orderly, reasoned and safety-conscious fashion



Recommendations

3. If found to be feasible, appropriate funding sources must identified and pursued
4. An objective study of comparative transit emissions is required if these issues are to be fairly evaluated
5. We should move toward emissions performance criteria attainment, not a command & control or prescriptive strategy

