Approval of Ships using LNG as fuel

Lasse Karlsen Technical Director  Norwegian Maritime Authority
Established:
1903

Vision:
Together for improved safety at sea in a clean environment
From Norway’s Shipping history

Year 1687
King Christian the Fifths Norwegian Act:

- 1/3 regulate shipping
LNG - The fuel for the future

– A paradigm may take place
  • LNG may substitute heavy fuel oil and marine gas oil as the former change from sails to coal or coal to fuel oils

– Challenges
  • The supply chain and availability of bunkering station in ports
LNG as Shipping Fuel

The important drivers

• Quantity
  – The predicted amount of natural gas is huge. May last for the next 1000 years if Gas Hydrates are included

• A clean fuel
  – Can meet the IMO tier 3 requirements on emissions

• Economical
  – LNG has the potential to be economical competitive to heavy fuel oil (HFO)
Natural gas + Methane Hydrates (2009)

![Bar chart showing reserves of different energy sources.]

Fig 2 Futures of natural gas reserves in the world (Demibas 2009)

\[1 \times 10^{15} \text{ MJ (equ. } 1.67 \times 10^{11} \text{ billion barrels of crude oil)}\]

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LNG as Shipping Fuel

Tariffs 2011 --- 2012 USD/ton

Current HFO  Current MGO  LNG Zeebrugge

Tariffs 2011 --- 2012 USD/ton
History of Natural Gas - Methane

• China first to use Methane
  – 2500 years ago the Chinese started to hardness (pipe) the natural gas for the purpose of heating water to obtain salt*

• Used in England since 1659
  – Did not on world base replace coal gas before 1945

• First used in USA in 1816
  – In gas lamps to illuminate the streets of Baltimore

* A. Demirbas 2010
History of LNG

LNG dates back to 1825, when British chemist and physicist Michael Faraday experimented with liquefying of gases.

German engineer Karl van Linde built the first practical refrigerator machine in 1873.
History of LNG

• Today 31 LNG liquefaction plants in operation (5 Norway)
  – 9 liquefaction plants under construction
  – 22 new liquefaction plant under planning

• Snøhvit (N)

Source: www.globallnginfo.com
The history of LNG shipping

Large Scale LNG Shipping: 50 years of operation

- Started in 1962 from Arzew in Algeria
- Millions of tonns transported WW
LNG as base for fuel – Clean fuel, but a Gas

• LNG Cryogenic -162°C
  – Special material requirements
  – Mild steel may brittle – possible structural damage

• Re-heated to become natural Methane/Ethane gas (30-40°C)
  – Colorless and odorless
  – Non toxic
  – Asphyxiating – displaces oxygen

• General Safety Precautions
  – To be contained and continuously monitored
The history of LNG propulsion ships

- Høegh LNG-tanker Norman Lady 1973
dual fuel LNG/HFO

- MOSSWW
  spherical tank design

- Ship still in operation!
Safety record on Shipping of LNG

Very good, only 6 recorded accidents;
- 2 fires and;
- 4 spills,
- no fatalities
Safety record on Shipping of LNG

- 2 Ship fires recorded after 50 years of operation
  - 1964, MS Methane Progress – Lightning struck vent riser and ignited vapor - extinguished
  - 1965, MS Methane Progress – Lightning struck vent riser and ignited vapor – extinguished

Sours: California Energy Commission + La'o Hamutuk
Safety record on Shipping of LNG

4 Spills and leaks after 50 years of operation:

- 1965, MS Methane Princess – LNG from prematurely disconnected loading arm – fracture in deck plate
- 1974, Massachusetts Barge – LNG thru 1” Nitrogen-purge valve – fractures in deck plates’
- 1977, MS Aquarius – LNG overflowed thru vent mast (roll ower)
- 1979, MS Mostafa Ben Bouliad – LNG thru check valve – fractures in deck plates

Sours: California Energy Commission + La’o Hamutuk
Norway – Leading in use of LNG in Shipping

- First ferry in 2000
- Research on gas engines since 1980
- Good LNG supply
- 29 ships in operation
- 11 under building
- Notable international interest
Positive proof of global warming.

RA II focus on environment

17th of May 1970: Morocco to Barbados
Norwegian use of LNG in shipping

Environment driven focus on use of LNG in Norwegian shipping

- Political decisions
- High NOx tax in Norway
- IMO – MARPOL Annex VI
  - ECA
- EU - Sulphur directive
Norwegian experience on emission

- **Particles**: MDO - 1% S has significantly higher emissions compared to LNG.

- **SOx**: LNG has lower emissions compared to MDO - 1% S.

- **CO2**: MDO - 1% S has higher CO2 emissions than LNG.

- **NOx**: LNG has lower NOx emissions compared to MDO - 1% S.

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## 29 LNG fuelled ships flying NIS/NOR flag

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**NIS/NOR**

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The World’s largest LNG-Powered Ferry, December 2011. 130x19,2m, 242 cars or 22 trailers + cars on lower deck. NOX red 90% compared to diesel.
MS Tidekongen LNG Powered passenger ferry, July 2009. 50x12,1m 628 pax. (1of 3 in OSLO)
11 New LNG ships to NOR/NIS flag

2012 Car/passenger ferry
2012 Car/passenger ferry
2012 Car/passenger ferry
2012 Car/passenger ferry
2012 Car/passenger ferry
2012 Kleven no: 346 PSV
2013 Kleven no: 347 PSV
2013 Car/passenger ferry
2013 Car/passenger ferry
2013 TUG
2014 ROPAX
2014 TUG

10 more expected in 2012

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Bunkering of LNG

- From shore based tank farms, at LNG plants
- From shore based tank farms, refilled through Costal LNG tanker
- From trailers on quay / ferry terminal (most common method today)
LNG – production facilities in Norway

• Tjeldbergodden LNG plant
• Kolsnes LNG plant
• Karmøy LNG plant
• Risvika LNG plant
• Snøhvit LNG plant
  (first export plant in Europe)
Major LNG supply terminals in Norway

- **LODINGEN**
  - MOSKENES
  - BODØ
  - Barents Naturgass
  - Terminaler 150 – 250 m³ (ferdig 2012)

- **ÅLESUND, Naturgass Møre**
  - Terminal 1366 m³

- **ÅGOTNES (CCB), Gasnor**
  - Terminal 450 m³

- **HALHJEM, Gasnor**
  - Terminal 1000 m³

- **RISAVIKA (Stavanger)**
  - Skangass
  - Fabrikk/Terminal 30 000 m³

- **HAMMERFEST, Barents Naturgass**
  - Bunkringsportal 100 m³

Approval of Ships using LNG as fuel
Safety record for LNG fuel system (NO)

• No reported or recorded accidents
• Some backfire in engine manifolds due to sudden change in load. (Otto motors w/ electric ignition)
• 2 cases of blackout on new ferry's and consequential anchor dropping– reason not known but possible unstable gas heating.
• One heavy crash with quay due to failure in maneuvering system – No problem with the LNG tank or gas system (Glutra)
approval of Ships using LNG as fuel
Accidents in conjunction with bunkering (NO)

- One problem with valve system on semitrailer. Very small spill onshore.
- One leakage on hose and a small spill of LNG onshore (1 litre)
- No other accident recorded.
Safety for LNG trailers in Norway

A history of 12 years operation with more than 40,000 loading and unloading operations to ships, industry and local feeder tank farms

- One leakage on horse during loading of truck and a small spill of LNG onshore (2 litre)
- One trailer that ran out of the road in 2002. No LNG spill and trailer recovered
- A second trailer ran out of the road in 2010. No LNG spill and trailer recovered
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Norwegian Experience in LNG as Shipping fuel

• Status June 2012
  - NMA concludes that the safety of the LNG fuelled ships is good, but notes that most LNG shipping operations to day are focused with dedicated bunkering arrangement.

  - A general increase LNG shipping activity may require standard solutions which can be utilized by “any” LNG ship.
Norwegian regulations on LNG fuelled ships

• Regulation in force

• Some of the strict rules are already lifted
  Today use of IMO Resolution MSC 285(86) Interim Guideline on safety for natural gas-fuelled engine installations in ships, accepted on passenger ships.
Gas-fuelled passenger ships - NMA regulations

- Applies to all passenger ships with more than 12 pax
- Unclassified ships:
  - Gas related matters not regulated by NMA shall be in acc. to DNV rules currently in force for gas-fuelled engine installations
- Classified ships:
  - Gas related matters not regulated by NMA shall be in acc. to DNV rules currently in force for gas-fuelled engine installations or equivalent rules of other recognized classification society
Gas-fuelled passenger ships - NMA regulations

• ISM required for all gas ships
• A comprehensive safety assessment of the ship’s gas concept and selected solutions including;
  – concept analysis
  – emergency preparedness
  – explosion analysis

• Safety level to be equivalent to the safety level of a new diesel-powered ship
Gas-fuelled passenger ships - NMA regulations

• Requirement on collision
  – Be able to hitting an unyielding object head on at 2/3 of operational speed without accident on board due to gas discharge
  – Allowance for a kinetic energy $E = \frac{1}{2} (\Delta + m) v^2$
    » $\Delta$ ship displacement in tons
    » $m$ trailing mass of water (0.1$\Delta$)
    » $V$ speed to be 2/3 of operational speed but not less than 5.1 m/s
  – Ship to withstand 2g side collision (not in force now)

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Gas-fuelled passenger ships - NMA regulations

- Regulates arrangements and design of explosion hazardous spaces and areas
  - Gas engine room
  - Tank spaces/bunker tanks
  - Bunker stations
  - Ventilation
  - Gas piping arrangement
  - Gas detection systems
  - Gas engine regulation and control
  - Fire protection
  - Electrical systems
Gas-fuelled passenger ships - NMA regulations

- Testing and control of gas-related equipment and arrangements before ships are placed in service
- Training
- Operation
Norwegian regulations on LNG fuelled ships

- Training requirements for the ship crew
  - Level 1  General for all crew (safety crew)
  - Level 2  Deck officers
            Engineer officers
Regulations on bunkering of LNG in Norway

Passenger ships, RORO ships and Cargo ships

- Written specific procedure to be established for each method of bunkering to be utilized (Also to be in acc. to the regulations from Directorate for Civil Protection and Emergency Planning - DSB (http://www.dsb.no/no/toppmeny/English/))
Regulations on LNG bunkering of ships

- Bunkering from shore to ship is regulated by the:
  - The Directorate for Civil Protection and Emergency Planning – DSB

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Ensuring Safe Bunkering of LNG

The important question now:

• Is it feasible to have passengers on board and to load or unload passengers or cargo whilst re-fuelling?

• Yes, if safe bunkering systems and the right safety measures are established, used, controlled and maintained
Cooperation for new regulations

• Common risk assessment of LNG bunkering operations both from shore and between ships

• A Nordic meeting between shore authorities and maritime authorities
What may Safe LNG Bunkering Systems be?

- Generic safety level equal to MDO systems
  - Standard connections to ship LNG bunkering station
  - Mechanical single action coupler – no manual bolting
  - Cold Gas return piping (no planned venting allowed)
  - No spill due to single failure – double barriers
  - No spill when decoupling – dry break system
  - Valve- and pipe design to allow sudden shut down (5 sec)
  - Weak link – break-away with dry-break function
  - All areas possible exposed to LNG to be of cryogenic safe materials (also if first barrier fails)
  - Water curtains
What may Safe LNG Bunkering Systems be?

- Drip trays to be fitted
- Gas and Nitrogen purging system
- ESD control system between shore and ship systems to be linked
- Fail Safe Systems, not dependable on operators
- Safety zone for any destructive forces / ignition source
- Risk assessment on the significant bunkering solution
- Safety work permit, before any bunkering operation
- Plan for emergency preparedness
- Plan for change in safety alert level and safe evacuation
- Standard ship bunkering regulation (EU. WW)
International regulations – the IGF code

- 2004 Proposal from Norway to develop gas code
- 2009 Interim guidelines on safety for natural gas-fuelled engine installations in ships was adopted in June 2009 Resolution MSC.285(86)
- 2013 Draft International Code of Safety for ships using gases or other low flashpoint fuels – to be ready
- 2014 Adoption by MSC
- 2016 In force

IMO
Safe use of LNG – Important work in ISO

ISO TC 67/WG 10 (Guidelines for systems and installations for supply of LNG as fuel to ships)

- Minimum requirement for the procedures, training and equipment necessary to ensure the safe LNG bunkering operations of gas fuelled ships from; bunkering vessels and barges, and onshore installations, either from fixed storage tanks or LNG trucks.
Norwegian regulations on LNG fuelled ships

• If questions regarding how to build and or operate vessel under the Norwegian flag:

Look for info at: www.sdir.no or
Send an e-mail: post@sdir.no or
Call us on +47 52745000

You are welcome!
As we safely dive into the future:

Thanks for Your Attention!