Extra insulation cover for *FSRU Toscana*

Syd Harris reports on the complex insulation upgrade being carried out by MGI as part of the conversion of LNGC *Golar Frost* to *FSRU Toscana*

Golar Frost in Dubai for conversion work which will include a full upgrade of its cargo tank insulation

Marine Gas Installation AS (MGI) of Tønsberg in Norway has assembled a team of insulation specialists to complete the contract it has secured on the *Golar Frost* FSRU conversion project in Dubai. The contract entails the refurbishment of the insulation on the 137,000m^3 vessel's four spherical cargo tanks and is part of work currently underway at Drydock World in Dubai to convert the LNG carrier into a floating storage and regasification unit named *FSRU Toscana*. The MGI contract has a price tag in the region of € 2 million (US$2.8 million) and is expected to be completed within eight to twelve weeks.

Following completion of the conversion in 2011, *FSRU Toscana* will be delivered to Offshore LNG Toscana (OLT) and positioned off the coast of Italy near Livorno. It will be the LNG industry's first FSRU to be moored at an offshore location in open seas.

Golar Frost was delivered to Golar LNG in April 2004 by Hyundai Heavy Industries (HHI) in South Korea. The ship was the fourth and final delivery in a series of Moss spherical cargo tank LNG carriers. Each ship has four cargo tanks and all the tanks have a diameter of 40.46m. The three other ships in the series were delivered to Bonny Gas Transport during 2002/03 as *LNG Rivers*, *LNG Sokoto* and *LNG Bayelsa*.

Golar Frost was built using a spiral generation system employed since 1974 for the hemispherical insulation of Moss tanks. With this system, extruded polystyrene insulation is rapidly applied in spirals using rotation booms to a thickness of approximately 250mm. Panels of insulation are fitted at the dome, north and south poles and in way of the cargo tank's equator skirt. An external vapour barrier consisting of 0.25mm aluminium foil completes the installation.

A notable safety feature of the Moss containment system is the purging of the space between the tank surface and the insulation with nitrogen gas to enable continuous monitoring for possible small cargo vapour leaks and the maintenance of a non-flammable atmosphere around the tank shell. The tightness of the vapour barrier is a key element of the design philosophy.

During inspections of the four *Golar Frost* cargo tanks in 2005, some minor deficiencies were found on the external surfaces. These included cold spots, loose sealing tape and delaminated aluminium foil. Subsequent similar inspections in 2009, in anticipation of the conversion project, identified further deteriorations, including cracking in way of the aluminium foil corrugations, loose sealing tape, partly and fully delaminated aluminium foil and puffing in way of the panel joints.

After a review of the situation it was determined that local repairs of the visually identified cold spots, delaminated or cracked aluminium foil and any subsequent cracked panel joints that might be found are all possible. However, it would not be possible to guarantee the long-term performance of the insulation or the prevention of

any further operational damages occurring.

As a result MGI decided that, rather than adopt a piecemeal approach, it would refurbish the complete insulation on the upper and lower tank hemispheres on all the *Golar Frost* tanks as well as attend to any defects found in the panel insulation at the equator skirt and north and south poles. The MGI upgrade package is intended to improve the structural and thermal performance of the original insulation.

MGI points out that its approach will result in operational cost savings in three key areas. By reducing nitrogen gas leakage and by restricting heat ingress due to the extra insulation it is providing, there will be not only an improved retention of inert gas in the annular space but also a reduction in cargo boil-off gas (BOG). Finally, the hull structure will have additional protection against extreme temperature changes. MGI states that the completed insulation will provide an improved partial secondary barrier and spray shield for fifteen days in the case of a small leak through the primary barrier.

In order to achieve a gas and vapour tightness of the insulation MGI will completely remove the existing aluminium foil from the four cargo tanks on *Golar Frost*. The surfaces will be cleaned and checked for deficiencies and, for the lower hemispheres, this will require the partial removal of the strap bands.

A glass fibre mesh will then be applied to the top of the original insulation prior to foaming to act as a crack arrester. The mesh will be secured with plastic plugs and bridged to panel surfaces by a two-component polyurethane glue. Following on, polyurethane foam, comprising two main premixed polyol and isocyanate components, will be applied by means of a spray gun until a required total foam thickness close to 20mm is achieved. This process will provide a continuous surface with no joints and an overall tank insulation thickness of over 270mm.

MGI explains that the polyurethane foam is flexible and can cope with the thermal contraction and expansion of the cargo tank and underlying original insulation. The foam, as applied, will have a typical density of 36-50 kg/m^3 with a closed cell content in excess of 90 per cent.

Finally, a hybrid polyurea/polyurethane coating will be sprayed onto the foam surface to a thickness close to 2mm as a homogeneous, continuous protective layer. Panel parts of the original insulation will also be covered by the coating. The insulation specialist confirms that the outer layer will serve as a vapour barrier and a spray shield as well as provide mechanical protection for the insulation against impact. In addition the coating is flexible enough to follow any thermal movement in the insulation.

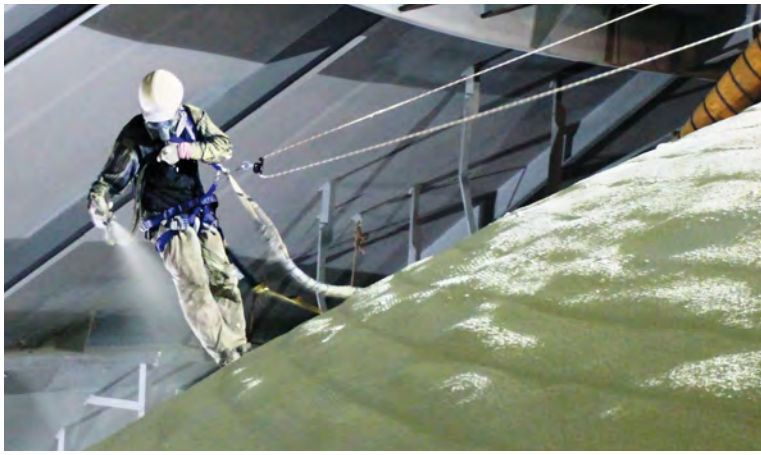
MGI will upgrade the membrane panel joints inside the equator skirt by injecting new polyurethane foam in the joint area. Surface joints will be covered with polymeric coating to provide sealing.

When asked if there is a potential market for similar insulation refurbishment work on older seagoing Moss LNG carriers for owners wishing to make operational savings, MGI's engineering manager, Bjorn Are Olsberg, replies emphatically, "Yes there is – mainly because of the general good quality of the many Moss LNG ships sailing worldwide and because the robust construction of spherical tanks has proved its qualities over years of service."

Mr Olsberg outlines three scenarios where a similar insulation upgrade could be an advantageous option for a spherical tank ship. For older ships with a cargo boil-off rate of 0.2-0.25 per cent per day an upgrade could easily reduce the level to 0.15 per cent per day. A second candidate would be an older ship experiencing random faults; for such a vessel a full upgrade would have advantages over short-term fixes to problems as and when they arise, not least because short-term fixes become an expensive proposition over time.

The third situation in which a full insulation upgrade could make sense is other types of floating LNG conversion projects. In addition to an FSRU conversion like *Golar Frost*, for example, the MGI package could yield benefits for an operator converting an LNG carrier into an LNG floating production storage and offloading (FPSO) vessel. For a start, fully upgraded insulation would minimise the need for expensive shutdowns for spot and quick-fix repairs every five years or so prior to a class survey being carried out.

Shipowners with Moss LNGCs in their fleets will wait with interest to see if potential benefits from this ambitious insulation refurbishment by MGI on *Golar Frost* arise in the form of cost savings and improved safety levels. *LNG*



The application of an additional polyurethane foam layer on top of Golar Frost's original polystyrene insulation