ELECTRO-TECHNICAL OFFICER TRAINING FOR THE MODERN ERA

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ABSTRACT

This paper addresses new requirements for the *Electro-Technical Officer* curriculum, as defined in the provisions of *Regulation III/6* of the *2010 Manila Conference regarding the International Convention on Standards of Training, Certification and Watch keeping for Seafarers (STCW),* as well as training in major additional categories for the Electro-Technical Officer's role in mission critical marine applications in the areas of electrical power plants, data acquisition/control, satellite/radio communications, multiple high speed digital communications, navigation and radar applications. Although the need for an officer trained and qualified to deal with the ever increasing complexity of systems aboard modern vessels has existed for many years, the standards set at the Manila Conference formalized the framework of training, which should be implemented for such officers. The emphasis of this paper is to explore and identify the training and skills that an optimum Electro-Technical Officer training program requires.

Keywords: *Electro-Technical Officer, training curriculum, 2010 Manila Conference (STCW) provisions.*

1. INTRODUCTION

Shipboard systems have evolved from relatively simple electrical and electromechanical systems to more advanced propulsion, control, telecommunications and radar systems requiring very specialized training in a variety of technical areas. The industry has responded to these needs by creating a new rating called the *Electro-Technical Officer*. These officers will equip the Engine Department with new skills needed for mission critical applications.

This paper documents the curriculums currently proposed at the California Maritime Academy to address industry needs by creating and implementing the following two majors.

1.1. Electrical and Computer Engineering Technology major

This is a non-licensed track designed to address shore-side engineering needs, as well as non-maritime industry applications in the automation, electronics, computer and aerospace/defense industries. It is currently designed to be a 120 semester-unit program. Because this major does not require USCG or STCW compliance, it will be implemented only with the California State University system approval.

1.2. Electro-Technical Officer major

Upon implementation of the Electrical and Computer Engineering Technology major and the United States of America adoption of STCW guidelines for Electro-Technical Officers, the California Maritime Academy will launch an Electro-Technical Officer major. Our efforts in this regard will be the basis for this paper.

2. ELECTROTECHNICAL OFFICER - STANDARDS OF TRAINING, CERTIFICATION AND WATCHKEEPING

Per IMO Circular Letter STCW/CONF.2/33 outlining the *Conference of Parties to the International Convention on Standards of Training, Certification and Watch keeping for Seafarers, 1978-Agenda item10*, 1 July 2010 [1]: *Regulation III/6:*

Mandatory Minimum Requirements for Certification of Electro-Technical Officers.

(1) Every electro-technical officer serving on a sea-going ship powered by main propulsion machinery of 750 KW propulsion power or more shall hold a certificate of competency.

(2) Every candidate for the certification shall –

1. Be not less than 18 years of age on the last date of application.

2. Have completed not less than 12 months of combined workshop skills training and approved sea going service of which not less than 6 months shall be seagoing service as part of an approved training program which meets the requirements of section A-III/6 of the STCW code and is documented in an approved training record book, or otherwise not less than 36 months of the combined workshop skills training and approved seagoing service of which not less than 30 months shall be seagoing service in the engine department.

3. Have completed approved education and training and meet the standard of competence specified in section A – III/6 of the STCW Code.

4. Meet the standard of competence specified in section A–VI/1, paragraph 2, section A-VI/2, paragraphs 1 to 4, section A-VI/3, paragraphs 1 to 4 and section A-VI/4, paragraphs 1 to 3 of the STCW Code.

(3) Every Party shall compare the standard of

competence which it required of electro-technical officers for certificates issued before 1 January 2012 with those specified for the certificate in section A-III/6 of the STCW Code, and shall determine the need for requiring those personnel to update their qualifications.
(4) Seafarers may be considered by the Party to have met the requirements of this regulation if they have served in a relevant capacity on board a ship for a period of not less than 12 months within the last sixty months preceding the entry into force of this regulation for that Party and meet the standard of competence specified in Section A-III/6 of the STCW Code.
(5) Notwithstanding the above requirements of paragraph 1 to 4, a suitably qualified person may be considered by a Party to be able to perform certain functions of section A-III/6.

3. ADOPTION OF ELECTRO-TECHNICAL OFFICER RATING IN THE UNITED STATES OF AMERICA

Current plans for implementation in the USA are determined by the United States Coast Guard (USCG) and the Department of Homeland Security.

The IMO started a comprehensive review of the entire STCW Convention and Code in 2007. The IMO adopted amendments from this review on June 25, 2010 in Manila Philippines. These amendments went into force January 1, 2012. On August 1, 2011, the United States Coast Guard published the Supplemental Notice of Proposed Rulemaking (SNPRM)*[2]* which proposed implementation of all STCW amendments, and changes to domestic endorsements. A timeline for that ruling is shown in Figure 1. Implementation in the United States will be driven by the final STCW rulemaking and associated policies.

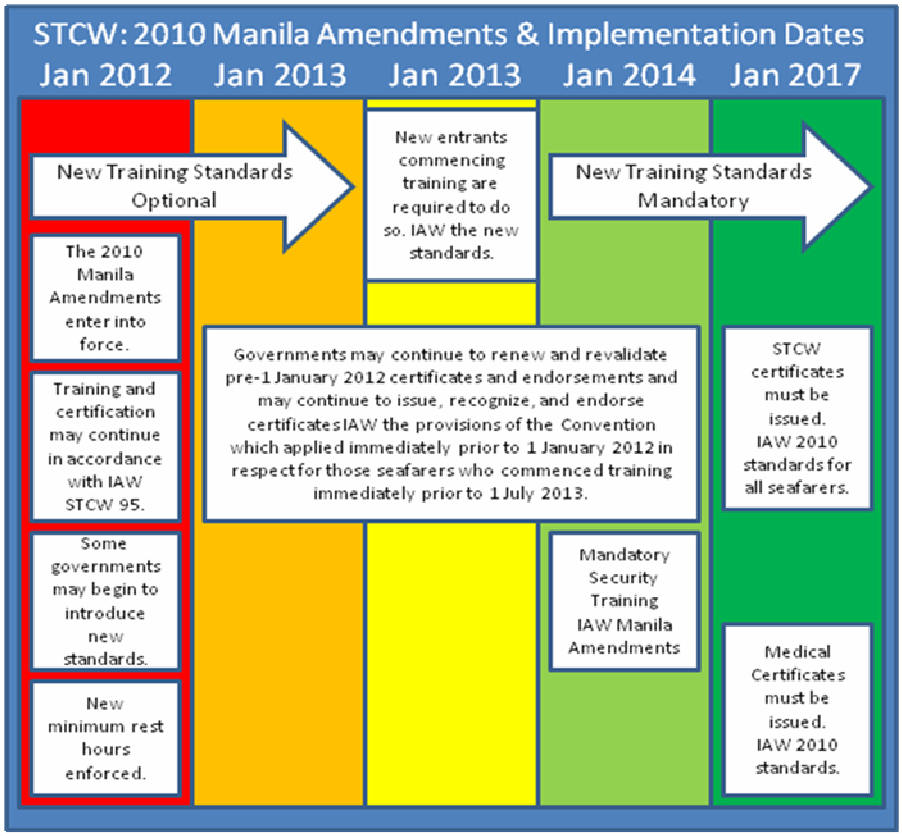

Figure 1 2010 Manila Amendments and Implementation Dates [2]

4. KEY KNOWLEDGE AREAS FOR ELECTRO-TECHNICAL OFFICER TRAINING

The duties of an Electro-Technical Officer can be varied, but will require a high degree of technical competence with emphasis on matters pertaining to electrical, electronic, automation and software issues.

Any training must provide expertise in these areas. Table 1 addresses the key seven knowledge areas we consider relevant and essential. All courses should include comprehensive laboratories to complement theory whenever possible. Detailed explanation of the curriculum contents and goals are provided below.

Table1. Electro-Technical Officer Knowledge Areas

KNOWLEDGE AREA	TOPIC	APPLICATIONS
1. Basic Electrical Circuits	- DC Circuit Theory - AC Circuit Theory	Foundation for all electrical and electronic applications
2. Electro-Mechanical Machinery	- AC/DC Motors - AC/DC Generators - Power Electronics - Motor Controllers	Winches, elevators, compressors, pumps, ventilation systems, propulsion systems, and other auxiliary machinery and equipment Ship power and propulsion systems Regulation and control of machine speeds, power, voltage and currents
3. Electronics	- Analog & Digital Solid State Technology	Electro-mechanical, data acquisition/ control, and networking systems. Used extensively in telecommunications and radar systems.
4. Automation	- Instrumentation and Automation	Hardware and software needed to acquire data and control shipboard systems.
5. Networking	- Computer Networking Technology	Transfer of computer-generated information within and outside a ship.
6. RF/MW Telecommunications and Radar	- RF/MW Technology - Radio and Satellite Technology - Radar Technology	Transmission and reception of all shipboard communications, navigation, satellite and radar systems.
7. GMDSS	- Operation and Repair	Shipboard radio systems

4.1. Knowledge Area 1: Basic Electrical Circuits

A *Basic Electrical Circuits* course must cover AC and DC electric circuits. It is the foundation course for all advanced studies in electricity and electronics. Learning goals for the course should include proficiency in:

- analyzing simple AC and DC circuits using network reduction, mesh and node analysis;
- using the Thévenin and Norton Equivalent circuits to model real voltage and current sources;
- creating and using phasor representations of sinusoidal voltages and currents;
- calculating apparent, real and reactive power and power factor in AC circuits;
- determining circuit modifications to adjust circuit power factor.

4.2. Knowledge Area 2: Electro-Mechanical Machinery

An *Electro-Mechanical Machinery* course covers fundamentals of:

- magnetism, magnetic flux and transformers;
- principles and operation of series, shunt, and compound DC generators and motors;
- single phase and three phase AC generators, synchronous and induction motors;
- DC and AC motor controllers, and stepper motors.

The understanding of system protective devices and safety is a core requirement of the course.

Three-phase circuit theory and basics of power electronic devices as they apply to speed controllers such as Variable Frequency Drives (VFDs) are a key competency for understanding state-of-the-art machinery.

4.3. Knowledge Area 3: Electronics

An *Electronics* course covers the basics of electronic theory and devices. Course goals include an understanding of:

- theory and operation of diodes, Bipolar Junction Transistor (BJT) and Metal Oxide Semiconductors Field Effect Transistor (MOS FET) technologies;
- two port devices, transfer functions and filtering;
- numbering systems, Boolean logic and digital devices.

An advanced course includes the basics of microprocessors, embedded systems and basic programming as applied to robotics. In preparation for the Instrumentation and Automation courses, a basic course on physical measurements, sensors and actuators is to be included in the curriculum.

4.4. Knowledge Area 4: Automation

Automation courses build on the knowledge gained in previous electrical courses. The goals of a course in *Basic Instrumentation* include:

- instrumentation devices and their uses in monitoring processes;
- instrumentation and sensors used for measuring temperature, pressure, level, flow, position and motion.

Other types of analytical measurements are intrinsic to all automation systems, and are therefore presented as fundamental subjects. Further key components of the curriculum are:

- principles of signal conditioning including operational-amplifier applications, filtering, applications to pneumatic systems and digital signal conditioning;
- an emphasis on how instrumentation relates to modern data acquisition and control systems;
- discussion of optimization of measurements in each relevant area.

An advanced Automation course includes applications in power plants, engineering processes, and manufacturing processes leading to an understanding of modern control systems. Important for the understanding of closed loop controlled systems is knowledge of the principles of analog and digital control systems, measurement methods and actuator devices. Proportional Plus Integral Plus Derivative (PID) control applications as well as Programmable Logic Controllers (PLC's) are included in the course.

4.5. Knowledge Area 5: Networking

Networking as it applies to telecommunications systems and computer networks is an important foundation for the understanding of communications systems. A *Networking* course includes the basics of signal conversion methods, sampling, quantization, pulse modulation techniques, error analysis methods, digital modulation techniques, encoding schemes, data transmission methods, Open System Interconnection model (OSI), frame transmission methods, multiplexing low-speed channels, Local Area Network (LAN), Transmission Control Protocol/ Internet Protocol (TCP/IP), Ethernet and IEEE 802 networking technology. Course goals include:

- understanding of Pulse Code Modulation (PCM), Delta Modulation and the transmission of digital signals over analog media;
- error detection, correction and analysis;
- Open Systems Interconnection (OSI) network model, network architecture and protocol;
- Local Area Network (LAN) technologies

4.6. Knowledge Area 6: RF/MW Telecommunications and Radar

Many marine wireless applications use Radio Frequency (RF) and Microwave (MW) frequencies. A thorough understanding of this knowledge area is fundamental for telecommunications and radar applications. The course includes:

- generation and transmission of signals;
- a survey of modern RF/Microwave applications, including radio, radar, terrestrial and satellite communication systems;

Course goals include:

- basic understanding of RF and Microwave theory and measurement techniques;
- understanding of the differences between lower frequency measurement methodology and higher frequency techniques;
- complete briefing on safety issues pertaining to higher frequency and higher power applications .

4.7.Knowledge Area 7: GMDSS Operation and Repair

The *Global Maritime Distress Safety System (GMDSS) Operation and Repair* course includes:

- use of a marine VHF radio, the Maritime Mobile Service and the Maritime Mobile Satellite Service;
- theoretical knowledge of equipment compliance, electronic communications systems, calling procedures, distress alerting techniques, and marine safety information;
- overall knowledge of the system, and modular approaches to its repair.

The course should lead to FCC licensing for *Marine Radio Operator Permit* (Element 1) and the *GMDSS Operator's License* (Element 7).

5. ELECTRO-TECHNICAL OFFICER CURRICULUM AT THE CALIFORNIA MARITIME ACADEMY

The adoption of the Electro-Technical Officer curriculum at The California Maritime Academy will depend on the U.S. Government's implementation of the 2010 Manila Convention Amendments. The California Maritime Academy plans to incorporate the knowledge areas mentioned above into the current Marine Engineering Technology curriculum and create an Electro-Technical Officer major.

6. CONCLUSIONS

A variety of Electro-Technical Officer training programs have been implemented throughout the world. Each has its own merits, and all do a fine job in providing skilled graduates to the maritime industry. The California Maritime Academy's approach aims to create a solid foundation in those pertinent technology areas that form the basis of an engineering technical degree. However, due to the ever-changing nature of technological innovation, it is ultimately the responsibility of each Electro-Technical Officer to constantly stay abreast of new technologies, and incorporate them in their daily work. Life-long learning is a skill that must be acquired as a student and kept in practice throughout a working career. Employees as well as employers should encourage and facilitate this effort in their work place.

7. REFERENCES

[1] IMO Circular Letter STCW/CONF.2/33 outlining the *Conference of Parties to the International Convention on Standards of Training, Certification and Watch keeping for Seafarers, 1978-Agenda item10*, 2010.
[2] SNPRM Docket ID: *USCG-2004-17914.*