SEAGAS LNG distribution to Viking Grace

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Background
LNG Bunkering approval process
SEAGAS
Summary
AGA’s LNG-terminal in Nynäshamn started up in March 2011.

AGA signed a contract with Viking Line in January 2012 regarding the delivery of LNG to Viking Grace.

AGA signed a contract with Sirius in June 2012 regarding the operation of SEAGAS.
IMO Directive 2015 – reduction of sulphur dioxide emissions, limiting the maximum sulphur content of marine fuel to 0.1% in SECA* from 2015

LNG is the cleanest marine fuel with substantial environmental- and health advantages compared to oil

<table>
<thead>
<tr>
<th>CO2</th>
<th>NOx</th>
<th>SO2</th>
<th>Particles</th>
</tr>
</thead>
<tbody>
<tr>
<td>-25%</td>
<td>-80%</td>
<td>-100%</td>
<td>-100%</td>
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</tbody>
</table>
AGA | Distribution av LNG till Viking Grace

- LNG distribution to VG today -
AGA | Distribution av LNG till Viking Grace

- LNG distribution to Sthlm tomorrow… -

"SEAGAS 2"
The SEAGAS Concept/Approval – General Concept Idea

<table>
<thead>
<tr>
<th>TIP</th>
<th>Media</th>
<th>Pressure barg</th>
<th>Flow l/min</th>
<th>Volume m³</th>
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<tr>
<td></td>
<td></td>
<td>min</td>
<td>normal</td>
<td>max</td>
</tr>
<tr>
<td>10</td>
<td>GNG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>LNG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>LNG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>LNG</td>
<td></td>
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</tr>
</tbody>
</table>

LNG Trailer comb.

LNG bunker barge

RoPax vessel

PRELIMINARY
CS-010 2010-11-08
PRE FUELING MEASURES
- Mooring
- Connect Hose
- Pressure test and ramp up

LNG TRANSFER
- LNG Transfer

POST FUELING MEASURES
- Strip/Purge
- Departure

In total max 60 mins!
In December 2010 AGA applied to the Swedish Transport Agency for permission to perform bunkering in the Port of Stockholm.

A lack of regulation and support documents covering the handling of LNG in a maritime environment is the reason why AGA have performed a number of risk & safety analyses to better understand and handle potential risks related to LNG operations.
## Approval process

<table>
<thead>
<tr>
<th>AGA</th>
<th>Viking Line</th>
<th>Sirius Shipping</th>
<th>Swedish Transport Agency</th>
<th>County Administrative Board</th>
<th>Ports of Stockholm</th>
<th>City of Stockholm</th>
<th>Fire Brigade</th>
<th>The Swedish Police</th>
<th>Swedish Coast Guard (KBV)</th>
<th>Swedish Civil Contingencies Agency (MSB)</th>
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<tr>
<td>AGA</td>
<td>Sirius Shipping</td>
<td>Cryo</td>
<td>Swedish Transport Agency</td>
<td>Fiskerstrand Verft</td>
<td>Viking Line</td>
<td>DNV</td>
<td>Mann-Teknik</td>
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</table>

## SEAGAS

| AGA | Sirius Shipping | Cryo            | Swedish Transport Agency  | Fiskerstrand Verft          | Viking Line        | DNV              | Mann-Teknik  |                   |                            |                                  |
Risk analyses - Content

1. RISK ANALYSIS PART 1 - General ("generic") risk analysis studying the LNG supply vessel movements in Stockholm harbor → vessel movements, operational instructions

2. RISK ANALYSIS PART 2 – Risk analysis (generic and platform independent) related to the bunkering operation. Dissemination calculations → Safety zones, Bunkering procedure, Vessel design, Cryo installation design

3. RISK ANALYSIS PART 2b – Risk analysis where collision and seakeeping between LNG fuelling vessel and another vessel were studied. → Vessel design
The SEAGAS Concept/Approval – Risk Assessment

Grundstötning/grundkänning
Kollision med kaj / bro eller dylikt
Kollision mellan fartyg
Maskinhaveri
Safetyzone 25 m around LNG fuelling vessel

Figur 1: Säkerhetszon (orange) och riskområde vid tow-away händelse med break-away koppling 6″. Vit: 25% LEL, blå: LEL, röd: UEL, cyan: jetbrand (3kW/m²)
Swedish Transport Agency 2013-03-19
"Transportstyrelsen have no objections to the risk identification and the analysis”.

City of Stockholm 2012-04-05
"No other actions are needed besides those suggested”.

County Administrative Board – “The proposed activity does not risk polluting or affecting the quality of water”.

The SEAGAS Concept/DESIGN

Concept 1

IGF-code "Inspired"

NOTE:
Cold box is defined as cargo area.
LNG tank is a double walled, vacuum insulated tank.
All gas connections from tank are located in cold box.
The SEAGAS Concept/DESIGN

Full IGC-code design
Comparison concept 1 and 2
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- SEAGAS sept 2012 -
AGA | Distribution av LNG till Viking Grace

- SEAGAS sept 2012 -
AGA | Distribution av LNG till Viking Grace

- SEAGAS jan 2013 -
AGA | Distribution av LNG till Viking Grace

- SEAGAS march 2013 -
The SEAGAS Concept/BUILDING

SEAGAS March 2012 – First meet with M/S
AGA | Distribution av LNG till Viking Grace

- SEAGAS march 2013 -
LNG Training in general

Category A: Basic training for the basic safety crew
Category B: Supplementary training for deck officers
Category C: Supplementary training for engineer officers

SEAGAS and Viking Line

• A: Theoretically “short” version.
• B & C: Theoretically “long” version, STCW “Gas Course”
• C: In addition, in-depth theoretical LNG course for engineers, System Specific training from Linde/Cryo AB and Wärtsilä respectively
The SEAGAS Concept/Operation – Training
Fueling procedure

1. Pre fueling actions, (abt. 5 min)
   * Tank system check, Mooring eq. Chk.
   * Fueling hose, mooring, connection of hoses, etc

2. Bunkering, LNG Transfer, (abt. 45 min)
   * Open LNG-valve, monitoring

3. Post fueling actions, (abt. 10 min)
   * Hose- and coupling handling, stripping of fueling lines, un-mooring
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- SEAGAS march 2013 -
- Dry Disconnect Coupling -
LNG/year 22500 ton = 50000 m³
Bunker barge capacity ~ 70 ton
Bunkering to Viking Grace 6 times/week → 5 times/week
LNG truck capacity 25 ton
Trucks/day 2-3
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- Bunkring Truck-to-ship -
The retrofit of a car-ferry to an LNG carrier is possible and well a working platform for LNG fuelling operations.

More than 640 fuelling operations performed since April 7th 2013! About 6 fueling operations are being done every week.

The developed procedures for ShipToShip transfer as well as TruckToShip transfer are tested and proven.
AGA has contributed to a new infrastructure solution for handling of LNG in the Port of Stockholm which allows for the following bunkering procedures:

• Ship-to-ship bunkering
• Truck-to-ship bunkering
• Stationary LNG tank on the quay is also possible

The processes are flexible and can be adapted to local conditions and other ports.
- The future -

- The belief in LNG as a viable fuel increases
- Many ship owners are investigating and planning for the use of LNG as fuel. Cruise ships → All types ships
- New design regulations for LNG-powered ships will facilitate their development
- ”All” ships can be powered by LNG
Thank you!

Jonas Åkermark

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