About SSPA
SSPA Sweden AB.

- Providing maritime consultancy services on a worldwide basis since 1940
- Independent consulting company, fully owned by the Foundation Chalmers University of Technology.
- Main clients; Maritime operators and shipyard industry, energy companies, industry, ports, authorities, European Commission, IMO, EMSA
- 20% internationally funded research
- 110 employees, 14 Million Euros

Bridge between theory and practice....
LNG projects at SSPA 1990 - 2014

• Over 50% of all LNG ship projects in the world ordered since 1990
• Over 450 LNG hull form configurations – designed and/or evaluated by SSPA experts
• LNG terminal designs and operations in USA, RazLaffan, Europe, Russia – Risk Analysis
• FLNG mooring, simulations, anchoring studies
• Strategic national and international papers
• SECA regulation related projects: ports, ship owners, gas suppliers etc.
Risk mitigation measures
SIGGTO LINK ESD connection

- Safe
- Relatively cost efficient
- Known technology
- Means for communication and data transfer is recommended by using a multiplexer on unused wires
- May provide a back-up system if more sophisticated e.g. fibre optical systems are used
Break-away couplings

- Safety break away couplings are designed to prevent pullaway accidents when loading or unloading tank trucks, railcars, vessels etc.
- Shall initiate ESD when pulled away
Dry Disconnect Couplings

To connect
Push and turn - it's coupled
- full flow

To disconnect
Turn and pull - it's released
- no spillage
Training and other measures

• Including risk and safety during planning phase
• Emergency planning
• Training of staff:
  – Familiarization
  – Basic training
  – Advanced training
  – Equipment specific training

  – Training for vessel staff
  – Training for terminal staff
  – Training for road tanker operators
Rules, regulations, guidelines and standards
LNG - rules and regulations
International level

- LNG fuel related rules and regulations still under development (GAP analysis)
- How should a vessel be certified and according to what guidelines and/or regulations
- The operator may build an “untradeable” vessel due to differing interpretations in different locations
• ISO standards and guidelines
• IMO Interim guidelines
• IGF Code
• IGC Code
• SIGTTO
• SGMF
• SOLAS
ISO 28460:2010 Installation and equipment for LNG STS interface and port operations

- Arriving at port/VTS area
- Transiting the port
- Mooring & Manoeuvring
- Unmooring & Manoeuvring
- Loading/Discharging LNG
- Transiting the port
- Manoeuvring & mooring
Bunkering scenarios
ISO standard for LNG bunkering

- Standard scenarios
  - Without simultaneous cargo operations
  - Without passengers onboard
- In case of bunkering during cargo operations, a quantitative risk assessment shall be performed to address effects of the simultaneous operations

SCOPE

Existing Regulations

LNG Supply Facilities

ESD

Onshore mobile supply

Shore-to-ship bunkering

Truck-to-ship bunkering

Ship-to-ship bunkering

LNG Bunkering Facilities

Receiving Ship

Existing Regulations

SSPA Your Maritime Solution Partner
ISO standard(28460-2010)
Installation and equipment for liquefied natural gas — Ship-to-shore interface and port operations (December 2010)

Scope:

• Pilotage and vessel traffic services (VTS);
• Tug and mooring boat operators;
• Terminal operators;
• Ship operators;
• Suppliers of bunkers, lubricants and stores and other providers of services whilst the LNG carrier is moored alongside the terminal.
ISO/TS 18683:2015 Systems and installations for supply of LNG as fuel to ships

• Scope:
  • Guidance on the minimum requirements for the design and operation of an LNG bunkering facility
  • Interface between LNG supply facilities and receiving ship
  • Requirements and recommendations for operator and crew competency, training
  • Functional requirements for equipment necessary to ensure safe LNG bunkering operations of LNG fuelled ships
Guidelines for ship to ship transfer

• Released March 2011, Scope: Applies to seagoing ships.
• Information exchange before, during, after LNG transfer
• Ship compatibility: Mooring, ESD, ERS, parallel body, vapour management etc.
• Procedures alongside: Cool down, Cargo transfer etc.
• Equipment: Cargo hoses, fenders etc.
LNG - rules and regulations
National and local

• Regulative and technical limitations when bunkering LNG
• The restrictions and regulations are most often set by ports or by national authorities
• Rules and requirements that differ from port to port for the same operator – sometimes during one and the same trip – can be a significant obstacle for shipping in shifting to LNG
National and local legislation and guidance

- National Rescue services
- Local rescue services
- Transport Administrations and Agencies
- County Administrations, Regional Adm or similar
- Ports
- Municipalities
LNG bunkering methods
Various types of bunkering solutions; ship-to-ship, truck-to-ship & terminal-to-ship via pipeline

In addition containerized solutions may become essential early solutions in the LNG market.
Recommendation (from DMA study 2013)

• (STS) bunkering is recommended to become the major bunkering method, where receiving vessels have a bunker volume from 100 m³. One LNG bunker vessel per receiving vessel only is appropriate if the turnaround time in port is to be kept short for customers. Typical capacity for LNG bunker vessels: 1,000 to 10,000 m³  (Rec. no. 1a)

• (TTS) bunkering is recommended for all sizes of terminals, where receiving vessels have a bunker volume requirement of a few cubic meters up to 200 m³  (Rec. no. 1b)

• The LNG terminal-to-ship via pipeline (TPS) bunkering solution is recommended for all different sizes of bunkering volumes and in terminals with recurrent customers and available space for associated bunker facilities  (Rec. no. 1c)
## Pros and cons of different bunkering solutions from a logistical and an operational perspective

<table>
<thead>
<tr>
<th></th>
<th>Ship to ship STS</th>
<th>Tank truck to ship TTS</th>
<th>Tank to ship via pipeline TPS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Advantages</strong></td>
<td>Flexibility</td>
<td>Flexibility</td>
<td>Availability</td>
</tr>
<tr>
<td></td>
<td>High loading rate</td>
<td>Low costs (investment and operation)</td>
<td>Large bunkering volumes possible</td>
</tr>
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<td></td>
<td>Large bunkering volumes possible</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Bunkering at sea (enlarged market)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Disadvantages</strong></td>
<td>Manoeuvrability in port basin</td>
<td>Small quantity</td>
<td>Fixed to certain quay</td>
</tr>
<tr>
<td></td>
<td>High costs (investment and operation)</td>
<td>Low loading rate</td>
<td>Occupy terminal space</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sunk costs</td>
</tr>
</tbody>
</table>
Suitable LNG bunkering solutions

- An LNG tank truck almost always has the same size, approximately 50 m³
- LNG bunker vessels and the intermediate LNG tanks can vary considerably in size.
- LNG bunker carriers may have a capacity ranging from 500 m³ up to 20,000 m³ depending on distance to supply, bunkering location, type of served clients and total bunker volumes.
- Intermediary LNG tanks, can range from 20 m³ for the small insulated pressurized tanks (“Type-C”) to 100,000 m³ for large import terminals.

<table>
<thead>
<tr>
<th>Type of vessel / Type of bunkering</th>
<th>STS</th>
<th>TTS</th>
<th>TPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>RoPax / RoRo Vessels</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Tugboats</td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Coastal Tankers / Bulk Carriers</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Container Feeder Vessel</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>LNG Feeder Vessels</td>
<td>1</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>LNG Bunker Vessels</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>LNG Tankers (140 000m3)</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Naval / Coast Guard Vessels</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Offshore Supply Vessels</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Smaller Passenger Vessels</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Larger Fishing Vessels</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>VLCC</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1: Best suitable LNG bunkering solution.
2: Suitable LNG bunkering solution, though not the best.
3: Unsuitable LNG bunkering solution for this vessel type.
Identified critical parameters for selection of suitable LNG bunkering solutions

- The LNG bunkering volumes
- Physical limitations in port
- Logistic issues
- Types of vessels and shipping companies
- Investment and operating costs
- Safety
- Technical and operational regulations
- Public communication
- Environmental and regulatory issues
Optional bunkering modes often governed under different jurisdiction frameworks.

STS – international maritime regulations

TTS - national regulations on road transportation of liquid flammable gases

TPS – national/ local permits on hazardous activities

**Recommendation (from DMA study 2013)**
The EU and national authorities are recommended to harmonise regulations and safety requirements for both land-based and sea based bunkering activities in order to attain a consistently high safety level and to avoid making safety issues a competitive factor between different bunkering modes. (Recommendation no. 10)
Import, production or intermediary terminal

1) Loading of feeder vessel or bunker vessel/barge

2) Transit of feeder vessel or bunker vessel/barge in the port area

3) Bunkering of LNG

Other ship traffic and port characteristics

Intermediary LNG terminal
# The bunkering process

<table>
<thead>
<tr>
<th>Before bunkering</th>
<th>During bunkering</th>
<th>After bunkering</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mooring</td>
<td>Cool down as needed</td>
<td>Shut manual valves</td>
</tr>
<tr>
<td>Checklist to receiving ship</td>
<td>Pump start</td>
<td>Inerting &amp; Purging of piping/hoses as needed</td>
</tr>
<tr>
<td>Connect ESD (SIGTTO)</td>
<td>Ramp up loading rate</td>
<td>Disconnection of liquid hose/arm</td>
</tr>
<tr>
<td>Connection of vapour return, if needed</td>
<td>Normal bunkering</td>
<td>Disconnect ESD (SIGTTO)</td>
</tr>
<tr>
<td>Connection liquid hose/arm(s)</td>
<td>Ramp down loading rate</td>
<td>Delivery cargo document</td>
</tr>
<tr>
<td>Open manual valves</td>
<td>Pump stop sequence</td>
<td>Disconnect vapour return, if connected</td>
</tr>
<tr>
<td>Ready signal both ships</td>
<td></td>
<td>Un-mooring</td>
</tr>
</tbody>
</table>
Thank you.

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More information?
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