PROCEDURES AND DEVICES PROVIDING THE SAFETY DURING LNG OPERATIONS

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Content

• Main LNG data and devices

• Main LNG operations
  – Procedures for the loading LNG from carrier to LNG storage facilities
  – Procedures for the loading from LNG storage facilities to LNG small carriers
  – Procedures for the unloading LNG from small LNG carriers to LNG bunkering stations
  – Procedures during LNG bunkering operations
MAIN LNG DATA

• Density – about 400 kg/m$^3$
• Composition
• Storage temperature - 163$^0$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

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>96.90</td>
<td>3.05</td>
<td>2.23</td>
<td>0.03</td>
<td>0.71</td>
</tr>
<tr>
<td>Baltimore Gas &amp; Electric</td>
<td>93.32</td>
<td>6.66</td>
<td>4.66</td>
<td>0.94</td>
<td>1.01</td>
</tr>
<tr>
<td>New York City</td>
<td>90.00</td>
<td>1.60</td>
<td>0.40</td>
<td>0.10</td>
<td>0.13</td>
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<tr>
<td>San Diego Gas &amp; Electric</td>
<td>92.60</td>
<td>5.00</td>
<td>1.00</td>
<td>-</td>
<td>1.00</td>
</tr>
</tbody>
</table>


Part-financed by the European Union (European Regional Development Fund)
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. astern of the LNG tanker no any ships movements)
LNG TANKER INSIDE PORT
(moored to quay wall ships must take precautions for the safe loading operations)
LNG TANKER IN PORT
(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

• Mooring team instructions

• Mooring equipment preparation
LNG TANKER IN LNG TERMINAL AREA (on FSRU or LNG terminal must be ready for the mooring operations)
LNG TANKER IN LNG TERMINAL AREA
(on FSRU or LNG terminal mooring team must be ready for mooring operations)
SHIP’S MOORING PROCEDURE

- Mooring scheme preparation. Discuss and agreed on 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 on the situation

- Mooring procedure should be executed according to 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)
LNG TANKER MOOVE TO FSRU
(port tugs must properly work, working language)
LNG TANKER MOORING TO FSRU START
MOORED LNG TANKER TO FSRU (mooring operation finished)
USING MOORING HOOKS
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)
FLANGE CONNECTIONS (all connection details must be checked and have valid certificates)
TERMINAL PREPARATION FOR THE LNG LOADING TO LNG STORAGE FACILITIES

FSRU tanks preparation (cooling off up to 0 degrees by dry nitrogen) (duration about 40 h)
LNG TANKER’S OR SHORE 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)
WATER FLOW UNDERPIPES (to avoid ships construction damages in case of LNG leakage)
LNG LOADING DATA IN LNG CONTROL ROOM (tanks fulfil up to 98 %)
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 DEPARTURE PORT (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 PREPARATION FOR THE SHIP YARD

- 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.

30'000 m³/h

52'500 kg/h
LNG TANKER PREPARATION FOR THE SHIP YARD

Some hours later...

Warming-up is finished when the tank reaches 0°C.
LNG TANKER TANKS FULFIL BY INERT GAS
LNG TANKER TANKS VENTILATION AND FULFIL BY AIR
LNG TANKER READY FOR SHIP YARD
THANK YOU FOR YOUR ATTENTION

Questions?