

LNG Study Status Report

August 18, 2011

Task 1. White Paper on LNG as an Energy Source for Vessel Propulsion

Task 1a. History of LNG use in vessels and ferries, worldwide and in the United States

- **LNG.** LNG is natural gas that has been converted to liquid form taking up about 1/600th of the volume of natural gas in the gaseous state and is carried at -259°F. This makes it cost efficient to transport over long distances where pipelines do not exist.
- **LNG carriers.**
 - LNG is moved by specially designed cryogenic sea vessels
 - First 1959
 - Beginning in 1964 LNG carrier vessels began using the boil-off of LNG as the fuel source for the vessel. (A small volume of LNG is naturally boiled off to keep the bulk of the LNG in its liquid form.) Additional LNG fuel is generated by heating some of the LNG cargo if needed. All current LNG carrier vessels use this method of fueling.
 - Most LNG carriers also have an oil fuel system and the steam boilers can use either gas or oil or both at the same time. There are some new LNG carriers than run on LNG only.
 - Currently approximately 200 LNG carrier vessels worldwide – none of which are US flagged.
 - LNG carrier vessels use United States ports and the Coast Guard has rules developed by each USCG Captain of the Port governing the arrival of such vessels. Have copy of rules for Chesapeake Bay.
- **LNG passenger vessels.**
 - Use LNG as a bunker fuel
 - Norway Passenger LNG Vessels (including ferries)
 - Discovered large quantities of natural gas on west coast in 1997 – allowed LNG to be available at an acceptable cost for ferry operation
 - Had completed several studies starting in 1989 that had concluded LNG ferries were not cost effective.
 - Starting in 1997 the Norwegian equivalent of the Coast Guard the Norwegian Maritime Directorate and ferry operators began a three year process of developing regulations for gas fuelled ships after the Directorate's initial safety concerns were satisfied.
 - First ferry, The Glutra, was constructed in 2000 with support from the Norwegian government at a cost that was 30 percent higher than an equivalent diesel vessel.
 - Norway now has more than 20 LNG fuelled passenger vessels – including 11 ferries and 3 Coast Guard vessels. The Norwegian government provides a substantial carbon tax credit to LNG passenger vessel owners. The world's largest LNG fuelled passenger vessel is currently being constructed for the Viking Line system that operates in Finland, Norway and the Baltic countries. The vessel is a cruise liner scheduled for delivery in 2012 with capacity for 2,800 passengers, 200 crew, 1,300 lane meters for trucks and 500 lane meters for cars and will operate between Stockholm and Turku, Finland.

- Other countries
 - High speed LNG catamaran under construction in Australia and will go into service in 2012 between Buenos Aires and Montevideo. It will be dual fuel, capable of operating on LNG or diesel, and will have capacity for 153 vehicles, 1,000 passengers, and have speeds up to 50 knots.

Task 1b. Economics of LNG Use Compared to Ultra Low Sulfur Diesel/Compressed Natural Gas

- **Local Supply.** Examining local supply of LNG. Discussed with Greg Nothstein and WSF. Meeting Thursday afternoon with potential expert. Will try to determine likely supply and cost during the first phase of the study.

Task 1c. Desirability of dual-fuel option versus solely LNG as a fuel source.

- John Boylston talked to Rolls Royce and Wärtsilä. Rolls Royce provided a comparison paper by Elliot Bay for WSF ferry assumed run, using Issaquah class on Mukilteo / Clinton route.
- Rolls Royce engine runs on gas only and cannot be configured to go back to diesel
- Wärtsilä- Engine can be taken back from LNG to diesel, but bit less efficient than the Rolls Royce engine.
- Neither engine approved by EPA. Both companies anticipated approval in early 2012.

Task 1d. Impact of LNG on vessel speed, performance, and maintenance.

- Examining training options
- Will need to get information from Norway on staffing and training requirements.

Task 1e. Regulatory requirements

- Have copy of US Coast Guard rules for LNG carriers docking.
- Have existing DNV and IMO guidelines – extensive work done by WSF
- Glasten has provided their analysis of Coast Guard and DNV regulations

Task 1f. Other considerations

- *Other US ferry systems and LNG*
 - Staten Island Ferry – received federal grant for LNG retrofit of an existing ferry - \$2. 3 million. Announced this week. WSF initiating contact with Staten Island Ferry system.
 - North Carolina Ferries- None considered. LNG retrofit is too expensive to implement on their older ferries, no new ones being considered. Concerned about other regulatory impacts on older ferry conversion.
 - Woods Hole- Island Home too new and stability / draft concerns, old ferry too old to be reasonable. Supply is of concern. Not sure of public reaction; lots of conservationists as customers, but might see it as too risky.
 - Cape May – Had some interest, but do not have enough \$ to do anything. Looking at high speed new ferries not suitable for LNG dues to space concerns, CNG would be worse.
 - Maine State- Not considered.

Task 2. Overview and Initial Assessment of WSF Studies and Reports

- Conference call with WSF
- Requested technical and cost information – WSF is in the process of gathering the information