



**Advisian**

WorleyParsons Group

# Alternative use of LNG tankers – converting traditional vessels and barges into FSRU/FSUs

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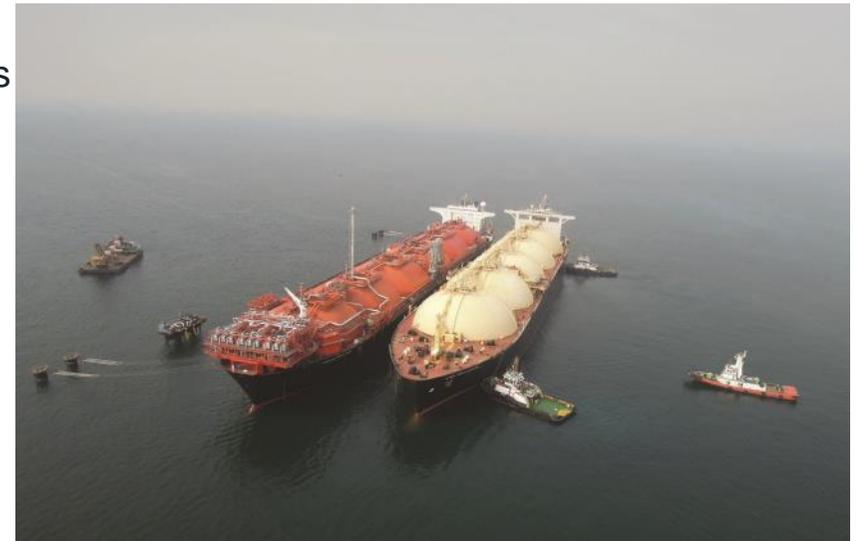
# Capability Overview

## World-class capabilities

Worley-Advisian has been involved in more than 40% of the world-wide nearshore regasification projects (planned and in operation), making Worley-Advisian a world leader as an independent engineering service provider to the FSRU and nearshore regasification market.

## Specific areas of expertise include:

- LNG regasification technology studies
- Hull integration of topside process equipment
- Selection of candidate LNG carriers for conversion into FSRU/FSUs
- Vessel hydrodynamic analysis for design of mooring systems
- Nearshore mooring design and breakwater design
- Coastal modelling, including sediment transportation dredging and
- Side-by-side and tandem offloading technology selection
- Hydrodynamic analysis of vessel interaction between floating LNG
- LNG supply logistics and planning
- Offshore and Onshore pipeline design including shore crossing
- Scoping and supervision of geotechnical, geophysical and metocean studies
- Regasification facility uptime/availability evaluation
- Gas demand and supply studies
- FSRU conversion and new build engineering





# Capability Overview



## Permitting/ Regulatory/HSE

Through Worley Parsons Environmental Group's EIS and regulatory project experience available in most local offices around the world, Worley Parsons can provide valuable insight and guidance through the permitting and regulatory process.



## Small Scale Regasification

The implementation of small scale LNG and hub-and-spoke models are part of our *Select* offering. Worley Parsons have developed a novel offshore regasification terminal based on a steel barge gravity foundation design with small LNG storage suitable for shallow water depth of up to 15m. This concept has been developed for regasification needs of less than 100mmSCFD.



## Gas to Wire Technology

With Worley Parsons Power Group we can integrate utility scale power generation on board FSRUs and can take full advantage of waste heat recovery for regasification and inlet air cooling. This capability is supported by our experience in subsea cabling technology and the design of smart power grid network system.



## Mooring System Design

Worley Parsons has designed mooring and riser system for the oil gas industry around the globe and offers the whole range of mooring systems design experience, from jetties to single-point moorings, spread moorings, turret and disconnectable buoy moorings for shallow water to medium and ultra deepwater applications.

# Selection of Project Experience



## 1. Cabrillo Port FSRU

**Customer:** BHP Billiton

**Location:** California, USA



- FEED Design of regas facility
- New technology development
- Offloading availability
- Specialized Tug design
- Under water noise assessments
- Detailed regasification technology comparisons and studies
- In depth study of regasification marinization aspects



## 2. Oceanway

**Customer:** Woodside

**Location:** California, USA



- Peer review of oceanway FSRU concept
- Support to deep-water port license application
- Review LNG offloading systems



## 3. Jamaica LNG Storage and Regasification (SRT)

**Customer:** Jamaica Government

**Location:** Jamaica



- Owner's Engineer for SRT Build, own, operate, transfer contract in Portland Bright, Kingston
- Concepts explored and site selection
- Acted as Owner's Engineer for Bid Evaluation of EPC Contractors



## 4. FSRU Due Diligence

**Customer:** Origin Energy

**Location:** South America



- Technical due diligence on FSRU Supply Agreement and Terminal Services Agreement

# Selection of Project Experience



## 5. Jakarta West Java Bay FSRU

**Customer:** Pertamina-PGN Joint Cooperation (Nunsantara)

**Location:** Jakarta , Indonesia



- Development of Base load FSRU
- Functional topside regasification (process) schematics and specifications
- CAPEX and OPEX estimates

## 6. West Java LNG Import Terminal and Power Plant Feasibility Study

 Sumitomo Corporation

**Customer:** Sumitomo

**Location:** Jakarta , Indonesia



- WorleyParsons, jointly developed with SOFREGAZ a marinised regasification module, capacity 700mmSCFD
- IFV propane loop technology
- Based on proven, reliable equipment and components



## 7. Bangladesh FSRU

**Customer:** MPC

**Location:** CONFIDENTIAL



- Development of Base load FSRU
- Functional topside regasification (process) schematics and specifications review
- CAPEX and OPEX estimates

## 8. LNG Import Terminal Feasibility Study

**Customer:** Meiya Power Company

**Location:** Bangladesh



- Concept selection and techno-commercial pre-feasibility study of an offshore LNG regasification terminal and power plant
- CAPEX and OPEX estimates



# The conversion market



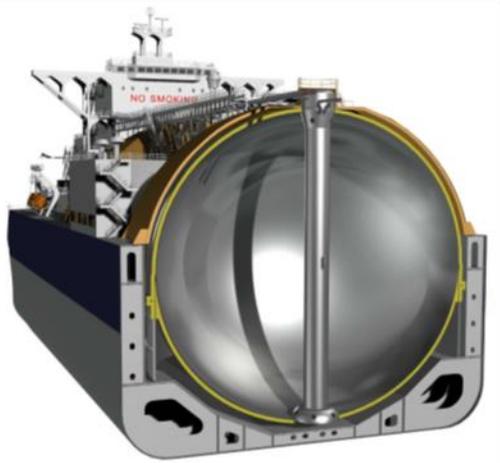
- Conversions have traditionally been older LNG ships.
- Barge conversion has not figured in the market because the aim has been to facilitate large ship to ship transfer
- Much has been talked about hub + spoke, but little done
- Retrofit of storage is key to economics



# LNG Containment Systems

## Field Proven Containment Systems

### Independent Tank Types



MOSS Sphere, Courtesy of Mossmaritime

### SPB LNG TANK



SPB tank Courtesy of IHI

### Non-self-supporting Tanks



MK III Membrane,  
Courtesy of Ipalo Enertech



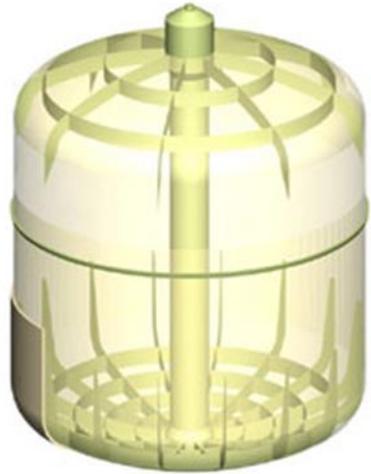
9 CS 1 Courtesy of Gas de France



# LNG Containment Systems

## Containment Systems Under Development

### Independent Tank Types

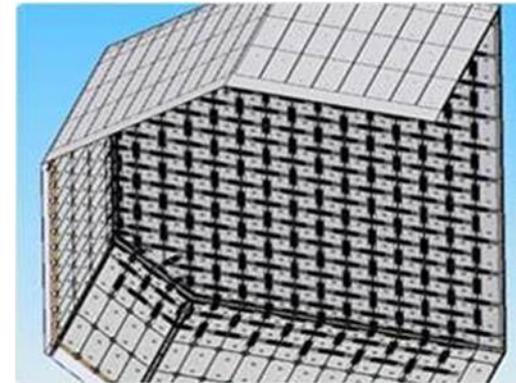


Ocean's LNG IMO Type B independent tank design

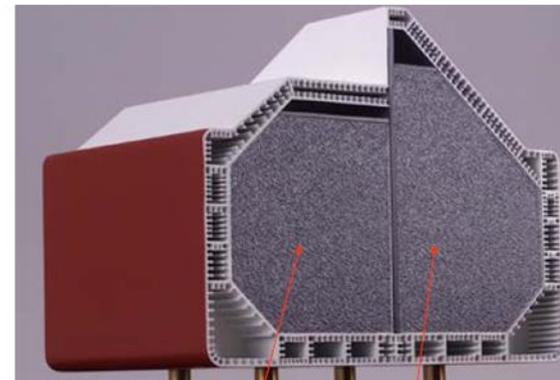


Courtesy of TGE

### Non-self-supporting Tanks



Courtesy of KOGAS, KC1 Internal structure



Existing Membrane Tank Design

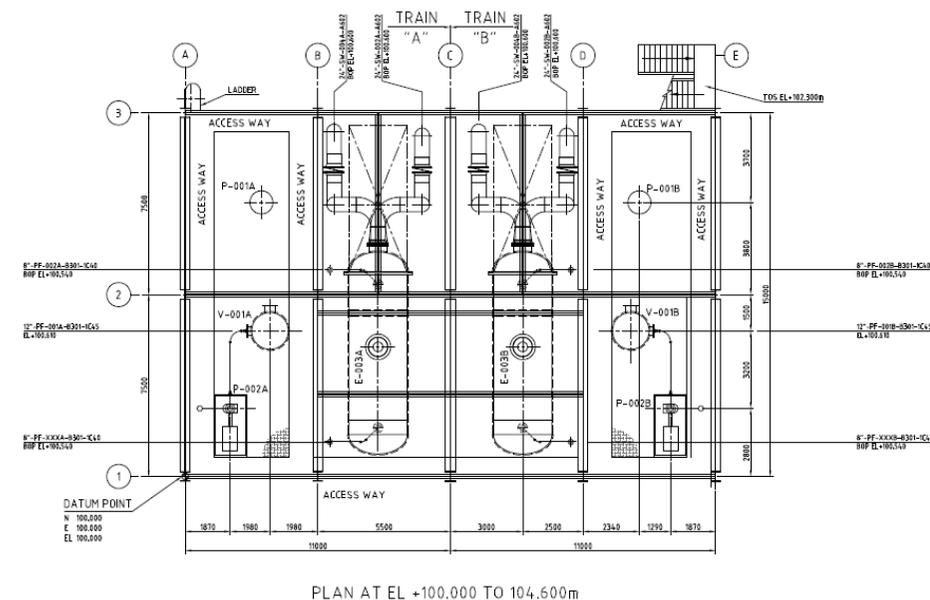
Pyramid Tank Design

Courtesy of ConocoPhillips, Pyramid Tank Design



# Regasification Systems

## WP LNG Regasification Module Layout



## LNG Regasification Module Dimensions

	Unit Capacity		
	1.25 Mtpa	2.5 Mtpa	3.75 Mtpa
<b>Dimensions</b>			
Length (m)	22	33	44
Width (m)	15	15	15
Height (m)	14.7	14.7	14.7
<b>Weight (metric tons)</b>	<b>1035</b>	<b>1590</b>	<b>2045</b>



# Regasification Systems

## LNG Regasification Module Overview:

- Suitable for most FSRU applications in terms of demand and location. Scalable to meet required capacity.
- Easy phased installation of 2, 3 or 4 trains dependent of throughput requirements
- Easy pre-assembly away from the FSRU hull and then installation as complete packages.
- Quality control and process guarantee by Worley
- Easy offshore maintenance of exchanger bundles
- Ability to also incorporate BOG handling, cold vent, sea water and integration through one company





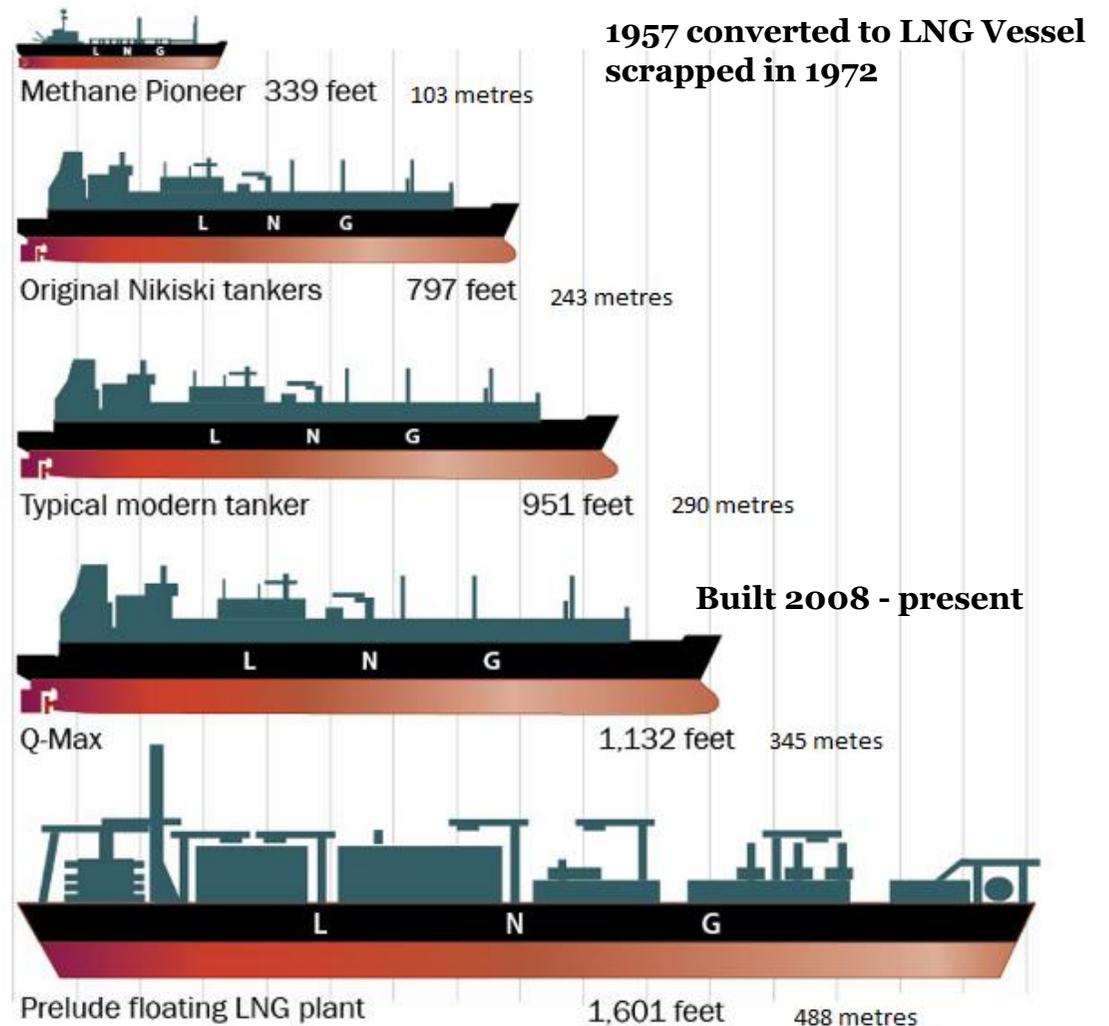
# LNG Vessel Sizes

LNG Vessels have grown in size over the decades driven by a number of factors including the demand for a clean energy source and the infrastructure and technologies to support this growth.

Barges are simply a lower cost version of the original ships converted.

OSVs also offer the potential for low cost small scale conversion.

## LNG tanker sizes



Thank You

