

# Floating LNG Terminals

The Impact on the Gas Industry

For

**TANKEROperator**

At



OSLO



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VERITAS**

For the benefit of business and people



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## SUMMARY

1. BV & the LNG Industry
2. Why floating facilities
3. LNG offshore terminals
4. Issues for Study
5. Rules & Guidelines
6. Impact of floating LNG facilities



➤ **BV & the LNG Industry**



**Bureau Veritas has been involved in LNG industry both onshore and afloat from the very earliest beginnings**

**Bureau Veritas is a world leader in the fatigue analysis and classification of offshore floating units**





## > Why Floating Facilities ?

- ▶ **Currently LNG is produced, shipped and delivered for distribution on a large scale:**
  - Large production facility
  - Large liner LNG Carriers
  - Large receiving plant
  - Large gas distribution network



- ▶ **This model has been true since the very earliest days of the LNG Industry**
  - Only the production and regasification plant have become larger
  - The ship size increased
  - The loading and discharge terminals have increased in size also



**This is nowhere better shown than in Qatar with the great expansion of Qatargas and Rasgas along with the massive export facilities, very large LNG Carriers and the huge import facilities in the USA and Europe**



- ▶ **There are however a number of issues with this model**
  - **Resistance to the location of regasification terminals in the very places where they are needed.**
  - **Impractical and too expensive for smaller gas reserves**
  - **Not geared up for importation and regasification on a smaller scale**

► **The answer perhaps, floating LNG facilities for:**

- Production
- Export
- Import
- Regasification
- GTL ?



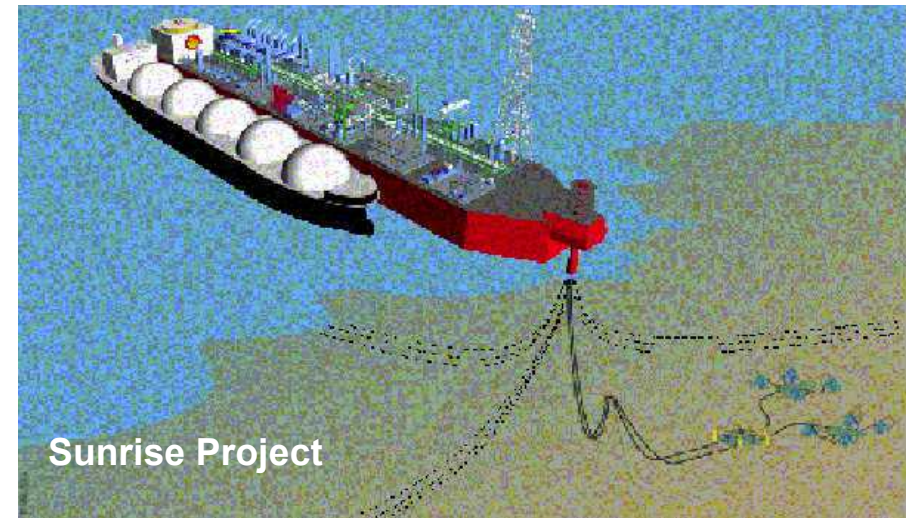
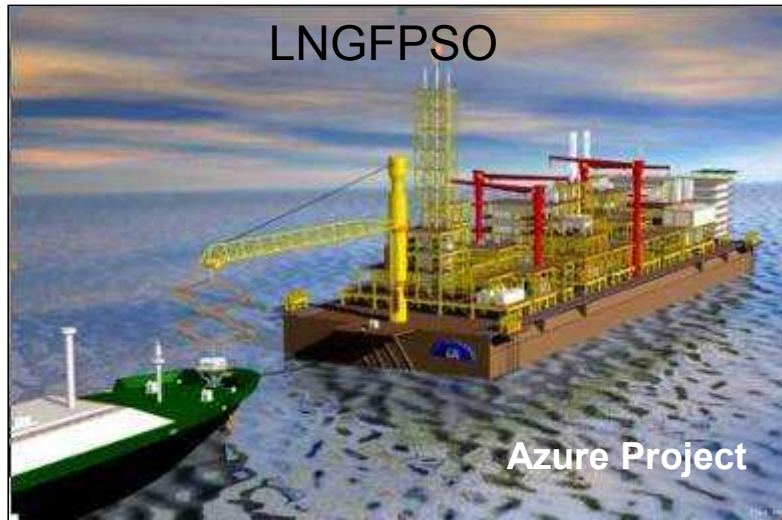


➤ **LNG Offshore Terminals**

- ▶ **Already well established in the oil market**
- ▶ **Relatively easy and quick to build at shipbuilding facilities or perhaps converted**
- ▶ **Can avoid NIMBY issues**
- ▶ **Easily movable if required**



There are many places where floating LNG production has been studied or is being seriously considered



## The worlds first offshore discharge terminal for high pressure natural gas from LNG is now a reality



EXMAR's LNG RV (Liquefied Natural Gas Vessel with Re-gasification on-board)

- Based on standard 138 000 m<sup>3</sup> DSME design, LNGRV is designed for services in world-wide navigation together with turret moored operation on the off-loading site
- BUREAU VERITAS provided overall technical support and assistance in extensive partial filling studies, following Owner's demand for the assessment of viable LNG off-shore discharging operation.



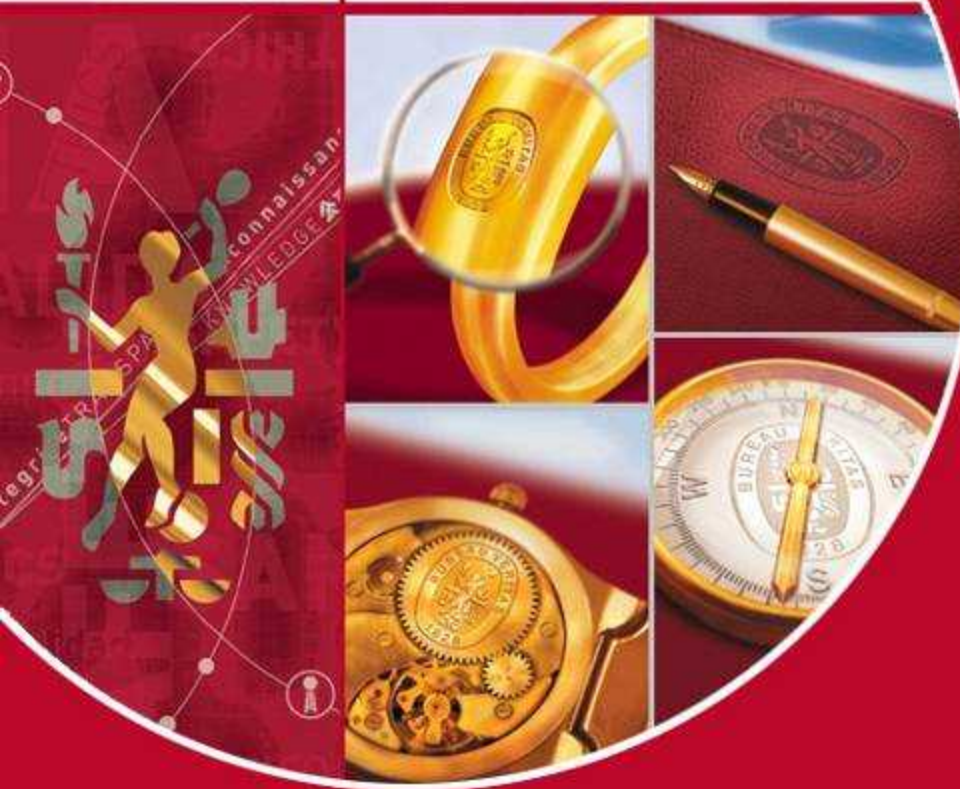


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Issues



- ▶ **There are a number of issues that need to be carefully examined when considering a floating LNG facility**
  - Location & sea condition
  - Type of vessel & containment
  - Mooring of the facility
  - Access for export / import vessels (tugs & pilotage)
  - Method of transfer of cargo
  - Type of plant, liquefaction / regasification
  - Deck congestion
  - What if the LNG supply vessel must leave part full ?



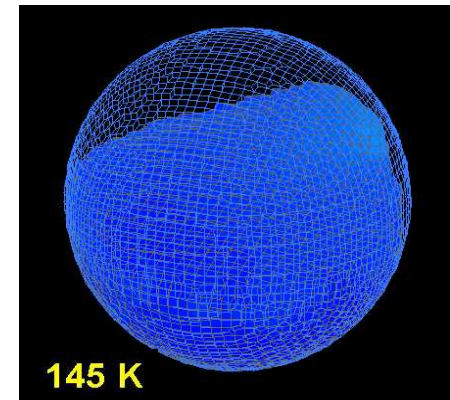
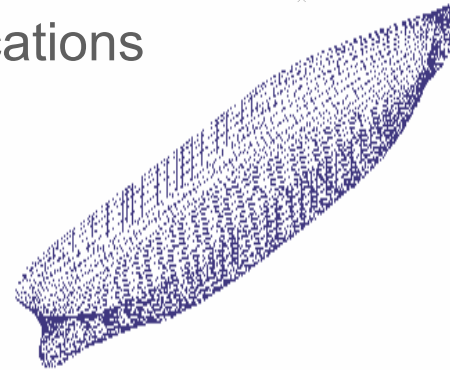
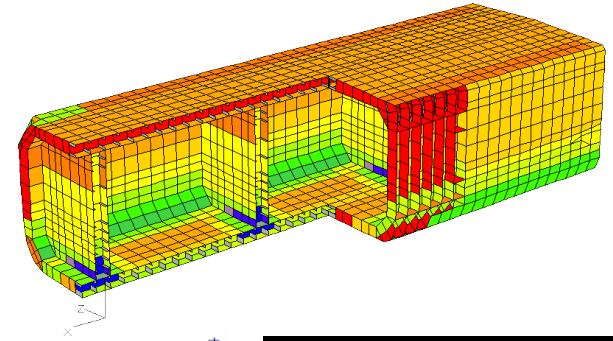
- ▶ **Selecting the location may not be as simple as it first appears**
  - Close to user
  - Far enough away to be un-noticed
  - Local administration
  - Safe sea access
  - Tug assistance
  - Prevailing weather



Courtesy of Knutsen & APL

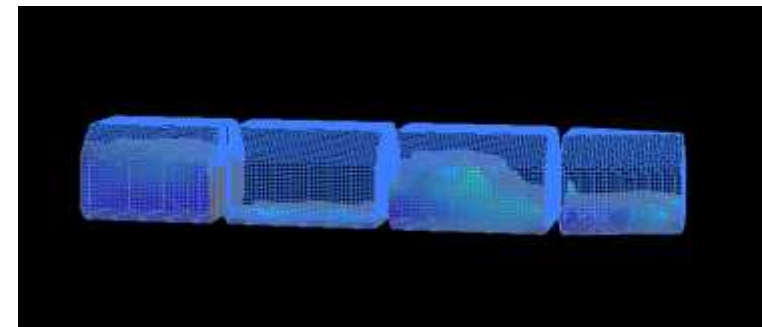
▶ **FSRU assessment:**

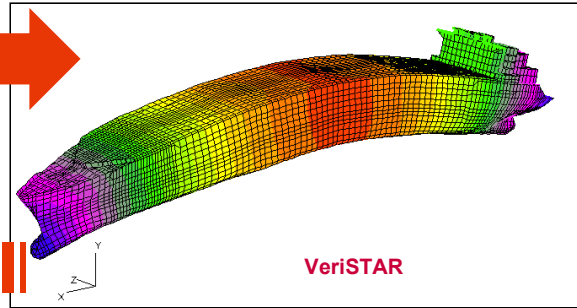
- Hydrodynamic analysis
- Structure based on site conditions
- Reinforcements for critical locations
- Sloshing analysis



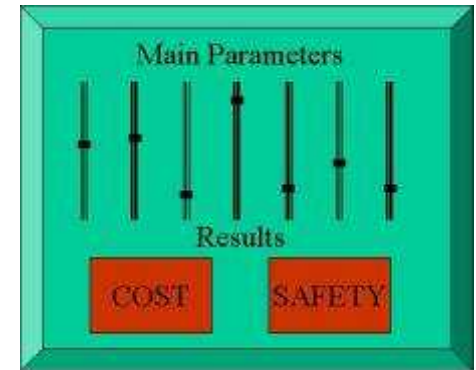
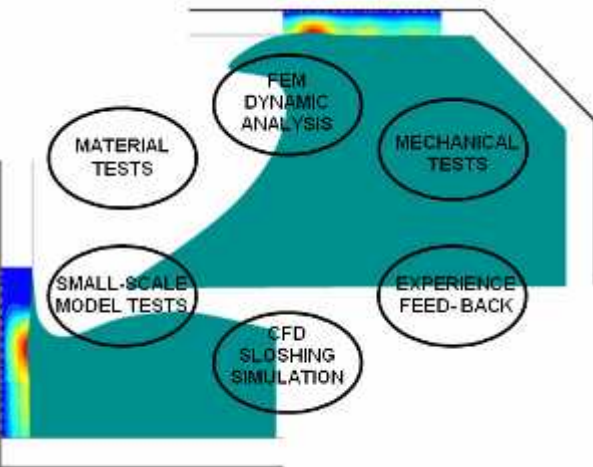
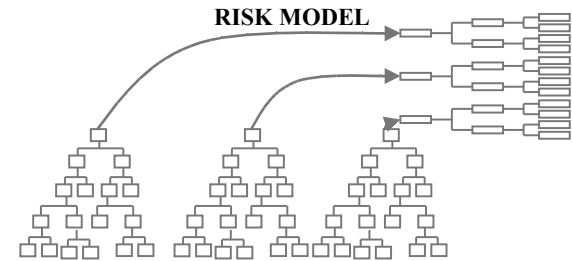
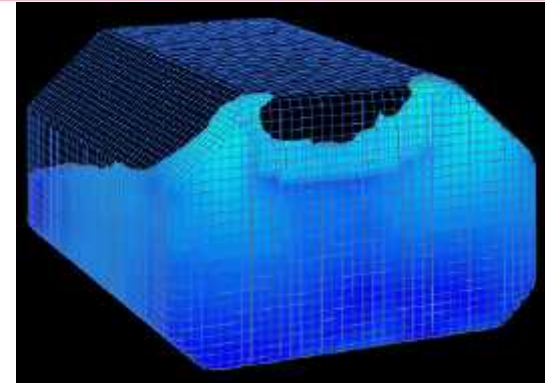
▶ **Assessment of LNG carrier structure**

- Operational history of vessel
- Fatigue based on trading routes
- Steel renewal





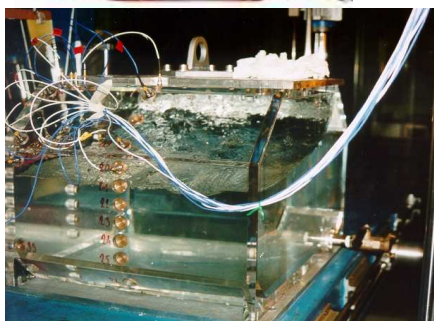
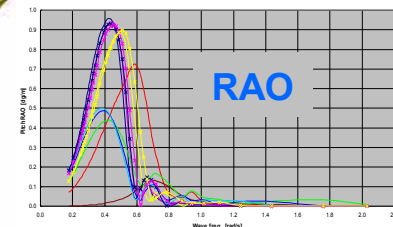
- ▶ Hydrodynamics & Mooring
- ▶ Sloshing
- ▶ Hydro-Elasticity
- ▶ Fatigue analysis
- ▶ Structural Integrity & RBI
- ▶ Risk-Based Design





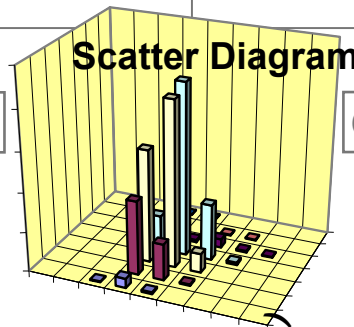
SEA KEEPING

MOTIONS



MODEL TESTS

CFD SIMULATIONS



$P_M$

$V, E_K$

$P_I, \Delta t$

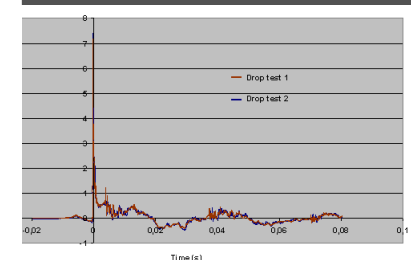
$P_I, P_{QS}, \Delta t$

Calibration

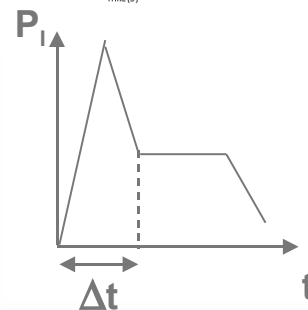
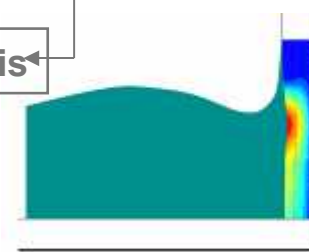
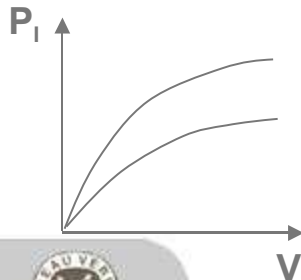
Membrane Qualification

Dynamic Structural Analysis

Hull Scantling



DROP TESTS

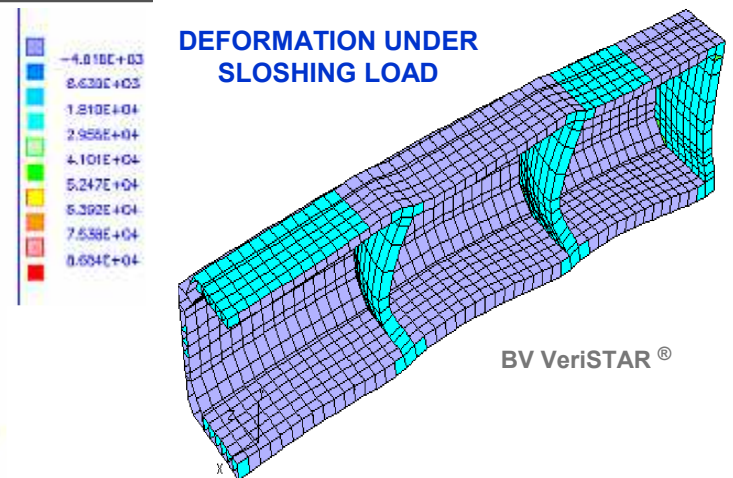
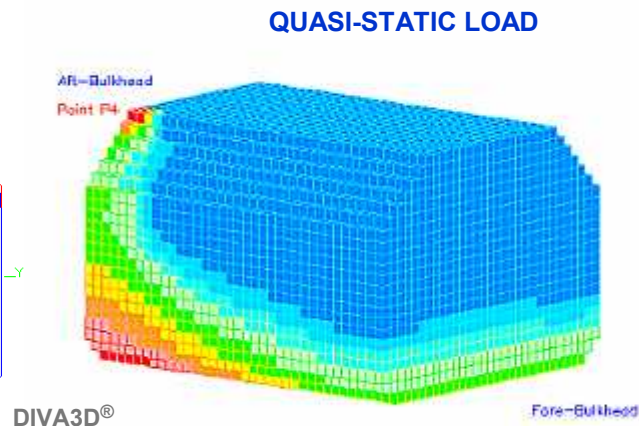
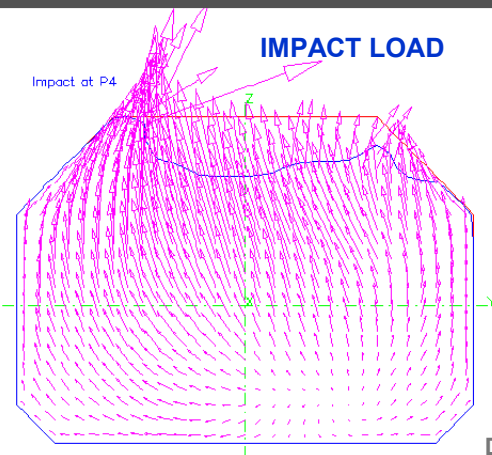


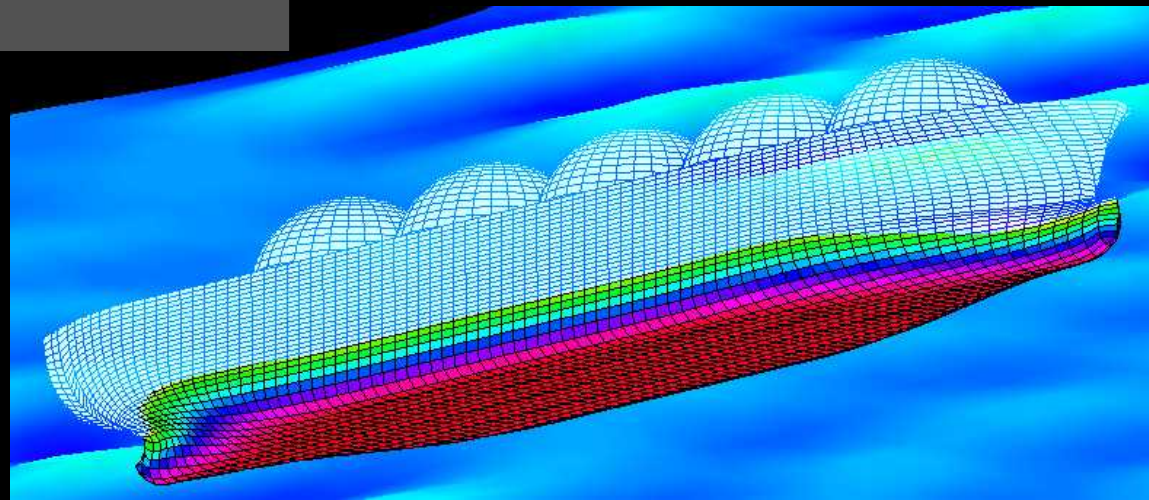
Numerical verification of Containment System and Hull Structure of **LNG RV** in partial filling condition

27%H

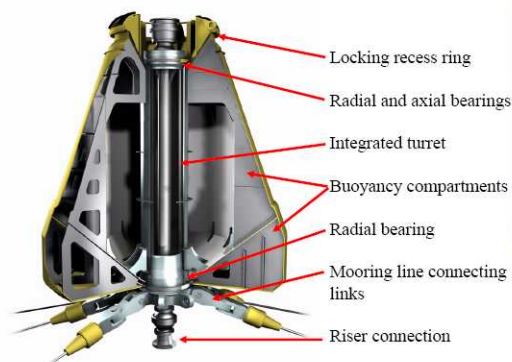
50%H

80%H

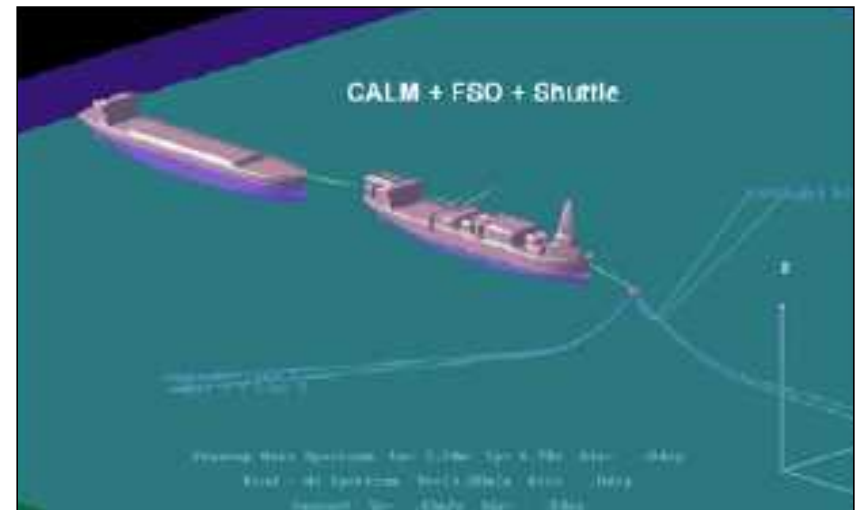




- ▶ The control of the moorings for any floating offshore facility is of extreme importance
- ▶ There are many types of location system but they all depend upon anchors or piles in the seabed and a spread of chain cables
- ▶ They must be designed for the worst possible operational conditions



APL submerged turret mooring



BUREAU VERITAS ARIANE SOFTWARE

- ▶ **Relative motion between two vessels may have to be considered for the site in question**



Bureau Veritas HYDOROSTAR

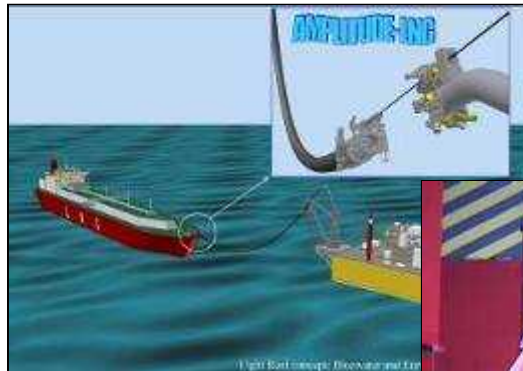
The mooring between the participating vessels must also be considered:

- Wires
- Tails
- Quick release hooks
- Fenders



Tandem mooring has been used for many years in the offshore oil industry for transfer in harsh environments, so the mooring technology is already available.

The LNG offshore industry is apparently waiting for a suitable cryogenic hose system

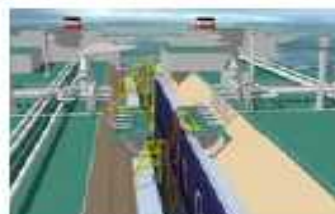


Courtesy of





- ▶ Many alternatives are being proposed
- ▶ The working group developing standards for offshore LNG loading/discharging systems is currently overseeing approval of hoses for ship to ship LNG transfer



- ▶ **Certainly the simplest is side by side with hoses**



- ▶ **Currently there is a lot of development going into the development of hoses suitable for LNG transfer at sea**



Photographs courtesy  
of

**Technip**



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► Under development

Double external sheath :

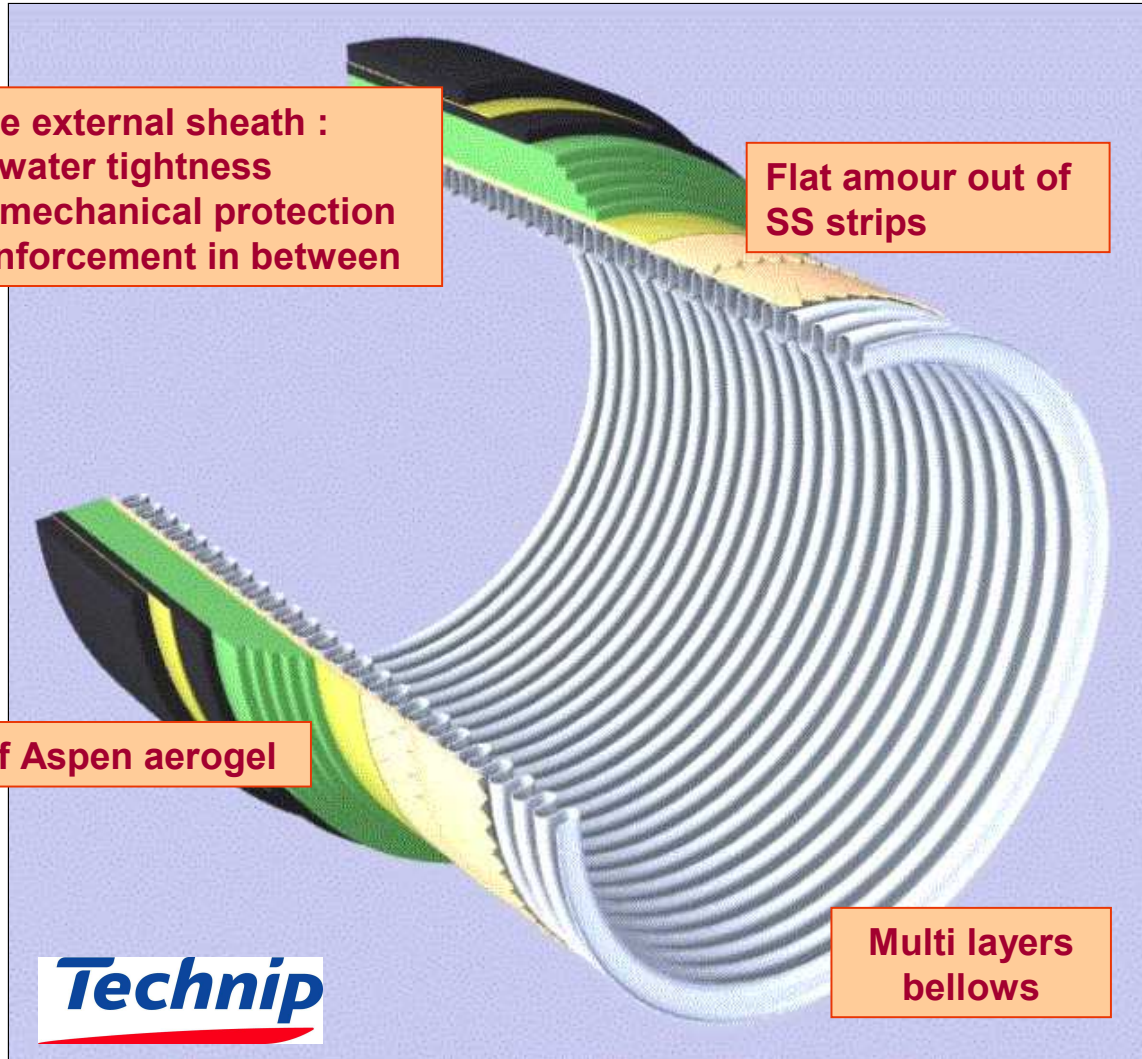
- inner for water tightness
- outer for mechanical protection

Kevlar reinforcement in between

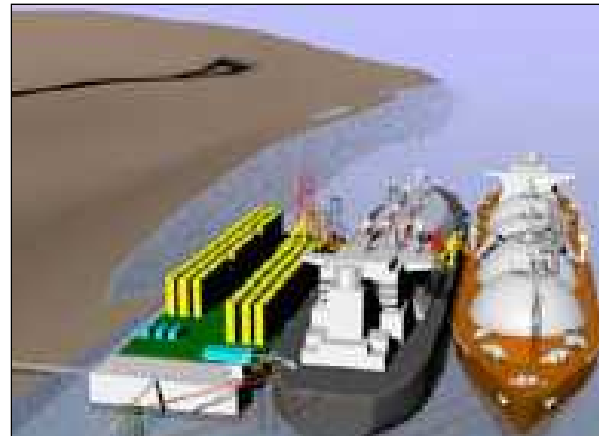
Flat amour out of  
SS strips

layers of Aspen aerogel

Multi layers  
bellows



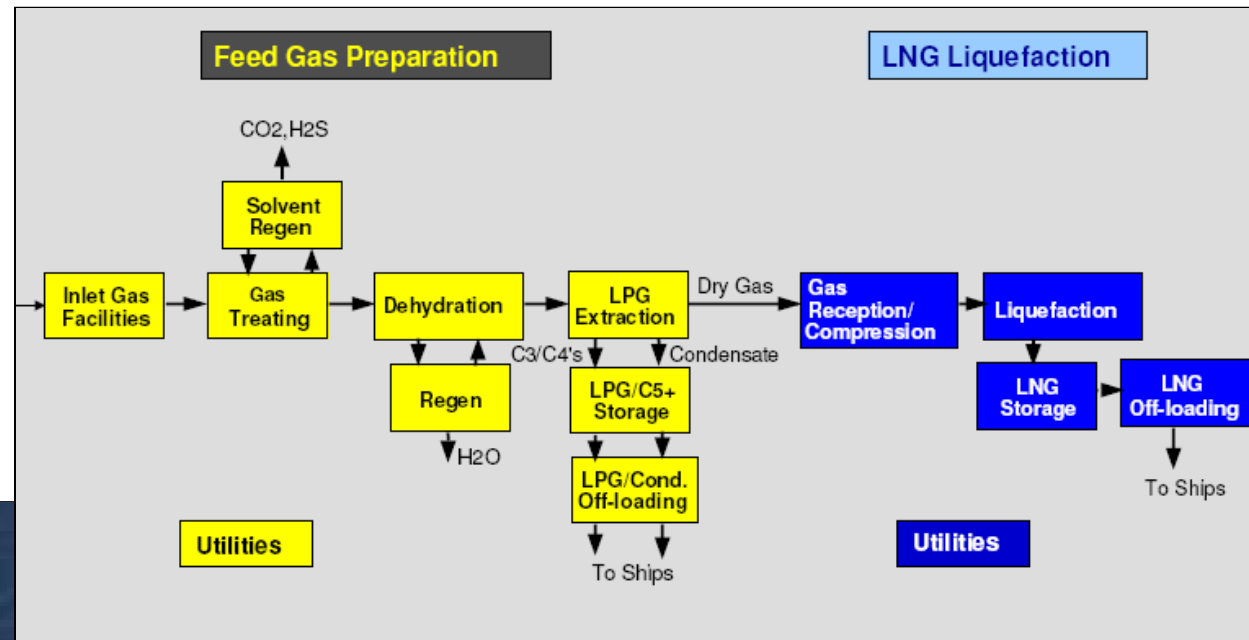
- ▶ **Floating units may be considered for :**
  - Liquefaction (on a small to medium scale)
  - Vaporisation
  - GTL



Photographs courtesy of



- ▶ Many issues need to be considered

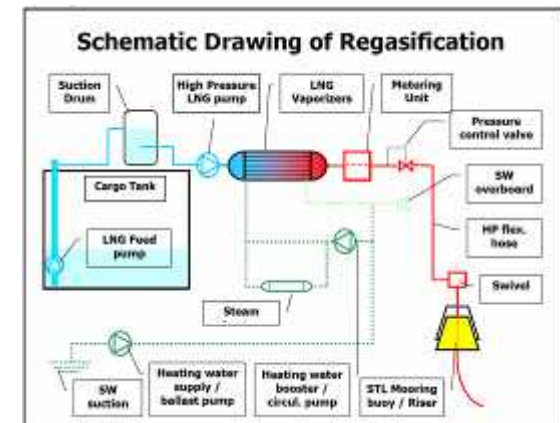


## Re-gasification may be by:

- Water
- Steam
- Steam & water
- Air

## Issues:

- Metering & control
- Handling the BOG
- Environment

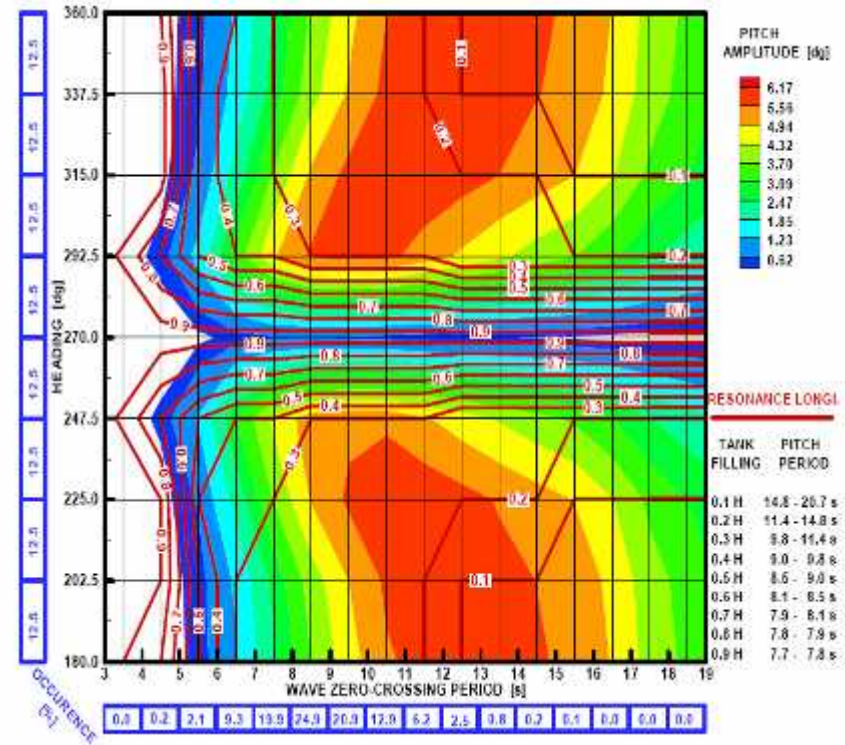


- ▶ This is a well known issue in gas and petrochemical plants
- ▶ An explosion will accelerate through closely packed plant and pipe racks causing more damage due to blast overpressure
- ▶ Space may be severely limited on floating units
- ▶ Great care will be required with the design of floating LNG units to ensure adequate space breaks in plant and pipework are provided



- ▶ What happens if the loading or discharging LNG carrier must leave in a partially filled condition due to heavy weather.
- ▶ Most LNG carriers are not suitably reinforced for operations at sea in a partially filled condition

Specialised study taking into consideration the ship, the containment type, the prevailing wind and waves



Gives the ship master sufficient information to place the vessel on the safest heading whilst cargo is re-distributed on board

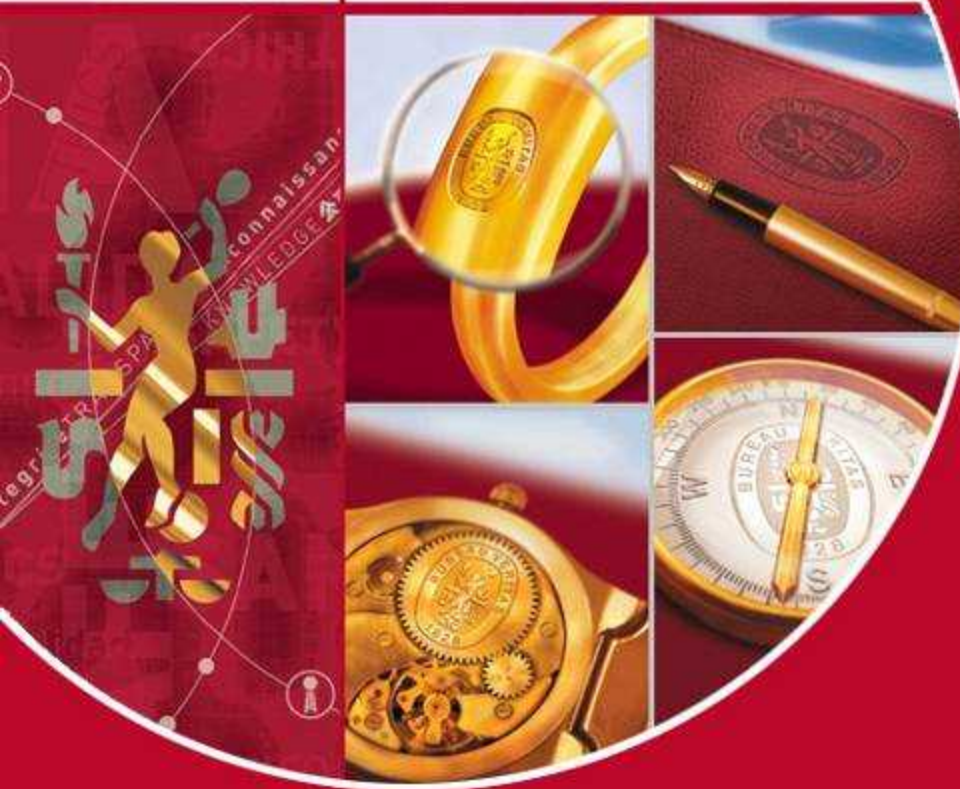




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> Rules & Guidelines

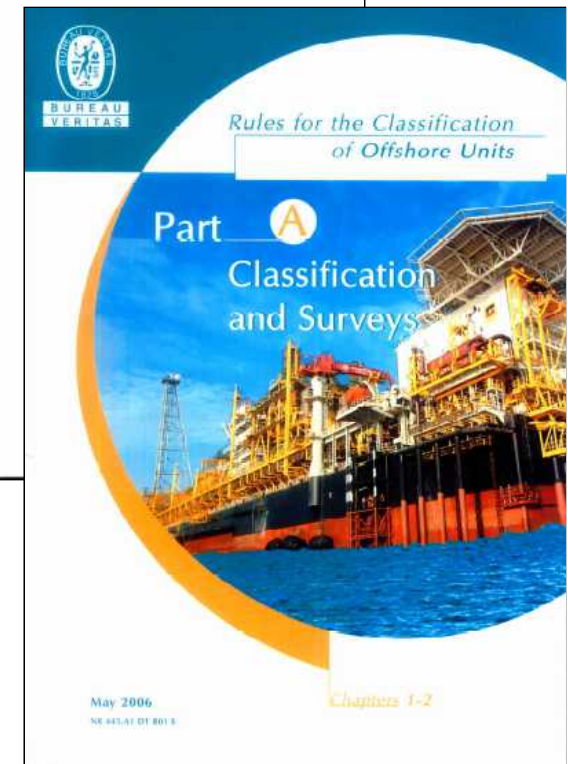
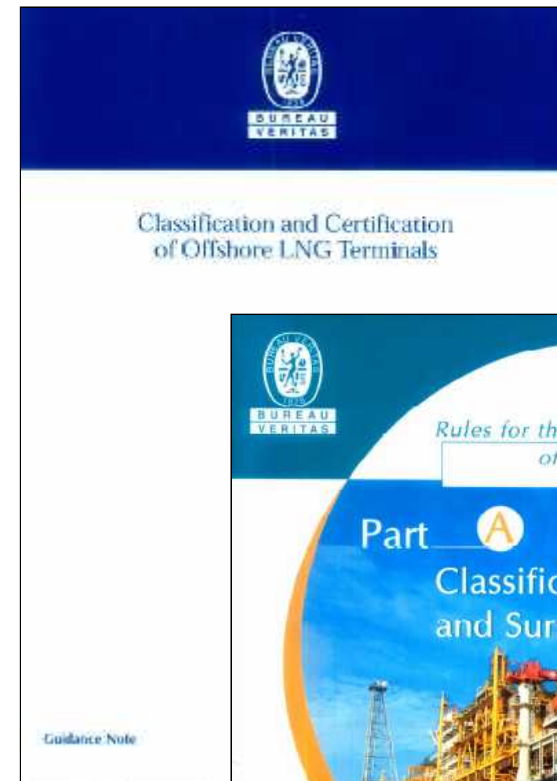


## Classification and Certification of Offshore LNG Terminals

NI 518

## Rules for the Classification of Offshore Units

NR 445



## Classification and Certification of Offshore LNG Terminals



### ▶ Objective

- To provide the requirements and recommendations for the classification and the certification of offshore LNG terminals

### ▶ Contents:

- General
- Impact and Safety Assessment
- Environmental Conditions
  - Loadings
- Stability and Subdivision
- Main Structure
- Process, Transfer and Storage Systems
- Electrical Equipment
- Utilities
- Fire Protection
- Safety Equipment & Systems
- Construction Survey & Commissioning

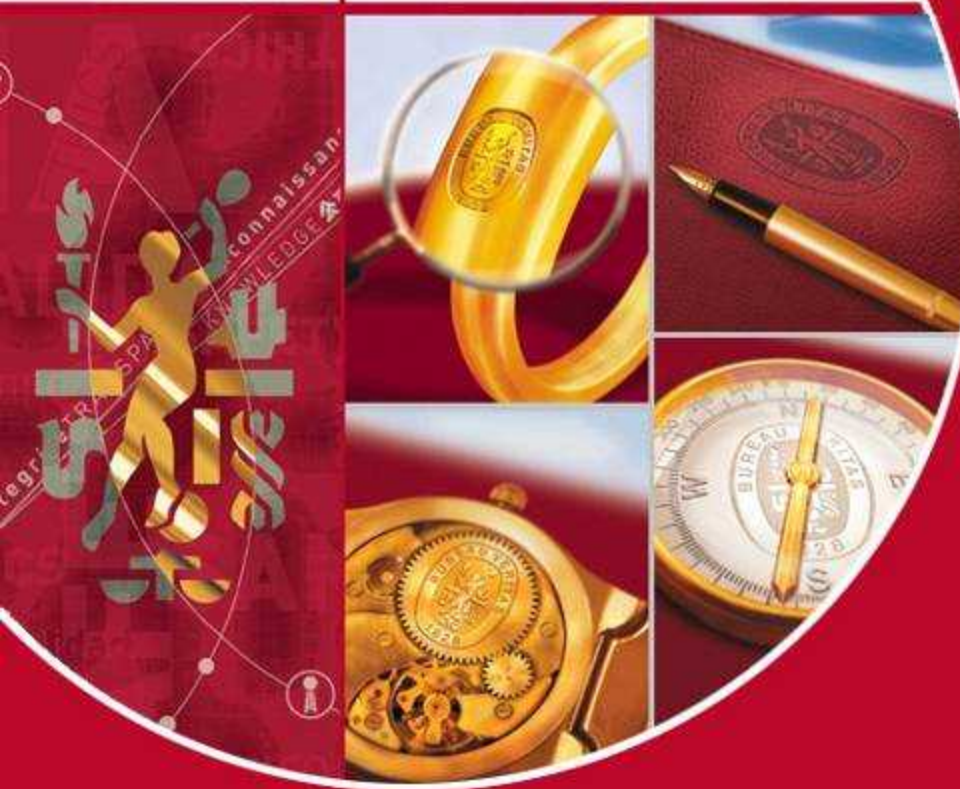




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> Impact of floating facilities



- ▶ **Floating facilities will happen**
- ▶ **Technology will continue to develop further**
- ▶ **They might not be the massive facilities as those that we have seen recently**
- ▶ **But they may form an important part of the LNG production and distribution chains to parts of the world where normal based facilities are not possible**





*Thank You for Your Attention!*

