PROCEDURES AND DEVICES PROVIDING THE SAFETY DURING LNG OPERATIONS (VC04)

Habil. Dr., prof. Vytautus Paulauskas
KSRC
MAIN LNG DATA

• Density – about 400 kg/m³
• Composition
• Storage temperature - 163°C
• Safety first
ADVANTAGES OF GAS LIQUEFACTION

http://www.beg.utexas.edu/energyecon/lng/LNG_introduction_07.pdf

Typical Natural Gas Composition

- Methane: 82%
- Other: 19%
- Ethane
- Nitrogen
- Propane
- Carbon Dioxide
- Butane
- Pentane

Typical LNG Composition

Examples of LNG composition are shown below:

<table>
<thead>
<tr>
<th>Source</th>
<th>Methane</th>
<th>Ethane</th>
<th>Propane</th>
<th>Butane</th>
<th>Nitrogen</th>
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</thead>
<tbody>
<tr>
<td>Alaska</td>
<td>95.72</td>
<td>0.06</td>
<td>0.0005</td>
<td>0.0005</td>
<td>0.20</td>
</tr>
<tr>
<td>Algeria</td>
<td>86.90</td>
<td>9.35</td>
<td>2.33</td>
<td>0.03</td>
<td>0.71</td>
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<tr>
<td>Baltimore Gas &amp; Electric</td>
<td>93.32</td>
<td>4.66</td>
<td>0.84</td>
<td>0.18</td>
<td>1.01</td>
</tr>
<tr>
<td>New York City</td>
<td>98.80</td>
<td>1.40</td>
<td>0.40</td>
<td>0.10</td>
<td>0.13</td>
</tr>
<tr>
<td>San Diego Gas &amp; Electric</td>
<td>92.90</td>
<td>6.00</td>
<td>1.00</td>
<td>-</td>
<td>1.00</td>
</tr>
</tbody>
</table>

MAIN LNG OPERATIONS

• Loading LNG from carrier to LNG storage facilities
• Loading from LNG storage facilities to LNG small carriers
• Unloading LNG from small LNG carriers to LNG bunkering stations
• LNG bunkering operations
PROCEDURES FOR THE LOADING LNG FROM CARRIER TO LNG STORAGE FACILITIES

- Port preparation for the LNG tanker entry in to the port
- Terminal preparation for the LNG tanker mooring
- Terminal preparation for the LNG loading to LNG storage facilities
- Link LNG tanker to the LNG unloading system
- Testing's before start LNG unloading from LNG tanker
- LNG unloading operation to LNG terminal storage facilities
- Procedures after LNG unloading
- LNG tanker departure from port
PORT PREPARATION FOR THE LNG TANKER ENTRY (PORT REGULATIONS)

• Information about LNG tanker entry in port (after leaving loading port)
• Addition information about entry in anchor area 72 h, 48 h, 24 h, 12 h, 4 h
• Pilotage
• Use tugs
• Limitations of the ships sailing in port during passing LNG tanker
LNG TANKER ARRIVAL IN PORT

- PILOT MEETING AREA *(Start port procedures)*
- LNG TANKER ENTRY TO PORT APPROACH CHANNEL *(port tugs in positions and start work)*
- LNG TANKER IN PORT GATE *(start limitations for the ships moving in port area, regulate by VTS)*
LNG TANKER INSIDE OF THE PORT

- 1,5 n.m. in front of LNG tanker and 0,5 n.m. astern of the LNG tanker no any ships movements
- moored to quay wall ships must take precautions for the safe loading operations
- Ships in port astern 0,5 n.m. or more of LNG tanker can start movement
TERMINAL PREPARATION FOR THE LNG TANKER MOORING

• Quay wall or FSRU preparation for the mooring operations (*Terminal regulations or ISM Code procedures*)

• Mooring scheme preparation and confirmation between terminal (FSRU) and LNG tanker (*ISM Code*)

• Mooring team instructions (*ISM Code*)

• Mooring equipment preparation (*ISM Code*)
LNG TANKER IN LNG TERMINAL AREA

• On FSRU or LNG terminal must be ready for the mooring operations
• on FSRU or LNG terminal mooring team must be ready for mooring operations
SHIP’S MOORING PROCEDURE

• Mooring scheme preparation. Discuss and agreed
Instruct of the teams participate in mooring procedure
Mooring equipment visual evaluation
Mooring mechanism testing
Mooring ropes (lines) preparation
Mooring procedure check list fulfil
Physical mooring operation and recognition
depends of the situation

• Mooring procedure should be executed according
ISM Code mooring procedure
LNG TANKER IN SHIPS TURNING BASIN (basin must be free)
LNG TANKER ARRIVE TO MOORING POSITION

- On LNG tanker and LNG terminal must be ready for the mooring operations
- Port tugs must properly work, working language
- ISM Code, Terminal regulations
MOORED LNG TANKER TO FSRU
(mooring operation finished)
USING MOORING HOOKS (useful information for operation and investigation)
SPECIAL LNG LOADING EQUIPMENT

• VAPOR MIXER AND HIGH AND LOW PERFORMANCE HEATER

• LOW AND HIGH PRESSURE COMPRESSORS
SHORE TERMINAL AND LNG TANKER LOADING SYSTEMS LINK BY ARMS OR BY PIPES
FLANGE CONNECTIONS

- Must be properly used devises, on every operation must be at least 2 persons
- All connection details must be checked and have valid certificates
TERMINAL OR LNG TANKER PREPARATION FOR THE LNG LOADING

• Tanks preparation (cooling off up to 0 degrees by dry nitrogen) (duration about 40 h)

• Tanks cooling off and fulfil by inert gas used low pressure compressor or without it (temperature decrees up to -45 degrees, duration about 20 h)

• LNG from tank for cooling off storage tanks and fulfil by LNG vapor (duration about 20 h)

• LNG tankers or storage tanks later cooling off and inert gas push out from tanks and future fulfil tanks by lng vapor (temperature decrees up to -130 degrees, duration about 10 h)
LNG UNLOADING FROM LNG TANKER ON FSRU OPERATION (must be control from ships bridges and in pipes connection places)
LNG TANKERS OR SHORE STORAGE TANKS LOADING BY LOADER EQUIPMENT IN NORMAL CONDITIONS AND IN NON STANDARD CONDITIONS (intensively up to 10000 cub. M per h)
WATER FLOW UNDER PIPES (to avoid ships construction damages in case of LNG leakage)
LNG LOADING DATA IN LNG CONTROL ROOM (tanks fulfil up to 98 %)
PROCEDURES AFTER LNG UNLOADING

ICE WASHED OFF FROM LNG LOADING PIPES

LNG PIPES DISCONNECTED (LNG terminal procedures)

LNG TANKER UNMOORING OPERATIONS (ISM Code)

LNG TANKER DEPARTURE LNG TERMINAL (port regulations)
LNG TANKER SAIL IN BALLAST
(LNG in tanks up to 5 %)
LNG TANKER PREPARATION FOR THE SHIP YARD

The High-duty compressors circulate the gas, and the heaters warm it up.

LNG TANKER TANKS
FULFIL BY INERT GAS

LNG TANKER TANKS
VENTILATION AND
FULFIL BY AIR

Operation duration:
- 36 hours (up to 72 hours)

Performance limits:
- Tank secondary barrier temperature: -5°C

Begin of Operation:
The H/D compressor circulates the gas, and the heaters warm it up.

The remaining LNG in the tank is vaporized.

Some hours later...
Warming-up is finished when the tank reaches 0°C.

Part-financed by the European Union
(European Regional Development Fund)
CONCLUSIONS

• LNG tanker’s arrive in to he port is typical ships entering in to the port routines
• Very accurate preparation port, LNG terminal and LNG tanker must be fellow LNG terminal and ISM code requirements
• LNG tanker operation could be optimize on basis good planning and execution of the main tankers and LNG terminal operations
TRANSFER/BUNKERING OPERATION OF LNG (VS01)

Habil. Dr., prof. Vytautas Paulauskas
KSRC
LNG TRANSFER FROM LNG IMPORT TERMINAL TO SHIPS AND BUNKERING STATIONS

• LNG transfer by small LNG tankers
• LNG transfer by trucks
• LNG transfer by rail tanks
• LNG transfer by LNG tank-containers
SMALL SCALE LNG TERMINALS
SAFETY DURING LNG TRANSFER AND BUNKERING

• Legal basis of the safety during LNG transfer (*Countries Administrations Regulations*)

• Safety zones (*Countries Administrations regulations*)

• Actions in emergency situation (*Must be prepared in advance*)
LNG DANGEROUS OR NOT FOR PEOPLE HEALTH ???
KLAIPEDA LNG IMPORT TERMINAL SAFETY ZONES
LNG SMALL SUPPLY AND BUNKERING SHIPS

- LNG small supply Sea ships (capacity from 4000 m³ up to 15000 m³ of LNG)
- LNG small supply IWW ships (capacity from 400 m³ up to 2000 m³ of LNG)
- Port LNG supply ships (capacity from 200 m³ up to 1000 m³ of LNG)
LNG SUPPLY AND PORT TANKERS
PORT LNG SUPPLY SHIPS MAIN PARAMETERS

• Length up to 40 – 50 m
• Width up to 10 – 12 m
• Draft up to 3,5 – 5,0 m
• Capacity (LNG) from 200 up to 1200 m³
• Speed up to 10 knots
LNG FUEL SUPPLY IN EAST BALTIC PORTS MAIN CONDITIONS

• LNG fuel quantity on LNG supply vessel should be at least for the 1 – 2 ports (at least for 4 - 6 Ro-Ro vessels in one port)

• LNG supply vessel must have possibility fulfill at least 1 time per week on LNG terminal

• LNG supply vessel could provide LNG supply operations near quay walls or in port waters

• LNG supply vessel should be able supply LNG shore facilities
LNG SUPPLY SHIPS FOR THE EAST BALTIC SEA MAIN PARAMETERS

- Length up to 100 - 115 m
- Width up to 12 – 16 m
- Draft up to 5,5 – 6,5 m
- Capacity (LNG) up to 5000 – 9000 m³
- Speed up to 14 – 16 knots
LNG LOADING ON LNG SUPPLY TANKER
SUPPLY SMALL SCALE LNG TERMINAL IN KLAIPEDA
LNG BUNKERING FACILITIES IN BALTIC SEA (Planning)
SHIPS LNG BUNKERING SYSTEMS
BUNKERING FROM MULTIPLE TANK TRAILERS

4 Tank Trailers
Serial or Parallel Connections
2 Pumps each with 60 m3/h
Flow rates 120 m3/h
LNG BUNKERING – INTERMEDIATE TANK ON QUAY

2 x 300 m³ tanks

Pump unit

2 x 65 m³/h pumps

Flow rates from 40-130 m³/h

One truck loading point
LNG BUNKERING – STATIONARY STORAGE TANK WITH MULTI TRAILER

- 40 - 320 m³/h bunkering flow
- 5-450 m³ per bunker operation
- Optionally equipped with PBU for fast bunkering
- Ideal to achieve high flow and maximum flexibility
- Possible to increase capacity and flow rate in phases
MULTIPLE FUEL STATION

- 400 m³ & 30 m³ LNG storage tanks
- LNG transfer pumps
- LNG measurement system
- LNG bunker system on the quay
- LNG and CNG filling station for road transport
BUNKERING CAPACITIES AND INTENSIVELY
LNG BUNKERING STS SAFETY ZONE
SAFETY FIRST (at least 2 persons must be on important operations, but???)
PERSONAL EDUCATION AND TRAINING
A Cap for Natural Gas Prices in the Region

Average annual natural gas import price

EUR/ MWh

Klaipėda LNG Terminal is in Operation

LNG price sets natural gas price cap

2012 2013 2014 2015 H1

EU average RU-DE boarder Regional average Lithuania NBP+3_LT, LV, EE, FI

Part-financed by the European Union (European Regional Development Fund)
CONCLUSIONS

- LNG transfer from LNG import terminals to ships and bunkering stations could be by LNG supply vessels, trucks, tank-containers.
- Safety during LNG transfer must be on basis fulfil IMDG Code, ADR Agreement, etc. basis.
- Safety during bunkering operations must be fulfil according terminal safety regulations and ISM Code on LNG ships.
- LNG ships and terminals personal education and train is the main way minimize non standard situations.
THANK YOU FOR YOUR ATTENTION

Questions?