# Toward an International Rubric: A Compilation of STCW Competency Assessment Methodologies

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*By learning you will teach;*
*by teaching you will understand*
Latin Proverb

## Abstract

The International Maritime Organization Convention on the Standards of Training, Certification and Watchkeeping for Seafarers (IMO/STCW) addresses specific assessments with respect to ship officer certification. Although the IMO provides limited guidance on methodologies to be employed for assessment of mariner skills, it does not offer detail with respect to specific evaluation techniques.

The STCW Code establishes general performance standards for simulators used for training or assessment activities conducted to meet a requirement of the Convention. The Code also provides detailed guidance on the use of simulators for training and assessment of candidates for STCW certificates. Qualifications of trainers and assessors are also outlined. Other provisions such as simulator training objectives, training procedures, and assessment procedures are specified. The STCW assessments follow the educational hierarchy of knowledge, understanding, and proficiency.

This paper will detail the processes through which selected mariner proficiencies are assessed at the United States Merchant Marine Academy (USMMA). For example, historically, the Shiphandling / Seamanship course offered at the USMMA did not provide for evaluation of midshipmen through practical competency assessment of mariner skills. Moreover, simulation was not traditionally used in the facilitation process to demonstrate ship behavior. With the advent of IMO model courses and implementation of STCW competency assessment, the Shiphandling/Seamanship course offered to midshipmen at the USMMA was redesigned to employ practical demonstration, performance evaluation and assessment through the use of multi-task and full

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mission simulation. Practical assessments of mariner skills, to be successfully objective and quantitative, are now executed in the controlled environment the simulators provide. In conclusion, this paper will encourage discourse and promote international collaboration toward a standardization of the methodologies of mariner competency assessment.

## I. Introduction

With the advent of STCW 95, mariner qualification was transferred from knowledge based to proficiency based examination. The Convention provides for several methods of testing, both written and practical. The latter method may involve the use of a simulator, a training ship or other merchant vessel. Strict standards governing the use of simulators in both mariner training and assessment are outlined in the Code. In chapter 1, guidelines are detailed regarding the performance standards of simulators, the qualifications of the instructors and assessors, and the procedures for simulator based training and assessment.

In chapter II of the STCW Convention, *Standards Regarding the Master and Deck Department,* Section A-II-1 provides mandatory minimum requirements for the certification of officers in charge of a navigational watch on ships of 500 gross tonnage or more. The included tables outline criteria for evaluating competence of these minimum standards according to three Functions: Navigation at the Operational Level (A-II/1); Navigation at the Management Level (A-II/2); and Navigation at the Support Level (A-II/4).

It is beyond the scope of this paper to enumerate all of the requisite standards of competence for persons in charge of a navigational watch. For each competence listed in the STCW Tables, methods for demonstrating competence and criteria for evaluating same are listed in exhaustive detail. Specific methodologies, however, are not provided. These are left to the discretion of the assessor, to be developed according to the parameters outlined.

For each competence, the Function defines a requisite Knowledge, Understanding, and Proficiency (KUP). It is interesting to consider the skill-sets detailed thus according to a taxonomy of educational objectives. Assessment of some competencies is basic, whereas others require much planning or database development when a simulator is employed. For the Function: *Navigation at the Operational Level*, more complex competencies will be detailed according to methodology and assessment criteria as evaluated at the United States Merchant Marine Academy. It is the hope of this author to open a dialogue between assessors for the purpose of working toward an international rubric, or standardized assessment of proficiency.

## 2. Performance Standards of Simulators

According to the STCW code, the use of a simulator is mandatory in only two cases: in training in RADAR and in Automatic Radar Plotting Aids (ARPA). Simulators are, however, identified frequently in the STCW code as an acceptable method or environment for demonstrating competence. Section A-I/12 of the STCW Code establishes specific performance standards for RADAR and ARPA, and general performance standards for simulators otherwise used for training or assessment activities conducted to meet a requirement of the Convention. Section B-I/12 of the STCW Code provides detailed guidance on the use of simulators for training and assessment of candidates for STCW certificates. [uscg.mil/STCW]

### 2.1. Use of Simulators for Training

Section A-I/12 Part 1 outlines general performance standards for simulators used for mandatory simulator based training. The unit must be capable of simulating the operation of the shipboard equipment concerned with a level of physical realism to include capabilities, limitations and possible errors of the equipment. The controlled operating environment the simulator provides must be also capable of producing a variety of conditions including but not limited to unusual situations, hazards, or emergencies relevant to the training objectives. The trainee must be able to interact with the equipment, the environment, and the instructor. The instructor must be able to control, monitor, and record exercises for effective debriefing. Peer debriefing is also encouraged.

### 2.2. Use of Simulators for Assessment

Section A-I/12 Part 1 outlines general performance standards for simulators used in assessment of mariner competence or demonstration of continued proficiency. In addition to the requirements outlined above, the simulator must have sufficient behavioral realism to allow a candidate to exhibit the skills appropriate to the assessment objectives. The assessor must be able to control, monitor, and record the exercises for the effective assessment performance of the candidates.

### 2.3. A Uniform Standard for Approved Simulators

When using simulators as a means to demonstrate competence (assessment) in competencies other than RADAR/ARPA, it is a mandatory requirement to use approved simulators. To be an approved simulator, the unit must meet performance standards as outlined above. The standard stipulates requirements for the performance of maritime simulators. The purpose of the standard is to ensure that the simulations provided by

any maritime simulator include an appropriate level of physical and behavioral realism in accordance with recognized training/assessment objectives.

Det Norske Veritas has developed a uniform standard for certification of maritime simulators for STCW competency assessment. Application of this standard ensures consistency in simulation training, and verifies that the simulator center is operating according to established practices and specific requirements. Their standard can be applied to all simulator centers offering education and training with simulators to the maritime industry. The standard supports the requirements and objectives of the ISM code and the revised STCW-95 Convention. [dnv.com]

## 3. Qualifications of Instructors and Assessors

If conducting training using a simulator, the instructor must have received appropriate guidance and have gained practical operational experience on the particular type of simulator being used. If a person is conducting assessment involving the use of simulators, they must have gained practical assessment experience on the particular type of simulator under the supervision and to the satisfaction of an experienced assessor. These qualifications for appropriate guidance and operational experience are met through the completion of an approved "Train the Trainer" course wherein assessors are trained with respect to comprehensive and uniform training and assessment methodologies.

## 4. Procedures for Simulator Based Training and Assessment

Section A-I/12 Part 2 provides for other provisions such as simulator training objectives, training and assessment procedures. According to the Code, the aims and objectives of simulator based training must be defined within an overall training program and specific training objectives and tasks must be selected so as to relate as closely as possible to shipboard tasks and practices.

### 4.1. Simulator Based Training Procedures

Instructors must ensure that trainees are briefed and given sufficient planning and familiarization time and guidance with respect to the simulator and its equipment. The exercise must be appropriate to objectives and tasks and to the level of trainee experience. The exercise must be effectively monitored and supported by audio and visual observation, and the trainees must be effectively debriefed to ensure that objectives were met.

### 4.2. Simulator Based Assessment Procedures

Assessors must ensure that performance criteria are established clearly and are explicit to ensure reliability and uniformity of assessment and to optimize measurement and evaluation so that subjective judgments are kept to a minimum. As in training, the candidates must be adequately briefed and familiar with the equipment and the tasks and/or skills to be assessed. Further, they must have an understanding of the performance criteria by which their competency will be determined.

## 5. Knowledge, Understanding, and Proficiency

A taxonomy of educational objectives was proposed in 1956 by Benjamin Bloom, an educational psychologist at the University of Chicago. Commonly referenced as Bloom's Taxonomy, it is a classification of objectives and skills for students. The educational objectives are divided into three domains, but the cognitive domain is the most relevant to mariner competence. Skills in the cognitive domain constitute knowledge, comprehension, and application. These skill objectives follow closely the Knowledge, Understanding, and Proficiency (KUP) requisites of STCW assessment. (Anderson, et.al. 2001)

### 5.1. Knowledge

The knowledge level is the lowest of the cognitive levels and requires only that a student exhibit memory of previously learned materials through recollection of basic terminology, facts, and basic concepts. Testing of such knowledge is of the simplest level and is easily accomplished through written examination. For example, if a student were shown a photograph of an anchor windlass, they would be able to identify it as such.

### 5.2. Understanding

The understanding, or comprehension level involves a demonstrative understanding of facts and ideas, often through description or interpretation. For example, a student may be shown a picture of an anchor windlass and asked to describe its function and operation. Testing of knowledge at this level may also be in written or oral format but would be more essay than short answer.

### 5.3. Proficiency

The highest of the skill objectives in STCW competency, demonstration of Proficiency entails an application or demonstration of acquired knowledge. For example, a student might be asked to demonstrate the function of an actual anchor windlass by dropping or weighing anchor. The best assessment at this cognitive level would be through practical examination.

## 6. Function: Navigation at the Operational Level

"Function," as specified in the STCW Code, is defined as a group of tasks, duties and responsibilities necessary for ship operation, safety of life at sea, or protection of the marine environment. This term is important because the standards of competence set out in the chapters of the STCW Code are based on seven functional areas at three levels of responsibility: Support, Operational, and Management. In this analysis, the functional area, Navigation, is selectively detailed at the Operational Level. Please refer to the table at the end of this paper.

### 6.1 Competence: Plan and Conduct a Passage and Determine Position

The KUPs (Knowledge, Understanding and Proficiency) for this competence range from celestial and terrestrial navigation, steering control systems, compass and gyro, meteorology to electronic navigation. The assessments range from the mundane (successful plot of a five star fix) to the complex (navigation). Two of the assessments from this competency have been selected for amplification.

#### 6.1.1. Ability to Determine the Ship's Position by Use of Electronic Navigation Aids

At USMMA, this competency is assessed by graded practical plotting examination during the Electronic Navigation course in the multi-task simulator, Navi-Trainer Professional 4000® manufactured by Transas. The student is assigned a scenario and allotted a one hour time limit to complete the exercise and accomplish a passing score of 70 or higher. For example, the student is given an initial position by Loran C TDs and required to plot same. Once underway, the GPS, echo sounder and radar may also be used to make good an intended track. If the vessel deviates from the intended track by more than a half mile, 30 points are deducted from the final score. After the run is completed, four additional questions (10 points each) are asked concerning the run. (Moskoff, 2007)

### 6.1.2. Echo Sounder: Ability to Operate the Equipment and Apply the Information Correctly

Demonstration of the use of an echo sounder is usually included as a part of a larger scenario rather than as a separate task. Although the competency is included in the Electronic Navigation course, it may also be evaluated during Bridge Watchstanding.

## 6.2. Competence: Maneuver the Ship

The KUPs for competency encompass a wide range of aspects of ship maneuvering and handling. The effects of wind, current, deadweight, draft, UKC (Under Keel Clearance), squat, shallow, shallow water, anchoring and mooring procedures are assessed, to name a few. Almost all of these assessments are accomplished in a simulator.

### 6.2.1. the Effects of Deadweight, Draft, Trim, Speed and Underkeel Clearance on Turning Circles and Stopping Distances

This competency assessment is accomplished using the PortSim® part-task simulator manufactured by SSPA. The students are given a series of practical exercises wherein they must determine whether factors such as draft, deadweight, shallow water, speed, etc have an effect on a vessel's maneuvering particulars, e.g., turning characteristics and stopping distance. As a final test, the student is assigned a ship model and required to stop in a designated channel by a given distance while remaining within the confines of the channel.

### 6.2.2. the Effects of Wind and Current on Shiphandling

This competency assessment is usually accomplished using the PortSim® part-task simulator. The students are given several exercises wherein they are required to successfully maneuver the vessel. (1) A post Panamax vessel must be maneuvered from a slipway in Rotterdam. This exercise is designed, among other learning objectives, to reinforce the concept that a ship will tend to back into the wind. (2) The student is required to successfully dock a vessel in Corpus Christi channel with a 1 knot ebb tide. The student is allowed to choose between a fixed pitch, right hand screw ship (post Panamax) and a controllable pitch right hand screw (1450 TEU container ship). The vessel chosen determines how the pier should be optimally approached. Finally, the student must successfully dock a twin screw ferry with wind and current.

### 6.2.3. Maneuvers and Procedures for the Rescue of Persons Overboard

This maneuver is best accomplished in the CAORF full mission simulator (NorControl) or the Navi-Trainer Professional 4000®. In these simulators, a person is reported overboard by the simulator operator (the victim is input on the database at the point of execution) and the student must maneuver to recover him within a specified time and distance using one of the practiced maneuvers. Wind, current, and visibility are also factors in this maneuver. This maneuver may also be accomplished on the PortSim® simulator.

### 6.2.4. Squat, Shallow Water and Similar Effects

This exercise is the most complex of the designated competencies in the Seamanship / Shiphandling course. If executed in the PortSim® simulator, the own ship is initially placed in the turning basin of the Corpus Christi channel outbound. In the course of the transit, the student will meet 10 ships inbound and must successfully meet a designated number to pass the competency. If executed in the Navi-Trainer Professional 4000®, the student is virtually on the bridge of a vessel inbound in the Houston Ship channel and must meet a vessel outbound as well as overtake another inbound. Bank effects, squat, and ship interaction are clearly demonstrated to adverse consequences if not held in check.

### 6.2.5. Proper Procedures for Anchoring and Mooring

This exercise is an example of a competency accomplished during the capstone course, Bridge Watchstanding. Meurn and Sandberg (2000) described well the use of a full mission simulator, such as CAORF, for competency assessment. It remains their belief that the use of experienced mariners, trained in simulator assessment through a course such as Train the Trainer, is the optimal method for minimizing loss of testing validity. Further, as this exercise exemplifies, they stressed the importance of accomplishing an assessment as a part of a complete scenario, rather than as an isolated proficiency. Anchoring and mooring procedures are accomplished as a two part exercise, each operation running about an hour in length. The tasks involved encompass passage planning, maneuvering, collision avoidance and navigation. The first hour, the ship is brought in to anchor inside the breakwater in Cristobel, Panama. The second hour (accomplished the following week), the ship anchor is weighed and the Canal transit is commenced. This is an example of an excellent exercise for evaluation of a number of additional competencies not listed in the chart below, such as following helm orders, steering on a range, interpreting an echo sounder and other instruments, handling traffic, to name a few.

## 7. Conclusion

The navigation simulator, whether part-task, multi-task, or full mission, remains the optimal venue for competency assessment. Well designed scenarios meet the STCW performance standards of behavioral realism within a controlled operating environment capable of producing a variety of conditions. Approved simulators are capable of simulating the operational capabilities of the shipboard equipment concerned to a level of physical realism appropriate to the assessment objectives and include the capabilities, limitations, and possible errors of such equipment (STCW section A-I/12). Approved simulator requirements, instructor/trainer requirements and competency methods are carefully outlined in the Code.

The STCW Code does not, however, detail assessment methodologies. Educational skill sets (to the level involved in competency assessment) are hierarchical and follow the knowledge, understanding and proficiency (KUP) objectives. Some competencies are very basic, i.e., those which are knowledge based, and so would have wide acceptance with respect to methodology. Consider, for example, competency assessment of helm orders. The proficiency (comprehension) level is highest and should therefore be carefully considered as a part of the evaluation process. These assessments necessarily involve detailed scenarios such as those examples provided. Such methodologies may vary widely between assessors.

Dr. Peter Muirhead (2006), of the World Maritime University, posed the question, "Is it realistic to expect marine simulators across the globe to be used uniformly by different assessors, against an agreed set of performance criteria, to measure seafarer competence?" The answer to his question is a resounding yes. May this paper be the genesis of a discourse between assessors toward such an international rubric.

## Appendix I: Definitions

The following definitions are summarized from the STCW Code Section A-1/1 and are germane to the understanding of the discussion of the STCW Code and its Annex found in this paper:

"**Approved**" means approved by the Party in accordance with the regulations in the Annex. This term is used in connection with requirements for "approved training", "approved seagoing service", "approved training record bo ok", "approved simulator training" etc. In each case, there are requirements which must be met before a party can give its approval.

"**Function**" means a group of tasks, duties and responsibilities, as specified in the STCW Code, necessary for ship operation, safety of life at sea or protection of the marine environment. This term is important because the standards of competence set

## FUNCTION: NAVIGATION AT THE OPERATIONAL LEVEL (excerpted examples)

| COMPETENCE | KNOWLEDGE, UNDERSTANDING AND PROFICIENCY | STCW METHODS OF DEMONSTRATING COMPETENCE | STCW CRITERIA FOR EVALUATING COMPETENCE | USMMA METHOD OF ASSESSMENT / WHERE ASSESSED |
|---|---|---|---|---|
| 1. Plan and conduct a passage and determine position (cont'd). | | Examination and assessment of evidence obtained from one or more of the following:<br>(1) Approved in-service experience;<br>(2) Approved training ship experience;<br>(3) Approved simulator training, where appropriate;<br>(4) Approved laboratory equipment training; | (continued)<br>(2) The primary method of fixing the ship's position is the most appropriate to the prevailing circumstances and conditions;<br>(3) The position is determined within the limits of acceptable instrument/system errors; | |
| | (g) Ability to determine the ship's position by use of electronic navigation aids. | | | Graded plotting exam in multi-task simulator.<br>Electronic Navigation |
| | Echo sounders: | | | |
| | (h) Ability to operate the equipment and apply the information correctly. | | | Graded practical exam in CAORF simulator.<br>Electronic Navigation |
| 8. Maneuver the ship | Ship maneuvering and handling. | | | |
| | (a) The effects of deadweight, draught, trim, speed and under-keel clearance on turning circles and stopping distances. | Examination and assessment of evidence obtained from one or more of the following:<br>(1) Approved in-service experience;<br>(2) Approved training ship experience;<br>(3) Approved simulator training, where appropriate;<br>(4) Approved training on a manned scale ship model. | (1) Safe operating limits of ship propulsion, steering and power systems are not exceeded in normal maneuvers<br>(2) Adjustments made to the ship's course and speed maintain safety of navigation. | Graded practical exam in part or multi-task simulator.<br>Seamanship/Shiphandling |
| | (b) The effects of wind and current on ship handling. | | | Graded practical exam in part or multi-task simulator.<br>Seamanship/Shiphandling |
| | (c) Maneuvers and procedures for the rescue of persons overboard. | | | Graded practical exam in part or multi-task simulator.<br>Seamanship/Shiphandling |
| | (d) Squat, shallow water and similar effects. | | | Graded practical exam in part or multi-task simulator.<br>Seamanship/Shiphandling |
| | (e) Proper procedures for anchoring and mooring. | | | Anchoring: Graded practical exam in CAORF simulator.<br>Bridge Watchstanding |
| | (e) Proper procedures for anchoring and mooring. | | | Mooring: Graded sea project oral exam.<br>2nd sailing sea project |

Table condensed from a compilation – original by CDR Paul Zerafa

out in the chapters are based on seven functional areas at three levels of responsibility (which are broadly defined in section A-I/I of the STCW Code).

"**Standard of competence**" means the level of proficiency to be achieved for the proper performance of functions on board ship in accordance with the internationally agreed criteria as set forth in the Code and incorporating prescribed standards or levels of knowledge, understanding and demonstrated skill.

"**Management level**" means the level of responsibility associated with serving as master, chief mate, chief engineer officer or second engineer officer on board a seagoing ship, and ensuring that all functions within the designated area of responsibility are properly performed.

"**Operational level**" means the level of responsibility associated with: serving as officer in charge of a navigational watch on board a seagoing ship, and maintaining direct control over the performance of all functions within the designated area of responsibility in accordance with proper procedures and under the direction of an individual serving in the management level for that area of responsibility.

"**Support level**" means the level of responsibility associated with performing assigned tasks, duties or responsibilities on board a seagoing ship under the direction of an individual serving in the operational or management level.

"**Evaluation criteria**" are the entries appearing in column 4 of the "Specifications of Minimum Standards of Competence" tables in Part A and provide the means for an assessor to judge whether or not a candidate can perform the related tasks, duties and responsibilities.

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