

Study on Application of Simulator-based Training and Assessment for Sea Service Equivalence

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14. ABSTRACT The Volpe National Transportation Systems Center was asked to undertake two related tasks, ultimately with the goal of increasing the pool of mariners seeking an endorsement. (1) In the first task, Volpe was asked to evaluate current sea service requirements and support evidence-based recommendations for granting sea service equivalencies for training and assessment of Navigation and Vessel Inspection Circular (NVIC) tasks learned and assessed using one of five methods: training first at sea either on or not on a training vessel and training first on land either without a simulator, with a part-task simulator, or with a full-mission simulator. Subject matter experts' (SMEs') estimates of the time to reach proficiency at sea on each NIVC task trained using a given method were obtained for each of six Standards of Training, Certification, and Watchkeeping (STCW) endorsements: Ratings Forming Part of a Navigational Watch (RFPNW), Ratings Forming Part of an Engineering Watch (RFPEW), Officer in Charge of Navigational Watch (OICNW), Officer in Charge of Engineering Watch (OICEW), Master/Chief Mate, and Chief Engineer/2nd Engineer Officer. A total of 2,163 SME such estimates of the time to reach proficiency were obtained. Based on these estimates, a rule was developed by the Volpe Center that was used to infer sea service equivalence from the time to proficiency for the tasks included in the NVICs that were required for each of the six STCW endorsements. These task estimates can then be used to determine for an individual mariner the overall sea service equivalency for any subset of tasks on which the mariner has been trained. (2) In the second task, Volpe was asked to determine which of two methods of training mariners was most effective. Comparisons were made between the performance of mariners in courses involving full-mission versus part-task simulator training, one versus multiple trainees per simulator, and initial versus recertification training within Radar Observer. No statistically significant differences in performance were observed in any comparison. This suggest that mariners can take a course taught using a method that they believe is best suited to their learning results.				
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The views expressed herein are those of the authors and do not necessarily reflect the views of the Volpe National Transportation Systems Center, the U.S. Department of Transportation, or the U.S. Coast Guard.

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Definitions¹

Symbol/Term	Definition
<i>task</i>	Tasks are referenced in NVICs and correspond to particular STCW competencies and related knowledge, understanding and proficiency, performance conditions, performance behaviors, and performance standards. For example, in Enclosure (2) to USCG Navigation and Vessel Inspection Circular No, o6-14, Change 6 [1], Task 1.1.A (Steady on a new course) corresponds to a particular STCW competence (Steer the ship and also comply with helm orders in the English language) and related knowledge, understanding and proficiency, performance conditions, performance behaviors, and performance standards.
c_i	The i^{th} task (competency) listed in an NVIC that is required for an STCW endorsement where, as indicated above, the i^{th} task is associated with a particular STCW competency. Note: a single endorsement may span tasks across multiple NVICs ; however, for an RFPNW endorsement, there is a single NVIC with tasks listed in listed in Enclosure (2) of USCG Navigation and Vessel Inspection Circular No, o6-14, Change 6 [1] that correspond to the competencies listed in STCW Table A-11/4.
C	The set of tasks listed in an NVIC (or set of NVICs) to obtain a particular STCW endorsement, exclusive of those that are required as part of basic training. For example, set C for an RFPNW is the set $\{c_1, c_2, \dots, c_{27}\}$ of 27 tasks outlined in Enclosure (2) of NVIC o6-14, Change 6 for an RFPNW that can be trained at sea, exclusive of the 5 tasks that are required as part of basic training.
m_j	Training method m_j ; m_o is no training; $j \geq 1$ with training.
A	The set $\{(c_{i_1}, m_{j_1}), \dots, (c_{i_n}, m_{j_n})\}$ of n task-method pairs, i.e., the n pairs of tasks and training methods submitted by a mariner for an STCW endorsement from a set S of courses that have been approved by the USCG for awarding sea service equivalency (SSE) credit for an NVIC task c_i trained with method m_j . Set A would be empty if the mariner were untrained before going to sea.
U	The set $\{(c_{k_1}, m_o), \dots, (c_{k_p}, m_o)\}$ of p task-method pairs that have not been trained prior to sea service or have been trained, but not approved for SSE.
C_A	The set $\{c_{i_1}, \dots, c_{i_n}\}$ of n trained tasks that have been approved for SSE credit when trained with method m_j , i.e., the set of tasks in A without the associated training method.
C_U	The set $\{c_{k_1}, \dots, c_{k_p}\}$ of p untrained (or unapproved) tasks that are the complement of the set of trained tasks in C_A . Note that $C_A \cup C_U = C$ and $C_A \cap C_U = \emptyset$.
h_i	The time in hours at sea to complete one repetition of task c_i (it is assumed that this time does not vary with the training method m_j).

¹ Note that the definitions are laid out in such a way that one can read from top to bottom without having to refer to rows below the one which is the focus of attention.

Symbol/Term	Definition
r_{ij}	The number of repetitions of task c_i in a NVIC (or set of NVICs) required for an STCW endorsement that it takes to reach proficiency at sea when the task was trained with method m_j .
t_{ij}	The raw, single-task proficiency acquisition time in hours to complete all repetitions of a task at sea required to reach proficiency after training on task c_i using method m_j . Note that if no training has occurred on land, t_{ij} is equal to the time required in hours to train and assess the task at sea. Assuming that the task is assessed successfully, the mariner is deemed proficient. If a mariner has been trained on land on task c_i using method m_j , t_{ij} is assumed to be the time at sea that is needed to acquire proficiency
T_j	The raw, total single-method proficiency acquisition time in hours that it takes to complete the training at sea of all tasks that are in C using a single method m_j .
T_{day}	The time on average each day a mariner with no training needs to spend each day on the tasks in an endorsement in order to reach proficiency after 180 days at sea.
T_{AU}	The raw, total mixed-method proficiency acquisition time that it takes to acquire proficiency for the tasks in C for an STCW endorsement, where the tasks are spread among A and U , such that $C_A \cup C_U = C$ and $C_A \cap C_U = \emptyset$.
T_A	The raw, total mixed-method proficiency acquisition time that it takes to acquire proficiency for the tasks in A .
T_U	The raw, total mixed-method proficiency acquisition time that it takes to acquire proficiency for the tasks in U .
S	The set of courses that were approved to award SSE credit for task-method pairs in A .
SSD_j	The number of sea service days to acquire proficiency, assuming that all tasks in C are trained using method m_j .
SSD_{AU}	The number of sea service days to acquire proficiency, assuming that for each task-method pair (c_i, m_j) in A task c_i is trained using method m_j and for each task-method pair (c_i, m_o) in U task c_i is trained using method m_o .
SSD_{min}^A	The minimum SSD required of a mariner to be at sea assuming that all tasks have been trained on land and were completed in approved courses for an RFPNW.
SSD_{min}^U	The minimum SSD required of a mariner to be at sea assuming that none of the tasks for the RFPNW have been trained on land (exclusive of the tasks that are covered in baseline training).
SSE_{ij}	The sea service equivalency in days for task c_i trained with method m_j .
SSE_j	The sea service equivalency in days for a set of tasks all of whom have been trained using method m_j .
SSE_{AU}	The sea service equivalency in days for a mariner submitting a set A of task-method pairs for credit which have been taught in approved courses.

Executive Summary

Overview

There are two related goals for the work undertaken by the U.S. Department of Transportation Volpe National Transportation Systems Center (Volpe Center) for the United States Coast Guard (USCG). To achieve Goal 1, the Volpe Center was asked to undertake the research required to evaluate current sea service requirements and support evidence-based recommendations for granting sea service equivalencies for training and assessment of NVIC tasks² first learned and assessed at sea as well as for tasks taught and assessed on land with and without simulators. Subject matter experts' estimates of the time to reach proficiency at sea on each NVIC task trained using a given method were obtained for each of six STCW endorsements: Ratings Forming Part of a Navigational Watch (RFPNW) [1], Ratings Forming Part of an Engineering Watch (RFPEW) [2], Officer in Charge of Navigational Watch (OICNW) [3], Officer in Charge of Engineering Watch (OICEW) [4], Master/Chief Mate [5], and Chief Engineer/2nd Engineer Officer [6]. Based on these estimates, a rule was developed by the Volpe Center that was used to provide sea service equivalencies for the tasks included in the NVICs that were required for each of the six STCW endorsements.

To achieve Goal 2, the Volpe Center was asked to undertake the research needed to determine which of various combinations of two training methods was better given the proliferation of training methods for which no information existed on their comparative performance. This comparative data can be used not only for better understanding how to evaluate courses that have a bearing on the six STCW endorsements studied here, but also more broadly for other endorsements. The final comparisons included: full-mission vs. part-task training in Radar Observer (Unlimited) courses; 1 vs. 2 trainees per part-task simulator training in Radar Observer (Unlimited) courses; and Radar Observer (Unlimited) and Radar Observer (Recertification). Six different measures were used to evaluate students' performance. Only two of the 18 comparisons of course outcomes (six measures times three comparisons) were significant, the difference in the written score on the first attempt and the difference in passing rates on the first attempt between trainees in the Radar Observer (unlimited) course and in the Radar Observer (Recertification) course, with the Radar Observer (unlimited) being better in both cases.

Goal 1: Estimates of Sea Service Equivalency

In pursuit of Goal 1, the granting of sea service equivalencies, two objectives were identified. First, the USCG gathered information from subject matter experts (SMEs) that was used to determine the cumulative sea service equivalency (*SSE*³) of any subset of tasks required to reach proficiency for each of the above six STCW endorsements. This data collection objective involved three steps for the RFPNW and RFPEW endorsements: (i) The USCG collected simulator training instructors' estimates of the number of task repetitions and duration of each task repetition at sea required for a mariner to reach proficiency at sea for each of the tasks specified in an STCW endorsement under different training regimens, including, where applicable: training only at sea, training on land in courses with no simulators, training on land in courses with part-task simulators, training on land in courses with full-mission simulators, and training at sea on vessels specifically dedicated to training. (ii) The USCG convened one focus group for each of the RFPNW and RFPEW endorsements to review the instructor estimates and establish consensus estimates. (iii) Volpe documented the results of the instructor estimates and the consensus panels. The data collection objective

² Note that the NVIC tasks are associated 1-1 with STCW competences. For example, see [1] for the relation between NVIC tasks and STCW competencies for an RFPNW endorsement.

³ Variables that take on numeric values will be italicized.

involved only two steps for the OICNW, OICEW, Master/Chief Mate, and Chief/2nd Engineer Officer. In particular, only Steps (i) and (iii) were included. It was felt that the instructors estimates themselves were sufficient when combined.

Second, the Volpe Center developed three rules⁴ to calculate sea service equivalency for both individual tasks and subsets of tasks taught under the different training methods using the consensus estimates: the additive rule, the subtractive rule, and the distributive rule. The distributive rule was the most promising. Four major assumptions were made. (i) It was assumed that mariners had to be at sea for a minimum of 60 days regardless of their prior training on land, consistent with STCW RFPNW § 12.605 [7]. (ii) It was assumed that mariners who had had no prior training on land had to be at sea for a minimum of 180 days, regardless of whether they had completed successfully the training and assessment of all tasks for an endorsement, again consistent with STCW RFPNW § 12.605 [7]. (iii) It was assumed for mariners who had no training on land that the subject matter experts' estimates of the time T_0 that it took a mariner to reach proficiency at sea for all tasks in an endorsement was the sum of the time it took the mariner to reach proficiency on each of the tasks in the endorsement. (d) Finally, it was assumed that the time T_{day} on average a mariner had available each day to devote to reaching proficiency on the set of tasks was simply equal to the ratio of the total time to reach proficiency on all tasks given no training on land, T_0 , to the number of days a mariner was required to be at sea when the mariner had no prior training on land (180), $T_{\text{day}} = T_0/180$.

Given the above assumptions, the distributive rule can be used to compute the sea service days (SSD⁵) and sea service equivalency (SSE) for each of the individual tasks under the different methods of training for each of the six endorsements. For example, using a simple tool supplied with this report, the USCG needs to make only 27 entries for the assignment of sea service equivalency combinations of tasks and methods for an endorsement as an RFPNW and only 47 entries for the assignment of sea service equivalency combinations of methods and tasks for an endorsement as an RFPEW. Note the savings that are achieved for just these two endorsements. In particular, the distributive rule requires the USCG to make only 27 entries for any of the 4^{27} ($= 1.80 \text{ E}+16$) combinations of tasks and methods for an endorsement as an RFPNW and only 47 entries for any of the 5^{47} ($= 1.98 \text{ E}+28$) combinations of methods and tasks for an endorsement as an RFPEW. Similar remarks hold for the other four endorsements.

In summary, the USCG now has access to a method that it could potentially use to the assign sea service equivalencies to any combination of tasks taught using any of the methods evaluated for endorsements as an RFPNW, RFPEW, OICNW, OICEW, Master/Chief Mate, and Chief/2nd Engineer Officer.

Goal 2: Comparison of the Efficacy of Different Training Methods

Second, the USCG required research to determine which of various combinations of two training methods was better given the proliferation of training methods for which no information existed on their comparative performance. In pursuit of this goal, the USCG gathered data from instructors on the performance of students in both of the two courses involved in a given comparison. The Volpe Center then used the data provided by the USCG to compare the performance of students undertaking the same general course of study using the two different training methods. The course comparisons included: full-mission vs. part-task training in Radar Observer (Unlimited) courses; 1 vs. 2 trainees per part-task simulator training in Radar Observer (Unlimited) courses; and initial

⁴ Slight, but important, variations on the rules are discussed in the relevant sections.

⁵ All acronyms such as SSD and SSE are spelled out in the Definitions at the beginning of this report.

versus recertification training in Radar courses. The USCG delivered the student data to the Volpe Center without personally identifiable information.

Volpe compared the courses on six different variables: 1) average written exam score (out of 100); 2) percent passing the written exam (70% is passing); 3) percent passing the practical exam on the 1st attempt; 4) average number of practical exam attempts (out of 3); 5) percent passing the practical exam on the 1st, 2nd and 3rd attempts; and 6) percent passing the course. Only two of the 18 comparisons were significant. These differences occurred in the comparison of the Radar Observer (Unlimited) and Radar Observer (Recertification) courses. In particular, 96.1% of the students in the Radar Observer (Unlimited) course passed the written exam on the first attempt whereas only 40.0% of the students in the Radar Observer (Recertification) course passed the written exam on the first attempt. Related to this, the average written score on the 1st attempt of the students in the Radar Observer (Unlimited) course was 88.3% whereas the average written score on the 1st attempt of the students in the Radar Observer (Recertification) course was 56.0%. The small number of statistically significant differences may reflect more on the small sample sizes in each course than a lack of real differences in the performance of the students in the courses being compared. However, it may also reflect the fact that there may only be very small differences between the number of students who passed the written or practical exams in any given comparison. This makes sense given that every attempt is made to train the students to pass the assessment.

In summary, the small, absolute and statistically insignificant differences between the performance of mariners taking courses that were compared with each other has potentially important implications for the USCG and for the students who take courses for an endorsement. Specifically, the findings suggest that all other things being equal, students can take whatever course for an endorsement that is most appropriate and convenient for them. As noted at the very beginning, not all of the intended comparisons between training methods could be tested. Some training methods which were originally proposed for comparison were simply not being taught using the method as specified. One way of interpreting this lack of data is that training schools already considered other ways of offering their course content and already ruled out methods that would be less effective or produce worse student outcomes.

I. Goal 1: Sea Service Equivalency

A. Introduction

1. Overview

The purpose of Goal 1 is to provide the USCG with a new procedure for estimating the sea service equivalency (SSE) of each of the tasks that must be trained and assessed to receive an endorsement for either an RFPNW (Ratings Forming Part of Navigational Watch) or RFPEW (Ratings Forming Part of Engineering Watch). This new procedure should produce estimates of SSE for each of the tasks that are sensitive to the method used to train that task. Four training methods were considered for the RFPNW, specifically, the mariner was trained and assessed: entirely at sea, in a course on land without any simulator, in a course on land with a part-task simulator, or in a course on land with a full-mission simulator. Five training methods were considered for the RFPEW, the additional method using a training vessel.

The idea of offering sea service equivalency for training is not a new one. For example, the Coast Guard recognizes an equivalency for deck cadets at the United States Merchant Marine Academy and the six state maritime academies. The academies are USCG approved programs to qualify for STCW endorsements as Officer in Charge of a Navigational Watch (OICNW). The academy programs include a 40-hour simulator-based bridge watchkeeping course. The USCG has recognized a 30-day equivalency for this course to meet the requirement for not less than 12 months of seagoing service [STCW Regulation II/1, Paragraph 2.2]. Moreover, the substitution of simulator training as a way of obtaining sea service equivalency has been discussed since the 1990s [8]. However, a new procedure is worth exploring for three related reasons.

First, the ways of training have greatly expanded beyond fixed-base simulators⁶, including virtual reality and online training as just two examples. Second, a mariner might demonstrate having met the required standard of competence and knowledge, understanding and proficiency using multiple methods. Third, the USCG does now have a systematic way to assign sea service equivalency to individual tasks taught using either longstanding or new methods of training.

If a new procedure is going to be developed to assign sea service equivalency to particular combinations of competencies and training methods that is not cost prohibitive, then one such procedure that meets this requirement relies on subject matter experts' estimates of the time it takes a mariner to acquire proficiency at sea on any given task using any one of the training methods approved for the task. The generation of these estimates is not a trivial endeavor. Using the RFPNW NVIC, there are a total of 32 tasks identified to assist in demonstrating and providing evidence of having achieved the required standard of competence in the STCW [1]. Five of these tasks are part of basic training and so are not considered. Given that there are 27 remaining tasks and potentially four methods of training and assessing each task, that means that 108 (4×27) estimates are needed of the time that it takes a mariner to acquire proficiency on all combinations of tasks and training methods. For receiving an endorsement as an RFPEW, there are a total of 47 tasks in the STCW that must be trained and assessed as part of the requirement [2]. Given that there are 47 tasks and 5 possible training methods, in this case a total of 235 estimates are needed

⁶ Fixed-base simulators include both part-task simulators and full-mission simulators that themselves are attached to a base that does not move. Virtual reality headset simulators, by contrast, are attached to a person's head and do move as the person and his or her head moves.

of that it takes a mariner to acquire proficiency on all combinations of tasks and training methods. The number of tasks for each endorsement that were evaluated are included in Column 2 of Table 1, along with the number of instructors who provided estimates.

Table 1. Number of tasks, instructor estimates, existence of consensus panel, and number of SMEs on consensus panel.

Endorsement	# NVIC Tasks	# Instructors	Consensus Panel	# SMEs
RFPNW	27	10	Yes	7
RFPEW	47	3	Yes	3
OICNW	76	8	No	N/A
OIENW	91	2	No	N/A
Master/Chief Mate	97	8	No	N/A
Chief/2nd Engineering Officer	29	2	No	N/A

With the above in mind and the goal of being able to assign sea service equivalency to individual combinations of tasks and training methods, the following procedure was undertaken. To begin, consider the RFPNW. As a first step, individual instructors were asked to provide the estimates of the duration and number of repetitions for the 108 RFPNW task-method pairs. In the case of RFPNW, this included a total of 10 instructors (Column 3 of Table 1). The estimates were averaged across instructors and given to subject matter experts. A total of seven subject matter experts were then convened (Column 4 of Table 1). Together with the average of the instructor estimates, the SMEs formed consensus estimates of the duration and number of repetitions of each of the 108 task-method pairs. These are listed in Table 23 in Section IV.A.2. For a particular task-method pair, the duration of a single task and the number of repetitions was used to compute the task proficiency acquisition time. For RFPNW, these times are listed in Table 24 of Section IV.A.2. Next consider the RFPEW. Similar to the RFPNW, individual instructors were asked to provide the 235 estimates for the RFPEW task-method pairs, averages were obtained across three instructors, and these averages supplied to subject matter experts who were then convened to form a consensus in Table 31 in Section IV.B.1. As with RFPNW, for RFPEW the duration and number of repetitions for a task trained with a given method were used to estimate the task-method proficiency acquisition time (Table 32, Section IV.B.3). For the remaining four endorsements (OICNW, OICEW, Master/Chief Mate, and Mate/2nd Engineer), estimates from individual instructors of the duration and number of repetitions of each task using a given method of training were obtained and then averaged, but there was no consensus panel. The task proficiency acquisition times were computed from these estimates.

Three rules were developed for mapping the task-method proficiency acquisition times into sea service equivalencies: the additive, subtractive, and distributive rules. The results of the distributive rule were consistent with current practices for all six endorsements. For example, with respect to the RFPNW, mariners that had had no training on land on any of the 27 tasks required 180 days to achieve proficiency ($SSE = 0$). Mariners who had the very best training (full-mission simulators) on all 27 tasks required 60 days of training ($SSE = 120$). The single-method SSD and SSE are given in Table 26. These rules can be applied to any combination of task-method pairs. An example is given at the end of this final report of how to do such for an arbitrary set of the full 27 task-method pairs on which proficiency must be acquired [Section I.B.4.c)]. Similarly, with respect

to the RFPEW, mariners who had no training on land on any of the 47 tasks required 180 days at sea to achieve proficiency. Interestingly, mariners who received their training on board a training vessel were estimated to require 112 days to achieve proficiency, almost double the minimum number of days required when completing a Coast Guard-approved or accepted training (46 CFR 12.609).

In summary, a procedure is developed and discussed which can be used to assign the sea service equivalency for any set of combinations of tasks and training methods that the USCG has approved for all six endorsements. This procedure is grounded in subject matter experts' estimates of the time it takes a mariner to acquire proficiency for each possible combination of task and method. All three rules that are discussed map the subject matter experts' estimates to estimates of sea service equivalency. However, only the distributive rule is consistent with current USCG practices. A number of assumptions are built into the rules that are discussed so that the USCG is aware of the limitations of the distributive rule and the way in which the estimates of the time to acquire proficiency on a given task using a given method are computed. The details are described below for the RFPNW and RFPEW endorsements. Worksheets needed to compute the sea service equivalency for any combination of task-method pairs for the six endorsements have been provided with this final report. The time to proficiency for each task-method pair for each of the six endorsements is included in the appendices.

2. Endorsements

A total of six endorsements are described below along with the attachments which contain the particular NVIC tasks (as they relate to the STCW competencies) for which estimates of the time to reach proficiency at sea on the tasks were obtained from SMEs.

a) RFPNW

The Navigational and Vessel Inspection Circular No. 06-14, Change 6 [1], describes a series of tasks to be performed by a mariner to meet the knowledge, understanding and proficiency (KUP) that must be demonstrated⁷. In particular, in order to receive an endorsement as an RFPNW the mariner must provide evidence of meeting the standards of competence described in Table A-II/4 of the STCW Code (Enclosure 2 in [1]). The STCW endorsement for a rating standing a navigational watch is Rating Forming Part of a Navigational Watch (RFPNW). Title 46 of the Code of Federal Regulations (CFR) §12.605 [7], together with Navigation and Vessel Inspection Circular (NVIC) 06-14, Change 6 [1], define the requirements for a mariner to receive an STCW endorsement as an RFPNW issued by the United States Coast Guard.

As noted above using the NVIC, a total of 32 tasks need to be trained and assessed for a mariner to qualify for an endorsement as an RFPNW. Of these 32 tasks, a total of 27 tasks need to be learned and assessed at sea; 5 need to be learned in basic training (Table A-II/4 which is Enclosure 2 in [1]). In this report, we are focusing on the 27 tasks that need to be trained and then assessed at sea. These 27 tasks will be referred to as the set C of STCW tasks for an RFPNW endorsement, i.e., $C = \{c_1, c_2, \dots, c_{27}\}$. To be clear, Task c_1 is task 1.1.A in Table A-II/4, c_2 is task 1.1.B in Table A-II/4, and so on. These tasks are listed in the relevant attachment.⁸ Additionally, we note that mariners who have no training and related assessments on land on the above 27 tasks required for an RFPNW

⁷ As noted earlier, the tasks in the NVIC are associated with the competencies in the Seafarer's Training, Certification and Watchkeeping (STCW) Code.

⁸ RFPNW __ CombinedStatisticsConsensus06-14v04.xlsx.

endorsement must spend at least 180 days at sea⁹. Mariners in approved programs who have been trained and assessed on all 27 tasks need to spend only 60 days at sea (Table 2).

Table 2. Maximum and minimum SSD

	Max SSD	Min SSD
RFPNW	180	60
RFPEW	180	60
OICNW	1080	360
OICEW	1080	360
Master/Chief Mate	1080	720
Chief/2nd Engineer	1080	720

b) RFPEW

Enclosure (2) of Navigation and Vessel Inspecting Circular No. 7-14, Change 2 [2], states that every candidate for certification as rating forming part of an engineering watch (RFPEW) shall provide evidence of having achieved the required standard of competence as specified in Table A-III/4 of the STCW Code (46 Code of Federal Regulations (CFR) 12.609(a)(3)). The table in the NVIC was adopted from Table A-III/4 of the STCW Code (found in Enclosure (5)). The tasks in the NVIC are associated with the competencies in the STCW Code.

As noted above using the NVIC, a total of 47 tasks need to be trained and assessed for a mariner to receive an endorsement as an RFPEW. These 47 tasks will be referred to as the set *C* of STCW tasks for an RFPEW endorsement, i.e., $C = \{c_1, c_2, \dots, c_{47}\}$. These tasks are listed in the relevant attachment.¹⁰ It will be clear from context to which set *C* we are referring (the one for an RFPNW endorsement or the one for an RFPEW endorsement). Where it may be unclear, we will subscript *C* appropriately as C_{RFPNW} or C_{RFPEW} . As with the RFPNW, mariners need to spend at least 180 days at sea if they have not been trained and assessed on land on all of the tasks required for an RFPEW endorsement. If they have been trained in an approved program, they require only 60 days at sea.

c) OICNW

Enclosure (2) of Navigation and Vessel Inspecting Circular No. 12-14, Change 3 [3] states that, as specified in 46 CFR 11.309(a)(3), every candidate for an endorsement as Officer in Charge of a Navigational Watch (OICNW) on vessels of 500 GT or more must provide evidence of having achieved the required standard of competence specified in Table A-II/1 of the STCW Code. The table in the NVIC was adopted from Table A-II/1 of the STCW Code (found in Enclosure (5)). The NVIC maps the tasks to STCW competencies. The tasks that were evaluated by the SMEs are listed in the relevant attachment.¹¹ There are a total of 76 tasks (Table 1). Mariners need to spend at least 1080 days at sea if they have not completed an approved program that includes at least 360 days of seagoing service. (Table 2).

d) OICEW

Enclosure (2) of Navigation and Vessel Inspection Circular 17-14, Change 2 [4], states that, as specified in 46 CFR 11.329(a)(3), every candidate for an endorsement as Officer in Charge of an

⁹ Mariners will need to spend more time at sea if they have not been approved on all tasks for an endorsement which were not trained and approved on land.

¹⁰ RFPEW __ CombinedStatisticsConsensus07-14v01.xlsx.

¹¹ OICNW __ CombinedStatisticsConsensus12-14v01.xlsx

Engineering Watch in a Manned Engine-Room or Designated Duty Engineer in a Periodically Unmanned Engine-Room on Vessels Powered by Main Propulsion Machinery of 750 kW/1,000 HP must provide evidence of having achieved the required standard of competence specified in Table A-III/1 of the STCW Code. The table in the NVIC was adopted from Table A-III/1 of the STCW Code. The tasks for which estimates were obtained from SMEs are listed in the relevant attachment.¹² There are a total of 91 tasks (Table 1). Mariners need to spend at least 1080 days at sea if they have not completed an approved program that includes a combination of at least 360 days of seagoing service and workshop skills. The seagoing service must include at least 180 days performing engine-room watchkeeping duties (Table 2).

e) Master/Chief Mate

Enclosure (2) of Navigation and Vessel Inspecting Circular No. 10-14, Change 4 [5] states that every candidate for an STCW endorsement as Master or Chief Mate on Vessels of 3,000 GT or More (Management Level) must provide evidence of having achieved the required standard of competence as specified in Table A-II/2 of the STCW Code (46 CFR 1.305(a)(2) and 11.307(a)(2)). The table in the NVICs circular which maps competencies to tasks was adopted from Table A-II/2 of the STCW Code (found in Enclosure (5)). The exact set of tasks evaluated by the SME consensus panel for the endorsement as a Master or Chief Mate is contained in the relevant attachment¹³. There are a total of 97 tasks (Table 1). Mariners need to spend at least 1080 days at sea if they have not been trained and assessed on land on all of the tasks required for a Master/Chief Mate endorsement. If they have been trained in an approved program, they require only 720 days at sea (Table 2).

f) Chief/2nd Engineering Officer

Enclosure 2 of Navigation and Vessel Inspection Circular 15-14, Change 4 [6] that, as specified in 46 CFR 11.325(a)(2) and 11.327(a)(2), every candidate for an endorsement as Chief Engineer Officer and Second Engineer Officer on Ships Powered by Main Propulsion Machinery of 3,000 kW/4,000 HP Propulsion Power or More must provide evidence of having achieved the required standard of competence specified in Table A-III/2 of the STCW Code. The table in the NVIC was adopted from Table A-III/2 of the STCW Code. The tasks rated by the SMEs are listed in the relevant attachment.¹⁴ There are a total of 29 tasks (Table 1). Mariners need to spend at least 1080 days at sea if they have not been trained and assessed on land on all of the tasks required for a Chief/2nd Engineer endorsement. If they have been trained in an approved program, they require only 720 days at sea (Table 2).

3. Procedures for Awarding Sea Service Equivalency

Before setting out the objectives of Goal 1, it is useful to describe the three current procedures for awarding sea service equivalency and a new procedure which is the focus of this report. First, consider Procedure I. It applies to mariners who have not been trained in a USCG approved or accepted program for an RFPNW or RFPEW (we refer to these as Group I mariners). A mariner in this group not only needs to provide evidence of meeting the performance standards of all tasks in the relevant STCW but also must provide evidence of having 180 days of approved sea going service. A mariner in this group who did not provide evidence of meeting the performance standards for one or more of the tasks would need to remain at sea until such evidence was provided.

¹² OICEW __ CombinedStatisticsConsensus17-14v01.xlsx

¹³ Master Chief Mate __ CombinedStatisticsConsensus10-14v01.xlsx

¹⁴ Chief 2nd Eng __ CombinedStatisticsConsensus15-14v01.xlsx

Second, consider Procedure II. It applies to mariners who provide proof of successful completion of USCG-approved or accepted training for an RFPNW or RFPEW endorsement (Group II mariners). Using this option, such a mariner could receive an RFPNW (RFPEW) endorsement after having completed 60 days of approved seagoing service which requires the performance of the relevant duties ($SSD_{CG} = 60$). By extension under this option, they receive a total of 120 days of sea service equivalency credit ($SSE_{CG} = 120$).

Third, consider Procedure III. It is possible that there may be another group of mariners similar to Group II above, but who have been approved for sea service equivalency for only a subset of the tasks trained and assessed in a course (Group III). The procedure for doing such is described in Chapter 7, Volume III of the Marine Safety Manual [9]. We are unaware of any such courses, but want to acknowledge their possible existence.

Fourth, consider Procedure IV, the focus of Goal 1. This procedure could be used in the future, perhaps to replace or supplement one or more of the above three procedures, to assign sea service equivalency to any combination of the tasks and training methods used to satisfy the assessments required for an endorsement as an RFPNW or RFPEW.

4. Training Methods and Training Sets

a) RFPNW

For an RFPNW, we consider four different methods m_j of training a given task c_i in set C : no training on land ($j = 0$), training on land without a simulator ($j = 1$), training on land with a part-task simulator ($j = 2$), and training on land with a full-mission simulator ($j = 3$) (Table 3). Each task c_i trained and assessed with a given method m_j will be referred to as a task-method pair and labeled (c_i, m_j) . Other methods can and do exist than the four discussed here, but this report addresses only these four methods for the RFPNW.

For any course both which trains and assesses tasks on land that are required for endorsement as an RFPNW and which is reviewed by the USCG, there will be tasks in set C that are trained and assessed with methods that are approved by the USCG. The set A will be used to designate the task-method pairs (c_i, m_j) approved for sea service equivalency. Given that a course may not cover all 27 tasks in C (untrained tasks) or that the tasks may be trained and assessed in the course but not approved for sea service equivalency (unapproved), there is another set U of task-method pairs which are untrained or not approved. To be clear, there are 27 tasks in the union of sets A and U , specifically one and only one instance of each of the tasks in set C .

Table 3. For each endorsement, the number of tasks, training methods, instructors and institutes, use of a consensus panel, and number of SMEs and institutes on consensus panel when one was used

Endorsement	#NVIC Tasks	Training Methods	# Instructors	Institutes	Consensus Panel	# SMEs	Institutes
RFPNW	27	4	10	7	Yes	10	5
RFPEW	47	5	3	2	Yes	3	3
OICNW	76	5	8	3	No	N/A	N/A
OICEW	91	5	2	2	No	N/A	N/A
Master/Chief Mate	95	5	8	3	No	N/A	N/A

Endorsement	#NVIC Tasks	Training Methods	# Instructors	Institutes	Consensus Panel	# SMEs	Institutes
Chief/2nd Engineering Officer	29	5	2	2	No	N/A	N/A

b) RFPEW

For an RFPEW, we consider five different methods m_j of training a given task c_i in set C: no training on land ($j = 0$), training on land without a simulator ($j = 1$), training on land with a part-task simulator ($j = 2$), training on land with a full-mission simulator ($j = 3$), and training at sea on a vessel ($j = 4$) (Table 3). As above, each task c_i trained and assessed with a given method m_j will be referred to as a task-method pair and labeled (c_i, m_j) . And as above, other methods can and do exist than the four discussed here, but this report addresses only these five methods for the RFPEW.

c) OICNW

The same five training methods were considered for OICNW as were considered for RFPEW.

d) OICEW

The same five training methods were considered for OICEW as were considered for RFPEW.

e) Master/Chief Mate

The same five training methods were considered for Master/Chief Mate as were considered for RFPEW.

f) Chief/2nd Engineer

The same five training methods were considered for Chief/2nd Engineer as were considered for RFPEW.

5. Input from Instructors and Consensus Panels

a) RFPNW

Individual instructors were asked to provide estimates for each task c_i in C and method m_j of training both of the number of repetitions r_{ij} of a task c_i trained with method m_j to reach proficiency at sea and of the time h_i to complete each repetition. Note that it is assumed that the time to complete each repetition stays constant across methods m_j (i.e., h_i is not indexed by j , the training method, in addition to i , the task). Importantly, these estimates assume for courses taught on land that the training and assessment methods have been approved and that a mariner has completed the assessment successfully. Thus, for the RFPNW the instructors were asked to provide a total of $5 \times 27 = 135$ estimates, 27 of h_i and 108 of r_{ij} (4 methods times 27 tasks) (Table 3). A total of 10 instructors from 7 institutes provided these estimates (Table 3).

The instructors' estimates of r_{ij} and h_i were combined and provided as averages to an RFPNW consensus panel of subject matter experts. A total of ten subject matter experts from 5 institutes served on the RFPNW consensus panel which met Friday, September 13, 2024 (Table 3). The 135 estimates of r_{ij} and h_i were discussed for each of the tasks in Table 23 (Section IV.A.2) and a consensus was reached and is displayed in that table as well. The panel met for a total of three hours.

b) RFPEW

Methods were similar for the RFPEW. The instructors were asked to provide a total of $6 \times 47 = 282$ estimates, 47 of h_i and 235 of r_{ij} (5 methods times 27 tasks). A total of three instructors from

two institutes provided these estimates. The instructors' estimates of r_{ij} and h_i were combined and provided as averages to an RFPEW consensus panel of subject matter experts. A total of 22 subject matter experts were invited to serve on the RFPNW consensus panel which met Friday, September 13, 2024. The 282 estimates of r_{ij} and h_i were discussed for each of the tasks in Table 31 (Section IV.B.1) and a consensus was reached and is displayed in that table as well. The panel met for a total of three hours. A total of three individuals from three institutes comprised the subject matter expert consensus panel.

c) OICNW

For OICNW, the instructors were asked to provide a total of $6 \times 76 = 456$ estimates, 76 of h_i and 380 of r_{ij} (5 methods times 76 tasks). A total of eight instructors from three institutes provided these estimates. There was no consensus panel given that the Coast Guard was satisfied with the average of the instructor estimates.

d) OICEW

For OICEW, the instructors were asked to provide a total of $6 \times 91 = 546$ estimates, 91 of h_i and 455 of r_{ij} (5 methods times 91 tasks). A total of two instructors from two institutes provided these estimates. There was no consensus panel given that the Coast Guard was satisfied with the average of the instructor estimates.

e) Master/Chief Mate

For Master/Chief, the instructors were asked to provide a total of $6 \times 95 = 570$ estimates, 95 of h_i and 475 of r_{ij} (5 methods times 95 tasks). A total of eight instructors from three institutes provided these estimates. There was no consensus panel given that the Coast Guard was satisfied with the average of the instructor estimates.

f) Chief/2nd Engineer

For Chief/2nd Engineer, the instructors were asked to provide a total of $6 \times 29 = 174$ estimates, 29 of h_i and 145 of r_{ij} (5 methods times 29 tasks). A total of two instructors from two institutes provided these estimates. There was no consensus panel given that the Coast Guard was satisfied with the average of the instructor estimates.

6. Objectives

The overarching goal of this effort as discussed above in Section 1 is to provide the USCG with a procedure (Procedure IV) for estimating the sea service equivalency of each of the tasks used to demonstrate STCW competencies and KUPs using each of the different methods of training. There are three related objectives that comprise this Goal 1.

a) Objective 1

The first objective, an element common to each of the three rules, is to provide the USCG with estimates of the raw time at sea in hours that it is expected to take a mariner to perform each task in order to reach proficiency on the task at sea. We refer to the time to reach proficiency as the raw, single-task proficiency acquisition time since it represents the sum of the durations of each repetition of the task at sea required to reach proficiency, not the number of days over which those repetitions need to be spread. That is, it represents the massed time, not the distributed time.

b) Objective 2

The second objective is to provide the USCG with rules for assigning sea service equivalency to a single course relevant to an RFPNW or RFPEW endorsement training. The single course must have been reviewed by the USCG and will, after review, consist of a set A of approved tasks and set U of

unapproved or untrained tasks where $A \cup U = C$ and $A \cap U = \emptyset$ (the null set), i.e., the set of tasks in the union of sets A and U consist of all tasks and only tasks that must be trained and assessed for an endorsement¹⁵. The rules for assigning SSE to a set of approved tasks in a course take as input for each task trained and assessed with a given method the raw, single-task proficiency acquisition times that were estimated by the subject matter experts for training and assessing the task with the given method (i.e., the output of the first objective). Note that the assignment of SSE to a set of tasks is confined to tasks that are taught using only the methods to train and assess the tasks which are considered in this report. Furthermore, as a point of emphasis, note that not all courses will necessarily teach or assesses all tasks required for an RFPNW or RFPEW endorsement.

c) Objective 3

The third objective is to provide the USCG with rules for assigning sea service equivalency to the set of approved, non-overlapping tasks that have been trained and assessed in more than one course and are relevant to an endorsement for an RFPNW or RFPEW. The rules for assigning SSE to a set of approved, non-overlapping tasks taken in two or more courses follow the same general procedures as the rules to assigning SSE to a set of approved tasks in a single course.

B. RFPNW: Sea Service Days and Sea Service Equivalency

Below, the three objectives in Section I.A.6 are discussed in detail with respect to an endorsement for an RFPNW.

1. Acquisition Time

Consider now the first objective of Goal 1. To repeat, the first objective is to provide the USCG with estimates of the raw time at sea in hours that it is expected to take a mariner to reach proficiency at sea on each of the 27 tasks in C (RFPNW) trained with any one of the four methods, i.e., the 108 estimates of the raw, single-task proficiency acquisition times. Specifically, the first objective is to identify a method for computing the raw, single-task proficiency acquisition time t_{ij} in hours it takes a mariner to reach proficiency at sea for each task c_i taught using method m_j both for mariners who have received no training on land on a given task c_i ($j = 0$) (the tasks in set U) and for mariners who have received training on land on the task c_i and been assessed as satisfactory on land on that task ($j = 1, 2, 3$) (the tasks in set A). This first objective uses the estimates obtained from the consensus panel of h_i and r_{ij} . The consensus panel estimates of the duration of each task and the number of repetitions along with the instructors estimates are provided in the attachment “RFPNW __ CombinedStatisticsConsensus06-14v04.xpss” included with this report.

Related to this first objective are two subobjectives that need to be mentioned at the outset. (a) We want to provide the USCG with a method for computing the raw, total acquisition time T_j in hours that it takes a mariner to reach proficiency on all 27 tasks in the NVIC for each of the four training methods when the 27 tasks are trained using the same method m_j in a course. This part of the first goal uses the estimates of t_{ij} computed above. We refer to this as the raw, total single-method proficiency acquisition time. (b) We also want to provide the USCG with a method for computing the raw, total acquisition time T_{AU} in hours that it takes a mariner to reach proficiency on all 27 tasks who has been trained and assessed on the task-method pairs in A and not trained (or not approved for training) on the task-method pairs in U for any sets A and U . This part of the first objective also uses the estimates of t_{ij} obtained from above. We refer to this as the raw, total mixed-method proficiency acquisition time.

¹⁵ As noted previously, tasks that are trained as part of basic training are not included in set C .

a) Raw, Single-Task Proficiency Acquisition Time t_{ij}

The raw, single-task proficiency acquisition time for a task c_i trained using method m_j is defined as the total time t_{ij} in hours that is spent at sea practicing the task until the mariner has reached proficiency. Three assumptions are made when computing the raw, single-task proficiency acquisition time. First, the raw, single-task proficiency acquisition time is assumed to be equal to the sum of the times each task must be practiced at sea to reach proficiency. So, for example, if task c_i trained and assessed using method m_j had to be practiced at sea 8 times for 1.0 hour each in order to reach proficiency, then the raw, single-task proficiency acquisition time t_{ij} would be 8 hours. Second, it is assumed that this training time is not a function of how the practice periods are distributed across sea service days (i.e., whether the practice times are massed or distributed). In the above example, the training and assessment could occur all in one day or spread across, say, 64 days (one hour every 8 days). Third, it is assumed that the time h_i required to practice a task c_i which was taught on land using method m_j does not vary as a function of the method used to train the task.

With the above as assumptions, then estimates are needed of two quantities to compute t_{ij} . First, an estimate is needed of the time h_i in hours at sea required for a single repetition of a task taught using one of the four methods m_j . Second, an estimate is needed of the number of repetitions r_{ij} of task c_i using method m_j . Given this, the raw, single-task proficiency acquisition time t_{ij} in hours is computed as follows in Equation 1:

$$t_{ij} = h_i \times r_{ij}$$

Equation 1. t_{ij} : raw, single-task proficiency acquisition time (hours) for a task c_i taught using method m_j

As indicated above in Section I.A.5.a) and as recorded in Table 23 (Section IV.A.2), the 135 estimates of h_i and r_{ij} needed for all tasks (27) and all training methods (4) were obtained from subject matter experts. The raw, single-task proficiency acquisition times computed using Equation 1 are provided in Table 24 (Section IV.A.3).

b) Raw, Total Single-Method Proficiency Acquisition Time T_j

There are four training methods considered for the RFPNW, as explained above in Section I.A.4.a). The raw, total single-method proficiency acquisition time T_j for each method m_j is then computed as the sum of raw, single-task proficiency acquisition times within the same method m_j . Mathematically, this is expressed below in Equation 2:

$$T_j = \sum_{i=1}^{27} t_{ij}$$

Equation 2. T_j : raw, total single-method proficiency acquisition time (hours)

where $j = 0, 1, 2, 3$ for each different method m_j .

Performing the above computations for each of the four training methods yields (also see RFPNW Raw, Total Single-Method Proficiency Acquisition Times

Table 25, Section IV.A.2, for more detailed computations) T_j in hours and in days (assuming 8-hour days):

Table 4. Raw, total Single-Method Proficiency Acquisition Times

Method	No course ($j=0$)	Course, No sim ($j=1$)	Part Task ($j=2$)	Full Mission ($j=3$)
Hours (T_j)	61.94	45.28	33.16	18.28
8-Hour Days ($T_j/8$)	7.74	5.66	4.15	2.29

Specifically, the raw, total single-method proficiency acquisition times listed in Table 4 are:

- No training on land for any course: 61.94 hours
- Training on land without a simulator for all courses: 45.28 hours
- Training on land with a part-task simulator for all courses: 33.16 hours
- Training on land with a full-mission simulator for all courses: 18.28 hours

It is clear from the above that adding simulator training to a course reduces the raw, total single-method proficiency acquisition time at sea and that using a full-mission simulator as opposed to a part-task simulator reduces the raw, total single-method proficiency acquisition time still more (from 33.16 hours to 18.28 hours).

c) *Raw, Total Mixed-Method Proficiency Acquisition Time T_{AU} for a Mariner*

The raw, total mixed-method training time T_{AU} is equal to the sum of the individual task training times in sets A (T_A) and U (T_U). For any given mariner a subset A of the tasks in C were trained on land and the complementary subset U of tasks were not trained on land or, if trained, were not approved by the USCG for sea service equivalency. The raw, total mixed-method training time T_{AU} can then be written as below in Equation 3:

$$T_{AU} = T_A + T_U = \sum_{(i,j) \in A} t_{ij} + \sum_{(i,j) \in U} t_{ij}$$

Equation 3. T_{AU} , T_A , T_U : raw, total mixed-method proficiency acquisition time (hours) for sets A and U

d) *Limitations*

It goes without saying that mariners cannot train continuously at sea the first day they go to sea for the 27 tasks in C regardless of what set of mixed-methods they use for the 27 tasks. That raw, total single-method proficiency runs between 61.94 hours (T_0) as a maximum if trained continuously (with no prior training on land) and 18.28 hours (T_3) as a minimum if trained continuously with prior training on land using a full-mission simulator. The question then becomes of how this training gets spread across days. Three rules for determining the sea service days (SSD) and corresponding sea service equivalency (SSE) are described below. One will be referred to as the additive rule, the second as the subtractive rule, and the third as the distributive rule.

Note that the fundamental reliance in all three rules on the elemental raw, single-task proficiency acquisition time requires us to point out the assumptions laid out at the beginning of Section I.B.1.a) to which attention must be paid. More generally, we should add that the assumptions are based on subject matter expert estimates, that the estimates are averages only, and that no track is kept on board a vessel of the number of repetitions at sea or of the hours that are estimated each repetition will take. More complex rules and more gathering of data are needed in order to make more precise determinations of sea service equivalency for each task and method.

2. Computing SSD and SSE: The Additive Rule

This completes the discussion of the first objective, the development of a common method for computing the raw, single-task proficiency acquisition time. Consider now the second and third objectives, the development of a procedure for assigning sea service equivalency to, respectively, a single course or multiple courses. It was mentioned that there were three rules for undertaking said assignment, the additive, subtractive, and distributive rules. Perhaps the simplest rule is what we will refer to as the additive rule. It is assumed here that the mariner can begin acquiring proficiency on a task as soon as the mariner has spent a minimum number of days at sea. Thus, we “add” the days to acquire proficiency to the minimum days at sea.

Before discussing this rule, we need to define some notation. Recall that the second goal is to provide the USCG with rules for assigning sea service equivalency SSE_{AU} (in days) to a single course relevant to an endorsement for an RFPNW where A is the set of approved tasks and U is the set of unapproved or untrained tasks. So, for example, suppose that a course trains and assesses tasks c_1, c_2, c_3, c_4 and c_5 (and perhaps other tasks, just not those considered in the set C of required tasks for an endorsement as an RFPNW). Suppose the first three tasks, c_1, c_2 , and c_3 , were trained respectively with methods m_{j_1}, m_{j_2} , and m_{j_3} and were approved for sea service equivalency. Then, set A consists of the task-method pairs in Equation 4:

$$A = \{(c_1, m_{j_1}), (c_2, m_{j_2}), (c_3, m_{j_3})\}.$$

Equation 4. Task-method pairs in set A

Assume that tasks c_4 and c_5 were not approved for sea service equivalency. Finally assume that tasks $c_6, \dots, c_{27}$ were not trained in the course. So, set U consists of the task-method pairs in Equation 5:

$$U = \{(c_4, m_{j_4}), (c_5, m_{j_5}), (c_6, m_{j_6}), \dots, (c_{27}, m_{j_{27}})\}.$$

Equation 5. Task-method pairs in set U

Note that by definition $m_{j_4} = \dots = m_{j_{27}} = m_0$.

a) Computations: Single-Method

We can now turn to the details of the additive rule. For this rule it turns out to be easier to compute the sea service equivalency SSE_{AU} for a course by first computing the sea service days SSD_{AU} . SSD_{AU} is a function of the sea service days (SSD_A) it is estimated it will take a mariner to reach proficiency on the set A of approved trained task-method pairs on land, the number of sea service days (SSD_U) that it takes the mariner to reach proficiency on the tasks which have not been trained on land, and the minimum number of days that a mariner must be at sea with even the very best of training. In the examples that follow, we assume that this minimum is 60 days, i.e., $SSD_{min}^A = 60$. We assume this because 60 days is the minimum number of days that a mariner successfully completing a USCG approved or accepted training for an endorsement as an RFPNW must be at sea [1]. Thus, the sea service days SSD_{AU} the USCG would assign to the task-method pairs in set A and set U are equal to the sum in Equation 6:

$$SSD_{AU} = SSD_{min}^A + SSD_A + SSD_U$$

Equation 6. SSD_{AU} : sea service days for mixed-method training using training sets A and U

The SSE_{AU} (sea service equivalency) is dependent on the SSD_{AU} where the latter is defined in Equation 6. Before computing SSE_{AU} it is useful to consider the range. In particular, it is assumed

that the range of SSE_{AU} lies between 0 and 120 days. The reasoning for this assumption is as follows. If a mariner has not been trained on land on any of the tasks in C, then the mariner must be at sea at least 180 days, i.e., $SSD_{min}^U = 180$. If the mariner has received the very best of training, then the mariner must be at sea for at least 60 days. Thus, the SSE needs to range between 120 days ($SSD_{min}^A = 60$) and 0 ($SSD_{min}^U = 180$).

To begin the computation of SSE_{AU} with a simple case, imagine that the additive rule is used to compute the sea service equivalency in a situation in which all 27 tasks in C are trained using the same method. Three assumptions are needed in this case. First, it is assumed that the mariner can train continuously for 8 hours. (We recognize that this assumption is one which will need to be altered; we present it here only to show the conclusions to which it leads just in case the USCG ever decided massed training was possible.) Second, it is assumed that the mariner begins training with the first task at the beginning of a day and continues training on subsequent tasks until the 8-hour limit is reached for a day. Third, it is assumed that the mariner begins training the next day with the next task that requires training, whether it is a new task or the completion of the repetition of a task that was interrupted when the 8-hour limit was hit for the prior day.

With these assumptions, the sum $SSD_A + SSD_U$ can be written as SSD_j since all tasks are trained with the same method m_j . It follows from Equation 6 that the sea service days SSD_j required to reach proficiency using a single method of training m_j in fractions of a day is simply the sum of the raw, total single-method proficiency acquisition time as measured in days plus the minimum training days. Since the unit for the raw, total single-method proficiency acquisition time is hours, we need to divide this time by 8 to obtain the number of days:

$$SSD_j = SSD_{min}^A + \frac{T_j \text{ hrs}}{8 \text{ hrs/day}}$$

Equation 7. SSD_j : sea service days for single-method training – additive rule

Using the information in Table 4 and Equation 1 and assuming that $SSD_{min}^A = 60$, the single-method sea service days SSD_j for each of the four methods m_j are equal to [also see Table 5]:

- No training on land: 67.74 days (60.00+ 7.74)
- Training on land without a simulator: 65.66 days
- Training on land with a part-task simulator: 64.15 days
- Training on land with a full-mission simulator: 62.29 days

The sea service equivalency SSE_j for each estimate of sea service days SSD_j for single-method training is then assumed to be equal to the difference between the minimum sea service days for someone who has no onshore training and the single-method sea service days SSD_j as shown in Equation 8 below. If we assume that $SSD_{min}^U = 180$, then we get

$$SSE_j = SSD_{min}^U - SSD_j = 180 - SSD_j$$

Equation 8. SSE_j : sea service equivalency for single method training – additive rule

The estimates of SSE_j obtained using Table 4, Equation 7, and Equation 8 are given below in Table 5.

Table 5. Total Single-Method Proficiency Acquisition Times – Additive Rule¹⁶

Method	No course	No sim	Part Task	Full Mission
Sea Service Days	67.74	65.66	64.15	62.29
Sea Service Equivalency	112.26	114.34	115.85	117.71

b) Limitations

There are two clear limitations to the additive rule for establishing the sea service equivalency SSE_j for single-method training. First, it is unlikely that a mariner would be able to acquire massed proficiency on a task day after day until the mariner was fully proficient at sea. Thus, presumably the mariner spreads his or her training over some number of the 120 days after the minimum needed (assumed to be 60 in this case). Second, related to this, the estimate of the sea service days for a mariner who has received no training is 67.74 days. Yet, currently fully 180 days are required regardless of the fact that all tasks may have been assessed as proficient before then. Given these limitations to the additive rule for assigning sea service equivalency single-method training, we will not pursue the computations for the additive rule for mixed-method training. The additive rule is a liberal rule in that it appears to award too many days of sea service equivalency.

3. Computing SSD and SSE: The Subtractive Rule

The limitations of the additive rule lead to the consideration of another rule, specifically what we refer to as the subtractive rule, for assigning sea service equivalency to a single course or multiple courses. Specifically, another way to think about assigning sea service equivalency would be to assume that the acquisition of proficiency at sea occurs near the very end of the 180-day maximum, and in particular on that day when the mariner has just enough time to complete the massed training of all 27 tasks assuming that the mariner has had no training on land. In the case of the RFPNW, that would be Day 172.26. That is because it takes 7.74 days for a mariner to acquire proficiency without any prior training of the 27 tasks that must be trained and assessed successfully in order to receive an endorsement as an RFPNW (see Table 4, 8-hour days, No Course). Thus, instead of beginning to acquire proficiency on Day 60 in the additive rule, the mariner begins to acquire proficiency on Day 172.26 using the subtractive rule.

a) Computations: Single-Method

The simplest scenario to which to apply the subtractive rule, as with the additive rule, is one where the training method is the same across all 27 tasks. By definition of the subtractive rule, the sea service days SSD_0 when no training has occurred on land is 180, the last 7.74 days being used to acquire proficiency on the tasks for which no training has been received (see the entry in Table 4, no course, 8-hour days). In this case, the sea service days SSD_j for single-method training are computed as in Equation 9 and listed in Table 6.

$$SSD_j = \left(180 - \frac{T_0 \text{ hrs}}{8 \text{ hrs/day}}\right) + \frac{T_j \text{ hrs}}{8 \text{ hrs/day}} = 172.26 + \frac{T_j \text{ hrs}}{8 \text{ hrs/day}}$$

¹⁶ Note here and elsewhere, if a particular method of training is not suitable for a given task, then it is assumed that the mariner has not received any training.

Equation 9. Single-method sea service days – subtractive rule

The sea service equivalency to obtain proficiency on all 27 tasks using a single method is then equal to the difference between SSD_0 and SSD_j as computed in Equation 10:

$$SSE_j = SSD_0 - SSD_j$$

$$= 180 - \left[\left(180 - \frac{T_0 \text{ hrs}}{8 \text{ hrs/day}} \right) + \frac{T_j \text{ hrs}}{8 \text{ hrs/day}} \right]$$

$$SSE_j = \frac{T_0 \text{ hrs}}{8 \text{ hrs/day}} - \frac{T_j \text{ hrs}}{8 \text{ hrs/day}}$$

Equation 10. SSE_j : Single-method sea service equivalency – subtractive rule

For example, it takes only 5.66 days to acquire proficiency in a course with no simulator (Table 4, Course, No Sim). Thus, the sea service equivalency would be equal to $7.74 - 5.66 = 1.88$ days (SSE_1) and the sea service days would be 177.92 ($172.26 + 5.66 = 1.77.92$ (SSD_1)). More generally the sea service equivalency in days for a set of tasks that have been trained with a single method m_j is the difference between the raw, total single-method proficiency acquisition time in days when no training is received and the raw, total single-method proficiency acquisition time in days when method m_j has been used. Carrying out the above computations for the four methods yields the estimates of sea service days and sea service equivalency in Table 6 below.

Table 6. Total Single-Method Proficiency Acquisition Times – Subtractive Rule

Method	No course	No sim	Part Task	Full Mission
Sea Service Days	180	177.92	176.41	174.55
Sea Service Equivalency	0	2.08	3.59	5.45

b) Limitations

The limitations of this method are two-fold. First, as with the additive rule, it is unlikely that a mariner can practice continuously until they have acquired proficiency on all tasks. Second, again as with the additive rule, it seems like the sea service equivalency estimate does not reflect what is now the case for all programs approved by the USCG for the RFPNW. These courses provide a sea service equivalency of 120 days (e.g., [10]). Yet, using the subtractive rule the maximum sea service equivalency using Equation 10 is 5.45 days ($7.74 - 2.29$).

4. Computing SSD and SSE: The Distributive Rule

There is a third rule, the distributive rule, which is not subject to the limitations described above with the additive and subtractive rule that makes an assumption from which SSD and SSE easily follow. The assumption that the distributive rule makes is about the average number of hours at sea each day a mariner has to acquire proficiency on a given task. The assumption is based on current USCG requirements for mariners who have received no training on land on any of the 27 tasks in C.

Briefly, it is currently the case that a full 180 days are required at sea if a mariner has had no training on land for the 27 tasks in the RFPNW for which something other than baseline training is indicated. As estimated by the subject matter experts, the raw proficiency total acquisition time for such a mariner is 61.94 hours or 7.74 8-hour days (Table 4).

We can use the above information to estimate the average time each day a mariner has to practice a task. Specifically, with 27 tasks the mariner needs to train on average 0.3441 hours each day in order to achieve a total of 61.94 hours of practice over the 180 days (180 days $\times$ 0.3441 hrs/day = 61.94 hrs). To keep things simple, assume that the same time is available each day for a mariner to practice any one of the tasks, regardless of the method of training prior to being at sea (none on land, or one of the three other methods of training on land which are being considered here).

a) Single-Method SSD_j and SSE_j : Single Course

We now want to compute the sea service days and sea service equivalency for the four single-methods of training using the distributive rule assuming that the training has occurred in one course (or no training has yet been delivered). The distributive rule inputs obtained from the SMEs are highlighted in purple in Table 7 and include the raw, total single-method proficiency acquisition time and the time on average available to practice tasks on any given day. The rule inputs from the USCG are highlighted in green and include the minimum days at sea with the very best of training on land and with no training on land. As has been the case with the additive and subtractive rules, assume that the minimum SSD with training is 60 days and the minimum SSD without any training on land is 180 days.

Table 7. Estimates of single-method SSD_j and SSE_j for the four training methods – the distributive rule

	SME Consensus Input: Continuous	SME Consensus Input: 180 Days	USCG: SSD(min)	USCG: SSD(min)	Rule Output: Distributive	Rule Output: Distributive
Training	Training Hours	Training hours/day	Train	No Train	SSD(days)	SSE (days)
No training	61.94	0.34 ¹⁷	60	180	180	0
Classroom	45.28	0.34	60	180	132	48
Part-Task	33.16	0.34	60	180	96	84
Full-Mission	18.28	0.34	60	180	60	120

The four estimates of sea service days SSD_j can be calculated using Equation 11 where SSD_{min}^A is the minimum days at sea assuming that training is an approved program or course for an RFPNW. Additionally, the corresponding four estimates for sea service equivalency SSE_j can be computed from Equation 8 and are also listed in Table 7. The rule outputs, sea service days and sea service equivalency, are highlighted in blue (also see Table 26 in Section IV.A.4).

$$SSD_j = \max \left\{ \left(\frac{T_j \text{ hrs}}{0.34 \text{ hrs/day}} \right), SSD_{min}^A \right\}$$

Equation 11. SSD_j : single-method sea service days – the distributive rule

Note the apparent reasonableness of the estimates provided by the distributive rule. The sea service days for a course with no approved tasks (or for a mariner who has not received any training on land) is 180. The corresponding sea service equivalency is 0 days. This is consistent with USCG

¹⁷ Note that here and elsewhere, the training hours per day is rounded to 0.34 to keep the tables simple, but the actual quantity used is 0.3441 = (27/180), the latter number itself being rounded.

requirements. Similarly, the sea service days for the very best of training methods, the full-mission simulator, on all 27 tasks in C is 60 days and the sea service equivalency is 120 days. Again, this is consistent with USCG practices.

b) Mixed Method SSD_{AU} and SSE_{AU} : Multiple Methods

The distributed rule was applied above to a single course trained and assessed using a single method. Ultimately, the goal is to provide the USCG with a procedure (Procedure IV, Section A.4) that they can use to assign the sea service equivalency to a reviewed course (Objective 2) or set of courses (Objective 3) based on the set A of task-method pairs that have been trained on land and approved for SSE in the reviewed courses and the set U of task-method pairs that have not been trained on land (or not approved for SSE in the set of reviewed courses).

As in previous cases, we first compute the sea service days SSD_{AU} that are required to achieve proficiency for the set of task-method pairs that appear in sets A and U . The sum of the sea service days SSD_A and SSD_U needs to be greater than or equal to the minimum sea service days that are required for someone in an approved program for an RFPNW. With these constraints, we compute the sea service days SSD_{AU} as below in Equation 12:

$$SSD_{AU} = \max \{ (SSD_A + SSD_U), SSD_{min}^A \}.$$

Equation 12. SSD_{AU} : Sea service days for mixed-method training where the task pairs come from sets A and U – the distributive rule

SSD_A is equal to the sum all of the raw, single-task proficiency acquisition times in hours to complete each of the task-method pairs that are in set A divided by the number of hours per day on average that a mariner can practice a given task c_i . This quantity is given below in Equation 13:

$$SSD_A = \sum_{(i,j) \in A} \frac{t_{ij} \text{ hrs}}{0.34 \text{ hrs/day}}$$

Equation 13. SSD_A : Sea service days for a mixed-method training where the task pairs are from set A – the distributive rule

Similarly, SSD_U is computed as below in Equation 14:

$$SSD_U = \sum_{(i,j) \in U} \frac{t_{ij} \text{ hrs}}{0.34 \text{ hrs/day}}$$

Equation 14. SSD_U : Sea service days for a mixed-method training where the task pairs are from set U – the distributive rule

The sea service equivalency SSE_{AU} follows directly once SSD_{AU} has been computed. It is equal to the difference between the minimum number of days that a mariner who has received no training on land must be at sea (180) and the number of sea service days to acquire proficiency on the sets A and U of task-method pairs, as indicated below in Equation 15:

$$SSE_{AU} = 180 - SSD_{AU}$$

Equation 15. Sea service equivalency for mixed-method training where the task pairs come from sets A and U – the distributive rule

c) *Mixed Method SSD_{AU} and SSE_{AU} : Example*

An example can make clear exactly how concretely to assign sea service equivalency for a set A and set U of tasks using the distributive rule. There are three steps. First, put an “x” opposite each task in the cell which represents the method that was used to train the task. An “x” should appear opposite each of the 27 tasks in Table 8 after this step is completed.

Table 8. Mixed-methods example using the distributive rule: RFPNW

NVIC 06-14 Support Deck (RFPNW) Task Number & Name	USCG Student X: No course (j=0)	USCG Student X: No sim (j=1)	USCG Student X: Part Task (j=2)	USCG Student X: Full Mission (j=3)
1.1.A Steady on a new course				x
1.1.B Steer a course by gyrocompass		x		
1.1.C Steer a course by magnetic compass			x	
1.2.A Comply with "right (starboard) rudder" command	x			
1.2.B Comply with "left (port) rudder" command				x
1.2.C Comply with "rudder hard over" command		x		
1.2.D Comply with "ease the rudder" command		x		
1.2.E Comply with "midships the wheel" command	x			
1.2.F Comply with "shift your rudder" command			x	
1.2.G Comply with "meet her" or "check her" command	x			
1.2.H Comply with "steady as she goes" command			x	
1.2.I Comply with "nothing to the right/left" command		x		
1.3.A Change steering mode from auto pilot to hand steering			x	
1.3.B Change steering mode from hand steering to auto pilot			x	
2.1.A Report bearings in daylight			x	
2.1.B Report bearings at night			x	
2.1.C Report bearings by sound			x	
3.1.A Shipboard terms and definitions			x	
3.2.A Use of communications and alarm systems				x
3.3.A Communicate potential collision situations in daylight				x
3.3.B Communicate potential collision situations at night				x

3.4.A Relief of the lookout				x
3.4.B Relief of the helmsman				x
3.5.A Relief of the anchor watch				x
3.5.B Relief of the in-port watch	x			
3.6.A Environmental protection at sea	x			
3.6.B Environmental protection in port	x			

Second, form the sets A and U of tasks from the entries in Table 8. In particular, the set A of all task-method pairs consists of all cells with an “x” in the last three columns of Table 8. So, for example, the first task-method pair in A is (c_1, m_3) , i.e., Task 1.1.A taught using a full-mission simulator (m_3). The second task-method pair in A is (c_2, m_1) , i.e., Task 1.1.B taught using a course without any simulators. The set U of task-method pairs that are untrained are in the first column highlighted in green in Table 8. It may be useful to enumerate these task-method pairs for this example as is done in Equation 16:

$$U = \{(c_4, m_0), (c_8, m_0), (c_{10}, m_0), (c_{25}, m_0), (c_{26}, m_0), (c_{27}, m_0)\}$$

Equation 16. Tasks in set U of distributive rule example

Third, for the tasks in set A identify the raw, single-task proficiency acquisition time t_{ij} for each task-method pair (c_i, m_j) from the SME estimates in Table 24. Enter that time t_{ij} into Equation 13. For example, for task-method pair (c_1, m_3) we find from Table 24 that the raw, single-task proficiency acquisition time for Task 1.1.A taught using a full-mission simulator is 0.42 hours. Do the same for all tasks in set A . $SSD_A = 64.41$ days. Specifically, using Equation 13 we find:

$$SSD_A = \sum_{(i,j) \in A} \frac{t_{ij} \text{ hrs}}{0.34 \text{ hrs/day}} = 63.64 \text{ days}$$

Equation 17. SSD_A for distributive rule example

Do the same for all tasks in set U . Using Equation 14 we find:

$$SSD_U = \sum_{(i,j) \in U} \frac{t_{ij} \text{ hrs}}{0.34 \text{ hrs/day}} = 51.73 \text{ days}$$

Equation 18. SSD_U for distributive rule example.

We can now use Equation 12 to estimate the sea service days SSD_{AU} for the complete set of tasks in A and U . This estimate appears in Equation 19 below.

$$SSD_{AU} = \max\{(SSD_A + SSD_U), SSD_{min}^A\} = \max\{(63.64 + 51.73), 60\} = 115.37 \text{ days.}$$

Equation 19. SSD_{AU} for distributive rule example

The sea service equivalency SSE_{AU} is computed using Equation 20:

$$SSE_{AU} = 180 - SSD_{AU} = 180 - 116.76 = 64.63 \text{ days}$$

Equation 20. SSE_{AU} for distributive rule example

Note that this method applies to a single course with mixed- or single-methods and to multiple courses with mixed- or single-methods as long as the course has been reviewed and particular

tasks in the course included in set A have been approved for the awarding of sea service equivalency.

d) Limitations

We have made a number of assumptions in order to compute *SSD* and *SSE* for the distributive rule that we want to list. Some have been listed before, but we think it is important with this rule to list the three major assumptions and their potential limitations. First, we assumed that the time to train a task c_i to proficiency at sea using method m_j was equal to the time to complete a single repetition (h_i) times the number of repetitions (r_{ij}). Note that the time to complete a single repetition is not assumed to vary as a function of the training method or the position of the repetition in the sequence of repetitions. It is an open question of both whether the time to complete a single repetition varies as a function of the training method and whether the time to complete a single repetition varies as a function of the position of the repetition in the sequence of repetitions. Second, we assumed that the time on average each day that was available to a mariner for acquiring task proficiency was equal to the time to acquire proficiency at sea for mariners who had received no training on land for any of the 27 tasks (61.94 hours as estimated by the subject matter experts) divided by the minimum number of days at sea for such mariners (180 days), or in our case $(61.94 \text{ hrs})/(180 \text{ days}) = 0.34 \text{ hrs/day}$. It is an open question whether there will be enough practice time available on average for mariners to complete all tasks. As just one example, there may be little opportunity to practice steering a container ship traveling between ports in China and the United States. However, there will be more than enough time to practice steering ships traveling inland waterways. Third, we assumed that the sea service days were equal to the time it took to acquire proficiency on all 27 tasks if that time was greater than 60 days. The USCG may well decide to change the minimum. The increase in the sea service days beyond 60 would reduce the sea service equivalency that was awarded.

Note that there are corrective measures for the second and third assumptions. In particular, for the second assumption if a mariner is not trained on land prior to sea service on any of the 27 tasks, then if that mariner is not assessed as proficient on all tasks after 180 days, the mariner must continue sea service until such time as all tasks are so assessed. Notably this does not apply to mariners who have been trained on land prior to sea service. That is, there is no assessment once sea service equivalency has been awarded. For the third assumption, the minimum times in Equation 11 would need to be adjusted. This corrective measure would apply to all mariners, not just mariners who had been trained only at sea.

5. Discussion

There is much to be learned from the above exercise. The original designation of 180 days may have been too long given the additive rule. In particular, assume that the tasks are trained consecutively (massed training) and the training time can be captured in an estimate of the number of repetitions at sea given a prior training method m_j and the time it takes for each repetition. In this case, if no tasks were trained prior to going to sea and 60 days were the minimum number of required days, only 67.7 days of sea service would be required [Section I.B.2.a), Table 5]. The sea service equivalency would be 112.26 days. On the other hand, if all tasks were trained on a full-mission simulator, the number of sea service days would be reduced to 62.29 and the sea service equivalency would be 117.71 days. This implies that training has little impact ($117.71 - 112.26 = 5.5$). Rather than invest in possibly lengthy and expensive training ashore, a mariner only needs to spend 5.5 more days at sea for the same credit. It seems unlikely that a mere 5 or 6 extra days aboard a vessel in fact provides the same training benefit as days in sophisticated simulators with

dedicated instructors where all time and effort is focused on mariner instruction rather than split with ship operations.

If United States USCG decides that the original estimate of 180 days at sea for a mariner without training to achieve proficiency no longer applied and/or that the estimate of 60 days at sea for a mariner to achieve proficiency with an approved course of study no longer applies, then new estimates of SSD and SSE could easily be applied to the additive rule to see if they yield more acceptable results¹⁸.

In contrast, if 180 days is regarded as a reasonable estimate of the time it takes to train a mariner to proficiency given no prior training, then 180 days would be required at sea. The 180 days may well be a reasonable estimate given a desire to maximize learning across trials (distributed training), provide opportunities for a mariner to practice each task for the required number of times, and allow senior staff time to perform all of their duties, not just the assessment of mariners who wish to receive an endorsement for an RFPNW.

This leaves the distributive rule as the best candidate for assigning SSE for single-method training or a mix of task-method pairs in sets A and U . If the USCG determines that the distributive rule requires assumptions that can only be supported in part, then additional study is needed of the time to acquire proficiency at sea for each of the tasks. Perhaps instead of constants for estimates of the hours it takes to perform a single of a task, random variables could be used [11, 12]. This would allow an estimation of the number of days at sea below which, say, 95% of the time mariners with no prior training on land could achieve proficiency on all 27 tasks.

C. RFPEW: Sea Service Days and Sea Service Equivalency

Below, the three objectives in Section I.A.6 are discussed in detail with respect to an endorsement for an RFPEW.

1. Acquisition Time

To repeat, the first objective is to provide the USCG with estimates of the raw time at sea in hours that it is expected to take a mariner to reach proficiency at sea on each of the 47 tasks in C (RFPEW) trained with any one of the five methods discussed in Section I.A.4.b), i.e., the 135 estimates of the raw, single-task proficiency acquisition times.

a) Raw, Single-Task Proficiency Acquisition Time t_{ij}

As defined above in Section I.B.1.a), the raw, single-task proficiency acquisition time for a task c_i trained using method m_j is defined as the total time t_{ij} in hours that is spent at sea practicing the task until the mariner has reached proficiency. The 235 estimates of h_i and r_{ij} needed for all tasks (47) and all training methods (4) were obtained from subject matter experts and are listed in Table 31 (Section IV.B.1). Note that in Table 31 some cells are shaded dark gray and marked with a single asterisk (*). This means that the NVIC does not approve of that task being taught with that method, so we sought no panel consensus on it. This was decided before the panel session based on the text of the NVIC. A cell shaded red that says “Black” with two asterisks (**) is also not included. The difference from gray (*) is that the panel decided that the “Black” (**) task practically can’t (or isn’t) instructed by the given method, and so no consensus was derived.

The three assumptions needed to compute the raw, single-task proficiency acquisition time are listed in Section I.B.1.a), as is the formula for computing this time (Equation 1). Recall that t_{ij} is just

¹⁸ Any changes to SSD_{max} and SSD_{min} can just as easily be applied to the additive and subtractive rules too.

the product of h_i and r_{ij} . The raw, single-task proficiency acquisition times computed using Equation 1 are provided in Table 32 (Section IV.B.3).

b) Raw, Total Single-Method Proficiency Acquisition Time T_j

There are five training methods for the RFPEW, as explained above in Section I.A.4.b). The raw, total single-method proficiency acquisition time T_j for each method m_j is then computed as the sum of raw, single-task proficiency acquisition times within the same method m_j (Equation 2). Performing the computations in Equation 2 for each of the five training methods yields (also see Table 32, Section IV.B.3, for more detailed computations) T_j in hours and in days (assuming 8-hour days), we get the estimates below in Table 9. At first glance, it may seem odd that the raw, total single-method task proficiency acquisition time for a part-task simulator (71.74 hours) is greater than that for a course taught on land with no simulators (Lab). In fact, there is a simple explanation as discussed below.

Table 9. Raw, total Single-Method Proficiency Acquisition Times for RFPEW

Method	No Train	Lab	Part-Task	Full - Mission	Vessel
Hours	82.28	61.08	71.74	62.23	51.15
8-Hour Days	10.29	7.64	8.97	7.78	6.39

Specifically, when a task could not be trained with a particular method, it was assumed that the raw, single task proficiency acquisition time was equal to that of a mariner who had had no prior training. Thus, although the raw, *single task* proficiency acquisition times are shorter for tasks which can be trained with a part-task simulator than they are for tasks trained on land in a lab, the raw, *total single method* proficiency acquisition time for someone trained only with a part-task simulator is longer than the raw, total single method proficiency acquisition time for someone trained with a lab because part-task training does not apply to all tasks. Thus, the benefits of part-task training are reduced because fully 19 tasks must be trained entirely at sea (the number of gray shaded cells marked with * or red shaded cells marked with ** in the Part-Task column in Table 31). As just one example of how this trade-off occurs, consider Task 3.1.F (Table 32). If trained in a course with a lab, it requires 16 hours to reach proficiency. However, since it cannot be trained with a part-task simulator, the assumption is that it must be trained entirely at sea, which in this case takes 20 hours.

c) Raw, Total Mixed-Method Proficiency Acquisition Time T_{AU} for a Mariner

The raw, total mixed-method proficiency acquisition time for a set of tasks taught using a mixture of methods is computed for the RFPEW just as it is for the RFPNW using Equation 3. The only difference is that reference now needs to be made to the table of the raw, single-task proficiency acquisition times for the RFPEW (Table 32) when using Equation 3.

d) Limitations

The same limitations to this way of computing the raw, single-task proficiency acquisition times occur here as were discussed in Section I.B.1.d) for the RFPEW.

2. Computing SSD and SSE: The Additive Rule

The additive rule applies to the RFPEW just as it did to the RFPNW when computing *SSD* and *SSE* from the raw, single-task proficiency acquisition times assuming that a single method was used. The results are displayed in Table 10. The same general limitations apply here for the RFPEW as

applied for the RFPNW [Section I.B.2.b)]. In addition, recall that for the RFPEW, but not the RFPNW, some tasks could not be taught using a single method as discussed above in Section I.C.1.d). Thus, it was assumed that for courses that could not be taught using a single method that the training required to reach proficiency was the same as someone who had had no prior training on land. This is why the part-task SSD for the RFPEW is larger than the SSD for training received on land with a course, but no simulator (or, equivalently, why the part-task SSE for the RFPEW is less than the part-task SSE for training received on land with a course, but no simulator).

Table 10. Total Single-Method Proficiency Acquisition Times – Additive Rule. (Rounding errors are present because SSD and SSE are only displayed to the second decimal place.)

Method	No course	Course, No sim	Part Task	Full Mission	Vessel
Sea Service Days	70.29	67.64	68.97	67.78	66.39
Sea Service Equivalency	109.72	112.37	111.03	112.22	113.61

Note that if we assumed that for all courses that could not be trained with a part-task simulator, the mariner had prior training on land, then the estimates of SSD across the methods monotonically decrease as one would expect. In particular, the sea service days decrease as one goes from no training on land, to training on land without a simulator, training on land with a part-task simulator, training on land with a full-mission simulator, and then training at sea on a vessel (Table 11)

Table 11. Total Single-Method Proficiency Acquisition Times – Additive Rule. (If a task cannot be trained on a part-task or full-mission simulator, but can be trained on land it is assumed that the mariner who could not train on a simulator did train on land.)

Method	No course	Course, No sim	Part Task	Full Mission	Vessel
Sea Service Days	70.29	67.64	66.95	66.80	66.25
Sea Service Equivalency	109.72	112.37	113.06	113.20	113.75

3. Computing SSD and SSE: The Subtractive Rule

As did the additive rule apply to RFPEW just as did the additive rule apply to RFPNW, too the subtractive rule applies to RFPEW just as the subtractive rule applies to RFPNW when the tasks are taught using only a single method. The results are displayed in Table 12. The same limitations apply here as apply to the additive rule as discussed in Section I.B.3.b). In addition, it is also the case that we assumed

Table 12. Total Single-Method Proficiency Acquisition Times – Subtractive Rule

Method	No course	No sim	Part Task	Full Mission	Vessel
Sea Service Days	180.00	177.35	178.68	177.49	176.11
Sea Service Equivalency	0.00	2.65	1.32	2.51	3.89

Note that we find the same anomaly here with the subtractive rule and the RFPEW that we found with the additive rule and the RFPEW (Section I.C.2). In particular, the SSD for the part-task

simulator is longer than the SSD for training on land with no simulator (or equivalently, the SSE is less)

4. Computing SSD and SSE: The Distributive Rule

Given the limitations on the additive and subtractive rules, the rules were applied only in scenarios where a single method was used to train all tasks (or, if a single method could not be used with part-task or full-mission simulators, it was assumed that the task either was not trained on land or that it was trained on land, but without a simulator). In what follows below, the sea service days and sea service equivalency are computed both when the tasks required to receive an RFPEW endorsement are trained using a single method and when the tasks required to receive an RFPEW endorsement are trained using multiples methods.

a) Single-Method SSD_i and SSE_i: Single Course

As with the RFPNW, we now want to compute the sea service days and sea service equivalency for the five single-methods of training for the RFPEW using the distributive rule assuming that the training has occurred in one course (or no training has yet been delivered). The distributive rule inputs obtained from the SMEs are highlighted in purple in Table 13 and include the raw, total single-method proficiency acquisition time, and the time on average available to practice tasks on any given day. As with the RFPNW, we assume that the training hours per day remains the same across training methods and is equal to the ratio of the hours at sea for a mariner without prior training on land to become proficient (82.28) to the number of days said mariner is required to be at sea (180), i.e., the training hours per day available is equal $82.8/180 = 0.4571$. The rule inputs from the USCG are highlighted in green and include the minimum days at sea with the very best of training on land and with no training on land. As has been the case with all rules, we are assuming that the minimum SSD with training is 60 days and the minimum SSD without any training on land is 180 days.

Table 13. Estimates of single-method SSD_i and SSE_i for the five training methods –the distributive rule (assumes no training on land if training cannot occur on a simulator)

	SME Consensus Input: Continuous	SME Consensus Input: 180 Days	USCG: SSD(min)	USCG: SSD(min)	Rule Output: Distributive	Rule Output: Distributive
Training	Training Hours	Training hours/day	Train	No Train	SSD(days)	SSE (days)
No training	82.28	0.46	60	180	180	0
Classroom	61.08	0.46	60	180	134	46
Part-Task	71.74	0.46	60	180	157	23
Full-Mission	62.23	0.46	60	180	136	44
Vessel	51.15	0.46	60	180	112	68

Similar to the RFPNW, we find that SSD for the RFPEW does not monotonically decrease as the training method moves from no training to the most ecologically valid (training on a vessel). In particular, it is the case that part-task training actually increases the number of days at sea, from 134 with training on land to 157 with part-task simulator training. This situation occurs because the above computations assume that if a task could not be trained on a part-task simulator, the mariner had to train at sea. But it may be more representative of what occurs in practice to assume

that the mariner will receive training on land without a simulator. In this case, the distribution of SSD and SSE is what one would expect (Table 14). The number of sea service days being trained on a part-task simulator is smaller (122) than the number of sea-service days when the training occurs on land, but without any simulators (134).

Table 14. Estimates of single-method SSD_j and SSE_j for the five training methods –the distributive rule (assumes training on land if it cannot occur on a simulator)

	SME Consensus Input: Continuous	SME Consensus Input: 180 Days	USCG: SSD(min)	USCG: SSD(min)	Rule Output: Distributive	Rule Output: Distributive
Training	Training Hours	Training hours/day	Train	No Train	SSD(days)	SSE (days)
No training	82.28	0.46	60	180	180	0
Classroom	61.08	0.46	60	180	134	46
Part-Task	55.56	0.46	60	180	122	58
Full-Mission	54.39	0.46	60	180	119	61
Vessel	49.99	0.46	60	180	109	71

b) Mixed-Method SSD_{AU} and SSE_{AU} : Multiple Methods

If the tasks are taught using multiple methods, then the same procedure discussed in Section I.B.4.b) can be used to assign SSD and SSE to any combination of the 47 task-method pairs that might be submitted by a mariner for approval.

c) Mixed Method SSD_{AU} and SSE_{AU} : Example

An example can make clear exactly how concretely to assign sea service equivalency for an endorsement as an RFPEW using the distributive rule for a set A of tasks approved for the assignment of sea service equivalency given training on land or training at sea on a training vessel and set U of tasks that has not been so approved. As with the RFPNW, there are three steps. Put an “x” opposite each task in the cell which represents the method that was used to train the task. An “x” should appear opposite each of the 47 tasks in Table 15 after this step is completed. Completing the next two steps, one computes from the 47 raw, single-task proficiency acquisition times in Table 15 the raw, total mixed-method proficiency acquisition time. The raw, total mixed-method proficiency acquisition time is 58.07 hours, the SSD is 127 days and, correspondingly, the SSE is 53 days. A training vessel was not considered here because in most cases a mariner on board a training vessel would be unlikely to split tasks between a training vessel and other courses in which the tasks not learned on the training vessel were learned on land in a class.

Table 15. Mixed-methods example: RFPEW

NVIC 07-14 Support Engineering (RFPEW) Task Number & Name	USCG Student X: No course	USCG Student X: No sim	USCG Student X: Part Task	USCG Student X: Full Mission
1.1.A Conduct an engine room round				x
1.1.B (S) Monitor an electricity generating plant (steam)		x		
1.1.B (M) Monitor an electricity generating plant (motor)		x		
1.1.B (G) Monitor an electricity generating plant (gas turbine)		x		
1.1.C Monitor LO/FO purification systems		x		
1.1.D Monitor a compressed air plant		x		
1.1.E Monitor refrigeration and air conditioning plants		x		
1.1.F Determine tank and pressure vessel levels		x		
1.1.G Recharge a "waterlogged" potable water pressure tank with compressed air		x		
1.1.H (S) Monitor a steam operated distilling plant		x		
1.1.H (M) Monitor a jacket water-heated fresh water maker		x		
1.1.H (M) Monitor a reverse-osmosis desalination unit		x		
1.1.I (S) Monitor a main steam propulsion unit				x
1.1.I (M) Monitor a main diesel engine propulsion unit				x
1.1.I (G) Monitor a main gas turbine propulsion unit				x
1.1.J Monitor propulsion shafting and bearings		x		
1.1.K Monitor the steering gear		x		
1.2.A Add make-up oil to an auxiliary engine, reduction gear or deck machinery		x		
1.2.B Lubricate a bearing fitted with a grease cup		x		
1.2.B Lubricate a bearing fitted with grease fittings		x		
1.2.C Shift and clean a basket-type duplex basket strainer		x		
1.2.D Assist in cleaning a lube oil or fuel oil purifier		x		
1.2.E Take up on gate/globe valve stem stuffing box packing gland		x		
1.2.F Take on fresh water		x		
1.3.A Pump out bilge wells		x		
1.3.B Monitor an oily water separator		x		

1.3.C Monitor a sewage treatment plant		x		
2.1.A Relieve the watch		x		
2.1.B Hand over the watch		x		
2.1.C Assist in the pre-start checks of a diesel engine		x		
2.2.A Operate internal communications systems		x		
2.2.B Log engine order telegraph signals		x		
2.3.A Respond appropriately to alarms		x		
3.1.A Maintain main boiler water level and steam pressure		x		
3.1.B Maintain auxiliary boiler water level and steam pressure		x		
3.1.C Monitor the main propulsion boiler		x		
3.1.D Monitor a waste-heat auxiliary boiler		x		
3.1.D Monitor an oil-fired auxiliary boiler		x		
3.1.D1 Change out burners on a main propulsion boiler		x		
3.1.E Clean a burner atomizer assembly on a main propulsion boiler		x		
3.1.F Assist in preparing a main propulsion boiler for light-off				x
3.1.G Assist in manual light-off, raising steam, and cutting-in on line a main propulsion boiler		x		
3.1.H Assist in maintaining fires in a main propulsion boiler while maneuvering		x		
3.1.I Assist in the operation of boiler soot blowers		x		
4.1.A Locate all engine room escape routes		x		
4.2.A Locate machinery space firefighting and emergency equipment		x		
4.2.B Put a main or emergency fire pump in service		x		

d) Limitations

The same assumptions were made in order to compute the SSD and SSE using the distributive rule for an endorsement as an RFPEW as were made for an endorsement as an RFPNW [Section I.B.4.d)]. In addition, in order to compute the raw, single-method proficiency acquisition times we had to assume something about how a mariner learned tasks that could not be taught using a part-task simulator, a full-missions simulator, or a training vessel. It seemed most representative of what occurs in practice to assume that the mariner did receive training on the class, just not using the training method that was not applicable. However, we also gave estimates of the raw, single-method proficiency acquisition times assuming that no prior training on land occurred.

Importantly, note that these are not assumptions that will need to be made in practice. Mariners will provide the USCG with the set of tasks and methods that are used by them in training and assessment. There will be no guesswork involved for the USCG.

D. OICNW

For the OICNW endorsement, a total of 76 tasks were rated by eight instructors (Table 3). There was no consensus panel. The individual instructor estimates for each task and training method (hours/repetition; number of repetitions) are given in the individual instructor tabs in the attachment “OICNW __ CombinedStatisticsConsensus12-14v01.xlsx”. The group statistics for each task and training method (hours/repetition: mean, minimum, maximum, standard deviation; repetitions to achieve proficiency: mean, minimum, maximum, standard deviation) are given in the Statistics tab of this same attachment. The group statistics are also given in Table 35 in Section IV.C.1. The raw, single-task proficiency acquisition times computed using Equation 1 are given in Columns I – M of the Consensus tab of the attachment “SSE Tool OICNW 12-14 Distributed v0.xlsx”. They are also provided in Table 36 (Section IV.C.2) below. The total single-method *SSD* and *SSE* acquisition times are given below in Table 16 and also in Table 37 in Section IV.C.3. They can also be computed for a single method across tasks by using the SSE tab in attachment “SSE Tool 10-14 Distributed v0.xlsx”. Finally, the mixed-method *SSD* and *SSE* can be computed using that same tab in the attachment, specifying for each task which training method was used.

Table 16.Total Single-Method *SSD* and *SSE* for OICNW – the distributive rule

Method	No Train	Lab	Part-Task	Full - Mission	Vessel
<i>SSD</i>	1024	844	746	561	360
<i>SSE</i>	0	236	334	519	720

E. OICEW

For the OICEW endorsement, a total of 91 tasks were rated by two instructors (Table 3). There was no consensus panel. The individual instructor estimates for each task and training method (hours/repetition; number of repetitions) are given in the individual instructor tabs in the attachment “OICEW __ CombinedStatisticsConsensus17-14v01.xlsx”. The group statistics for each task and training method (hours/repetition: mean, minimum, maximum, standard deviation; repetitions to achieve proficiency: mean, minimum, maximum, standard deviation) are given in the Statistics tab of this same attachment. The group statistics are also given in Table 38 in Section IV.D.1. The raw, single-task proficiency acquisition times computed using Equation 1 are given in Columns I – M of the Consensus tab of the attachment “SSE Tool OIECW 17-14 Distributed v0.xlsx”. They are also provided in Table 39 (Section IV.D.2) below. The total single-method *SSD* and *SSE* acquisition times are given below in Table 17 and also in Table 40 in IV.D.3. They can also be computed for a single method across tasks by using the SSE tab in attachment “SSE Tool 10-14 Distributed v0.xlsx”. Finally, the mixed-method *SSD* and *SSE* can be computed using that same tab in the attachment, specifying for each task which training method was used.

Table 17. Total Single-Method *SSD* and *SSE* for OICEW – the distributive rule

Method	No Train	Lab	Part-Task	Full - Mission	Vessel
<i>SSD</i>	1080	923	986	986	917
<i>SSE</i>	0	157	94	94	163

The reader may find it surprising that either part-task or full-mission training receives less sea service equivalency than classroom training. As noted above (Footnote 16), if a task is not suitable for training using a given method, it is assumed here that the task was not trained. It is easy to change this assumption with the SSE calculators.

F. Master/Chief Mate

For the OICNW endorsement, a total of 27 tasks were rated by two instructors. There was no consensus panel. The individual instructor estimates for each task and training method (hours/repetition; number of repetitions) are given in the individual instructor tabs in the attachment “Master Chief Mate __ CombinedStatisticsConsensus10-14v01.xlsx”. The group statistics for each task and training method (hours/repetition: mean, minimum, maximum, standard deviation; repetitions to achieve proficiency: mean, minimum, maximum, standard deviation) are given in the Statistics tab of this same attachment. The group statistics are also given in Table 41 in Section IV.D.1. The raw, single-task proficiency acquisition times computed using Equation 1 are given in Columns I – M of the Consensus tab of the attachment “SSE Tool Master Chief Mate10-14 Distributed v0.xlsx”. They are also provided in Table 42 (Section IV.E.2) below. The total single-method SSD and SSE acquisition times are given below in **Error! Reference source not found.** and also in Table 43 in Section IV.E.3. They can also be computed for a single method across tasks by using the SSE tab in attachment “SSE Tool 10-14 Distributed v0.xlsx”. Finally, the mixed-method SSD and SSE can be computed using that same tab in the attachment, specifying for each task which training method was used.

Table 18. Total Single-Method SSD and SSE for Master/Chief Mate – the distributive rule

Method	No Train	Lab	Part-Task	Full - Mission	Vessel
SSD	360	192	289	294	120
SSE	0	168	71	66	240

G. Chief/2nd Engineer

For the Chief/2nd Engineer endorsement, a total of 29 tasks were rated by eight instructors. There was no consensus panel. The individual instructor estimates for each task and training method (hours/repetition; number of repetitions) are given in the individual instructor tabs in the attachment “Chief 2nd Engineer __ CombinedStatisticsConsensus10-14v01.xlsx”. The group statistics for each task and training method (hours/repetition: mean, minimum, maximum, standard deviation; repetitions to achieve proficiency: mean, minimum, maximum, standard deviation) are given in the Statistics tab of this same attachment. The group statistics are also given in Table 44 in Section IV.F.1. The raw, single-task proficiency acquisition times computed using Equation 1 are given in Columns I – M of the Consensus tab of the attachment “SSE Tool Chief 2nd Engineer 10-14 Distributed v0.xlsx”. They are also provided in Table 45 (Section IV.F.2) below. The total single-method SSD and SSE acquisition times are given below in **Error! Reference source not found.** and also in Table 46 in Section IV.F.3. They can also be computed for a single method across tasks by using the SSE tab in attachment “SSE Tool 10-14 Distributed v0.xlsx”. Finally, the mixed-method SSD and SSE can be computed using that same tab in the attachment, specifying for each task which training method was used.

Table 19. Total Single-Method SSD and SSE for Chief/2nd Engineer – the distributive rule

Method	No Train	Lab	Part-Task	Full - Mission	Vessel
SSD	360	192	360	294	120
SSE	0	8	0 ¹⁹	52	78

It should be noted that one of the instructors estimated that it would take up to twice as long to become proficient at sea if one had first learned a task on a part-task simulator as it would to become proficient at sea if one had not had any training at all on land. This suggests that more information may need to be gathered or, in fact, that there could be a negative transfer of learning. We were not in a position to differentiate between the possibilities, though we assumed that even if there was negative transfer the time to reach proficiency at sea would be no more than the maximum (360 days), assuming that the mariner had been suitably trained and assessed at sea even if the mariner had received prior training on a part-task simulator.

H. Discussion

There are three primary elements to the computation of the sea service equivalency. The first element is obtained from subject matter experts' estimates of the time that it takes to acquire proficiency at sea for each of the tasks required for an endorsement using a given training method. Briefly, the time that it takes to acquire proficiency at sea on a given task using a given training method was computed from subject matter experts' estimates of the time it took to complete the task once using the given training method multiplied by the number of repetitions needed to acquire proficiency. To the best of our knowledge, this is the first time that estimates have been made for the time to acquire proficiency at sea for each of various training methods for individual tasks required for the RFPNW or RFPEW endorsements. There are clear limitations to this approach. A discussion of the limitations of the approach are fully detailed in I.B.1.d).

The second element is the assignment of sea service equivalency for a given task taught using a given training method using the above task proficiency acquisition times. Three assignment rules were described: the additive, subtractive and distributive rules. The distributive rule is the one that it is argued best provides estimates of sea service equivalency consistent with current USCG guidelines. Very briefly, this rule relied on the experts' estimates of the time to reach proficiency at sea for a given task taught using a given method. These times were summed across all tasks for an endorsement. The time on average that was available each day for training for a given training method was assumed to be a constant (i.e., not to vary with the training method). In particular, this average time was set equal to the time that was available each day when all training had been given at sea (but not on a training vessel) divided by the number of days of required sea service (180). The distributive rule has clear limitations. The limitations of the distributive rule are discussed in Section I.B.4.d) for the RFPNW and in Section I.C.4.d) for the RFPEW.

Third, once one has the distributive rule in place and the time to reach proficiency on each task trained using a given method, the USCG can assign sea service equivalency to any combination of tasks and training methods. For the RFPNW with four methods and 27 tasks, there are 4²⁷ different

¹⁹ In this endorsement, some instructors estimated that it would take longer to achieve proficiency at sea on a task if one had first been trained on a part-task simulator on land. We capped that total days at sea at the maximum of 360 in this case. Also see the text for a more complete explanation.

combinations of possible tasks and methods that could possibly be submitted for sea service equivalency assignment. But the USCG does not need to estimate the sea service equivalency for each of the combinations. Rather, with the distributive rule in place and the time to acquire proficiency at sea for a task using a given training method available from subject matter experts' estimates, the USCG merely needs to draw from the appropriate table of estimates the 27 times to acquire proficiency at sea for each task-training method pair. Similar remarks hold for the RFPEW.

In summary, it is the opinion of the Volpe Center that the distributive rule provides a way of assigning sea service equivalency for the tasks required for an endorsement that are based on subject matter experts opinions and that are consistent with USCG current practices.

II. Goal 2: Simulator Comparisons

As noted in the Executive Summary there were two overall goals. This section addresses the second goal. In particular, the USCG required research to determine which of various combinations of two training methods was better given the proliferation of training methods for which no information existed on their comparative performance. In pursuit of this goal, the USCG gathered data from instructors on the performance of students in both of the two courses involved in a given comparison. The Volpe Center then used the data provided by the USCG to compare the performance of students undertaking the same general course of study using the two different training methods.

The USCG was interested in the following four comparisons:

1. Simulator class: Full-mission vs. part-task
2. Number of trainees: 1 vs. 2 (or more) trainees per simulator during training
3. Course type: Initial vs. recertification vs. refresher
4. Course location: On-site vs. remote

In the next section, we review the literature related to the above comparisons. Then we discuss the methods and results of the training efficacy assessment.

A. Literature Review

We conducted a literature review to inform our hypotheses about each of the four training efficacy comparisons. The review focused on the maritime literature, but expanded to other domains (e.g., medical or flight simulators/training) where the maritime literature was sparse. We found few studies that directly compared the training efficacy between the variables of interest (e.g., on-site vs. remote training). Rather, much of the literature evaluated the efficacy of individual methods, for example, comparing different versions of part-task training or assessing the ability of remote simulators to train students to set performance criteria.

1. Full Mission versus Part Task

Past research suggests that the best simulator class (i.e., full-mission or part-task) for training a particular task may depend on several factors. The first factor that needs to be considered is the complexity of the task. Full-mission training may be ideal for complex tasks which need to be coordinated at the same time, whereas part-task training may work better for complex tasks that can be broken down into simpler subtasks [13, 14, 15]. Specifically, for part-task training to be successful, it is important that the subtasks be ones that can be separated in time and space [13, 16, 17]. Moreover, even for complex tasks which need to be coordinated, novice trainees may benefit from starting training with simplified versions of the more complex, real-world tasks (e.g., simplified versions in a part-task simulator) and gradually increasing the task complexity and simulator fidelity over time [13, 14, 15]. The second factor that needs to be considered is the status of the trainee, an expert at one end of the spectrum of experience and a novice at the other end of the spectrum. Specifically, high fidelity simulators (e.g., full-mission in this case) may be beneficial for expert-level trainees who need complete details of the environment replicated in the simulator (e.g., high physical, visual, auditory, cognitive, manual fidelity), but not for novice-level trainees whose training is focused on technical principles, problem solving, or team coordination [18, 19,

20]. High-fidelity simulators (e.g., full-mission simulators) do not appear to work as well for novice trainees because it affects novice trainees' ability to attend to the critical cues [19, 21].

2. One Trainee versus Several Trainees

We did not find any literature about the number of trainees per simulator in the maritime domain, but we did find a few studies that examined individual versus team simulator training in other domains. The research suggests that teams may be more effective when the trainees work on the task together, as opposed to one trainee performing the task while the other observes [22]. Working together on a task allows trainees to learn from each other [20, 23].

3. Initial versus Refresher Training

There were no studies looking at the effectiveness of initial versus refresher training. Studies were identified that looked at the effectiveness of different intervals of refresher training on skill maintenance and the effectiveness of different ways of delivering the refresher training on skill maintenance [24].

4. Remote versus On-Site

The research on remote vs. on-site maritime simulator training was also limited. Two studies found success using remote simulators during the COVID-19 pandemic, but they did not compare remote training outcomes to on-site training outcomes [25] [26]. Distance-based training in general can offer trainees more opportunities to practice and learn on their own time [25, 27, 28], but this finding only applies to asynchronous online training (training that can be taken at a time and place of the trainee's choosing). Potential downsides of remote training include difficulty monitoring student performance and a lack of social interaction among trainees [27, 28].

B. Method

The USCG collected course data from maritime training providers to compare the training efficacy of a given content using different training methods. The data collection covered courses that were completed between February 2 and November 15, 2024.²⁰

1. Data Collection

The Coast Guard identified potential training providers and invited them to participate. Five providers volunteered. Each training provider was given a data collection worksheet that was tailored to their organization's course offerings. We did not collect data on asynchronous online training because no participating training providers offered it during the data collection period. Data were collected from the following five courses, organized by simulator type:

- Bridge (includes part-task radar simulators)
 - Advanced Shiphandling
 - Bridge Resource Management
 - Radar Observer Unlimited
 - Radar Observer Recertification
- Engine room
 - Marine Propulsion Plant

There was not a 1-to-1 correspondence between training providers and courses; the same courses were offered by different providers, sometimes in different formats.

²⁰ End date subject to change by USCG. This document will be updated as additional data are received.

Training providers distributed the worksheets to their training instructors to complete at the end of each course. The worksheets requested information about the course (e.g., simulator class, number of trainees per simulator, assessment criteria) and each of the trainees who took the course (e.g., mariner experience, written and practical test scores, number of attempts to pass). No personally identifiable information was collected on the trainees. For a full list of data fields, see Section IV.G.

Completed worksheets were returned to the USCG, who forwarded them to Volpe for analysis. We received data on all five courses. Each course may support one or more comparisons. Table 20 indicates which courses are applicable to each comparison, and whether we have data at each level of the independent variable (IV) for each comparison. Blank cells indicate that no data have been received.

Table 20. Data available for each comparison. (The data received are the number of students for whom information was provided.)

Comparison	Courses	Level of Independent Variable	Data Received
Simulator Class	Radar Observer (Unlimited)	Part Task	29
		Full Mission	22
	Marine Propulsion Plant	Part Task	10
		Full Mission	-
	Bridge Resource Management	Part Task	-
		Full Mission	15
Number of Trainees	Radar Observer (Unlimited)	1 Trainee	28
		2+ Trainees	23
	Marine Propulsion Plant	1 Trainee	10
		2+ Trainees	-
Course Type	Radar Observer (Unlimited)	Initial Training	51
	Radar Observer Recertification	Recertification	22 (5) ²¹
	Radar Observer Refresher	Refresher	-
Course Location	Marine Propulsion Plant	On-site	10
		Synchronous Online	-
	Advanced Shiphandling	[On-site] Full-Mission Simulator	35
		[Remote] Manned Model Simulator	-

²¹ At the time of this preliminary report, we only have exam and assessment results for 5 out of the 22 trainees in the recertification courses.

2. Comparisons

Data available to make the first three of the four training delivery comparisons:

- Full-mission vs. part-task training in Radar Observer (Unlimited) courses
- 1 vs. 2+ trainees per simulator in Radar Observer (Unlimited) courses
- Initial vs. Recertification training in radar courses

All courses for which we received data were offered on-site, so the comparison of remote with on-site training could not be tested. It may be the case that, at least for the selection of course content included in our sample, training schools made the decision that the material was not appropriate for remote learning.

3. Hypotheses

Based on the above literature review, we can specify for each of the above three comparisons (Section II.B.2) one or more hypotheses about relative performance on the delivery methods being compared if certain constraints are met. First, consider the comparison of the performance of trainees in courses using full-mission and part-task training simulators (H1). We might expect to find an interaction between the simulator class and the type of task. Specifically, it could be the case that part-task simulators are better for tasks in an endorsement which can be separated into subtasks in time and space, but full-mission simulators may be better for tasks in that endorsement that have multiple subtasks which must be coordinated and performed simultaneously. Second, consider the number of trainees per simulator. The literature review suggests that two or more trainees per simulator should perform better than only one trainee per simulator (H2). Third, although we had found no articles looking at the comparison between initial and refresher training on trainee performance, all other things being equal, we would expect that the closer the refresher training was to the initial training, the more proficient would be the trainees (as evidenced, say, by the number who passed the written or practical assessments on the first attempt) (H3).

4. Statistical Analyses

For data where comparisons were available, we present below course level means of student values, with a series of t-tests (for means) or Fisher's exact tests (for proportions) where appropriate. Fisher's exact test was used because the small sample size resulted in low counts or zeroes in some comparisons. In all cases, the null hypothesis is that there are no differences in performance on the course comparisons across the different delivery methods.

Note that using an a priori power test, we would need a sample size of 21 to identify a large effect (probability of a Type I error equals 0.05; probability of a Type II error equal 0.20) and a sample size of 51 to identify a medium effect [29]. The measure of effect size, Cohen's d, is equal to the difference in the means of two groups divided by the standard deviation. A large effect is equal to 0.8, meaning that the two means differ by 0.8 standard deviations. A medium effect is equal to 0.5, meaning that the two means differ by 0.5 standard deviations. To put this in perspective, suppose that 21 students were in each of two courses that were being compared with one another. If we were to find that the proportion of students passing one course on the first attempt was equal to 96.5% and the proportion of students passing a second course on the first attempt was equal to 90.0%, the difference would be large enough (0.8 standard deviations) to reject the null hypothesis with a probability of 0.05 of making a Type I error and a probability of 0.20 of making a Type II error.

C. Results

1. Overall Descriptive Statistics and Dependent Variables

The demographics and course outcomes of the sample of trainees across all responding training providers and courses are summarized in Table 21. There were a total of 106 trainees, 98 of whom were male and 8 of whom were female. The dependent outcome variables we used were:

- Percent of trainees who passed the written exam on 1st attempt (score of 70% or above)
- Average number of attempts to pass the written exam (out of 3)
- Percent of trainees who passed written exam (score of 70% or above on 1st, 2nd or 3rd attempt)
- Average written exam score on 1st attempt (highest possible score 100%)
- Percent of trainees who passed practical assessment on 1st attempt (scored as pass/fail)
- Average number of practical assessment attempts (out of 3)
- Percent of trainees who passed practical assessment (graded as “pass” on 1st, 2nd or 3rd attempt)
- Percent of trainees who passed the course

Note that students who are listed as not passing a course did not pass because they needed to retake an exam and/or assessment.

Table 21. Trainee descriptive statistics

Variable	Mean or % (95% CI)
Age	35.8 (33.7 – 37.8)
Past Simulator Experience	57.5% (46.2% - 68.9%)
Passed Written Exam on 1 st Attempt	94.3% (89.9% - 98.7%)
Written Exam Attempts	1.05 (1.01 - 1.09)
Passed Written Exams	98.1% (95.5% - 100.0%)
Written Exam Score 1 st Attempt (Out of 100)	85.6% (78.9% - 92.3%)
Passed Practical Assessment on 1 st Attempt (%)	97.2% (94.0% - 100.0%)
Practical Assessment Attempts	1.02 (0.99 - 1.05)
Passed Practical Assessment (%)	99.1% (97.2% - 100.0%)
Passed Course (%)	98.1% (95.5% - 100.0%)

D. Discussion

We compared courses with the same content on four different ways of delivering the training (Section II.C.1). Although as noted, it was expected that almost all students would pass a course given that the written and practical exams can be retaken, if there were differences between courses in terms of how well the courses trained students, we might expect to see differences in the various indicators of trainee performance such as the average written exam score or the percentage of students passing the practical exam on the first attempt.

1. Results and Implications

Only two of the comparisons of course outcomes were significant, the difference in the written score on the first attempt and the difference in passing rates on the first attempt between trainees in the radar observer unlimited course and in the radar observer recertification course. Both of these significant results were based on a very small sample of trainees. As noted earlier, the small number of statistically significant differences may reflect more of a power issue than a lack of real differences.

However, it may also reflect the fact that there may be no real differences between the number of students who passed the written or practical exams in any given comparison. This would indicate, all other things being equal, that students can take whatever course for an endorsement that is least expensive and most convenient. This could have large implications for trainees, especially if remote delivery were as effective as on-site delivery. Unfortunately, we did not have these data.

Not all of the intended comparisons between delivery methods for the same course content could be evaluated. Some course structures were simply not available in the data (e.g., remote). One way of interpreting this lack of data is that training schools already considered other ways of offering their course content and already ruled out methods that would be less effective or produce worse student outcomes.

2. Limitations

There are a number of limitations when making comparisons between courses. Several have been mentioned above, but bear repeating. First, the instructor teaching a course on a full-mission simulator is not the same as the instructor teaching the course on a part-task simulator. The same goes for other comparisons. Given that instructors are differentially effective, perhaps because of different teaching techniques, a much larger sample of instructors would be needed or, ideally, the same instructor could be assigned to teach the course in both formats. Put more simply, the different performance metrics of the courses involved in a given comparison may reflect more on the different instructors than on the different formats (e.g., full-mission versus part-task). Second, courses with the same title did not necessarily have identical tasks. Section IV.H provides information on the set of tasks that are taught in common in each of the Radar Observer (Unlimited) courses. The percentage of trainees performing at such and such a level on a given dependent variable in one course (say number of attempts to pass the practical exam) may have been taught tasks above and beyond those that were taught to trainees in another course. Thus, the differences in performance could be a result of trainees in one course being taught more tasks than trainees in another course, training on those other tasks generalizing to performance on the tasks evaluated in the assessment²². Third, we did not account for the fact that we were making multiple comparisons when comparing the dependent variables. A Bonferroni correction should be applied to each of the p values to determine whether it is statistically significant. We mention this in the tables containing the inferential statistics, but wanted to point it out again. Fourth, the number of observations was often below 30 when making comparisons between proportions. This means that the power of our tests is relatively low.

²² The Interim Report does not list the set of tasks other than the common tasks in the Radar Observer (Unlimited) course that are taught in a specific course (Appendix 2, Section IV.H.1.a)). The final report will contain those tasks if the Coast Guard wants to identify said tasks.

III. References

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IV. Appendices

A. RFPNW

1. RFPNW Assessment Guidelines²³ [1]

Table 22. RFPNW Assessment Guidelines [1].

Task No./Name	STCW Competence	Knowledge, Understanding and Proficiency	Performance Condition	Performance Behavior	Performance Standard
1.1.A Steady on a new course	Steer the ship and also comply with helm orders in the English language	Use of magnetic and gyro-compasses	On a vessel equipped with either a gyrocompass or a GNSS compass meeting IMO and IEC standards, or on a simulator, at full sea speed, while on a northeasterly heading, when hearing the command, in English, “steer 342,”** ** The assessor may select any course desired as long as it is more than 30° from the original heading. At least one assessment should include a turn to the right from the ordered course. If the vessel is not equipped with a gyrocompass, a GNSS compass that meets standards of the IMO and the IEC may be used.	The candidate turns the helm to bring the vessel to the new course and steady on the course of 342°. ** The assessor may select any course desired as long as it is more than 30° from the original heading. At least one assessment should include a turn to the right from the ordered course. If the vessel is not equipped with a gyrocompass, a GNSS compass that meets standards of the IMO and the IEC may be used.	The candidate: Repeats the order; Turns the helm in the direction of the fewest degrees to the ordered course using no more than 15° of rudder; Reports the ship’s heading, while swinging, in each 10° increment; Reduces the rudder angle as the vessel approaches the course; Steadies on the course of 342° with less than 5° of overshoot; and States “Steady on three four two.”

²³ Successful completion of these Assessment Guidelines will provide satisfactory evidence of meeting the standard of competence specified in Section A-II/4 of the STCW Code

2. RFPNW SME Panel Consensus Estimates

Table 23. SME RFPNW Panel Consensus Estimates

NVIC 06-14 Support Deck (RFPNW) Task Number & Name	Must be onboard?	Hours per Rep	Task Repetitions: No training	Task Repetitions: No Sim	Task Repetitions: Part Task	Task Repetitions: Full Mission
1.1.A Steady on a new course	No	0.07	20	20	10	6
1.1.B Steer a course by gyrocompass	No	0.33	13	13	7	4
1.1.C Steer a course by magnetic compass	No	0.33	13	13	7	4
1.2.A Comply with "right (starboard) rudder" command	No	0.02	5	5	3	1.5
1.2.B Comply with "left (port) rudder" command	No	0.02	5	5	3	1.5
1.2.C Comply with "rudder hard over" command	No	0.02	5	5	3	1.5
1.2.D Comply with "ease the rudder" command	No	0.02	5	5	3	1.5
1.2.E Comply with "midships the wheel" command	No	0.02	5	5	3	1.5
1.2.F Comply with "shift your rudder" command	No	0.02	5	5	3	1.5
1.2.G Comply with "meet her" or "check her" command	No	0.07	20	20	10	6
1.2.H Comply with "steady as she goes" command	No	0.2	17	17	9	5
1.2.I Comply with "nothing to the right/left" command	No	0.07	20	20	10	6
1.3.A Change steering mode from auto pilot to hand steering	No	0.02	4	4	2	2
1.3.B Change steering mode from hand steering to auto pilot	No	0.02	4	4	2	2
2.1.A Report bearings in daylight	No	0.02	30	20	20	10
2.1.B Report bearings at night	No	0.02	40	25	25	13
2.1.C Report bearings by sound	No	0.02	40	25	25	15
3.1.A Shipboard terms and definitions	No	4 ²⁴	1	0.62	0.40	0.20
3.2.A Use of communications and alarm systems	No	0.02	20	13	10	8
3.3.A Communicate potential collision situations in daylight	No	0.2	33	22	22	11
3.3.B Communicate potential collision situations at night	No	0.2	33	22	22	11
3.4.A Relief of the lookout	No	0.25	12	9	9	5
3.4.B Relief of the helmsman	No	0.25	12	9	9	5

²⁴ Note that the training of shipboard terms and definitions requires 4 hours if there were no prior learning on land. To fit into the model, this was specified as one repetition. If the mariner has full-mission simulator training, then only 0.80 hours were required, which is equal to 0.20 "repetitions".

3.5.A Relief of the anchor watch	No	0.25	12	9	9	5
3.5.B Relief of the in-port watch	No	0.25	12	9	9	5
3.6.A Environmental protection at sea	No	0.2	33	16	8	5
3.6.B Environmental protection in port	No	0.2	33	16	8	5

3. RFPNW Raw, Single-Task Proficiency Acquisition Times and Raw, total Single-Method Proficiency Acquisition Times

Table 24. Raw, single-task proficiency acquisition times

NVIC 06-14 Support Deck (RFPNW) Task Number & Name	Total Hours (reps * hours/rep): No course	Total Hours (reps * hours/rep): No sim	Total Hours (reps * hours/rep): Part Task	Total Hours (reps * hours/rep): Full Mission
1.1.A Steady on a new course	1.4	1.4	0.7	0.42
1.1.B Steer a course by gyrocompass	4.29	4.29	2.31	1.32
1.1.C Steer a course by magnetic compass	4.29	4.29	2.31	1.32
1.2.A Comply with "right (starboard) rudder" command	0.1	0.1	0.06	0.03
1.2.B Comply with "left (port) rudder" command	0.1	0.1	0.06	0.03
1.2.C Comply with "rudder hard over" command	0.1	0.1	0.06	0.03
1.2.D Comply with "ease the rudder" command	0.1	0.1	0.06	0.03
1.2.E Comply with "midships the wheel" command	0.1	0.1	0.06	0.03
1.2.F Comply with "shift your rudder" command	0.1	0.1	0.06	0.03
1.2.G Comply with "meet her" or "check her" command	1.4	1.4	0.7	0.42
1.2.H Comply with "steady as she goes" command	3.4	3.4	1.8	1
1.2.I Comply with "nothing to the right/left" command	1.4	1.4	0.7	0.42
1.3.A Change steering mode from auto pilot to hand steering	0.08	0.08	0.04	0.04
1.3.B Change steering mode from hand steering to auto pilot	0.08	0.08	0.04	0.04
2.1.A Report bearings in daylight	0.60	0.40	0.40	0.20
2.1.B Report bearings at night	0.80	0.50	0.50	0.26
2.1.C Report bearings by sound	0.80	0.50	0.50	0.30
3.1.A Shipboard terms and definitions	4.00	2.48	1.60	0.80
3.2.A Use of communications and alarm systems	0.40	0.26	0.20	0.16
3.3.A Communicate potential collision situations in daylight	6.60	4.40	4.40	2.20

3.3.B Communicate potential collision situations at night	6.60	4.40	4.40	2.20
3.4.A Relief of the lookout	3.00	2.25	2.25	1.25
3.4.B Relief of the helmsman	3.00	2.25	2.25	1.25
3.5.A Relief of the anchor watch	3.00	2.25	2.25	1.25
3.5.B Relief of the in-port watch	3.00	2.25	2.25	1.25
3.6.A Environmental protection at sea	6.60	3.20	1.60	1.00
3.6.B Environmental protection in port	6.60	3.20	1.60	1.00

4. RFPNW Raw, Total Single-Method Proficiency Acquisition Times

Table 25. Raw, total Single-Method Proficiency Acquisition Times for RFPNW

Method	No course	No sim	Part Task	Full Mission
Hours	61.94	45.28	33.16	18.28
8-Hour Days	7.74	5.66	4.15	2.29

5. RFPNW Single-Method SSD and SSE

Table 26. Single-Method SSD and SSE

Method	No course	No sim	Part Task	Full Mission
SSD	180	132	96	60
SSE	0	48	84	120

B. RFPEW

1. Current Analyses

a) Full Mission vs. Part Task

The Radar Observer Unlimited²⁵ courses were taught in both full-mission and part-task arrangements at different schools, allowing for a direct comparison between the effectiveness of different simulators covering the Radar Observer Unlimited course training objectives and assessments²⁶. Table 27 provides the results of this comparison for training outcome variables and student characteristics (potential moderator variables). The other courses were excluded from this analysis.

Table 27. Statistical results of simulator class comparison for radar observer unlimited courses

Variable	Full Mission	Part Task	p-value
N	22	29	
Age (Mean, in years)	38.2	36.9	0.64
Sex (% Male)	95.5%	96.6%	1.00
Past Simulator Experience (%)	54.5%	48.1%	0.78
Passed Written Exam on 1 st Attempt	95.5%	96.6%	1.00
Written Exam Attempts	1.05	1.00	0.33
Passed Written Exam (%)	100.0%	96.6%	1.00
Written Exam Score 1 st Attempt (Out of 100)	86.8%	89.4%	0.38
Passed Practical Assessment on 1 st Attempt (%)	100.0%	89.7%	0.25
Practical Assessment Attempts	1.00	1.07	0.16
Passed Practical Assessment (%)	100.0%	96.6%	1.00
Passed Course (%)	100.0%	96.6%	1.00

For the Radar Observer Unlimited course, no significant differences were found between student characteristics or outcomes in the full-mission and part-task versions of the course. Given the relatively small sample size, it is perhaps not surprising that the difference between the percentage of students in the full-mission and part-task versions of the course passing the practical exam on the first

²⁵ A mariner that qualifies for the Radar Observer Unlimited endorsement can operate a vessel on coastal waters, the Great Lakes, and inland rivers.

²⁶ Note that some Radar Observer Unlimited courses may include more tasks and assessments than are required for the Radar Observer training requirements of 46 CFR 11.480(d) for an endorsement as Radar Observer (Unlimited) and for the radar observer standards of competence required by 46 CFR 11.309(a)(3) and 11.319(a)(3). See Appendix 2 for the specific training requirements and standards of competence for the Radar Observer (Unlimited) courses used in the various comparisons.

attempt is not statistically significant. Moreover, and importantly, the tasks were not identified individually as ones which were best taught on a full-mission simulator and ones which were best taught on a part-task simulator. As noted in Section II.A.1, had the tasks been so partitioned, we might expect full-mission simulators to lead to better performance on tasks which cannot be separated in time and space into subtasks, but part-task simulators to lead to better performance on tasks which can be so separated.

In order to increase the sample size, note that the Marine Propulsion Plant course could be provided as either a full-mission or a part-task arrangement, but we only had data from a part-task version of the course. If we ignore the content of the courses and focus only on the course delivery method, we can compare full-mission to part-task courses using: (a) the data for part-task simulators from both students in the Radar Observer Unlimited courses and students in the Marine Propulsion Plant courses and (b) the data for full-mission simulators from only the Radar Unlimited courses, as summarized in Table 28. The other courses were excluded from this analysis.

Table 28. Statistical results of simulator class comparison for radar observer unlimited and marine propulsion courses

Variable	Full Mission	Part Task	p-value
N	22	39	
Age (Mean, in years)	38.23	35.26	0.26
Sex (% Male)	95.5%	92.3%	1.00
Past Simulator Experience (%)	54.5%	48.1%	0.78
Passed Written Exam on 1 st Attempt	95.5%	97.4%	1.00
Written Exam Attempts	1.05	1.00	0.33
Passed Written Exam	100.0%	97.4%	0.32
Written Exam Score 1 st Attempt (Out of 100)	86.82	88.7	0.50
Passed Practical Assessment on 1 st Attempt (%)	100.0%	92.3%	0.55
Practical Assessment Attempts	1.00	1.05	0.16
Passed Practical Assessment (%)	100.0%	97.4%	1.00
Passed Course (%)	100.0%	97.4%	1.00

When looking at both the Radar Observer Unlimited and the Marine Propulsion Plant courses (part-task), the results are no different from the results for the Radar Observer Unlimited courses alone (full-mission). No significant differences were found between student characteristics or outcomes in the full-mission and part-task versions of these courses. In fact, if anything, it appears that there is more noise in the data, probably due to the fact that the course content varies across the delivery methods.

b) One Trainee vs. Two or More Trainees

The Radar Observer Unlimited courses were taught with a single trainee per simulator and two or more trainees per simulator at different schools, allowing for a direct comparison between different methods of teaching the same course, as shown in Table 29. The other courses were excluded from this analysis.

Table 29. Statistical results of number-of-trainees-per-simulator comparison for radar observer unlimited course

Variable	1 Trainee	2+ Trainees	p-value
N	28	23	
Age (Mean, in years)	37.5	37.4	0.98
Sex (% Male)	96.4%	95.7%	1.00
Past Simulator Experience (%)	35.7%	71.4%	0.02* ²⁷
Passed Written Exam on 1 st Attempt	96.4%	95.7%	1.00
Written Exam Attempts	1.00	1.04	0.33
Passed Written Exam (%)	96.4%	100.0%	1.00
Written Score on 1 st Attempt (Out of 100)	90.5%	85.6%	0.09
Passed Practical Assessment on 1 st Attempt (%)	89.3%	100.0%	0.24
Practical Assessment Attempts	1.07	1.00	0.16
Passed Practical Assessment	96.4%	100.0%	1.00
Passed Course (%)	96.4%	100.0%	1.00

For the Radar Observer Unlimited course, no significant differences in course outcomes were found between teaching the course with a single trainee per simulator and teaching the course with two or more trainees per simulator. This is not consistent with our initial hypothesis (H2, Section II.B.3). Given the relatively small sample size, it is perhaps not surprising that the difference in written exams scores is not significant. Trainees in the course with more than one trainee per simulator also were significantly more likely to have past experience with simulators.

c) Initial Training vs. Recertification

The Radar Observer courses were taught as both initial training (Unlimited) and Recertification, allowing for a comparison between different methods of teaching the same course, as shown in Table 20. The other courses were excluded from this analysis.

²⁷ Note that Bonferroni corrections have not been applied to the p-values to determine statistical significance. Given that there are 6 different comparisons, a p-value of 0.05/6 would be required in order for the probability of a Type I error to be equal to 0.05.

At the time of this analysis, data on course results are only available for 5 of the trainees in the recertification courses, so the comparisons described below are based on this very small sample (Table 30).

Table 30. Statistical results of course-type comparison for radar observer unlimited course

Variable	Initial	Recertification	p-value
N	51	5	
Age (Mean, in years)	37.47	46.2	0.23
Sex (% Male)	96.1%	80.0%	1.00
Past Simulator Experience (%)	51.0%	60.0% ²⁸	0.19
Passed Written Exam on 1 st Attempt	96.1%	40.0%	0.00**
Written Exam Attempts	1.02	1.60	0.08
Passed Written Exam (%)	98.0%	100.0%	1.00
Written Score on 1 st Attempt (Out of 100)	88.3%	56.0%	0.02*
Passed Practical Assessment on 1 st Attempt (%)	94.1%	100.0%	1.00
Practical Assessment Attempts	1.04	1.00	0.16
Passed Practical Assessment (%)	98.0%	100.0%	1.00
Passed Course (%)	98.0%	100.0%	1.00

Contrary to our hypothesis (H3), the trainees in the recertification course performed worse overall on several metrics than the trainees given the Radar Observer (Unlimited) course for the first time. However, these results are based on a very small number of trainees and may be subject to change once course outcomes are reported for additional trainees.

d) On-Site vs. Remote

All courses for which we received data were offered on-site, so this comparison could not be tested. It may be the case that, at least for the selection of course content included in our sample, training schools made the decision that the material was not appropriate for remote learning.

²⁸ Note that since it is not possible to receive an original radar endorsement without a course that uses a part-task (or in rare cases a full-mission) simulator, the question asking about previous simulator experience may have been unclear, or perhaps the respondents did not know that a shipboard radar unit with simulated input is a part-task simulator.

2. RFPEW SME Panel Consensus Estimates

An dark gray cell marked with a single asterisk (*) is “black”, meaning the NVIC does not approve of that task being taught with that method, so we sought no panel consensus on it. This was decided before the panel session based on the text of the NVIC. A red cell that says “Black” with two asterisks (**) is also not included. The difference from gray (*) is that the panel decided that the “Black” task practically can’t (or isn’t) instructed by the given method, and so no consensus was derived.

Table 31. SME RFPEW Panel Consensus Estimates

NVIC 07-14 Support Engineering (RFPEW) Task Number & Name	Onboard	Hours/ Repetition	Task Repetitions: No Train	Task Repetitions: Lab	Task Repetitions: Part-Tsk	Task Repetitions: Full-Msn	Task Repetitions: Vessel
1.1.A Conduct an engine room round	No	0.67	4	*	3	2	2
1.1.B (S) Monitor an electricity generating plant (steam)	No	0.33	4	2	2	2	2
1.1.B (M) Monitor an electricity generating plant (motor)	No	0.33	4	2	2	2	2
1.1.B (G) Monitor an electricity generating plant (gas turbine)	No	0.33	4	2	2	2	*
1.1.C Monitor LO/FO purification systems	No	0.25	3	2	2	2	2
1.1.D Monitor a compressed air plant	No	0.25	3	2	2	2	2
1.1.E Monitor refrigeration and air conditioning plants	No	0.25	3	2	2	2	2
1.1.F Determine tank and pressure vessel levels	No	0.08	4	3	*	*	2
1.1.G Recharge a "waterlogged" potable water pressure tank with compressed air	No	0.5	3	2	2	2	2
1.1.H (S) Monitor a steam operated distilling plant	No	0.33	4	3	3	3	3
1.1.H (M) Monitor a jacket water-heated fresh water maker	No	0.33	4	3	3	3	3
1.1.H (M) Monitor a reverse-osmosis desalination unit	No	0.33	4	3	3	3	3

1.1.I (S) Monitor a main steam propulsion unit	No	0.67	5	*	Black**	4	4
1.1.I (M) Monitor a main diesel engine propulsion unit	No	0.5	4	3	Black**	2	2
1.1.I (G) Monitor a main gas turbine propulsion unit	No	0.5	4	3	3	2	*
1.1.J Monitor propulsion shafting and bearings	No	0.5	3	2	2	2	1
1.1.K Monitor the steering gear	No	0.25	3	2	2	2	2
1.2.A Add make-up oil to an auxiliary engine, reduction gear or deck machinery	No	0.25	3	2	*	*	2
1.2.B Lubricate a bearing fitted with a grease cup	No	0.25	3	2	*	*	2
1.2.B Lubricate a bearing fitted with grease fittings	No	0.25	3	2	*	*	2
1.2.C Shift and clean a basket-type duplex basket strainer	No	0.25	3	2	*	*	2
1.2.D Assist in cleaning a lube oil or fuel oil purifier	No	1	4	2	*	*	2
1.2.E Take up on gate/globe valve stem stuffing box packing gland	No	0.25	3	2	*	*	2
1.2.F Take on fresh water	No	0.33	3	2	*	*	2
1.3.A Pump out bilge wells	No	0.25	3	2	2	2	2
1.3.B Monitor an oily water separator	No	0.25	3	2	2	2	2
1.3.C Monitor a sewage treatment plant	No	0.25	3	2	2	2	2
2.1.A Relieve the watch	No	0.25	3	2	2	2	2
2.1.B Hand over the watch	No	0.25	3	2	2	2	2
2.1.C Assist in the pre-start checks of a diesel engine	No	0.4	4	3	3	3	3
2.2.A Operate internal communications systems	No	0.17	3	2	2	2	2
2.2.B Log engine order telegraph signals	No	0.08	4	1	1	1	1

2.3.A Respond appropriately to alarms	No	0.17	4	2	2	2	2
3.1.A Maintain main boiler water level and steam pressure	No	0.25	4	2	2	2	2
3.1.B Maintain auxiliary boiler water level and steam pressure	No	0.25	4	2	2	2	2
3.1.C Monitor the main propulsion boiler	No	0.5	4	3	3	3	2
3.1.D Monitor a waste-heat auxiliary boiler	No	0.25	4	3	3	3	2
3.1.D Monitor an oil-fired auxiliary boiler	No	0.25	4	3	3	3	2
3.1.D1 Change out burners on a main propulsion boiler	No	0.08	5	5	*	*	5
3.1.E Clean a burner atomizer assembly on a main propulsion boiler	No	0.5	4	3	*	*	3
3.1.F Assist in preparing a main propulsion boiler for light-off	No	4	5	4	Black**	4	3
3.1.G Assist in manual light-off, raising steam, and cutting-in on line a main propulsion boiler	No	1	5	4	Black**	4	3
3.1.H Assist in maintaining fires in a main propulsion boiler while maneuvering	No	1	5	4	Black**	4	3
3.1.I Assist in the operation of boiler soot blowers	No	0.5	4	3	Black**	3	3
4.1.A Locate all engine room escape routes	No	0.25	3	*	*	*	1
4.2.A Locate machinery space firefighting and emergency equipment	No	0.25	3	*	*	*	1
4.2.B Put a main or emergency fire pump in service	No	0.17	3	2	Black**	2	2

3. RFPEW Raw, Single-Task Proficiency Acquisition Times

Note that when a training method was not appropriate for a given task (the gray marked with * or red cells marked with **), it was assumed that the task had not been trained on land and so the raw, single-task proficiency acquisition time was set equal to this time assuming that the mariner had had no prior training.

Table 32. RFPEW Raw, Single-Task Proficiency Acquisition Times²⁹

NVIC 07-14 Support Engineering (RFPEW) Task Number & Name	No Train	Lab	Part-Task	Full-Mission	Vessel
1.1.A Conduct an engine room round	2.68	2.68*	2.01	1.34	1.34
1.1.B (S) Monitor an electricity generating plant (steam)	1.32	0.66	0.66	0.66	0.66
1.1.B (M) Monitor an electricity generating plant (motor)	1.32	0.66	0.66	0.66	0.66
1.1.B (G) Monitor an electricity generating plant (gas turbine)	1.32	0.66	0.66	0.66	1.32*
1.1.C Monitor LO/FO purification systems	0.75	0.5	0.5	0.5	0.5
1.1.D Monitor a compressed air plant	0.75	0.5	0.5	0.5	0.5
1.1.E Monitor refrigeration and air conditioning plants	0.75	0.50	0.50	0.50	0.50
1.1.F Determine tank and pressure vessel levels	0.32	0.24	0.32*	0.32*	0.16
1.1.G Recharge a "waterlogged" potable water pressure tank with compressed air	1.50	1.00	1.00	1.00	1.00
1.1.H (S) Monitor a steam operated distilling plant	1.32	0.99	0.99	0.99	0.99
1.1.H (M) Monitor a jacket water-heated fresh water maker	1.32	0.99	0.99	0.99	0.99
1.1.H (M) Monitor a reverse-osmosis desalination unit	1.32	0.99	0.99	0.99	0.99
1.1.I (S) Monitor a main steam propulsion unit	3.35	3.35*	3.35**	2.68	2.68
1.1.I (M) Monitor a main diesel engine propulsion unit	2.00	1.50	2.00**	1.00	1.00
1.1.I (G) Monitor a main gas turbine propulsion unit	2.00	1.50	1.50	1.00	2.00*
1.1.J Monitor propulsion shafting and bearings	1.50	1.00	1.00	1.00	0.50
1.1.K Monitor the steering gear	0.75	0.50	0.50	0.50	0.50
1.2.A Add make-up oil to an auxiliary engine, reduction gear or deck machinery	0.75	0.50	0.75*	0.75*	0.50

²⁹ Shaded cells are ones where the STCW does not approve of the method of training; red cells are ones where the SMEs did not believe that the method of training applied.

1.2.B Lubricate a bearing fitted with a grease cup	0.75	0.50	0.75*	0.75*	0.50
1.2.B Lubricate a bearing fitted with grease fittings	0.75	0.50	0.75*	0.75*	0.50
1.2.C Shift and clean a basket-type duplex basket strainer	0.75	0.50	0.75*	0.75*	0.50
1.2.D Assist in cleaning a lube oil or fuel oil purifier	4.00	2.00	4.00*	4.00*	2.00
1.2.E Take up on gate/globe valve stem stuffing box packing gland	0.75	0.50	0.75*	0.75*	0.50
1.2.F Take on fresh water	0.99	0.66	0.99*	0.99*	0.66
1.3.A Pump out bilge wells	0.75	0.50	0.50	0.50	0.50
1.3.B Monitor an oily water separator	0.75	0.50	0.50	0.50	0.50
1.3.C Monitor a sewage treatment plant	0.75	0.50	0.50	0.50	0.50
2.1.A Relieve the watch	0.75	0.50	0.50	0.50	0.50
2.1.B Hand over the watch	0.75	0.50	0.50	0.50	0.50
2.1.C Assist in the pre-start checks of a diesel engine	1.60	1.20	1.20	1.20	1.20
2.2.A Operate internal communications systems	0.51	0.34	0.34	0.34	0.34
2.2.B Log engine order telegraph signals	0.32	0.08	0.08	0.08	0.08
2.3.A Respond appropriately to alarms	0.68	0.34	0.34	0.34	0.34
3.1.A Maintain main boiler water level and steam pressure	1.00	0.50	0.50	0.50	0.50
3.1.B Maintain auxiliary boiler water level and steam pressure	1.00	0.50	0.50	0.50	0.50
3.1.C Monitor the main propulsion boiler	2.00	1.50	1.50	1.50	1.00
3.1.D Monitor a waste-heat auxiliary boiler	1.00	0.75	0.75	0.75	0.50
3.1.D Monitor an oil-fired auxiliary boiler	1.00	0.75	0.75	0.75	0.50
3.1.D1 Change out burners on a main propulsion boiler	0.40	0.40	0.40*	0.40*	0.40
3.1.E Clean a burner atomizer assembly on a main propulsion boiler	2.00	1.50	2.00*	2.00*	1.50
3.1.F Assist in preparing a main propulsion boiler for light-off	20.00	16.00	20.00**	16.00	12.00
3.1.G Assist in manual light-off, raising steam, and cutting-in on line a main propulsion boiler	5.00	4.00	5.00**	4.00	3.00
3.1.H Assist in maintaining fires in a main propulsion boiler while maneuvering	5.00	4.00	5.00**	4.00	3.00
3.1.I Assist in the operation of boiler soot blowers	2.00	1.50	2.00**	1.50	1.50
4.1.A Locate all engine room escape routes	0.75	0.75*	0.75*	0.75*	0.25

4.2.A Locate machinery space firefighting and emergency equipment	0.75	0.75*	0.75*	0.75*	0.25
4.2.B Put a main or emergency fire pump in service	0.51	0.34	0.51**	0.34	0.34

4. RFPEW Raw, Total Single-Method Proficiency Acquisition Times

The raw, total single-method proficiency acquisition times for the RFPEW are given in Table 33. As noted above, when a task could not be trained with a particular method, it was assumed that the raw, single task proficiency acquisition time was equal to that of a mariner who had had no prior training. Thus, although the raw, single task proficiency acquisition times are shorter for tasks which can be trained with a part-task simulator than they are for tasks trained on land in a lab, the raw, total single method proficiency acquisition time for someone trained only with a part-task simulator is longer than the raw, total single method proficiency acquisition time for someone trained with a lab because part task training does not apply to all tasks. Thus, the benefits of part-task training are reduced because fully 19 task must be trained entirely at sea. As just one example of how this trade-off occurs, consider Task 3.1.F (Table 32). If trained in a course with a lab, it requires 16 hours to reach proficiency. However, since it cannot be trained with a part-task simulator, the assumption is that it must be trained entirely at sea, which in this case takes 20 hours.

Table 33. RFPEW Raw, Total Single-Method Proficiency Acquisition Times

Method	No Train	Lab	Part-Task	Full - Mission	Vessel
Hours	82.28	61.08	71.74	62.23	51.15
8-Hour Days	10.29	7.64	8.97	7.78	6.39

5. RFPEW Single-Method SSD and SSE

Table 34. RFPEW Total Single-Method SSD and SSE

Method	No Train	Lab	Part-Task	Full - Mission	Vessel
SSD	180	134	157	136	112
SSE	0	46	23	44	68

C. OICNW

1. OICNW Average Instructor Estimates

Table 35. 1. OICNW Average Instructor Estimates

NVIC 12-14 Deck Operations (OICNW) Task Number & Name	Must be Onboard?	Hours/ Repetition	Task Repetitions: Not Trained/ Approved	Task Repetitions: Training Vessel	Task Repetitions: Lab/ Workshop	Task Repetitions: Part-task Simulator	Task Repetitions: Full-mission Simulator
1.1.A Adjust a sextant	No	2.433	7.889	3.250	3.000	*	*
1.1.B Measure the altitude of the sun	No	1.325	9.333	3.250	*	*	*
1.1.C Measure the altitude of at least 3 stars	No	2.910	11.000	4.500	*	*	*
1.1.D Measure the altitude of the sun at meridian passage (LAN)	No	2.780	9.556	4.250	*	*	*
1.1.E Celestial running fix	No	4.005	9.222	3.500	4.500	*	*
1.1.F Plot star fix	No	5.030	9.222	4.000	3.750	*	*
1.2.A Position fix by two bearings	No	0.780	7.222	2.750	*	3.000	3.667
1.2.B Plot DR position	No	1.015	7.000	2.500	*	3.000	4.222
1.2.C Determine the course to steer	No	1.310	6.889	2.750	3.000	3.286	4.444
1.3.A Correction of charts and publications	No	4.085	7.000	2.500	2.800	*	*
1.3.B Chart selection	No	2.100	6.375	2.500	2.667	*	*
1.3.C Route planning	No	7.250	7.667	3.000	2.667	*	*
1.4.A Position fix by two ranges	No	1.080	7.000	2.500	3.000	3.400	4.143
1.4.B Position fix by tangents to two identified objects	No	1.530	8.111	2.750	3.000	3.600	5.857
1.4.C Position fix by GPS	No	0.785	6.889	2.500	2.667	3.400	3.571
1.4.D Use of GPS position save function	No	0.532	4.556	2.250	1.000	2.400	2.286
1.5.A Use of echo sounder	No	0.600	5.625	2.500	*	2.250	2.333
1.6.A Magnetic variation	No	0.540	5.889	2.500	2.600	*	3.667*
1.6.B Correct for true heading	No	0.545	7.000	2.750	2.800	*	*

1.6.C Compass deviation	No	1.330	7.000	2.750	3.000	*	*
1.6.D Magnetic compass correction	No	1.430	7.111	3.000	3.000	*	*
1.7.A Determine the gyro-compass error by bearing of range	No	1.455	6.333	3.000	*	3.600	3.167
1.7.B Determine magnetic compass error	No	1.455	6.556	3.000	2.800	3.286	3.444
1.7.C Determine magnetic compass deviation	No	1.460	7.111	3.000	*	3.600	3.444
1.7.D Determine course to steer by magnetic compass	No	1.455	7.111	3.000	*	3.286	3.778
1.7.E Position fix by magnetic compass bearings	No	1.415	7.556	2.750	*	3.750	4.000
1.7.F Azimuth of the sun	No	2.660	7.375	3.250	*	*	5.000*
1.8.A Steering gear test	No	2.690	5.750	2.750	*	3.000	2.600
1.8.B Set weather controls	No	0.655	5.125	2.500	*	2.333	2.333
2.1.A Identify light configurations	No	0.772	6.750	2.500	3.333	2.667	3.000
2.1.B Identify day shapes	No	0.772	6.875	2.500	3.200	3.200	3.167
2.1.C Identify sound signals	No	0.772	6.875	2.500	3.200	3.167	3.125
2.1.D Determine risk of collision	No	1.450	7.889	2.750	*	4.000	3.444
2.1.E Maneuver to avoid risk of collision-crossing	No	3.420	9.111	3.250	*	3.833	4.000
2.1.F Maneuver to avoid risk of collision-meeting	No	3.410	9.111	3.000	*	3.833	3.889
2.1.G Maneuver to avoid risk of collision-overtaking	No	3.570	9.111	3.000	*	3.833	3.889
2.2.A Watch relief	No	1.820	9.000	2.500	*	*	3.500*
2.2.B Keep a safe navigation watch	No	56.800	20.000	3.500	*	*	5.000*
2.2.C Notify master when appropriate	No	2.135	6.875	2.500	2.667	*	*
2.2.D Keep a safe anchor watch	No	56.050	6.625	2.750	3.000	*	*
2.2.E Turn over a watch	No	3.795	13.750	2.500	*	*	2.000*
2.3.A Voyage planning-appraisal	No	8.100	10.500	3.250	4.500	*	*
2.3.B Voyage planning-planning	No	8.400	10.500	3.250	4.500	*	*
2.3.C Execute a voyage plan	No	51.100	21.875	4.750	*	4.250	9.800

2.4.A Situational Awareness	No	6.100	19.250	3.500	*	6.000	8.833
2.5.A Navigate in restricted visibility	No	3.240	16.500	2.750	*	6.000	7.833
2.6.A Vessel Traffic System (VTS)	no	3.170	15.875	2.500	*	3.000	5.571
2.7.A Recognition of watch condition	no	3.903	6.875	2.500	2.667	3.750	4.000
2.7.B BRM Condition III Collision Avoidance	no	4.020	13.875	2.750	3.500	3.833	6.000
2.7.C BRM Condition III Navigation	no	15.670	18.875	2.750	*	4.000	6.111
2.7.D BRM Condition II or III Error Trapping	no	8.065	11.375	2.500	*	3.833	4.778
2.7.E BRM Condition II or III Prioritization	no	4.800	13.875	2.500	*	3.833	5.333
2.7.F BRM Condition II Navigation and Collision Avoidance	no	5.450	17.625	2.500	*	4.000	5.556
2.7.G BRM Condition III Establish a Bridge Team	no	4.220	6.125	2.500	*	4.000	3.333
3.2.A Set up and maintain radar display	no	2.635	8.250	2.750	2.000	3.000	3.500
3.2.B Switch display modes	no	1.200	6.500	2.250	2.000	2.833	3.000
3.3.A Identify false echoes, sea return, racon, and SART	no	1.355	7.000	2.500	5.000*	3.833	3.571
3.5.A Set up and maintain ARPA display	no	1.478	8.000	3.250	3.000*	3.750	4.167
5.1.A Passenger safety	no	2.235	7.500	2.750	3.000	*	4.000*
5.2.A Action following collision or grounding	no	61.261	8.571	2.750	3.000	*	3.000*
5.3.A Rescuing persons from the sea, assisting a ship in distress, emergencies in port.	no	7.985	10.000	2.750	3.667	*	3.000*
9.1.A Turning circles and stopping distances	no	7.594	11.429	3.250	4.667	7.000*	4.500*
9.2.A Course change of more than 45°	no	3.856	10.429	3.250	*	4.000	4.400
9.2.B Emergency stop	no	3.961	9.714	2.750	*	4.000	4.000
9.3.A Maneuver for a man overboard	no	9.228	12.286	3.000	*	4.500	5.800
9.5.A Anchoring and mooring	no	16.694	10.000	2.750	4.000	*	5.500*
10.3 Effective communications during loading/unloading		49.050	5.000	2.500	2.667	*	*
12.1.A Pollution prevention precautions	No	7.056	5.143	2.500	2.800	*	*

12.2.A Anti-pollution procedures and associated equipment	No	7.056	5.143	2.500	2.667	*	*
12.3.A Importance of proactive measures	No	7.000	4.571	2.500	2.400	*	*
17.1.A International conventions	No	4.006	6.571	2.750	4.000	*	*
18.1.A Duties and responsibilities of shipboard personnel	No	7.611	5.714	2.500	4.333	*	*
18.2.A Maritime conventions and national legislation	No	4.150	7.000	2.750	4.000	*	*
18.3.A Task and workload management	No	8.056	7.250	2.750	*	4.250	3.800
18.4.A Resource management	No	7.775	6.889	2.750	*	*	4.500*
18.5.A Decision making techniques	No	7.200	7.000	2.750	*	*	*

2. OICNW Raw, Single-Task Proficiency Acquisition Times

Table 36. OICNW Raw, Single-Task Proficiency Acquisition Times

NVIC 12-14 Deck Operations (OICNW) Task Number & Name	Time to Proficiency at Sea: Not Trained/ Approved	Time to Proficiency at Sea: Training Vessel	Time to Proficiency at Sea: Lab/ Workshop	Time to Proficiency at Sea: Part-task Simulator	Time to Proficiency at Sea: Full-mission Simulator
1.1.A Adjust a sextant	19.194	7.907	7.299	19.194*	19.194*
1.1.B Measure the altitude of the sun	12.367	4.306	12.367*	12.367*	12.367*
1.1.C Measure the altitude of at least 3 stars	32.010	13.095	32.010*	32.010*	32.010*
1.1.D Measure the altitude of the sun at meridian passage (LAN)	26.564	11.815	26.564*	26.564*	26.564*
1.1.E Celestial running fix	36.935	14.018	18.023	36.935*	36.935*
1.1.F Plot star fix	46.388	20.120	18.863	46.388*	46.388*
1.2.A Position fix by two bearings	5.633	2.145	5.633*	2.340	2.860
1.2.B Plot DR position	7.105	2.538	7.105*	3.045	4.286
1.2.C Determine the course to steer	9.024	3.603	3.930	4.304	5.822
1.3.A Correction of charts and publications	28.595	10.213	11.438	28.595*	28.595*

1.3.B Chart selection	13.388	5.250	5.600	13.388*	13.388*
1.3.C Route planning	55.583	21.750	19.333	55.583*	55.583*
1.4.A Position fix by two ranges	7.560	2.700	3.240	3.672	4.474
1.4.B Position fix by tangents to two identified objects	12.410	4.208	4.590	5.508	8.961
1.4.C Position fix by GPS	5.408	1.963	2.093	2.669	2.804
1.4.D Use of GPS position save function	2.424	1.197	0.532	1.277	1.216
1.5.A Use of echo sounder	3.375	1.500	3.375*	1.350	1.400
1.6.A Magnetic variation	3.180	1.350	1.404	3.180*	1.980*
1.6.B Correct for true heading	3.815	1.499	1.526	3.815*	3.815*
1.6.C Compass deviation	9.310	3.658	3.990	9.310*	9.310*
1.6.D Magnetic compass correction	10.169	4.290	4.290	10.169*	10.169*
1.7.A Determine the gyro-compass error by bearing of range	9.215	4.365	9.215*	5.238	4.608
1.7.B Determine magnetic compass error	9.538	4.365	4.074	4.781	5.012
1.7.C Determine magnetic compass deviation	10.382	4.380	10.382*	5.256	5.029
1.7.D Determine course to steer by magnetic compass	10.347	4.365	10.347*	4.781	5.497
1.7.E Position fix by magnetic compass bearings	10.691	3.891	10.691*	5.306	5.660
1.7.F Azimuth of the sun	19.618	8.645	19.618*	19.618*	13.300*
1.8.A Steering gear test	15.468	7.398	15.468*	8.070	6.994
1.8.B Set weather controls	3.357	1.638	3.357*	1.528	1.528
2.1.A Identify light configurations	5.213	1.931	2.574	2.059	2.317
2.1.B Identify day shapes	5.309	1.931	2.471	2.471	2.445
2.1.C Identify sound signals	5.309	1.931	2.471	2.445	2.413
2.1.D Determine risk of collision	11.439	3.988	11.439*	5.800	4.994
2.1.E Maneuver to avoid risk of collision-crossing	31.160	11.115	31.160*	13.110	13.680
2.1.F Maneuver to avoid risk of collision-meeting	31.069	10.230	31.069*	13.072	13.261
2.1.G Maneuver to avoid risk of collision-overtaking	32.527	10.710	32.527*	13.685	13.883
2.2.A Watch relief	16.380	4.550	16.380*	16.380*	6.370*
2.2.B Keep a safe navigation watch	1136.000	198.800	1136.000*	1136.000*	284.000*

2.2.C Notify master when appropriate	14.678	5.338	5.693	14.678*	14.678*
2.2.D Keep a safe anchor watch	371.331	154.138	168.150	371.331*	371.331*
2.2.E Turn over a watch	52.181	9.488	52.181*	52.181*	7.590*
2.3.A Voyage planning-appraisal	85.050	26.325	36.450	85.050*	85.050*
2.3.B Voyage planning-planning	88.200	27.300	37.800	88.200*	88.200*
2.3.C Execute a voyage plan	1117.813	242.725	1117.813*	217.175	500.780
2.4.A Situational Awareness	117.425	21.350	117.425*	36.600	53.883
2.5.A Navigate in restricted visibility	53.460	8.910	53.460*	19.440	25.380
2.6.A Vessel Traffic System (VTS)	50.324	7.925	50.324*	9.510	17.661
2.7.A Recognition of watch condition	26.833	9.758	10.408	14.636	15.612
2.7.B BRM Condition III Collision Avoidance	55.778	11.055	14.070	15.410	24.120
2.7.C BRM Condition III Navigation	295.771	43.093	295.771*	62.680	95.761
2.7.D BRM Condition II or III Error Trapping	91.739	20.163	91.739*	30.916	38.533
2.7.E BRM Condition II or III Prioritization	66.600	12.000	66.600*	18.400	25.600
2.7.F BRM Condition II Navigation and Collision Avoidance	96.056	13.625	96.056*	21.800	30.278
2.7.G BRM Condition III Establish a Bridge Team	25.848	10.550	25.848*	16.880	14.067
3.2.A Set up and maintain radar display	21.739	7.246	5.270	7.905	9.223
3.2.B Switch display modes	7.803	2.701	2.401	3.401	3.601
3.3.A Identify false echoes, sea return, racon, and SART	9.485	3.388	6.775*	5.194	4.839
3.5.A Set up and maintain ARPA display	11.822	4.803	4.433*	5.542	6.157
5.1.A Passenger safety	16.763	6.146	6.705	16.763*	8.940*
5.2.A Action following collision or grounding	525.095	168.468	183.783	525.095*	183.783*
5.3.A Rescuing persons from the sea, assisting a ship in distress, emergencies in port.	79.850	21.959	29.278	79.850*	23.955*
9.1.A Turning circles and stopping distances	86.794	24.682	35.441	53.161*	34.175*
9.2.A Course change of more than 45°	40.208	12.531	40.208*	15.422	16.964
9.2.B Emergency stop	38.479	10.893	38.479*	15.844	15.844
9.3.A Maneuver for a man overboard	113.370	27.683	113.370*	41.525	53.521
9.5.A Anchoring and mooring	166.944	45.910	66.778	166.944*	91.819*

10.3 Effective communications during loading/unloading	245.250	122.625	130.800	245.250*	245.250*
12.1.A Pollution prevention precautions	36.286	17.639	19.756	36.286*	36.286*
12.2.A Anti-pollution procedures and associated equipment	36.286	17.639	18.815	36.286*	36.286*
12.3.A Importance of proactive measures	32.000	17.500	16.800	32.000*	32.000*
17.1.A International conventions	26.322	11.015	16.022	26.322*	26.322*
18.1.A Duties and responsibilities of shipboard personnel	43.492	19.028	32.981	43.492*	43.492*
18.2.A Maritime conventions and national legislation	29.050	11.413	16.600	29.050*	29.050*
18.3.A Task and workload management	58.403	22.153	58.403*	34.236	30.611
18.4.A Resource management	53.561	21.381	53.561*	53.561*	34.988*
18.5.A Decision making techniques	50.400	19.800	50.400*	50.400*	50.400*

3. OICNW Single-Method SSD and SSE

Table 37. Raw, total Single-Method SSD and SSE for OICNW – the distributive rule

Method	No Train	Lab	Part-Task	Full - Mission	Vessel
SSD	1024	844	746	561	360
SSE	0	236	334	519	720

D. OICEW

1. OICEW Average Instructor Estimates

Table 38. OICEW Average Instructor Estimates

NVIC 17-14 Engine Operations (OICEW) Task Number & Name	Must be onboard Hours/	Repetitions	Task Repetitions: Not Trained/ Approved	Task Repetitions: Training Vessel	Task Repetitions: Lab/ Workshop	Task Repetitions: Part-task Simulator	Task Repetitions: Full-mission Simulator
1.1.A Inspection of machinery spaces before taking over an engine room watch (all modes of propulsion)	No	0.65	3	2	2	2	2
1.1.B Assume and keep the motor plant engine room watch	No	1.1	3	2	2	2	2
1.1.C Assume and keep the steam plant engine room watch	No	1.6	3	2	2	2	2
1.1.D Assume and keep the gas turbine plant engine room watch	No	1.1	3	2	2	2	2
1.1.E Maintain log-book	No	1.1	2.5	1.5		1.5	1.5
1.1.F Hand over watch	No	0.6	3	2	2	2	2
1.2.A Change-over from remote to local & vice-versa	No	0.35	3	2	2	2	2
1.3.A Identify and respond to alarms (all modes of propulsion)	No	1.15	3.5	2	2	2	2
1.3.B Respond to a fire emergency	No	1.125	3.5	2.5	2.5	2.5	2.5
1.3.C Respond to an accident	No	1.125	3.5	2.5	2.5	2.5	2.5
1.3.D Respond to an oil system fire or accident	No	1.75	3.5	2.5	2.5	2.5	2.5
3.1.A Test internal communications equipment	No	0.6	2.5	1.5	1.5	1.5	1.5
4.1.A Engine room and deck machinery operating principles	No	2.25	3	2	2		
4.1.B Prepare for and light-off a main boiler	No	2.5	3.5	2.5	2.5	2.5	2.5

4.1.C Secure a main boiler	No	2.5	3.5	2.5	2.5	2.5	2.5
4.2.A Respond to scavenge space fires	Yes	1.1	3	2	1		
4.2.A Respond to steering gear failures	No	1.1	3	2	2		
4.2.B Respond to main boiler carryover	No	1.25	3	2	2	2	2
4.2.C Assist in starting a main propulsion diesel engine	No	1.15	3.5	2.5	2.5	2.5	2.5
4.3.A Assist in starting a main propulsion steam turbine	No	2	3.5	2.5	2.5	2.5	2.5
4.3.A Plan for and monitor a main propulsion diesel engine	No	1.75	3.5	2.5	2.5	2.5	2.5
4.3.B Assist in starting a main propulsion gas turbine	No	1.75	3.5	2.5	2.5	2.5	2.5
4.3.C Monitor main diesel engine operation	No	1.15	3	2	2	2	2
4.3.D Monitor a main propulsion steam turbine	No	1.7	3	2	2	2	2
4.3.E Monitor a main propulsion gas turbine	No	1.15	3	2	2	2	2
4.3.F Secure a main propulsion diesel engine	No	1.15	3	2	2	2	2
4.3.G Assist in securing a main propulsion steam turbine	No	1.75	3.5	2.5	2.5	2.5	2.5
4.3.H Assist in securing a main propulsion gas turbine	No	1.15	3	2	2	2	2
4.3.I Monitor a waste heat auxiliary boiler	No	1.15	3	2	2	2	2
4.3.I Monitor an oil-fired auxiliary boiler	No	1.15	3	2	2	2	2
4.3.J Perform main boiler water testing	No	1.65	3	2.5	2.5		
4.3.K Control main boiler water chemistry	No	1.65	3	2.5	2.5		
4.3.L Perform a bottom blow on a main boiler	No	0.4	3	2	2	2	2
4.3.M Change over from the online to standby service air compressor	No	0.4	2.5	2	2	2	2
4.3.N Plan for and start-up a jacket water heated fresh water maker	No	1.25	2.5	2	2	2	2
4.3.O Plan for and shutdown a jacket water heated fresh water maker	No	1.2	2.5	2	2	2	2
4.3.P Plan for and start-up a steam heated flash evaporator	No	1.25	3	2	2	2	2

4.3.Q Plan for and shutdown a steam heated flash evaporator	No	1.15	3	2	2	2	2
4.3.R Plan for and start-up a lube oil or fuel oil purifier	No	0.7	3	2	2	2	2
4.3.S Plan for and shut down a lube oil or fuel oil purifier	No	0.65	3	2	2	2	2
4.3.T Plan for and start up an air conditioning or refrigeration system	No	0.75	3	2	2	2	2
4.3.U Monitor an air conditioning or refrigeration system	No	0.625	3	2	2	2	2
4.3.V Plan for and shut down an air conditioning or refrigeration system	No	0.65	3	2	2	2	2
4.3.W Plan for and shutdown a reverse-osmosis desalination unit	No	0.65	3	2			
4.3.W Plan for and start-up a reverse-osmosis desalination unit	No	0.75	3	2			
5.1.A Operating characteristics of pumping systems	No	1.3	3	2	2	2	2
5.2.A Plan for and conduct an onboard fuel transfer	No	1.25	3	2	2	2	2
5.2.B Plan for and conduct ballasting of double-bottom or wing tanks	No	1.25	3	2	2	2	2
5.2.C Plan for and conduct deballasting of double-bottom or wing tanks	No	1.2	3	2	2	2	2
5.2.D Plan for and pump out engine room bilge wells	No	0.75	2.5	2	2	2	2
5.2.E Plan for and pump out cargo-hold or shaft-alley bilge wells	No	0.75	2.5	2	2	2	2
5.3.A Monitor an oily water separator/oil content monitor system	No	0.65	3	2	2	2	2
6.1.A Operating characteristics of electricity generating and distribution systems	No	1.3	3	2	2	2	2
6.1.B Plan for and conduct a pre-start inspection and start a diesel generator engine	No	0.5	3	2	2	2	2
6.1.C Plan for and conduct a pre-start inspection and start a steam turbogenerator	No	0.8	3	2	2	2	2

6.1.D Plan for connecting on-coming generator and disconnecting off-going generator	No	0.5	3	2	2	2	2
6.1.E Knowledge of motor controls, sequential control systems, and high voltage properties and precautions	No	18	2.5	3	3		
6.2.A Knowledge of basic electronic elements and diagrams	No	18	2.5	3	3		
6.3.A Knowledge of motor controls, sequential control systems, and high voltage properties and precautions	No	18	2.5	3	3		
7.1.A Use a Megger to measure and record the electric strength of insulation	No	1.25	3	2	2		
7.2.A Troubleshoot a malfunctioning motor controller	No	1.25	3	2	2		
7.2.B Repair a malfunctioning motor controller	No	1.25	3	2	2		
7.3.A Check for system grounds at main switchboard	No	1.125	3	2	2		
7.4.A Disassemble and re-assemble an electric motor	No	2.125	3	2	2		
7.5.A Test alarms	No	1.1	3	2	2		
7.5.B Perform a steering gear test	No	0.75	3	2	2		
7.5.C Test a low lube oil pressure shutdown protective device	No	0.65	3	2	2		
8.1.A Fabricate useful items using hand and machine tools	No	18	2.5	2	2		
8.1.B Perform arc welding processes	No	30.2	2.5	2	2		
8.1.C Use oxyacetylene equipment	No	4.2	2.5	2	2		
8.2.A Carry out temporary and emergency repairs	No	4.3	2.5	2	2		
8.2.B Replace a mechanical seal or repack a packing gland on a centrifugal pump	No	2.3	2.5	2	2		
8.2.C Repack a valve	No	1.15	2.5	2	2		
8.2.D Replace a pipe flange gasket	No	0.65	2.5	2	2		

8.3.A Open, clean, inspect, and close a lube oil or fuel oil purifier	No	4.375	2.5	2	2		
9.1.A Overhaul a centrifugal pump	No	2.5	2.5	2	2		
9.1.B Take up on excessively leaking rotary pump shaft gland packing	No	0.65	2.5	2	2		
10.1.A Put into service a sewage waste treatment plant	No	0.75	2.5	2	2		
10.1.A Secure a sewage waste treatment plant	No	0.675	2.5	2	2		
9.1.C Perform valve and diaphragm maintenance on an air-operated diaphragm pump	No	1.25	2.5	2	2		
10.1.B Put into service an oily water separator/oil content monitor system	No	0.8	3	2	2		
10.1.B Secure an oily water separator/oil content monitor system	No	0.7	3	2	2		
11.1.A Determine stability data for a vessel	No	1.25	3	2	2		
11.2.A Maintain watertight integrity on a vessel	Yes	1.25	3	2	1		
11.3.A Take action for a partial loss of intact buoyancy	Yes	1.25	3	2	1		
11.4.A Knowledge of ship construction	No	17.75	2.5	2	2		
15.1.A Knowledge of legislative requirements	No	2.25	2.5	2	2		
16.1.A Duties and responsibilities of shipboard personnel	No	1.75	2.5	2	2		
16.2.A Knowledge of international conventions and national regulations	No	2.25	2.5	2	2		
16.3.A Plan for and assist in taking on bunkers	No	2.375	2.5	2		2	2
16.4.A Supervise a fire or emergency team	No	2.25	2.5	2	2		

2. OICEW Raw, Single-Task Proficiency Acquisition Times

Table 39. OICEW Raw, Single-Task Proficiency Acquisition Times

NVIC 17-14 Engine Operations (OICEW) Task Number & Name	Time to Proficiency at Sea: Not Trained/ Approved	Time to Proficiency at Sea: Training Vessel	Time to Proficiency at Sea: Lab/ Workshop	Time to Proficiency at Sea: Part-task Simulator	Time to Proficiency at Sea: Full-mission Simulator
1.1.A Inspection of machinery spaces before taking over an engine room watch (all modes of propulsion)	1.950	1.300	1.300	1.300	1.300
1.1.B Assume and keep the motor plant engine room watch	3.300	2.200	2.200	2.200	2.200
1.1.C Assume and keep the steam plant engine room watch	4.800	3.200	3.200	3.200	3.200
1.1.D Assume and keep the gas turbine plant engine room watch	3.300	2.200	2.200	2.200	2.200
1.1.E Maintain log-book	2.750	1.650	2.750	1.650	1.650
1.1.F Hand over watch	1.800	1.200	1.200	1.200	1.200
1.2.A Change-over from remote to local & vice-versa	1.050	0.700	0.700	0.700	0.700
1.3.A Identify and respond to alarms (all modes of propulsion)	4.025	2.300	2.300	2.300	2.300
1.3.B Respond to a fire emergency	3.938	2.813	2.813	2.813	2.813
1.3.C Respond to an accident	3.938	2.813	2.813	2.813	2.813
1.3.D Respond to an oil system fire or accident	6.125	4.375	4.375	4.375	4.375
3.1.A Test internal communications equipment	1.500	0.900	0.900	0.900	0.900
4.1.A Engine room and deck machinery operating principles	6.750	4.500	4.500	6.750	6.750
4.1.B Prepare for and light-off a main boiler	8.750	6.250	6.250	6.250	6.250
4.1.C Secure a main boiler	8.750	6.250	6.250	6.250	6.250
4.2.A Respond to scavenge space fires	3.300	3.300	3.300	3.300	3.300
4.2.A Respond to steering gear failures	3.300	2.200	2.200	3.300	3.300
4.2.B Respond to main boiler carryover	3.750	2.500	2.500	2.500	2.500
4.2.C Assist in starting a main propulsion diesel engine	4.025	2.875	2.875	2.875	2.875
4.3.A Assist in starting a main propulsion steam turbine	7.000	5.000	5.000	5.000	5.000
4.3.A Plan for and monitor a main propulsion diesel engine	6.125	4.375	4.375	4.375	4.375
4.3.B Assist in starting a main propulsion gas turbine	6.125	4.375	4.375	4.375	4.375
4.3.C Monitor main diesel engine operation	3.450	2.300	2.300	2.300	2.300
4.3.D Monitor a main propulsion steam turbine	5.100	3.400	3.400	3.400	3.400

4.3.E Monitor a main propulsion gas turbine	3.450	2.300	2.300	2.300	2.300
4.3.F Secure a main propulsion diesel engine	3.450	2.300	2.300	2.300	2.300
4.3.G Assist in securing a main propulsion steam turbine	6.125	4.375	4.375	4.375	4.375
4.3.H Assist in securing a main propulsion gas turbine	3.450	2.300	2.300	2.300	2.300
4.3.I Monitor a waste heat auxiliary boiler	3.450	2.300	2.300	2.300	2.300
4.3.I Monitor an oil-fired auxiliary boiler	3.450	2.300	2.300	2.300	2.300
4.3.J Perform main boiler water testing	4.950	4.125	4.125	4.950	4.950
4.3.K Control main boiler water chemistry	4.950	4.125	4.125	4.950	4.950
4.3.L Perform a bottom blow on a main boiler	1.200	0.800	0.800	0.800	0.800
4.3.M Change over from the online to standby service air compressor	1.000	0.800	0.800	0.800	0.800
4.3.N Plan for and start-up a jacket water heated fresh water maker	3.125	2.500	2.500	2.500	2.500
4.3.O Plan for and shutdown a jacket water heated fresh water maker	3.000	2.400	2.400	2.400	2.400
4.3.P Plan for and start-up a steam heated flash evaporator	3.750	2.500	2.500	2.500	2.500
4.3.Q Plan for and shutdown a steam heated flash evaporator	3.450	2.300	2.300	2.300	2.300
4.3.R Plan for and start-up a lube oil or fuel oil purifier	2.100	1.400	1.400	1.400	1.400
4.3.S Plan for and shut down a lube oil or fuel oil purifier	1.950	1.300	1.300	1.300	1.300
4.3.T Plan for and start up an air conditioning or refrigeration system	2.250	1.500	1.500	1.500	1.500
4.3.U Monitor an air conditioning or refrigeration system	1.875	1.250	1.250	1.250	1.250
4.3.V Plan for and shut down an air conditioning or refrigeration system	1.950	1.300	1.300	1.300	1.300
4.3.W Plan for and shutdown a reverse-osmosis desalination unit	1.950	1.300	1.950	1.950	1.950
4.3.W Plan for and start-up a reverse-osmosis desalination unit	2.250	1.500	2.250	2.250	2.250
5.1.A Operating characteristics of pumping systems	3.900	2.600	2.600	2.600	2.600
5.2.A Plan for and conduct an onboard fuel transfer	3.750	2.500	2.500	2.500	2.500
5.2.B Plan for and conduct ballasting of double-bottom or wing tanks	3.750	2.500	2.500	2.500	2.500
5.2.C Plan for and conduct deballasting of double-bottom or wing tanks	3.600	2.400	2.400	2.400	2.400
5.2.D Plan for and pump out engine room bilge wells	1.875	1.500	1.500	1.500	1.500
5.2.E Plan for and pump out cargo-hold or shaft-alley bilge wells	1.875	1.500	1.500	1.500	1.500
5.3.A Monitor an oily water separator/oil content monitor system	1.950	1.300	1.300	1.300	1.300
6.1.A Operating characteristics of electricity generating and distribution systems	3.900	2.600	2.600	2.600	2.600

6.1.B Plan for and conduct a pre-start inspection and start a diesel generator engine	1.500	1.000	1.000	1.000	1.000
6.1.C Plan for and conduct a pre-start inspection and start a steam turbogenerator	2.400	1.600	1.600	1.600	1.600
6.1.D Plan for connecting on-coming generator and disconnecting off-going generator	1.500	1.000	1.000	1.000	1.000
6.1.E Knowledge of motor controls, sequential control systems, and high voltage properties and precautions	45.000	54.000	54.000	45.000	45.000
6.2.A Knowledge of basic electronic elements and diagrams	45.000	54.000	54.000	45.000	45.000
6.3.A Knowledge of motor controls, sequential control systems, and high voltage properties and precautions	45.000	54.000	54.000	45.000	45.000
7.1.A Use a Megger to measure and record dielectric strength of insulation	3.750	2.500	2.500	3.750	3.750
7.2.A Troubleshoot a malfunctioning motor controller	3.750	2.500	2.500	3.750	3.750
7.2.B Repair a malfunctioning motor controller	3.750	2.500	2.500	3.750	3.750
7.3.A Check for system grounds at main switchboard	3.375	2.250	2.250	3.375	3.375
7.4.A Disassemble and re-assemble an electric motor	6.375	4.250	4.250	6.375	6.375
7.5.A Test alarms	3.300	2.200	2.200	3.300	3.300
7.5.B Perform a steering gear test	2.250	1.500	1.500	2.250	2.250
7.5.C Test a low lube oil pressure shutdown protective device	1.950	1.300	1.300	1.950	1.950
8.1.A Fabricate useful items using hand and machine tools	45.000	36.000	36.000	45.000	45.000
8.1.B Perform arc welding processes	75.500	60.400	60.400	75.500	75.500
8.1.C Use oxyacetylene equipment	10.500	8.400	8.400	10.500	10.500
8.2.A Carry out temporary and emergency repairs	10.750	8.600	8.600	10.750	10.750
8.2.B Replace a mechanical seal or repack a packing gland on a centrifugal pump	5.750	4.600	4.600	5.750	5.750
8.2.C Repack a valve	2.875	2.300	2.300	2.875	2.875
8.2.D Replace a pipe flange gasket	1.625	1.300	1.300	1.625	1.625
8.3.A Open, clean, inspect, and close a lube oil or fuel oil purifier	10.938	8.750	8.750	10.938	10.938
9.1.A Overhaul a centrifugal pump	6.250	5.000	5.000	6.250	6.250
9.1.B Take up on excessively leaking rotary pump shaft gland packing	1.625	1.300	1.300	1.625	1.625
10.1.A Put into service a sewage waste treatment plant	1.875	1.500	1.500	1.875	1.875
10.1.A Secure a sewage waste treatment plant	1.688	1.350	1.350	1.688	1.688

9.1.C Perform valve and diaphragm maintenance on an air-operated diaphragm pump	3.125	2.500	2.500	3.125	3.125
10.1.B Put into service an oily water separator/oil content monitor system	2.400	1.600	1.600	2.400	2.400
10.1.B Secure an oily water separator/oil content monitor system	2.100	1.400	1.400	2.100	2.100
11.1.A Determine stability data for a vessel	3.750	2.500	2.500	3.750	3.750
11.2.A Maintain watertight integrity on a vessel	3.750	3.750	3.750	3.750	3.750
11.3.A Take action for a partial loss of intact buoyancy	3.750	3.750	3.750	3.750	3.750
11.4.A Knowledge of ship construction	44.375	35.500	35.500	44.375	44.375
15.1.A Knowledge of legislative requirements	5.625	4.500	4.500	5.625	5.625
16.1.A Duties and responsibilities of shipboard personnel	4.375	3.500	3.500	4.375	4.375
16.2.A Knowledge of international conventions and national regulations	5.625	4.500	4.500	5.625	5.625
16.3.A Plan for and assist in taking on bunkers	5.938	4.750	5.938	4.750	4.750
16.4.A Supervise a fire or emergency team	5.625	4.500	4.500	5.625	5.625

3. OICEW Raw, Single-Method Task Proficiency Acquisition Times

Table 40. Raw, total Single-Method *SSD* and *SSE* for OICEW – the distributive rule

Method	No Train	Lab	Part-Task	Full - Mission	Vessel
<i>SSD</i>	1080	923	986	986	917
<i>SSE</i>	0	157	94	94	163

E. Master/Chief Mate

1. Master/Chief Mate Average Instructor Estimates

Table 41. Master/Chief Mate Average Instructor Estimates

NVIC 10-14 Deck Management (Master or Chief Mate) Task Number and Name	Must be Onboard Hours/	Repetition	Task Repetitions: Not Trained/ Approved	Task Repetitions: Training Vessel	Task Repetitions: Lab/ Workshop	Task Repetitions: Part-task Simulator	Task Repetitions: Full-mission Simulator
1.1.A Create a voyage plan	No	5.000	8.857	1.000	1.000		
1.2.A Great circle sailing	No	1.042	7.667	2.000	2.500		
1.2.B Mercator sailing (initial course and distance)	No	0.792	7.333	1.000	2.000		
1.2.C Mercator sailing (final position)	No	0.792	7.333	1.000	2.000		
2.1.A Meridian transit (other than the sun)	No	0.600	11.600	2.000	2.500		
2.1.B Star identification	No	0.516	8.600	2.000	2.500		
2.1.C Star selection	No	0.516	8.600	2.000	2.500		
2.2.A GPS routing	No	0.550	7.200	2.000	2.000	2.333	2.333
3.1.A Amplitude of a celestial body	No	0.476	7.800	1.000	1.500	2.000	2.000
3.2.A Write a standing order for compasses	No	0.620	4.200	1.000	1.000		
3.3.A Operation and care of gyrocompasses	No	0.600	5.000	2.000	2.000		
5.2.A Blind pilotage planning	No	0.792	4.800	2.000	2.000		
5.3.A Plan and execute a passage	No	1.917	12.200	2.000		2.000	4.250
7.4.A Calculate height of tide	No	3.217	8.333	2.000	2.000		
7.4.B Calculate the tidal current	No	3.050	8.333	2.000	2.000		
7.4.C Calculate time for desired height of tide	No	3.050	8.333	2.000	2.000		
8.5.A Damage control	No	4.400	7.400	2.000	2.500	2.333	2.333
8.6.A Emergency steering	No	4.190	7.000	2.000		2.500	2.500

8.7.A Emergency towing	No	1.290	5.200	2.000	2.000	2.000	2.000
9.1.A Embark or disembark a pilot	No	4.600	8.500	3.000		2.000	3.250
9.2.A Counter set and drift	No	2.670	7.000	2.000		2.000	2.000
9.3.A Constant radius turn	No	2.640	6.600	2.000		2.000	2.000
9.4.A Maneuver in shallow water	No	1.550	8.200	3.000		3.000	3.000
9.5.A Canal effect	No	4.100	15.800	2.000		3.000	5.000
9.6.A Dock starboard side to	No	1.700	17.600	5.000		6.000	7.000
9.6.B Dock port side to	No	2.700	16.400	5.000		6.000	7.000
9.7.A Turn ship short around	No	2.150	7.800	2.000		4.500	3.667
9.8.A Anchor a ship	No	4.800	16.600	3.000		4.000	5.667
9.9.A Dragging anchor	No	2.600	7.200	1.000		4.000	2.667
9.9.B Clearing a fouled anchor	No	2.220	5.000	1.000	3.000		
9.16.A Ice navigation	No	2.520	4.800	1.000	4.000	6.000	5.000
9.16.B Ice accumulation	No	1.620	4.400	2.000	3.500	4.000	4.000
9.17.A Maneuver in traffic separation schemes	No	1.320	4.400	1.000	3.000	4.000	4.000
10.1.A Diesel engines	No	1.250	4.400	1.000	2.500		
10.1.B Steam turbine systems	No	1.250	4.400	2.000	3.000		
10.1.C Propeller and propeller shaft	No	1.250	4.400	1.000	2.500		
10.1.D Bridge control	No	2.450	5.000	1.000	2.500		
10.2.A Waste heat boilers	No	1.020	4.400	1.000	2.500		
10.2.B Distillation and fresh water systems	No	1.420	4.400	1.000	2.500		
10.2.C Pumps and pumping systems	No	2.450	5.000	1.000	2.500		
10.2.D Steering gear	No	1.450	4.600	1.000	2.500		
10.2.E Remotely operate steering gear	No	1.292	5.500	2.000	2.000		
10.2.F Generators, alternators, and electrical distribution	No	2.850	6.200	2.000	3.000		
10.2.G Air conditioning and ventilation	No	2.620	5.000	1.000	2.500		
10.2.H Sewage treatment plants	No	2.650	5.400	2.000	3.000		
10.2.I Oily water separators and oil filtering equipment	No	1.650	5.400	2.000	3.000		

10.2.J Deck machinery	No	1.650	5.000	1.000	1.500		
10.2.K Hydraulic systems	No	1.250	4.600	1.000	1.500		
10.3.A Engineering terms	No	1.375	3.833	2.000	2.000		
10.3.B Fuel consumption	No	2.208	4.833	2.000	2.000		
11.1.A International regulations for cargo operations	No	2.292	5.143	2.000	2.000		
11.1.B Prepare a loading and discharge plan	No	4.000	8.800	5.000	5.500		
11.4.B Container and stowage and securing	No	1.550	4.600	1.000	2.500		
11.4.C Stowage and securing of heavy lift cargoes	No	2.750	5.000	1.000	2.500		
11.4.D Stowage and securing of cargoes on Ro-Ro ships	No	1.950	5.400	1.000	2.500		
11.5.A Receipt, tallying, and delivery of cargo	No	1.150	4.600	1.000	1.500		
11.5.B Care of cargo during carriage	No	1.550	5.000	1.000	2.000		
11.5.C Safe use of cargo handling gear	No	4.208	7.500	1.000	1.500		
11.5.D Develop a loading plan	No	5.167	10.167	3.000	4.500		
11.5.E Inspect cargo running gear	No	4.375	9.167	1.000	2.000		
11.6.A Basic concepts of tanker operations	No	3.958	7.833	2.000	2.000		
11.6.B ISGOTT contents and application	No	3.625	7.500	1.000	1.500		
11.6.C Oil and chemical tanker operations	No	2.125	5.833	2.000	2.000		
11.6.D Basic concepts of liquefied gas tanker operations	No	2.125	5.833	2.000	2.000		
11.7.A Basic concepts of bulk carriers	No	3.792	6.167	2.000	2.000		
11.8.A Develop a garbage plan	No	4.708	8.000	1.000	1.000		
11.8.B Loading of dangerous packaged goods	No	3.958	7.833	1.000	3.000		
11.9.A Conduct cargo transfer meeting	No	4.708	8.167	1.000	2.000		
12.1.A Basic concepts of bulk carriers	No	2.458	5.000	1.000	1.500		

13.1.A Carriage of dangerous goods	No	2.125	5.333	1.000	3.000		
15.1.A Certificates required by international conventions	No	3.667	8.500	1.000	2.500		
15.1.B Certificates required to be carried onboard	No	3.333	8.500	1.000	2.500		
15.1.C Documents required at arrival and departure	No	4.000	7.833	1.000	1.500		
15.2.A International convention on load lines	No	2.167	7.833	1.000	3.000		
15.3.A International Convention for the Safety of Life at Sea	No	1.904	5.167	1.000	3.000		
15.4.A MARPOL 73/78	No	1.750	6.000	1.000	3.000		
15.4.B MARPOL Annex I	No	1.761	6.143	1.000	3.000		
15.4.C MARPOL Annex II	No	1.750	6.000	1.000	3.000		
15.4.D MARPOL Annex III	No	1.200	4.800	1.000	3.000		
15.4.E MARPOL Annex IV	No	1.464	5.571	1.000	3.000		
15.4.F MARPOL Annex V	No	0.875	4.667	1.000	3.000		
15.4.G MARPOL Annex VI	No	1.464	5.429	1.000	3.000		
15.5.A International health regulations	No	1.600	5.000	1.000	3.000		
15.6.A International instruments affecting the safety of the ship, passengers, crew and cargo (agreements and conventions)	No	1.400	5.000	1.000	3.000		
15.6.B International instruments affecting the safety of the ship, passengers, crew and cargo (instruments)	No	1.600	4.800	1.000	3.000		
15.7.A Pollution prevention	No	2.167	6.833	1.000	2.000		
15.8.A National regulations to implement international conventions	No	2.667	5.833	1.000	3.000		
16.1.A Lifesaving appliance regulations	No	2.333	6.167	1.000	2.500		
16.2.A Plan fire or emergency drill	No	2.250	5.833	2.000	2.500		

16.3.A Develop a maintenance plan for lifesaving and firefighting equipment	No	1.583	4.333	2.000	2.500		
16.4.A Procedures to rescue persons from a ship in distress	No	1.350	4.200	1.000	2.000		
16.4.B Man overboard procedures	No	1.350	8.833	1.000	2.000		
16.5.A Actions following fire, explosion, collision or grounding	No	3.750	4.600	1.000	3.000		
16.5.B Abandon ship procedures	No	2.150	4.200	1.000	2.000		
17.2.A Prepare a damage control plan	No	1.417	5.000	2.000	3.500		

2. Master/Chief Mate Raw, Single-Task Proficiency Acquisition Times

Table 42. Master/Chief Raw, Single-Task Proficiency Acquisition Times

NVIC 10-14 Deck Management Deck Management (Master or Chief Mate) Task Number and Name	Time to Proficiency at Sea: Not Trained/ Approved	Time to Proficiency at Sea: Training Vessel	Time to Proficiency at Sea: Lab/ Workshop	Time to Proficiency at Sea: Part-task Simulator	Time to Proficiency at Sea: Full-mission Simulator
1.1.A Create a voyage plan	44.286	5.000	5.000	44.286	44.286
1.2.A Great circle sailing	7.986	2.083	2.604	7.986	7.986
1.2.B Mercator sailing (initial course and distance)	5.806	0.792	1.583	5.806	5.806
1.2.C Mercator sailing (final position)	5.806	0.792	1.583	5.806	5.806
2.1.A Meridian transit (other than the sun)	6.960	1.200	1.500	6.960	6.960
2.1.B Star identification	4.438	1.032	1.290	4.438	4.438
2.1.C Star selection	4.438	1.032	1.290	4.438	4.438
2.2.A GPS routing	3.960	1.100	1.100	1.283	1.283
3.1.A Amplitude of a celestial body	3.713	0.476	0.714	0.952	0.952
3.2.A Write a standing order for compasses	2.604	0.620	0.620	2.604	2.604
3.3.A Operation and care of gyrocompasses	3.000	1.200	1.200	3.000	3.000

5.2.A Blind pilotage planning	3.800	1.583	1.583	3.800	3.800
5.3.A Plan and execute a passage	23.383	3.833	23.383	3.833	8.146
7.4.A Calculate height of tide	26.806	6.433	6.433	26.806	26.806
7.4.B Calculate the tidal current	25.417	6.100	6.100	25.417	25.417
7.4.C Calculate time for desired height of tide	25.417	6.100	6.100	25.417	25.417
8.5.A Damage control	32.560	8.800	11.000	10.267	10.267
8.6.A Emergency steering	29.330	8.380	29.330	10.475	10.475
8.7.A Emergency towing	6.708	2.580	2.580	2.580	2.580
9.1.A Embark or disembark a pilot	39.100	13.800	39.100	9.200	14.950
9.2.A Counter set and drift	18.690	5.340	18.690	5.340	5.340
9.3.A Constant radius turn	17.424	5.280	17.424	5.280	5.280
9.4.A Maneuver in shallow water	12.710	4.650	12.710	4.650	4.650
9.5.A Canal effect	64.780	8.200	64.780	12.300	20.500
9.6.A Dock starboard side to	29.920	8.500	29.920	10.200	11.900
9.6.B Dock port side to	44.280	13.500	44.280	16.200	18.900
9.7.A Turn ship short around	16.770	4.300	16.770	9.675	7.883
9.8.A Anchor a ship	79.680	14.400	79.680	19.200	27.200
9.9.A Dragging anchor	18.720	2.600	18.720	10.400	6.933
9.9.B Clearing a fouled anchor	11.100	2.220	6.660	11.100	11.100
9.16.A Ice navigation	12.096	2.520	10.080	15.120	12.600
9.16.B Ice accumulation	7.128	3.240	5.670	6.480	6.480
9.17.A Maneuver in traffic separation schemes	5.808	1.320	3.960	5.280	5.280
10.1.A Diesel engines	5.500	1.250	3.125	5.500	5.500
10.1.B Steam turbine systems	5.500	2.500	3.750	5.500	5.500
10.1.C Propeller and propeller shaft	5.500	1.250	3.125	5.500	5.500
10.1.D Bridge control	12.250	2.450	6.125	12.250	12.250
10.2.A Waste heat boilers	4.488	1.020	2.550	4.488	4.488
10.2.B Distillation and fresh water systems	6.248	1.420	3.550	6.248	6.248
10.2.C Pumps and pumping systems	12.250	2.450	6.125	12.250	12.250
10.2.D Steering gear	6.670	1.450	3.625	6.670	6.670
10.2.E Remotely operate steering gear	7.104	2.583	2.583	7.104	7.104
10.2.F Generators, alternators, and electrical distribution	17.670	5.700	8.550	17.670	17.670
10.2.G Air conditioning and ventilation	13.100	2.620	6.550	13.100	13.100
10.2.H Sewage treatment plants	14.310	5.300	7.950	14.310	14.310

10.2.I Oily water separators and oil filtering equipment	8.910	3.300	4.950	8.910	8.910
10.2.J Deck machinery	8.250	1.650	2.475	8.250	8.250
10.2.K Hydraulic systems	5.750	1.250	1.875	5.750	5.750
10.3.A Engineering terms	5.271	2.750	2.750	5.271	5.271
10.3.B Fuel consumption	10.674	4.417	4.417	10.674	10.674
11.1.A International regulations for cargo operations	11.786	4.583	4.583	11.786	11.786
11.1.B Prepare a loading and discharge plan	35.200	20.000	22.000	35.200	35.200
11.4.B Container and stowage and securing	7.130	1.550	3.875	7.130	7.130
11.4.C Stowage and securing of heavy lift cargoes	13.750	2.750	6.875	13.750	13.750
11.4.D Stowage and securing of cargoes on Ro-Ro ships	10.530	1.950	4.875	10.530	10.530
11.5.A Receipt, tallying, and delivery of cargo	5.290	1.150	1.725	5.290	5.290
11.5.B Care of cargo during carriage	7.750	1.550	3.100	7.750	7.750
11.5.C Safe use of cargo handling gear	31.563	4.208	6.313	31.563	31.563
11.5.D Develop a loading plan	52.528	15.500	23.250	52.528	52.528
11.5.E Inspect cargo running gear	40.104	4.375	8.750	40.104	40.104
11.6.A Basic concepts of tanker operations	31.007	7.917	7.917	31.007	31.007
11.6.B ISGOTT contents and application	27.188	3.625	5.438	27.188	27.188
11.6.C Oil and chemical tanker operations	12.396	4.250	4.250	12.396	12.396
11.6.D Basic concepts of liquefied gas tanker operations	12.396	4.250	4.250	12.396	12.396
11.7.A Basic concepts of bulk carriers	23.382	7.583	7.583	23.382	23.382
11.8.A Develop a garbage plan	37.667	4.708	4.708	37.667	37.667
11.8.B Loading of dangerous packaged goods	31.007	3.958	11.875	31.007	31.007
11.9.A Conduct cargo transfer meeting	38.451	4.708	9.417	38.451	38.451
12.1.A Basic concepts of bulk carriers	12.292	2.458	3.688	12.292	12.292
13.1.A Carriage of dangerous goods	11.333	2.125	6.375	11.333	11.333
15.1.A Certificates required by international conventions	31.167	3.667	9.167	31.167	31.167
15.1.B Certificates required to be carried onboard	28.333	3.333	8.333	28.333	28.333
15.1.C Documents required at arrival and departure	31.333	4.000	6.000	31.333	31.333
15.2.A International convention on load lines	16.972	2.167	6.500	16.972	16.972
15.3.A International Convention for the Safety of Life at Sea	9.839	1.904	5.713	9.839	9.839

15.4.A MARPOL 73/78	10.500	1.750	5.250	10.500	10.500
15.4.B MARPOL Annex I	10.820	1.761	5.284	10.820	10.820
15.4.C MARPOL Annex II	10.500	1.750	5.250	10.500	10.500
15.4.D MARPOL Annex III	5.760	1.200	3.600	5.760	5.760
15.4.E MARPOL Annex IV	8.158	1.464	4.393	8.158	8.158
15.4.F MARPOL Annex V	4.083	0.875	2.625	4.083	4.083
15.4.G MARPOL Annex VI	7.949	1.464	4.393	7.949	7.949
15.5.A International health regulations	8.000	1.600	4.800	8.000	8.000
15.6.A International instruments affecting the safety of the ship, passengers, crew and cargo (agreements and conventions)	7.000	1.400	4.200	7.000	7.000
15.6.B International instruments affecting the safety of the ship, passengers, crew and cargo (instruments)	7.680	1.600	4.800	7.680	7.680
15.7.A Pollution prevention	14.806	2.167	4.333	14.806	14.806
15.8.A National regulations to implement international conventions	15.556	2.667	8.000	15.556	15.556
16.1.A Lifesaving appliance regulations	14.389	2.333	5.833	14.389	14.389
16.2.A Plan fire or emergency drill	13.125	4.500	5.625	13.125	13.125
16.3.A Develop a maintenance plan for lifesaving and firefighting equipment	6.861	3.167	3.958	6.861	6.861
16.4.A Procedures to rescue persons from a ship in distress	5.670	1.350	2.700	5.670	5.670
16.4.B Man overboard procedures	11.925	1.350	2.700	11.925	11.925
16.5.A Actions following fire, explosion, collision or grounding	17.250	3.750	11.250	17.250	17.250
16.5.B Abandon ship procedures	9.030	2.150	4.300	9.030	9.030
17.2.A Prepare a damage control plan	7.083	2.833	4.958	7.083	7.083

3. Master/Chief Mate Raw, Single-Method Task Proficiency Acquisition Times

Table 43. Raw, total Single-Method *SSD* and *SSE* for Master/Chief

Method	No Train	Lab	Part-Task	Full - Mission	Vessel
<i>SSD</i>	360	192	289	294	120
<i>SSE</i>	0	168	71	66	240

F. Chief/2nd Engineer

1. Chief/2nd Engineer Average Instructor Estimates

Table 44. Chief/2nd Engineer Average Instructor Estimates

NVIC 15-14 Engine Management Chief & 2nd Engineer Officer Task Number & Name USES CONSENSUS DATA FROM TWO INSTRUCTORS	Must be Onboard	Hours per Repetition	Reps to Proficiency at Sea: Not Trained/ Approved	Reps to Proficiency at Sea: Training Vessel	Reps to Proficiency at Sea: Lab/ Workshop	Reps to Proficiency at Sea: Part-task Simulator	Reps to Proficiency at Sea: Full-mission Simulator
1.1.A Direct the main diesel propulsion plant be made ready for seagoing operations	Yes	3.500	2.500	2.000	*	4.000*	2.000*
1.1.B Direct main diesel propulsion plant operations during vessel maneuvering	No	3.000	2.000	1.000	*	3.000	1.500
1.1.C Direct main diesel propulsion plant operations at full sea speed	No	2.500	1.500	1.000	*	3.000	1.500
1.1.D Direct the main diesel propulsion plant be shutdown and secured	No	3.000	2.500	2.000	*	3.000	1.500
1.2.A Direct the main steam propulsion plant be made ready for seagoing operations	Yes	7.000	3.000	2.000	*	4.000*	2.000*
1.2.B Direct main steam propulsion plant operations during vessel maneuvering	No	3.500	2.000	1.000	*	3.000	1.500
1.2.C Direct main steam propulsion plant operations at full sea speed	No	3.000	1.500	2.000	*	3.000	1.500
1.2.D Direct the main steam propulsion plant be shutdown and secured	Yes	4.500	2.500	2.000	*	4.000*	2.000*
1.3.A Direct the main gas turbine propulsion plant be made ready for seagoing operations	Yes	3.500	3.000	2.000	*	4.000*	2.000*
1.3.B Direct main gas turbine propulsion plant operations during vessel maneuvering	No	3.000	2.000	1.000	*	3.000	1.500
1.3.C Direct main gas turbine propulsion plant operations at full sea speed	No	2.500	1.500	1.000	*	3.000	1.500

1.3.D Direct the main gas turbine propulsion plant be shutdown and secured	No	3.000	2.000	1.000	*	3.000	1.500
2.1.A Plan for and schedule vessel operations	Yes	3.000	2.000	1.000	*	*	*
3.1.A Manage main diesel propulsion plant performance and efficiency	No	2.500	2.000	1.000	*	3.000	1.500
3.2.A Manage main steam plant propulsion plant performance and efficiency	No	3.500	2.000	1.000	*	3.000	1.500
3.3.A Manage main gas turbine propulsion plant performance and efficiency	No	2.500	2.000	1.000	*	3.000	1.500
3.4.A Measure and calculate auxiliary plant load and heat distribution	No	2.000	2.000	1.000	*	2.000	1.000
3.5.A Manage auxiliary and ancillary systems performance and efficiency	No	3.000	2.000	1.000	1.000	*	*
4.1.A Direct fuel, lubricating oil, ballast water, and bilge water transfers	Yes	5.000	2.500	2.000	*	4.000*	2.000*
7.1.A Manage motor plant maintenance and repairs	No	6.000	2.000	1.000	2.000	3.000	1.500
7.1.B Manage steam plant maintenance and repairs	No	8.000	2.500	2.000	3.000	3.000	1.500
7.1.C Manage gas turbine plant maintenance and repairs	No	6.000	2.000	1.000	2.000	3.000	1.500
7.1.D Manage engine room maintenance and repair	No	6.000	2.500	2.000	1.000	*	*
8.1.A Detect and locate faults and malfunctions of propulsion and auxiliary machinery	Yes	3.000	2.000	1.000	*	4.000*	2.000*
9.1.A Direct safe working practices	No	4.000	2.500	2.000	2.000	3.000	1.500
10.1.A Direct engine room operations within safe vessel stability and stress criteria	Yes	2.500	2.000	1.000	*	4.000*	2.000*
11.1.A Manage compliance with international codes and conventions and national regulations	No	2.000	2.000	1.000	1.000	*	*
12.1.A Manage the safety and security of the vessel, crew, and passengers	No	2.000	2.000	2.000	2.000	*	*
13.1.A Develop a damage control plan	Yes	3.500	2.000	2.000	*	*	*

2. Chief/2nd Engineer Raw, Single-Task Proficiency Acquisition Times

Table 45. Chief/2nd Engineer Raw, Single-Task Proficiency Acquisition Times

NVIC 15-14 Engine Management Chief & 2nd Engineer Officer Task Number & Name USES CONSENSUS DATA FROM TWO INSTRUCTORS	Time to Proficiency: Not Trained/ Approved	Time to Proficiency: Training Vessel	Time to Proficiency: Lab/ Workshop	Time to Proficiency: Part-task Simulator	Time to Proficiency: Full-mission Simulator
1.1.A Direct the main diesel propulsion plant be made ready for seagoing operations	8.750	8.750	8.750	8.750	8.750
1.1.B Direct main diesel propulsion plant operations during vessel maneuvering	6.000	3.000	6.000	9.000	4.500
1.1.C Direct main diesel propulsion plant operations at full sea speed	3.750	2.500	3.750	7.500	3.750
1.1.D Direct the main diesel propulsion plant be shutdown and secured	7.500	6.000	7.500	9.000	4.500
1.2.A Direct the main steam propulsion plant be made ready for seagoing operations	21.000	21.000	21.000	21.000	21.000
1.2.B Direct main steam propulsion plant operations during vessel maneuvering	7.000	3.500	7.000	10.500	5.250
1.2.C Direct main steam propulsion plant operations at full sea speed	4.500	6.000	4.500	9.000	4.500
1.2.D Direct the main steam propulsion plant be shutdown and secured	11.250	11.250	11.250	11.250	11.250
1.3.A Direct the main gas turbine propulsion plant be made ready for seagoing operations	10.500	10.500	10.500	10.500	10.500
1.3.B Direct main gas turbine propulsion plant operations during vessel maneuvering	6.000	3.000	6.000	9.000	4.500
1.3.C Direct main gas turbine propulsion plant operations at full sea speed	3.750	2.500	3.750	7.500	3.750
1.3.D Direct the main gas turbine propulsion plant be shutdown and secured	6.000	3.000	6.000	9.000	4.500
2.1.A Plan for and schedule vessel operations	6.000	6.000	6.000	6.000	6.000
3.1.A Manage main diesel propulsion plant performance and efficiency	5.000	2.500	5.000	7.500	3.750

3.2.A Manage main steam plant propulsion plant performance and efficiency	7.000	3.500	7.000	10.500	5.250
3.3.A Manage main gas turbine propulsion plant performance and efficiency	5.000	2.500	5.000	7.500	3.750
3.4.A Measure and calculate auxiliary plant load and heat distribution	4.000	2.000	4.000	4.000	2.000
3.5.A Manage auxiliary and ancillary systems performance and efficiency	6.000	3.000	3.000	6.000	#VALUE!
4.1.A Direct fuel, lubricating oil, ballast water, and bilge water transfers	12.500	12.500	12.500	12.500	12.500
7.1.A Manage motor plant maintenance and repairs	12.000	6.000	12.000	18.000	9.000
7.1.B Manage steam plant maintenance and repairs	20.000	16.000	24.000	24.000	12.000
7.1.C Manage gas turbine plant maintenance and repairs	12.000	6.000	12.000	18.000	9.000
7.1.D Manage engine room maintenance and repair	15.000	12.000	6.000	15.000	15.000
8.1.A Detect and locate faults and malfunctions of propulsion and auxiliary machinery	6.000	6.000	6.000	6.000	6.000
9.1.A Direct safe working practices	10.000	8.000	8.000	12.000	6.000
10.1.A Direct engine room operations within safe vessel stability and stress criteria	5.000	5.000	5.000	5.000	5.000
11.1.A Manage compliance with international codes and conventions and national regulations	4.000	2.000	2.000	4.000	4.000
12.1.A Manage the safety and security of the vessel, crew, and passengers	4.000	4.000	4.000	4.000	4.000
13.1.A Develop a damage control plan	7.000	7.000	7.000	7.000	7.000

3. Chief/2nd Engineer Raw, Single-Method Task Proficiency Acquisition Times

Table 46. Raw, total Single-Method SSD and SSE for Chief/2nd Engineer – the distributive rule

Method	No Train	Lab	Part-Task	Full - Mission	Vessel
SSD	360	192	360	294	120
SSE	0	8	0	52	78

G. Simulator Comparisons: Data Collection Worksheet Fields

Table 47. Course information collected

Category	Data Field	Response Options
Basic information	Course name	N/A (free response)
	Location	On-site, online/distance, or blended
	Start date	N/A (free response)
	Delivery time frame	Short course, semester-based, or other
Simulator	Manufacturer	N/A (free response)
	Model number	N/A (free response)
	Class/type	Full-mission, multi-task, limited/part-task/desktop, distance-based/online, special task, AR/VR, manned model, or other
	Delivery method	On-site, all-distance (asynchronous)*, or simultaneous on-site and distance-based (synchronous)]
Instructor/assessor	Instructor name	N/A (free response)
	Assessor name	N/A (free response)
Written exam	Number of questions	1-100
	Passing score (%)	50%-100% ³⁰
Practical exam	Number of approved NVIC tasks	1-100
	Assessment criteria (% or pass/fail)	Percentage or pass/fail
Enrollment data	Number of students who begin course	1-24
	Number of students who pass course	1-24
	Number of students required to retake a portion of the course	1-24

³⁰ While a training provider could set a passing score between 50% and 100% for a given course, all of the courses in the dataset had a passing score of 70% for the written exam.

Category	Data Field	Response Options
	Number of students required to retake entire course	1-24

Table 48. Trainee data collected

Category	Data Field	Response Options
Basic information	Student ID number	N/A (free response)
	Age	N/A (free response)
	Gender	N/A (free response)
	Company	N/A (free response)
Experience	Highest education	N/A (free response)
	Years of sailing experience	N/A (free response)
	Highest endorsement	N/A (free response)
	Vessel type experience (e.g., tanker)	N/A (free response)
	Last discharge date	N/A (free response)
	1 st time taking course? (Y/N)	N/A (free response)
	Previous simulator experience (Y/N)	N/A (free response)
Written exam scores	1 st attempt	N/A (free response)
	2 nd attempt	N/A (free response)
	3 rd attempt	N/A (free response)
Practical exam scores	1 st attempt	N/A (free response)
	2 nd attempt	N/A (free response)
	3 rd attempt	N/A (free response)

H. Simulator Comparisons: Course Training and Competency Requirements

1. Radar Observer (Unlimited)

a) Common Task

NVIC 06-14 Support Deck (RFPNW)
Task Number & Name
1.1.A Steady on a new course
1.1.B Steer a course by gyrocompass
1.1.C Steer a course by magnetic compass
1.2.A Comply with "right (starboard) rudder" command
1.2.B Comply with "left (port) rudder" command
1.2.C Comply with "rudder hard over" command
1.2.D Comply with "ease the rudder" command
1.2.E Comply with "midships the wheel" command
1.2.F Comply with "shift your rudder" command
1.2.G Comply with "meet her" or "check her" command
1.2.H Comply with "steady as she goes" command
1.2.I Comply with "nothing to the right/left" command
1.3.A Change steering mode from auto pilot to hand steering
1.3.B Change steering mode from hand steering to auto pilot
2.1.A Report bearings in daylight
2.1.B Report bearings at night
2.1.C Report bearings by sound
3.1.A Shipboard terms and definitions
3.2.A Use of communications and alarm systems
3.3.A Communicate potential collision situations in daylight
3.3.B Communicate potential collision situations at night
3.4.A Relief of the lookout
3.4.B Relief of the helmsman
3.5.A Relief of the anchor watch
3.5.B Relief of the in-port watch
3.6.A Environmental protection at sea
3.6.B Environmental protection in port

b) Course Specific Tasks

Provider	#NVIC Tasks ³¹	Requirements Met (USCG approval for course)	Tasks Taught in a Course that are not Part of the Set of Common Tasks
Harry Lundeberg School of Seamanship	9	Any applicant who has successfully completed your Radar Observer (Unlimited) (SHLSOS-399) course, including successful demonstration of all practical assessments, will satisfy the requirements of 46 CFR 11.480(d) for an endorsement as Radar Observer (Unlimited) and the radar training requirements of Section A-II/1 and Table A-II/1 of the STCW Code, as amended 2010 for certification as Officer in Charge of a Navigational Watch on vessels of 500 or more gross tonnage (ITC). The practical assessments conducted in this course will be accepted as the equivalent of the following assessments from the National Assessment Guidelines for Table A-II/1 of the STCW Code NVIC 12-14 (Ch-1) Tasks: 3.1, 3.2.A, 3.2.B, 3.3.A, 1.2.C, and 3.4. Applicants who have successfully completed your course need not present completed Control Sheets for these assessments in application for STCW certification.	
Maritime Institute	8 or 9	Any applicant who has successfully completed your Radar Observer (Unlimited) (MARINS-399) course will satisfy: • The radar observer training requirements of 46 CFR 11.480(d) for an endorsement as Radar Observer (Unlimited); AND • The radar observer training requirements of 46 CFR 11.309(a)(4)(ii), 11.317(a)(3)(vi), 11.319(a)(4)(ii), and 11.321(a)(3)(vi); AND • The radar observer standards of competence required by 46 CFR 11.309(a)(3) and 11.319(a)(3); STCW Code Section A-II/1 and Table A-II/1, as amended 2010, meeting the National Assessment Guidelines from NVICs 12-14(Ch-6) and 02-18(Ch-4) Tasks 1.4.A, 1.4.B, 3.1, 3.2A, 3.2.B, 3.3.A, and 3.4; AND	

³¹ According to instructors who provided course data for this study

Provider	#NVIC Tasks ³¹	Requirements Met (USCG approval for course)	Tasks Taught in a Course that are not Part of the Set of Common Tasks
		The radar observer standards of competence required by 46 CFR 11.317(a)(2) and 11.321(a)(2); STCW Code Section A-II/3 and Table A-II/3, as amended 2010, meeting the National Assessment Guidelines from NVIC 13-14(Ch-4) Tasks 1.8.A and 1.8.B. Applicants who have successfully completed your course need not present completed Task Control Sheets for these assessments in application for STCW certification.	
Chesapeake Maritime Training Institute (CMTI)	9	Any applicant who has successfully completed your Radar Observer (Unlimited) (CMTIVA-399) course will satisfy: - The radar observer training requirements of 46 CFR 11.480(d) for an endorsement as Radar Observer (Unlimited); AND - The radar observer training requirements of 46 CFR 11.309(a)(4)(ii), 11.317(a)(3)(vi), 11.319(a)(4)(ii), and 11.321(a)(3)(vi); AND - The radar observer standards of competence required by 46 CFR 11.309(a)(3) and 11.319(a)(3); STCW Code Section A-II/1 and Table A-II/1, as amended 2010, meeting the - National Assessment Guidelines from NVICs 12-14(Ch-7) and 02-18(Ch-5) Tasks 1.4.A, 1.4.B, 3.1, 3.2A, 3.2.B, 3.3.A, and 3.4; AND - The radar observer standards of competence required by 46 CFR 11.317(a)(2) and 11.321(a)(2); STCW Code Section A-II/3 and Table A-II/3, as amended 2010, meeting the - National Assessment Guidelines from NVIC 13-14(Ch-5) Tasks 1.8.A and 1.8.B.	

Provider	#NVIC Tasks ³¹	Requirements Met (USCG approval for course)	Tasks Taught in a Course that are not Part of the Set of Common Tasks
		Applicants who have successfully completed your course need not present completed Task Control Sheets for these assessments in application for STCW certification.	