Latest Trends - FSRU and FSU

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OVERVIEW

- Floating Storage Unit
- Types of LNG carrier
- Floating Storage regasification unit
- Business case for FSRU’s
- Land based LNG Terminal vs FSRU
- Conversion of LNG carriers into FSRU
- Mooring, loading arm regasification system and gas transfer
- Complexities
Floating Storage Unit (FSU)

- LNG Floating Storage Units are used for temporary storage of LNG before being transferred to the regasification system.
- FSU concept is typically based on chartering a conventional LNG carrier.
- LNG is loaded into the FSU by Ship to Ship Transfer operation.
Moss type LNG Carrier
Membrane type LNG carrier
FSRU’s

• FSRU’s are floating terminals where LNG is stored before being regasified.

• FSRU’s have ability to move from one demand centre to another.

• FSRU may be designed to trade also as a LNG carrier.
Floating Storage and Regasification Unit (FSRU)

Business case for floating storage and regasification centers on three issues:

• Economic attractiveness

• Technical acceptability &

• Flexibility as FSRU’s can be moved from one demand centre to another. Mitigates fluctuations due to seasonal demand.
In general FSRU’s cost less than land based schemes of a similar size.
FSRU’S

- General cost comparisons must be treated with caution, as the circumstances surrounding floating and land based developments can affect the cost of both significantly.

- In general FSRU’s may provide a faster return on capital.
• Attraction for FSRU’s also lies in the fact that residents tend to favor energy supply solutions that are situated far away from where they live…NIMBY syndrome.

• Attraction is also obvious in areas where economic growth is uncertain or where there is an element of political or economic instability.
Onshore terminal development may require extensive planning. Depending on the topography, it may also take more construction time as compared to the FSRU’s which are converted from an existing LNG carrier.

In LNG carriers, much of the required equipments are already available.

No generic solution to industry off shore’s regasification needs. Each FSRU has to be designed to meet the specific requirements of the charterer for particular project.
Construction and Design of FSRU
Floating Storage Regasification Unit

FSRU may be

- Purpose built

Or

- A LNG carrier converted to FSRU

FSRU’s are available in wide range capacities upto 305,000 cbm.
Typical details of a large purpose built FSRU

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
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<tbody>
<tr>
<td>Length overall</td>
<td>325m</td>
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<tr>
<td>LBP</td>
<td>325m</td>
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<tr>
<td>Breadth</td>
<td>55.0m</td>
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<tr>
<td>Depth</td>
<td>27.0m</td>
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<tr>
<td>Design draft</td>
<td>11.5m</td>
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<tr>
<td>Storage capacity</td>
<td>305,000 cbm</td>
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<tr>
<td>No of tanks</td>
<td>5</td>
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<tr>
<td>Containment</td>
<td>GTT No 96</td>
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<tr>
<td>Regasification capacity</td>
<td>6.5 MMTPA</td>
</tr>
</tbody>
</table>
Typical details of a FSRU converted from a LNG carrier

- Length-289m,
- Breadth-44.6m,
- Draft-11.4m

- Performance
  - Tank type-Moss
  - No of tanks- 5
  - Cargo tanks capacity-129,000cbm
  - Gas send out-2 MMTPA
  - Time for berthing loading and unberthing-24hrs
FSRU converted from LNG carrier

- No single factor to decide which type of LNG carrier makes the best FSRU.

- Availability and cost are the prime considerations when seeking candidate.

- Technically older Moss vessels are favored especially if intention is to just moor and vessel will not be utilized to trade LNG.
Converting LNG carrier into FSRU is simple in principle but execution is a challenge.

- Risk of suitability and quality of design;
- Quality of construction;
- On time delivery of vessel;
- High level of technical integration;
- Long lead times for specialist equipment

In general, time required is 18 months for engineering and 6 months for the shipyard work.
• Add vaporizers, loading arms and extra pumps to the LNG carrier, upgrade its power, electrical and control systems and you have an FSRU.

• Older vessels are generally more conservatively designed, more robust and provide easier foundations for major engineering modifications.

• More Modern membrane tank vessel, having efficient propulsion system is favored when intention is to continue using the vessel to trade LNG.
• The self supporting Moss type tanks have strong structural integrity and do not have operational cargo filling restrictions.

• A more modern membrane tank vessel has a more efficient propulsion system and may be more attractive if the intention is to continue using the vessel to trade LNG.
FSRU Storage capacity is dictated by the port and supply logistics.

Gas send capacities, temperatures and pressures will be influenced by maximum and minimum rate demands.

Mooring system design will depend on the local weather conditions and the jetty configuration.

FSRU’s communication links and ESD systems are integrated with the onsite LNG and natural gas handling systems.
The LNG tankers off loading to the FSRU may be moored in a side by side configuration.
This offloading tanker may also be moored across the pier.
Mooring

FSRU Terminal allows safe berthing of standard LNG carrier without need of extensive modification.

FSRU Terminal can also be moored to seabed with a turret mooring arrangement.

Turret is equipped with a turntable which allows 360 deg continuous rotation of the FSRU.
Loading Arms

- Standard loading arms to allow side by side transfer of LNG and vapor return.

- Loading arms similar to ones used on onshore terminals additionally modified to account for relative motions between carrier and FSRU.

- Fitted with equipment for guiding the arms onto the carrier’s connection flanges.

- Wide capacities FSRU’s with LNG capacity ranging from 1,25,000 cbm to 305,000 cbm are in operation.
LNG Regasification System

- LNG is sent from the tanks to the regasification skid. Which generally comprises of booster pumps and steam heated vaporizers. Few designs also use propane.

- The booster pumps will increase the pressure to about 85 to 90 bars.

- High pressure LNG is vaporized.

- Regasification can be both in open or closed loop mode.
Additional regas equipment fitted on one of the LNG carrier converted to FSRU
Skid Mounted Regasification unit
Gas Transfer

- May be via a riser to a subsea gas pipeline via gas swivel assembly.

Or

- May be designed to allow gas transfer via a high pressure loading arms fixed on the jetty
Depending on whether FSRU is permanently moored or to retain the flexibility as a LNG carrier FSRU may adopt characteristics of:

- An LNG carrier
- A land based regasification facility and/or
- An offshore floating crude oil storage and production unit

Charter Party to capture provisions accordingly.
Complexities of FSRU

- Technical specification must be robust capturing all the operational requirements.
- Vital to spend time with the end user, to make specifications of the FSRU as close as possible to the operational requirements.
- Converting existing LNG carrier into FSRU: Integration requires extreme efforts.
- High pressure associated with FSRU operations introduce a new set of risks not present on conventional LNG carriers.
- Operation and maintenance of the vessel.
Complexities of FSRU

- FSRU have upgraded fire and gas detection systems and fire fighting systems.

- In addition a more sophisticated emergency shut down system based on the rules for offshore oil and gas operations is provided.

- As an FSRU forms part of the shore infrastructure, EIA and assurance of vessels compliance with the local as well as international marine requirements are also central issues.
Chartering FSU’s

- Full fledged LNG carriers may be used as a FSU.
- Few LNG carriers built by shipowners for speculation remain open on offer most of the time.
- Shipowners owning old carriers may also remain interested in offering as FSU’s in sync with prevailing LNG carrier long term charter rates.
- Owners of New LNG carriers may not remain interested in offering as FSU for longer duration.
- New carrier not being used entirely on the account of propulsion and auxiliary machinery may generate speed warranty & machinery issues.
Chartering

- Unlike LNG carrier, FSRU’s is newly built or an existing LNG carrier is converted to FSRU when employment is in hand.

- Chartering is for relatively long term. Spot availability is difficult as very few owners FSRU’s are built by owners on speculation basis.

- Majority of the FSRU’s today under construction or delivered are already committed.
Summary

- Cost, speed of delivery and flexibility are the main advantages of FSRU’s.

- Concept of FSRU’s may provide in general a rapid and competitively priced turnkey alternative to a shore based gas terminal.

- FSRU business is challenging.

- It involves sound aggregation of shipping and energy technology, commercial skills and marine operating experience.
Thanks