PROCEDURES AND DEVICES PROVIDING THE SAFETY DURING LNG OPERATIONS

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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
MAIN LNG DATA

- Density – about 400 kg/m³
- Storage temperature - 163°C
- Safety first in all LNG operations
ADVANTAGES OF GAS LIQUEFACTION

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>
</tr>
</thead>
<tbody>
<tr>
<td>Alaska</td>
<td>99.72</td>
<td>0.06</td>
<td>0.0005</td>
<td>0.0005</td>
<td>0.20</td>
</tr>
<tr>
<td>Algeria</td>
<td>96.98</td>
<td>0.35</td>
<td>2.33</td>
<td>0.53</td>
<td>0.71</td>
</tr>
<tr>
<td>Baltimore Gas &amp; Electric</td>
<td>93.32</td>
<td>4.66</td>
<td>0.94</td>
<td>0.18</td>
<td>1.01</td>
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<tr>
<td>New York City</td>
<td>88.00</td>
<td>1.40</td>
<td>0.40</td>
<td>0.10</td>
<td>0.10</td>
</tr>
<tr>
<td>San Diego Gas &amp; Electric</td>
<td>92.00</td>
<td>6.00</td>
<td>1.00</td>
<td>-</td>
<td>1.00</td>
</tr>
</tbody>
</table>

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

600 m³  →  1 m³
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 into 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. in 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 the 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 devices, 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 decreases 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**
  - Operation duration: 36 hours (up to 72 hours)
  - Performance limits: Tank secondary barrier temperature: -25°C

- **LNG TANKER TANKS VENTILATION AND FULFIL BY AIR**
  - 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.

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CONCLUSIONS

• LNG tanker’s arrive in to the 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
THANK YOU FOR YOUR ATTENTION

Questions?