FSRUs: the interesting, the innovative, the avoidable

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Presentation documents:
Page 2: David Lee, Dunlop Oil & Marine
Page 9: Keith Hutchinson, Safinah Group
Page 17: Andrew Brown, Smit Lamnalco
FSRU – Innovative Hose Based Gas Transfer System
Innovative Bonded Gas Transfer Hose
Specifications

› Standard: API 17K 3rd Edition (API 17B)
› Internal diameter: 2 to 16”
› Design pressure: 10 to 120bar
› Design temperature: -30°C to 90°C
› Length: Up to 60m sections
› Fire rated cover: Yes (Certified to Lloyds OD1000/499)
Transfer Option 1 – FSRU to PLEM
Transfer applications for double banking FSRU-Ship-Shore

› Allows for extreme vessel excursions
› Optimised design concept
› Buoyancy devices & location collars
› Mitigate seabed & vessel clashing
› Detachable release system
Transfer Option 2 – FSRU to Jetty
Turnkey Solution for Jetty Arrangement

› 1. Flexible hose assembly
› 2. Jetty structure
› 3. Emergency release system
› 4. Distance sensing system
› 5. Hose recovery system (not shown)
Transfer Option 3 – Vessel to Tower Yoke Platform
Disconnectable Tower Mooring System
Innovative Bonded Gas Transfer Hose
In-house Dynamic & Fatigue Analysis

› Conceptual design to detailed engineering
› Static, quasi-static hose length analysis
› Hydrodynamic analysis
› Survival analysis
› Fatigue analysis
› Hose modelling Orcaflex
Innovative Bonded Gas Transfer Hose

Advantages

› Bespoke design
› 4-6 months lead time enabling fast track projects
› Lower investment
› 20-year design life
› Minimal maintenance
FSRUs – scalable and flexible solutions

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LNG Shipping
& Terminals
Webinar Week
Presentation Agenda

Introduction

1. LNG floating supply and utilisation chain
2. Floating, Storage and Regasification Units
3. Scalability and functionality
4. Execution and cost considerations

…

Questions? … and maybe answers!
1. Floating LNG Chain

Process / Liquefaction - FLNG

Transportation - LNGC

Regasification - FSRU

... and now supply to trading ships - LBV

FSRUs – scalable and flexible solutions, KW Hutchinson, Safinah Group
FSRUs: the interesting, the innovative, the avoidable - LNG Shipping and Terminals Webinar Week, Riviera Marine Media, Online (RMM Webinar), United Kingdom, 3rd August 2021
2. Floating, Storage and Regasification Units

○ FSRU is a moored, buoy or jetty, facility which receives LNG from a LNGC, stores and, as required, re-gasifies the LNG and exports the gas to shore via a pipeline

○ Flexible, cost-effective way to receive and process LNG where no onshore infrastructure exists or requirements are small / temporary

○ FSRUs are cheaper and quicker to build than onshore plants, hence suitable technology for low commodity etc. projects

○ FRSUs can be readily redeployed globally to meet market demand

○ Current fleet:
  - ~40 FSRUs operational worldwide - new-build and converted / modified LNGCs
  - ~15 FSRUs are on order – new construction and LNGCs being modified
  - ~40 FSRUs planned in the immediate future

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2. Floating, Storage and Regasification Units

◎ Size
10,000 to 350,000 metres\(^3\)

◎ Philosophy
LNCG conversion or new-build

◎ Deployment
Open water or harbour

◎ Mooring
Jetty, pile, spread, yoke, turret

◎ Re-use
Re-deployable – with / without refit

◎ Application
Centre of flexible utilisation chain?
3. Scalability and functionality

- **LNG Storage / Distribution Hub**
  - Small scale near-shore sheltered locations as well as offshore
    - Coastal LNGCs / inland LNGBs
      - ~1,000 to ~40,000 metres
    - LNG Bunker Vessels (LBV)
      - ~3,000 to ~20,000 metres – DO etc?
    - LNG Bunker Barges (LBB)
      - Inshore / harbour bunkering
    - Propelled Power Barge (PPB)
      - Shore supply to ships in harbour
      - Small, flexible, highly manoeuvrable
    - Land-based road or rail tankers

- **LNG Power Generation**
  - LNG Floating Power Barge (FPB)
4. Execution and cost Considerations

◎ Optioneering
Methodical but exhaustive Design Solution development
Comprehensive exploration multi-attribute Design Space
Robust Solution selection – technical and economic

◎ Design
Multiple Solutions developed in early stages
Objective and Subjective Attributes considered

◎ Engineering
Complex, exhaustive and realistic Programmes
Early Engineering – identify Long Lead Items
Mature System / Equipment Specifications
Vendor engagement / trade-off – cost reduction
Completion before Fabrication etc.

Cost / Stage

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That’s all folks!

... well, from me for now anyway until the Q&A!
Complex and challenging LNG transfer in near and offshore Floating LNG (FLNG FPSO, FSRU, FSU).

Andrew Brown – Business and Project Development Director.
What do we see today in Floating LNG?

- FSRU ships in high demand as buyers seek quicker route to LNG
- FSRU’s FSU’s offer emerging nations a cheaper, quicker way to attack power shortages by importing liquefied natural gas (LNG).
- “The main driver is speed,” We see that this has caused a very strong increase in requests.”
- Complexed offshore FLNG FPSO’s require a much higher operability competency
- Innovation: A variety of conceptual designs to meet the challenge of the location and/or environment
- Gas to Power & Gas to Grid combinations
- New challenges for Cargo transfer (SBS –STS)
- New players who do not have LNG background

Source: Statements from Bloomberg and the industry
New players
The various stakeholders –
• The gas customer
• The LNG supplier(s)
• The FSRU/FLNG provider,
• The local authorities including the port authorities
• Project financing

Consultants
➢ The first stage may start with an energy consultant who represents the gas customer.
➢ The consultant may include preliminary conceptual design work to ensure financial and technical feasibility which provides Capex boundaries.
➢ This can be a very fast process
➢ What may not be considered in this process is a detailed study on Opex and operational challenges
Three Key Factors for Floating LNG (FLNG FPSO’s, FSRU FSU)

**Operability**
- Understanding the operability parameters to ensure a safe and efficient offtake
- Spend considerable time and effort to fully understand the needs to meet the offtake
- Investment in simulation
- Mooring dynamics
- Risk assessment

**Operation**
Delivering the Operation:
- In a safe and efficient manner
- In accordance with the research and evaluation of the Operability parameters
- With all the components working together

**Delivery**
- Running a Safe and Efficient Facility
- LNG production
- Gas Delivery
- Transfer
- Cost effective
The components

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<thead>
<tr>
<th>Shipping</th>
<th>Terminal</th>
<th>Supporting Elements</th>
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<tbody>
<tr>
<td>• LNG ship-owner</td>
<td>• FSRU nearshore</td>
<td>• Governance</td>
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<tr>
<td>• LNG Charterer</td>
<td>• FSRU offshore</td>
<td>• Authorities</td>
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<td>• FLNG FPSO</td>
<td>• Marine services</td>
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The Client
- Gas to Power
- Gas to Grid
- Both
- Production

Emergency Response for Floating Terminals
What does this look like?
Emergency Response for Floating Terminals

Problem definition: In the event of an incident at a Floating Terminal, the current best practice in terms of design or operations may not be suitable.

Define the nature of the problem and the current best practice – identify clearly the gap and the associated risks:

- Floating solution still considered as temporary facility rather than a permanent facility.
- Services from the Floating terminal are varied – regas to shore, LNG to shore, reload to bunkering/small scale/conventional LNGC.
- Terminal set-up can be highly variable – (jetties, internal/external turrets, subsea gas lines, floating STS connections, etc.).
- **Multiple floating assets at the same facility** – FSRU, LNG, regas barges, power plant, integrated problem.
- New range of hazards not normally considered.

Identify most suitable emergency response option(s) for a range of incidents.
Provide guidance to developers on best practice points to consider.
Provide guidance to developers on operations and training that must be carried out.

Source: FSRU Solutions Ltd
Summary:

All components must work together to develop ER relevant to the operation and location.

New challenges (Double banking Emergency Response).

Ship to Ship to Shore links

All components to be involved with the risk assessment and mitigation

Education and Training

And More training
A Scenario Challenge:

Top Event: A mooring failure from the jetty

Hazard: What happens next?
Thank you and happy to answer any questions