Steam Ship Certificate of Competency Course
At
Singapore Maritime Academy (SMA)
[Revised Proposal dated 20thth July 2007]

Module Code: MA 7501

Table of Content

1. Background

The current phase of rapid growth in LNG transportation at sea was not really anticipated. The resulting acute manpower shortage in this niche industry sector requires a specialized training course to train engineers who are competent in steam engineering and further equipped to handle propulsion boilers running on LNG boil-off gas as well as fuel oil.

Singapore Maritime Academy (SMA) with support from Maritime Port Authority of Singapore started a Certificate of Competency Course covering Steam Engineering for LNG Propulsion in October 2006 with only two students. A second cohort of ten participants was successfully completed during March 2007.

The COC (Steam) Course is catered for the sea-going marine engineers with Class I or Class II COC (Motorship), who would like to get a steam COC for sailing on LNG Carriers using boil-off LNG gas for steam propulsion.

This document provides the entry requirements, course curriculum and other details of course delivery and assessment method. The feedback from the last two cohorts and future plans of course improvement are also included in the following sections.

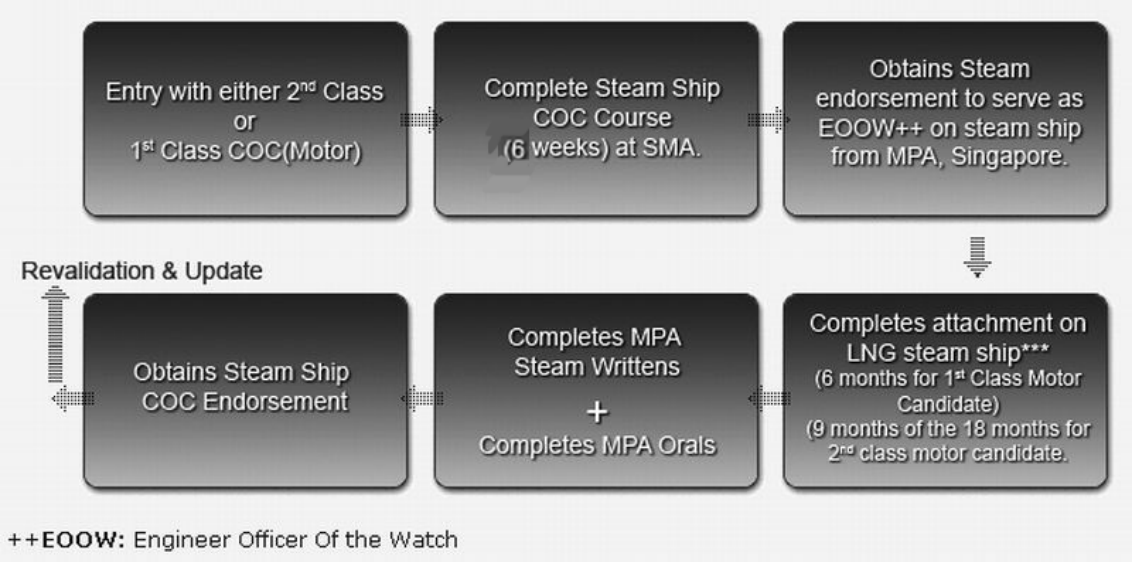
The following course blog-site has been established to improve online availability of the course information and to establish a communication channel between learners and SMA:

http://lngsteam.blogspot.com/

2. Entry Requirements

Either Second Class Certificate of Competency (Motor) or First Class Certificate of Competency (Motor) from Maritime Port Authorities (MPA), Singapore or an equivalent qualification recognized by MPA, Singapore.

3. Progression



*** **Steam Ship Sailing Time –** The requirement for obtaining COC (Steam) Endorsement is 6 months sailing time for 1st Class (Motorship) Engineers or 9 months sailing time for 2nd Class (Motorship) Engineers on board a steam turbine propelled vessel.

However, MPA would consider granting remission up to a maximum of 3 months of sea service for those who had served on vessels with steam machinery of at least 1500 kW aggregate capacity (on machinery e.g. ships with steam turbine generators, steam turbine operated cargo pumps on tankers or other suitable steam operated auxiliaries). The actual period of remission will be based on the evaluation of competency of the applicant by the MPA, Singapore.

4. Course Components & Durations

Organization/ Location	Course Components	Duration	Remarks
A. Singapore Maritime Academy (SMA)	Lecture (L):	32 hours	The course hours are based on two 4-hour evening sessions per week and three 8-hour sessions on 3 Saturdays. However, as the course components are computer-based, some of the components can also be completed during the day, which will lead to a shorter duration of the course.
	Lab & Simulation (T):	42 hours	
	Assignment (A):	16 hours	
	Guided Learning (GL):	30 hours	
	Total:	120 hours	
	Course Duration	A minimum of 6 weeks	
B. Shipboard Attachment	Experience as an engineer on a steam turbine propelled ship, preferably LNG carrier.	6 to 9 months^{++}	Experience at least as a 4th engineer. (Gas engineer position on an LNG steam ship is also acceptable)
C. Singapore Maritime Academy (SMA) Maritime Port Authority (MPA)	Written Examination Orals Examination		Award of COC Steam Endorsement
Total time required for the Steam Ship Endorsement (Minimum) (A + B = 1½+ 6) or 7½ months^{++}		7½ months	Includes academic components and shipboard attachment.
$^{++}$ For clarification on sailing time requirements for Steam Endorsement see under ***Progression [Section3].***			

5. Module Aims

To understand the principles, applications and safe working practices of steam propulsion machinery including its thermal system, cycle's energy conversion, boilers, steam turbines, feed, condensate and LNG systems. The knowledge is important for the students preparing to serve as engineers on board LNG carriers with steam propulsion.

6. Teaching Methods / Learning Tasks

The course would be delivered on a competency-based learning platform, with distinct task procedures (see under *Intended Learning Outcomes [Section 12F]*), which the learners will familiarise themselves through the use of an LNG Steam Propulsion Simulator. The procedures will cover the competency requirements of the Steamship

Certificate of Competency Syllabus (see under *Intended Learning Outcomes [Section 12]*). Each procedure would be broken down into smaller procedures and the related knowledge components. These knowledge components (see under *Intended Learning Outcomes [Section 12A, B, C, D & E]*) will be covered as background information before the student can understand and complete each procedure.

The course delivery will be through a set of lectures, lab work, simulator practice and self-learning packages.

At the end of each procedure, the student will undergo an online formative assessment, which will immediately feed back about his learning progress. In the event the student finds his performance to be lacking in a certain area, he will revise the component(s) to make good his deficiencies.

As the system will be computer-based, intervention by the facilitator will be minimal. However, the facilitator will monitor the progress of each student as all the steps taken by the students would be recorded on computer for detailed analysis of their progress and performance.

Additionally, the students would be developing two assignments for each area of coverage (see under *Table of Specifications [Section 11]*) as portfolio of his understanding in the subject domain. So, for the six main areas of coverage, there will be 6 x 2 or 12 assignments, which will be assessed for formative assessment. However, these marks will also contribute towards his aggregate score.

Finally, an online *End of Course Assessment* will be conducted to establish the outcome of the training.

7. Shipboard Assignments

A set of shipboard structured assignments will have to be completed by the students. These constitute the last component of the course prior to the *Oral Examinations* conducted by MPA. These assignments, one each for six main areas of coverage (see under *Table of Specifications [Section 11]*) will append the student's individual portfolio (Coursework B) started during the course at the SMA (see under *Means of Assessment [Section 8]*).

8. Means of Assessment

Assessment Components	Type of Assessment	When Conducted	Weightage %
1. Coursework A	Computer-based online assessment	Continuous (in-Course)	15
2. Coursework B	12 Assignments – 2 each for 6 main areas of coverage. (*Individual Portfolio*)	Continuous (in-Course)	15
3. Summative Assessment	Computer-based online assessment	End of Course	55
4. Shipboard	6 Assignments – 1	During steam ship	15

Assignments	each for 6 main areas of coverage. (Appending *Individual Portfolio)*	attachment (preferably LNG carrier).	

Note: Assessments will cover

- The knowledge components *[Subsections A, B, C, D and E in Section 12]* using knowledge-based tools and computer-based drill & practice.
- The competency-based components *[Subsections F in Section 12]* using Steam Simulator.

9. Recommended Text

1. Eastop & McConkey (2003), *Applied Thermodynamics for Engineering Technology*, Prentice Hall.
2. Morton, T. D. (2003), *Steam Engineering Knowledge for Marine Engineers*, Adlard Coles Nautical, London.

10. References

1. Milton, J. H. and Roy, M.L. (1980), *Marine Steam Boilers*, Butterworths, London.
2. McBirnie, S. C. (1980). *Marine Steam Engines and Turbines*, Butterworths, London.

11. Table of Specifications

Topics – Six Main Areas of Coverage		Abilities (%)			Total (%)
		K	C	A/HA	
Knowledge of	**A.** Steam Boilers	4	4	12	20
	B. Combustion Theory & Practice	2.5	2.5	2	7
	C. Main Condensate & Feed Water System	2	2	6	10
	D. Steam Turbines	4	4	12	20
	E. LNG System	2.5	2.5	2	7
Proficiency in	**F.** Plant Operation	6	6	24	36
Total		**23**	**23**	**54**	**100**

Note:

1. The letters K, C, A/HA in the table of specifications denote respectively, the Knowledge, Comprehension, and Application/Higher than Application levels of Bloom's Taxonomy in the cognitive domain.

12. Intended Learning Outcomes

In this Section:

- All objectives should be understood to be prefixed by the words: "**At the end of instruction, the learner should be able to…**"
- L: Lb+Sm: A: GL symbols denote as follows:
  - L - Lecture hours,
  - Lb+Sm - Lab and Simulator hours,
  - A - Assignment hours and
  - GL – Guided Learning hours.
- **Subsection F** in the *Learning Outcomes* (below) describes the main competencies to be covered during the Steam Ship COC Endorsement Course. The Subsections A, B, C, D and E cover the knowledge components, which form the background information for the learners.

	LEARNING OUTCOMES	L	Lb+Sm	A	GL
A	**STEAM BOILERS**	**8**	**6**	**4**	**8**
1	**Describe the steam boilers used in marine practice, relating various components of these boilers, their functions, the associated boiler mountings and the safety devices.**				
1.100	Classify marine propulsion boilers and enumerate their constructional differences.				
1.200	Identify the following components in boiler, label the significant parts, and describe the function of the components, their constructional details and operational importance in the steam cycle.				
1.201	• Water and steam drums				
1.202	• Tubes				
1.203	• Headers				
1.204	• Downcomers & Risers				
1.205	• Membrane walls				
1.206	• Refractory				
1.207	• Furnaces				
1.208	• Economisers				
1.209	• Superheaters				
1.210	• Attemperators/ Desuperheaters				
1.211	• Forced Draft Fans				
1.212	• Air preheaters				
1.213	• Boiler mountings				
1.214	• Safety devices				

	LEARNING OUTCOMES	L	Lb+Sm	A	GL
1.215	• Soot blowers				
1.300	**Describe the principles involved in boiler automation and control system and enumerate the functions and working of following sub systems:**				
1.301	• Overall steam load-based control for boiler				
1.302	• Combustion and draft control				
1.303	• Feed water and level control				
1.304	• Steam temperature control				
1.305	• Fuel oil & fuel gas control				
1.400	**Explain the needs for boiler & feed water treatment.**				
1.401	Describe the types of boiler & feed water treatment undertaken on board.				
1.402	Relate the test carried out to ascertain the condition of boiler water.				
1.403	Explain the purpose of blowdown and distinguish the difference between surface blowdown and bottom blowdown.				
1.404	Enumerate the problems which could be encountered if the boiler water treatment is not monitored and dosed.				
B	**COMBUSTION THEORY & PRACTICE**	**4**	**4**	**1**	**2**
2	**Understand the basic combustion process, air-fuel ratio, fuel oil/gas burning and associated combustion equipment.**				
2.100	Define conditions which must be satisfied for proper chemical reactions take place in the combustion process.				
2.101	Describe the processes by which residual fuel oil/gas is burnt in a boiler furnace.				
2.102	Identify & describe the following • Air-steam atomizing oil burners • Gas burners • Dual Fuel Oil-gas burners				
2.103	Explain the working of the burner flame safeguard system with the associated flame detection systems, interlocks, and relays which will sense the presence of a proper flame in the furnace if a hazardous situation develops.				
2.104	Discuss the monitoring devices, which could ascertain the conditions of combustion in the furnace.				
2.105	Discuss the environmental considerations for combustion in boilers.				

	LEARNING OUTCOMES	L	Lb+Sm	A	GL
C	**MAIN CONDENSATE & FEED WATER SYSTEM**	**4**	**4**	**1**	**2**
3	Understand the basic advantages of closed feed system, importance of system components, which contribute towards improvement of the overall cycle thermal efficiency.				
3.100	Differentiate between open and closed feed systems.				
3.101	Draw and explain the working of a typical marine closed feed system which includes a steam dumping system.				
3.102	Explain the working principles of a deaerator in the main feed system.				
3.103	Describe a typical main condenser, list out the functions and regular maintenance required for its proper functioning.				
3.104	Describe the working of a main condensate pump explaining the conditions under which it operates and the additional attentions required for such operating conditions.				
3.105	Sketch a main feed pump and explain its salient features.				
3.106	Explain the purpose of a feed heater and discuss the design dilemma while deciding on the number of feed heaters in the feed cycle.				
3.107	Sketch and describe a gland sealing steam circuit.				
3.108	Explain the working of a typical distiller on a steam ship.				
3.109	Sketch and describe a typical condensate drain system, including contaminated drains from fuel tanks.				
3.110	Describe the working of various types of steam traps in the drain system and explain why traps could improve the cycle efficiency.				
D	**STEAM TURBINES**	**8**	**6**	**4**	**8**
4	**Understand the basic classification of steam turbines, construction of these classes of turbines and associated reduction gearing.**				
4.100	Describe the working of the following steam turbines: • Reaction turbine • Impulse and Impulse-reaction turbines				
4.101	Sketch and describe the construction of the following components of turbines: • Rotors • Stators				

	LEARNING OUTCOMES	L	Lb+Sm	A	GL
	• Blades • Glands • Bearings • Flexible couplings • Gearings				
4.102	Describe the main propulsion turbine lubricating oil system and explain its safety features.				
4.103	Enumerate the various safety systems on the propulsion turbines and state how these are kept in good working condition.				
4.104	Describe the turbine manoeuvring valve arrangement and how the speed control is accomplished.				
E	**LNG SYSTEM**	**2**	**2**	**2**	**2**
5	**Understand the method of LNG cargo carriage, its need to be burnt in the boiler and how the overall system is managed safely.**				
5.100	Describe the methods of cargo carriage in LNG vessels including the various tank arrangements and insulation system.				
5.102	Describe how a nitrogen generator works and how the inter-barrier spaces are safeguarded.				
5.103	List out the pressure settings in cargo tanks during ballast and laden voyages and state the normal operating range and when the tank protection control is activated.				
5.104	Explain why there is a requirement to burn LNG in boilers during the passage of LNG carriage.				
5.105	Compute the gas flow rate, which is necessary to achieve a zero tank pressure increase rate on an LNG carrier.				
5.106	Explain the function of LD Compressor, de-mister and the BOG heater.				
5.107	Explain the functions of forcing vaporizer and stripping/spray pumps.				
F	**PLANT OPERATION**	**6**	**20**	**4**	**8**
6	**Able to operate a steam propulsion steam plant using LNG and fuel oil.**				
6.100	**Show an acceptable level of proficiency in undertaking the relevant procedures for the following tasks:**				
6.101	• Plant-up procedure for a steam propulsion plant.				

	LEARNING OUTCOMES	L	Lb+Sm	A	GL
6.102 6.103 6.104 6.105 6.106 6.107 6.108 6.109 6.110	• Plant-down procedure for steam propulsion plant • Warming up procedures of a main propulsion turbine • Starting a propulsion boiler from cold • Procedures for one boiler operation • Procedures for emergency turbine operation • Procedures for starting turbo generator • Procedures for starting turbo feed pump • Procedures for keeping watch in a steam turbine plant • Procedures for fault-finding on steam systems				
Note:	Competence units E_ENG_6, 7 and 8 of SIGTTO ('*Guidance and suggested best practice for the LNG industry in the 21st century*' 1st Ed. Nov 2005) are to be incorporated in the Subsection F above.				
	Total Running Time (hours)	**32**	**42**	**16**	**30**
	Grand Total (hours)	120			

13.Feedback from Cohort 001 & 002

The feedback received was generally positive and would encourage us to pursue this new way of computer-mediated learning for maritime education at the SMA. The following table summarizes the feedback received from the 10 mature students in our first cohort.

Feedback to Improve Learning (n=10)	
Questions	Feedback
1. List out the *useful* features of the module.	○ Course was information rich ○ Use of Internet to study ○ Sharing of course material among participants ○ Knowledge-based learning ○ Group learning ○ Team work ○ Hands-on experience on steam simulator gave us a realistic view of LNG ship operation ○ Good coverage ○ Video of LNG ship ○ Use of CmapTools suite ○ Use of ExamView software ○ Updated information on subjects ○ Computer-mediated learning

	drives our interest to learn more o Assess ourselves everyday with immediate feedback o Course gave us confidence on running of LNG ships
2. List out the *NOT so useful* features of the module.	o Nil
3. What are the *strengths* of the module?	o New approach to learning ⇒ Time saving ⇒ Better in-depth understanding ⇒ Direct involvement with content during course o Computer-based learning o Good coordination of course-coordinator o Use of CmapTools & ExamView o Exposure to new ways of learning o Ample scope for group discussion during the course o Learning with a partner o Freedom to research and make assignments using software
4. What are the *weaknesses* of the module?	o This method of teaching may not be effective for those who are expecting to spoon feeding. o Cannot find any flaw in this method of learning. Given a choice between traditional learning and this method, I shall choose the later. o Student without having some minimum knowledge of computing will find this course difficult. o No shipboard visit
5. Was the module *enjoyable*?	o Module was really interesting o Very interesting and informative o Very friendly and informal environment o Very enjoyable throughout the course o All the way yes
6. Why choose Singapore? ++	o Cost effective and I find Singapore to be a homely environment o Cheaper and yet the course is using a lot of technology

	○ Faculty is knowledgeable ○ Singapore is more advanced in computer usage ○ I continued from my earlier course in Singapore. So it was convenient
7. Any other comments.	○ We should keep in touch, contribute to the knowledgebase and share the same ○ A ship visit to LNG carrier would be useful. ○ SMA could arrange for placement to LNG ships ○ SIGTTO safety guidelines should be included ○ Boiler manufacturing techniques should be included ○ High voltage distribution system found in LNG ship should be included ○ One month of course time is too short
++ These are all international students.	

Table I. Feedback to Improve Learning

From above that, it can be said that this new way of learning was quite acceptable to this mature group of students. However, at the beginning of the module a few of the students were worried about the adequacy of their computer knowledge. It was also found that the younger learners were more comfortable in using CmapTools and ExamView software. Hence, their contributions to the knowledgebase were more than the older members of the cohort.

14.Future Plans for Improvement

⇒ The course content will be revised in collaboration with World Maritime University, Malmö, Sweden during August-September 2007.

⇒ A working steam lab will be obtained by Dec. 2007 to improve the course delivery.