Maritime Training for Gas Ships

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Abstract

The current phase of unprecedented rapid growth in LNG transportation at sea was not really anticipated. The resulting acute manpower shortage in this niche industry sector provides a unique opportunity for the maritime training institutes worldwide. Singapore Maritime Academy (SMA) is in the process of grappling with this challenge. The paper describes the nature of challenge posed by this swift development in the maritime industry and relates the training facilities created at the SMA to cope with this new demand. The paper further details the training needs anticipated in the foreseeable future in the LNG transportation industry and suggests ways to develop professional learning systems at the SMA to help towards Singapore's goal of becoming a Global Maritime Centre.

Keywords: *LNG transportation, LNG ship training, LNG manpower, steam propulsion, steam certification of competency for LNG ships.*

INTRODUCTION

With a humble beginning in January 1959, the world's first LNG tanker, the Methane Pioneer (a converted World War II Liberty freighter) carried liquefied natural gas from Lake Charles, La., to Canvey Island, United Kingdom. This passage served as an initial feasibility study of safe transportation of large quantities of liquefied natural gas across the ocean. The Methane Pioneer subsequently carried seven additional LNG cargoes to Canvey Island.

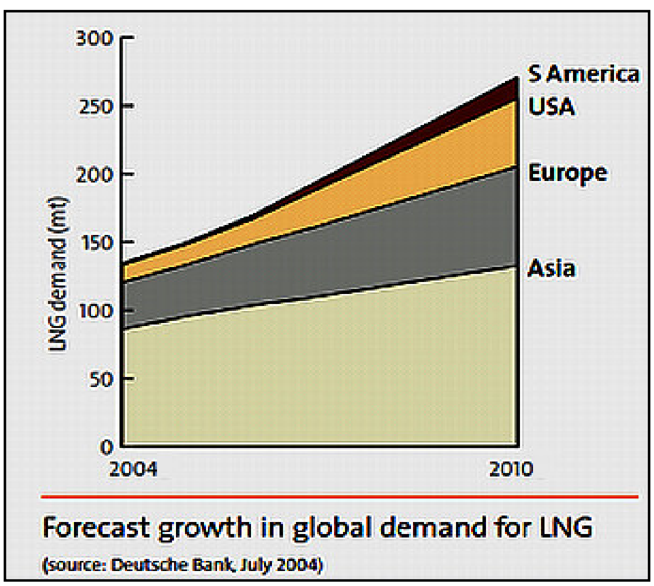

Figure.1 Escalating global demand for LNG.

Since then, LNG, as an energy commodity, has grown to become an essential component of the world's available energy resources (Figure 1). To cope with this increased demand in LNG, the transportation industry is also going through a phenomenal growth period. The LNG fleet growth (with a present strength of around 200 dedicated LNG carriers) is projected to be more than 300 vessels before 2010. LNG shipping has traditionally been limited to relatively few owners and yards, well established and experienced in this business segment.

Now, with the rapid increase in LNG fleet worldwide, new owners, operators and yards are entering the scene.
The technical needs of safely for transporting of large amounts of liquefied gas at very low temperature are significant. An accident could have a major impact on the environment. Hence, the importance of safety and reliability of operation and shipboard practices cannot be overemphasized.

However, in the past 40 years there have been more than 33,000 LNG ship voyages without a significant accident or cargo spillage. This enviable safety record in LNG shipping over the last 40 years is made possible by providing the requisite good training and practices by the few traditional LNG operators. Traditionally, the shipping companies owning/managing the LNG fleet used to have their own training centres, which were well managed and supported with ample company resources. The training costs were also significantly high compared to the cost of standardised STCW Certificate of Competency Courses run by traditional Maritime Education & Training (MET) institutions.

With the present proliferations of this industry sector to these new heights will lead to many new entrants, who lack the technological know-how and more importantly the experience of operating LNG carriers, which are unique in several ways. There is, therefore, a need for MET institutions to provide for this gap in industrial training needs.

The paper describes in subsequent sections,

- The challenge posed by this LNG sector with respect to its training needs
- The steam propulsion certification course for LNG ships, which has just been launched at the Singapore Maritime Academy, and finally
- The future plans, which has to be constantly modified to meet the changing needs of the industry.

THE CHALLENGE

The distinctive natures of these gas ships warrant good understanding of the considerations of their typical design characteristics. The main features unique to these ships are:

- The nature of the cargo being cryogenic (held at about -160^{0}C), the surfaces that come in contact with the cargo must be able to withstand such low temperatures. The material is typically, stainless steel, aluminium or invar. Hence, there are specialized welding techniques involved in their construction. Operational parameter involved is avoidance of temperatures shocks while loading/ unloading.
- Double containment and an internal hold. They cargo tanks are usually referred to as the 'cargo containment system'. This is often a completely separate from the ship; i.e. not part of the ship's structure or its strength members. This is a major difference between gas carriers and the oil tankers and chemical carriers. Cargo tanks may be of the independent self-supporting type or of a membrane design. The resulting cofferdam area is maintained with pressurised nitrogen, which requires onboard generation of N_2 and close monitoring of the N_2 pressure during voyage and loading/ unloading.
- Boil off. The LNG vessels do not have onboard re-liquification plant and as the insulation is not 100%, there is a constant heat leakage into the cargo systems. Hence, there is continuous boil off of the cargo. Venting of this boil off is not normally allowed by the classification societies. So, the cargo boil off is burnt in a steam propulsion boiler. If there is any excess energy from the burning of this boil off, a steam dumping system is provided to dispose the excess energy to the sea. During ballast voyages an amount of cargo (called ‘heel’) is left behind for boiler consumption (sometimes through forced vaporisation) and for pre-cooling before the next loading.

- Typically, the propulsion system is steam driven unlike the bulk of the shipping tonnage, which is run with more efficient slow-speed diesel engines. The diesel engines do not run directly on LNG and a re-liquification plant is called for. Additionally, the level of reliability of well-maintained and properly operated steam turbine plant is well-proven in the LNG transportation industry. The steam turbine plant has much less maintenance and is thus suitable for LNG projects, which typically run on fixed routes for long periods of contract (usually, 25 to 30 years).

Although officers serving on LNG carriers must have gas carrier endorsement, there are no mandatory requirements in STCW for LNG-specific training. Hence, many of the LNG operators have set up their own training centres to cater to these specialized training.

The Society of International Gas Tanker and Terminal Operators (SIGTTO) was established about 25 years ago to provide and facilitate exchange of experience in order to promote good practices and professional standards within the gas industry. SIGTTO have just completed a project on the requirements LNG manpower skills entitled 'LNG Shipping Suggested Competency Standards'. These competency standards cover the needs of deck, engine as well as cargo engineers and serve as a minimum standard for training throughout the gas transportation industry. It is expected that after a suitable review period by all concerned parties, these standards are likely to form a part of STCW requirements. It is important that these competency requirements are translated into suitable learning objectives for wider application through all MET institutions.

Typically, a nautical/ engineering cadet requires about 6 to 8 years rising through the ranks to become senior management level officers at sea. Hence, producing competent gas ship officers, within a short period of time, could only be possible if MET institutions provide upgrading training for existing management level officers from non-gas ship tonnage. To make the training effective, MET institutions need to work towards reducing the crucial training time, through the use of latest technologies for teaching and learning. This is crucial in meeting this industrial requirement of competent manpower with specialized skills. A computer-mediated teaching and learning environment is envisaged with significant time spent on LNG ship simulators, which could provide a good substitute for the lack of experience on the actual plant. Traditionally, the duration of these certificates of competency course for steam endorsement is three months. The feedback from the industry points to a preference of the training duration to be no more than four weeks. This is a real challenge for the MET institutions, to cut the time spent at the institution to a third of the usual duration and yet make the training effective.

In the next section, I describe the Certificate of Competency Course for Steam Propulsion, tailored specifically for LNG carriers, which has just been launched at the Singapore Maritime Academy. The course attempts to address these challenges described above.

LNG TRAINING FACILITIES AT SINGAPORE MARITIME ACADEMY

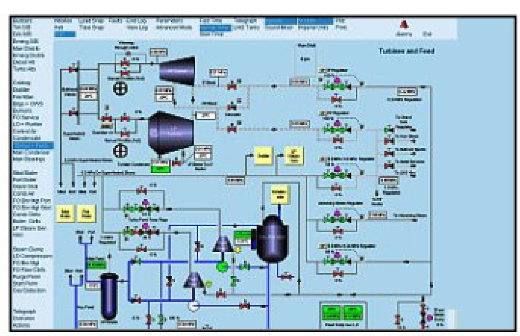

Figure 2. MPRI Ship Analytics Steam Simulator

The steam propulsion simulator, selected for the course, is from the MPRI Ship Analytics, UK (Figure 2). Presently they are the only vendor with a simulator, which is specifically based on an actual LNG carrier. The logic for the simulator was developed in conjunction with the California Maritime Academy, Vallejo U.S.A. It has two D-Type boilers with separate controls generating superheated as well as de-superheated steam using an attemperator.

The plant has steam turbine propulsion, which has two stage of high pressure and low pressure turbines and an astern stage for reversing the engine. A dynamic Mollier diagram is also available for advance level training.

Provisions have been made for twelve students per cohort and a cooperating learning environment has been created as each station with dual-monitor (Figure 3) system will be occupied by two students. This approach is taken to promote team work and to encourage cooperative problem-solving, which may result in quicker grasping of the domain knowledge.

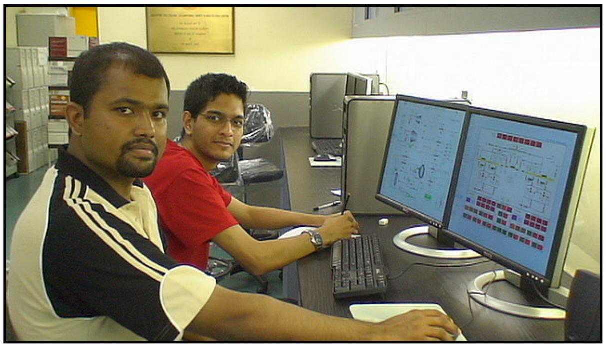

Figure 3. Dual monitor for simulator stations

The course is made modular with small learning objects, which has its own independent computer-based formative assessment system. As the students advance through the course, they are able to monitor their progress using this assessment system and take necessary action for remedial purposes.

The modular nature of the learning object-based development will lend itself towards industrial requirements of short courses for upgrading of the ship's officers. A gap-analysis could establish the actual training requirement of an individual engineer and a tailored course could be quickly put together using the available modular learning objects.

The old boiler house at the Singapore Maritime Academy has been revamped and the facility is being converted into a Steam Learning Centre. The AQ12 boiler for Aalborg, Denmark, has been fitted with the state of the art computer-based control system. Thus, the whole boiler and its auxiliaries can be controlled from an elevated control room through a pc-interface. A steam dumping system, common to LNG steam propulsion is incorporated to prove hands-on training to the learners.

The simulation training is supplemented by development of process-based advance learning organisers, which provide visual overview of processes in a sequential manner.

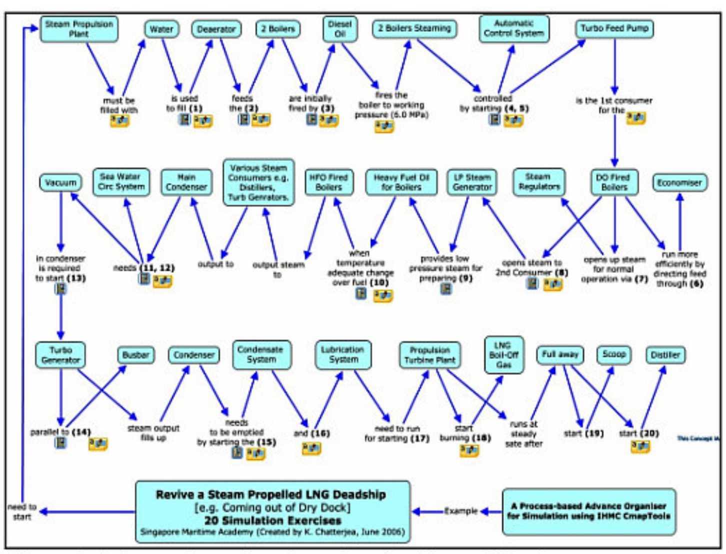

Figure 4. Advance Learning Organiser for Steam Simulator

These organisers are made by CmapTools, which is developed by The Institute for Human and Machine Cognition (IHMC) of University of West Florida, USA. The CmapTools is the resulted outcome of many years of research by Professor Joseph D. Novak (presently the Emeritus professor of Biology & Education, Cornell University, USA and Senior Research Scientist at IHMC).

It is expected that the use of these advance process-based learning organiser will facilitate faster assimilation of the new knowledge. Subsequently, the skill levels could be enhanced through the use of simulators. The CmapTools software suite would also be extensively used to capture of the domain knowledge and keep the knowledge level updated through further knowledge capture as the students return from the their shipboard experience on LNG vessels with assignments.

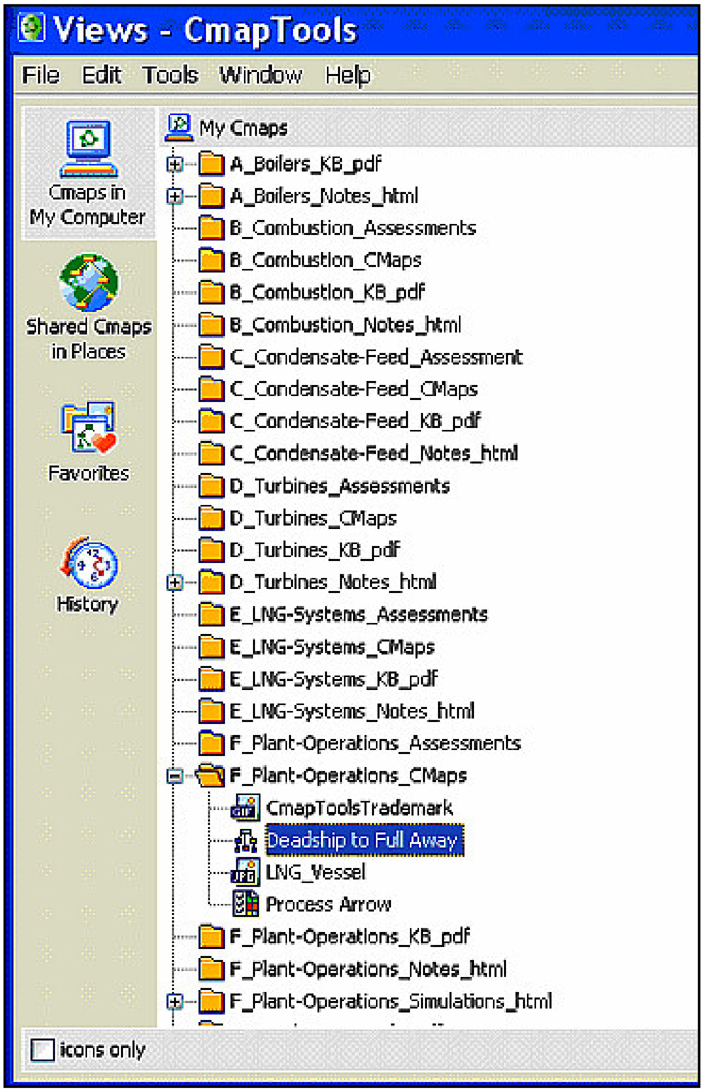

Figure 5. Knowledge-based Teaching & Learning Environment

The complete knowledge-capture environment is portrayed in the CmapTools Views (Figure 5), which manages the entire knowledge-base.

The importance of this knowledge capture phase in the course curriculum cannot be overemphasized as the lecturers are not able to sail on the ships on regular basis, it is essential to have a component in the course which will capture the students' learning experience and thereby update the knowledge-base. The ends of course assignments have to be carefully chosen, which will try and elicit the changes in the shipboard technology.

The entry requirements for this course is either Second Class Certificate of Competency (Motorship) or First Class Certificate of Competency (Motorship) from Maritime Port Authorities (MPA), Singapore or an equivalent qualification recognized by MPA, Singapore.

The course progression is shown in the Figure 6, which explains the various stages of the Steam COC.

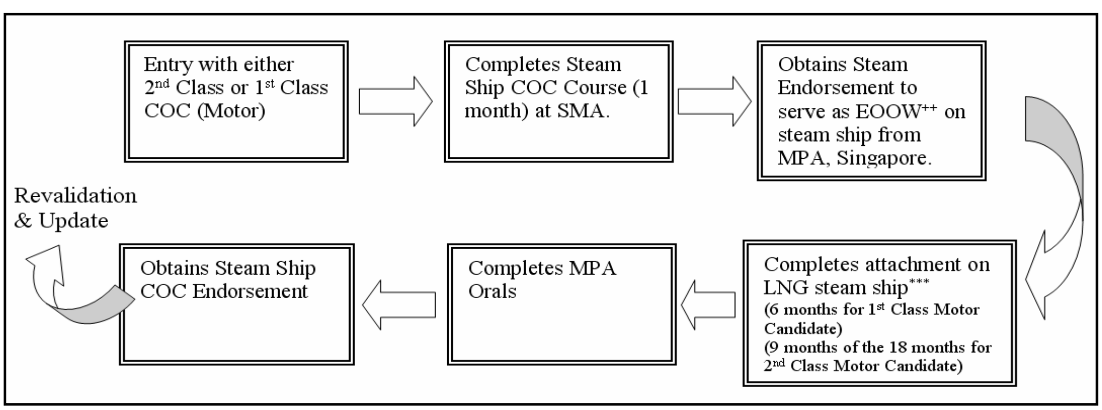

Figure 6. Progression through the Steam Certificate of Competency for LNG Carrier

++**EOOW –** Engineering Officer Of the Watch on Singapore Registered Ships.

FUTURE PLANS AT SMA

The industrial requirements for training sometimes change rapidly due to the adjustments in the markets and today's training institutions need to be vigilant and flexible enough to put together new courses as the demand arises.

In the LNG transportation industry, we already anticipate changes in the foreseeable future. The sizes of the ships are likely to increase significantly with possible changes in propulsion. The present capacity around 130 000 m^3 is likely to increase towards 200 000 m^3 or beyond. A number of these bigger vessels are planned with diesel propulsion with reliquification plants on board. However, there are also plans to improve the steam propulsion system with more efficient reheat cycles.

It is imperative that SMA keeps track of these technological changes in the transportation industry and additionally acquire the latest teaching, learning and assessment technologies to provide competitive training opportunities at the academy.

Certificate of competency course for steam propulsion has just been started at SMA. We need to follow up with COC course for the deck officers on LNG ships. Finally, we need to start the cargo engineers' course as well. SMA needs to have a comprehensive plan to develop a niche training segment for the LNG transportation industry.

CONCLUSION

The paper described the phenomenal changes in the LNG transportation industry and SMA's response in meeting the training needs of this specialised maritime sector. If we react proactively, we have the possibility of turning Singapore as a premier location for training of officers on LNG carrier. We need to work together closely with the industry, the Maritime Officers Union and Maritime Port Authorities to capitalise the potential provided by this unique situation.

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