The Technical & Practical challenges of FLNG


Jeff Baker – Energy Compliance Technical Manager, Australasia
The Technical & Practical challenges of FLNG
Lloyds Register’s role in FLNG

- Prelude - world’s first Floating LNG Project.
  - FEED design review at generic & project specific concept stage,
  - Verification, Certification, Classification and Validation services.


- Supporting publications including:
  - Surveys by ROV,
  - Risk based inspection for hull structures,
  - Risk based analysis for cryogenics spills,
  - Fire loading and protection,
  - Calculation of probabilistic explosion loads,
  - Technology Qualification.
Access stranded gas, using:

- Floating offshore or near shore structure permanently moored
- Subsea wells, via flowlines and risers (or other incoming supply)
- Fractionation and cleaning modules
- Liquefaction (refrigeration)
- Storage – LNG, LPGs and condensate (oil)
- Offloading - tandem or side by side
The Challenge

Combine new technologies, codes, standards and practice from three industries.

- Marine LNGCs
- Floating Offshore Installations
- Land based liquefaction

Complex supply chain

Significant new IP

Harsh environment
FLNG Design Issues

- New concept => risks associated with:
  - Process (restricted footprint versus land plant)
  - Vessel motions - effect on process plant
  - Process plant reliability (limited line pack available)
  - Storage of large quantities of process chemicals
  - Potential production and storage of multiple liquid and gas types
  - Managing Cryogenic fluids in proximity to large, critical hull structures
FLNG Design Issues

- Sloshing (dynamic loading of LNG CCS through filling range)
- Vessel strength and fatigue at fixed offshore location for (long) on station design life in harsh environments (e.g. Cyclone areas)
- Cooling water demands – uptake and discharge
- Very high Topsides – hull – turret loads
- Ballast tank hydrostatic head design issues
- Stationkeeping for offloading (tandem or side by side?)
- High mooring interface loads between FLNG and LNGC
- Very HV Power Generation and control - voltages beyond normal floating offshore and marine practice
- Fire and Blast challenges
- Dynamic Offloading Systems
- Regulatory issues
Challenges of Scale

- Largest floating offshore facility in the world
- Production from 2 MTPA to in excess of 6 MTPA
- Deck size more than 4 football fields
- Hull/substructure:
  - Deck area equivalent of four typical FPSOs
  - Volume equivalent of eight typical FPSOs
- Topsides facilities – four to five tiered modules over the same deck area + accommodation block and turret
- Operating weight is six times largest aircraft carrier
- One quarter size of onshore equivalent plant
- Equipment stacked vertically for space optimisation
- Cargo liquids containment capacity of 175 olympic size swimming pools
- All operating permanently offshore in depths of water from 100 to over 1000 metres

Image courtesy of Shell Australia
Size and scale versus current practice

- LNGC 50 m x 30 m
- LNGC 330 m
- Oil FPSO 60 m x 40 m
- Oil FPSO 330 m
- FLNG 75 m x 45 m
- FLNG 480 m
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Loads due to offshore outfitting

- Turret bearings
- Crane pedestals
- Lifeboat platforms
- Helideck
- Topside plant
- Flare stack
Topsides Layout and Loads

- Oil FPSO topsides – up to 40,000 tonnes?
- FLNG topsides – up to 90,000 tonnes?
- FPSO Module total typically 4,500t max, static reaction loads up to 1,250t, dynamic 2000t
- FLNG Liquefaction modules total 25,000 to 30,000t, dynamic reaction loads up to 4,000t
## Comparison of marine containment systems

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<thead>
<tr>
<th>Membrane</th>
<th>Moss</th>
<th>SPB</th>
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<tr>
<td>- No cool-down rate limit</td>
<td>- Less chance of damage by mis-operation</td>
<td>- Same as Moss, but:</td>
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<tr>
<td>- Good visibility from bridge</td>
<td>- Primary barrier fully gas-tight</td>
<td>- Good visibility from bridge</td>
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<tr>
<td>- Space efficient</td>
<td>- Visible secondary barrier</td>
<td>- Flat deck area is potentially beneficial for FLNG</td>
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<td>- Flat deck area is potentially beneficial for FLNG</td>
<td>- No barred fill ranges</td>
<td>- Prefabricated, possibly offsite</td>
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<tr>
<td>- Design company available for in-service advice</td>
<td>- Easier access for repair</td>
<td>- More space efficient than Moss</td>
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<tr>
<td>- Complex - Integrity of containment system depends on quality from many sub-contractors</td>
<td>- Expensive build facilities at shipyard</td>
<td>- In-service experience limited</td>
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<tr>
<td>- Potentially vulnerable to partial fillings - sloshing damage</td>
<td>- Domed tanks give poor deck area for FLNG and bridge visibility issues</td>
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Marine LNG Containment Systems suitable for FLNGs

Membrane Systems

- GTT Mark III
- GTT NO96

Independent Tanks

- Prismatic (SPB)
  - Stainless steel
  - Aluminium alloy
  (Also used for LPGs)

Source: IHIMU
Offloading Systems

- LNG
  - Side by side
  - Tandem Over-the-stern
  - Remote
- LPG
  - As LNG
- Condensate
  - Hose reels
  - Floating hoses over-the-stern

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Safety aspects - Cryogenics

• Trading gas carriers - Only manifold section needs to be considered:
  • Used periodically with loading arms connected and disconnected in benign conditions

• FLNG more complex - LNG rundown into storage tanks and liquefaction processes in constant use and at cryogenic temperatures
ANY QUESTIONS?

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