

Offshore LNG

World's First FSRU Conversion

Krone Filter
SOLUTIONS IN FILTRATION

Special Report
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A showcase of Keppel Shipyard's market leadership in offshore & marine conversion and LNGC repair

The world's first Liquefied Natural Gas (LNG) floating storage and re-gasification unit (FSRU) conversion was successfully completed by Keppel Shipyard which is already undertaking the conversion of a second FSRU.

Keppel Shipyard is a world leader in FPSO/ FSO conversions, having completed the region's first FPSO conversion and more than 70 FPSO/ FSO conversions and upgrading projects since 1981. As the leading LNGC repair yard outside Japan, it has the proven expertise and a strong track record of repairing more than 90 LNGC since 1990.



Keppel Shipyard

(a member of Keppel Group)

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Filters for uninterrupted regasification

The self-cleaning filters Krone is providing for the FSRU *Golar Winter* will enable uninterrupted seawater filtration, and thus LNG regasification

Krone Filter GmbH of Germany has secured an order to provide three 24-inch, self-cleaning KAF seawater filters for use with the regasification process chosen for the floating storage and regasification unit (FSRU) *Golar Winter*. *Golar Winter* is the second of two LNG carrier conversion projects being undertaken by Golar LNG to provide Petrobras of Brazil with FSRUs for long-term charter.

The vessel has recently arrived at the Keppel yard in Singapore for the work to be carried out and is scheduled to leave the yard, as an FSRU, in the second quarter of 2009. The regasification system for *Golar Winter* is based on technology developed by Moss Maritime.

L N G regasification vessels and LNG carriers fitted with reliquefaction

plants utilise strainers in the reliquefaction and regasification processes. These are used primarily to protect shell and tube heat exchangers in open rack vaporisers and plate heat exchangers in intermediate fluid vaporiser systems.

In the regasification process equipment such as open rack vaporisers (ORVs), direct seawater shell and tube vaporisers (STVs) and intermediate fluid vaporisers and operations like boiloff gas management all benefit from reliable seawater filtration.

Each of the three Krone stainless steel seawater strainers for *Golar Winter*, with their 1,000 micron (1mm)

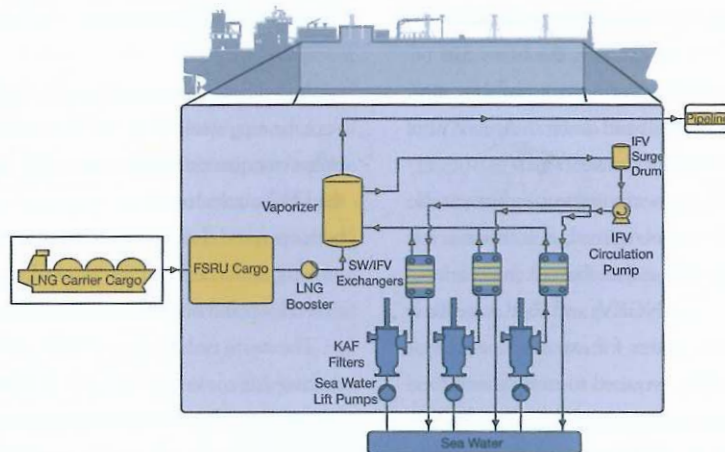
wedged wire inserts, will be able to handle flow rates of up to 4,750m³/hour. The three filters to be provided will be controlled by ATEX Zone 1-certified equipment and via the vessel's integrated automation system. Krone Filter points out that the units can be mounted in all piping positions, irrespective of whether the pipework is vertical or horizontal.

The self-cleaning function of the KAF filters enables fully automatic cleaning of the filter screens to be initiated even at low working pressures and results in only

a very low pressure differential within the system. The geometry and position of the flanges within the filter ensure that the deposition of dirt particles progresses in a defined manner from the end of the filter screen to the feed inlet. With the buildup of impurities the speed of flow

within the filter is reduced and the static pressure at the filter entry rises until the differential pressure switch initiates an automatic rinsing procedure based on a two-stage flushing process. This is done without interruption of the filtration process.

Krone Filter states that its filters require only minimal maintenance. If specified, the flushing process can be activated at preset time intervals by means of a supplied control unit. A further controlling unit, when coupled with the differential pressure gauging system, enables the direct transfer of recorded performance data to a central control point. *LNG*



The schematic diagram shows the place of the seawater filters within the overall regasification process on *Golar Winter*

Moss has perfect FSRU score

All four FSRU conversion projects agreed so far will incorporate regasification plants based on Moss Maritime technology

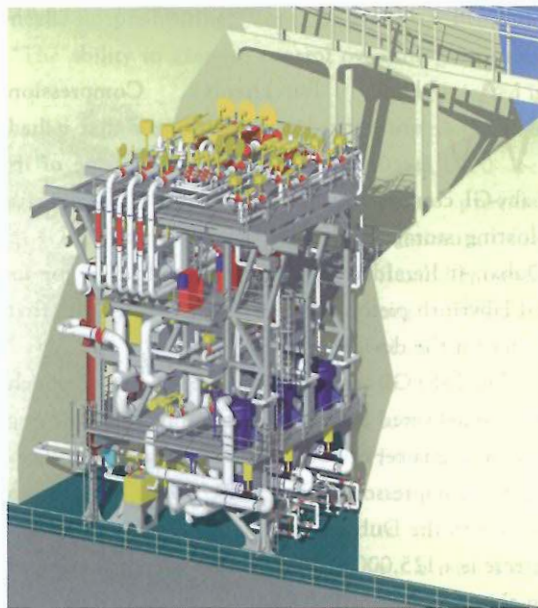
Moss Maritime AS, a technology development company focused on providing integrated solutions for the LNG shipping and offshore industry, has already established notable offshore LNG credentials. The company launched early concepts for floating storage and regasification units (FSRUs) and floating liquefaction plants (FLNGs) and *Golar Spirit*, the world's first FSRU conversion project, incorporates technology developed and designed by Moss Maritime.

"We carried out design development and detail engineering of the regasification plant that was retrofitted onboard, as well as detail engineering for the LNG carrier conversion," explains Tor Skogen, vice president, gas at Moss Maritime. "In addition, our personnel assisted the Golar LNG site team with follow-up of the conversion work at Keppel Shipyard in Singapore and assisted Golar with the operational planning. *Golar Spirit* is commencing operations as an FSRU this autumn in Pecem, Brazil on behalf of Petrobras.

"Moss is currently carrying out the conversion engineering for *Golar Winter*, a second Golar LNG vessel being converted to an FSRU for charter to Petrobras, and *Golar Freeze*, a ship which will enter service in Dubai as an FSRU on behalf of the Dubai Supply Authority in the second quarter of 2010. We are also assisting Saipem, the owner of Moss Maritime since 2001, with engineering related to their Livorno FSRU project in Italy. This is based on the conversion of *Golar Frost* and is due for startup at the end of 2010. As a result, Moss Maritime is involved in all the FSRU conversion projects launched so far," points out Mr Skogen.

Moss is also an established name in LNG shipping and has achieved recent success with new technologies in this sector. In the early days of the LNG industry the company developed the Moss spherical tank LNG containment system concept and, to date, more than 100 Moss type LNG carriers have been built, equivalent to about 38 per cent of the global LNG carrier fleet.

The company also developed the Moss LNG Reliquefaction System (Moss RS) which reliquefies boiloff gas from LNG cargo tanks and enables the free choice of ship propulsion system. The Moss RS was selected for all 31 of the Q-flex LNG carriers under construction in Korea. The equipment



Conceptualised view of the Moss regasification plant on *Golar Spirit* – the world's first FSRU

itself has been delivered by Hamworthy Gas Systems under a licence agreement with Moss Maritime.

In considering the challenges faced by technology companies leading the LNG industry's current drive into the offshore sector, Tor Skogen comments, "Offshore LNG projects represent the use of existing technology in a new application. In that respect the *Golar Spirit* FSRU project presented an interesting challenge since it is the first FSRU conversion project ever with few "off-the-shelf" solutions ready.

"There were no class society rules prepared for such a unit and, in addition, Golar LNG's client Petrobras specified that the design of the FSRU should be based on risk analyses. It was a challenge to mix the traditional shipping solutions with the more offshore process-oriented solutions for the regasification plant. In addition, the knock-on effects of mixing the two approaches, not least on the requirements affecting safety systems, had to be considered."

Moss Maritime continues to develop and launch concepts for the offshore LNG sector. The company is currently involved in several front-end engineering and design (FEED) projects related to both FSRUs and FLNGs. *LNG*