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Littoral Combat Ship (LCS) Project: Consideration of an ASVAB Requirement for JOOD Screening

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14. ABSTRACT

The Littoral Combat Ship (LCS) is a small war-fighting mission specific platform configured for a reduced manning crew. The LCS has one of three war-fighting missions (Anti-submarine, Surface, and Mine detection and countermeasures). Because there are a limited number of LCS core enlisted crew members, each member must take on more than their legacy rating's duties. The Junior Officer of the Deck (JOOD), for example, takes on the duties of both the Boatswain's Mate (BM) and Quartermaster (QM). Both the BM and QM ratings are designated to fill the JOOD billet; however, the BM rating has a much lower aptitude/ability standard than QM as currently measured by the Armed Services Vocational Aptitude Battery (ASVAB). Even though the LCS training is intended to prepare the JOOD for all duties, the most critical JOOD duty, Bridge watch standing, appears to be complicated enough to require a floor level ASVAB standard. The ASVAB model recommended for the JOOD billet is the same as adopted for the non-technical Submarine ratings and will serve to ensure that (1) training will be adequately learned in a reasonable time frame and (2) the execution of the Bridge Team (JOOD and OOD) duties will be well balanced.

15. SUBJECT TERMS

LCS, Junior Officer of the Deck, JOOD, ASVAB standard

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Foreword

The Littoral Combat Ship (LCS) is a new Navy platform that employs a unique manning concept. With only a small group of highly trained individuals to operate the platform, the Sailors chosen to operate an LCS must be technically proficient, team-oriented, and ready learners. This report describes an effort to identify a selection/classification algorithm appropriate for determining which Sailors are suitable for specific duties aboard LCS.

This effort was supported by the Office of Naval Research, and made possible through the cooperation of the staff at the LCS Shore-Based Training Facility (SBTF) in San Diego, CA. The point of contact for this effort is Ms. Janet Held, Navy Personnel Research, Studies, and Technology, (901) 874-4650.

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Executive Summary

This report considers an Armed Services Vocational Aptitude Battery (ASVAB) LCS standard that would be modeled after the ASVAB standards developed for the Submarine community. Sailors classified to the non-technical ratings of the Submarine Community (Culinary Specialist, Storekeeper, and Yeoman) and Seaman must meet the Submarine ASVAB "floor" standard in order to pass their initial basic training that deals with the technical and systems aspects of their submarines.

With the limited number of crew members, like LCS, all submariners must be knowledgeable and prepared to deal with at least the basic submarine technical issues that could arise while at sea. This report focuses on the Junior Officer of the Deck (JOOD) billet aboard LCS and the specific duty of Bridge operator (the enlisted complement to the officer as a 2-member team). The Bridge Team is responsible for a host of technically complex and coordinated tasks that drive the ship. The training at the individual and team level is non-trivial. The JOOD billet is currently filled by Sailors from five source ratings: Boatswain's Mate (BM), Quartermaster (QM), Gas Turbine Systems Technician (Mechanical) (GSM), Gas Turbine Systems Technician (Electrical) (GSE), and Damage Controlman (DC). These ratings have different ASVAB standards that may impact a Sailor's preparedness to absorb and operationalize the Bridge Team portion of the JOOD billet training. Of these ratings, the BM has the lowest ASVAB standards of all Navy ratings and substantially larger annual goals than most of the other JOOD ratings.

The following considerations were made in recommending the Submarine non-technical ratings' ASVAB standards for the LCS JOOD: (1) A comparison of the ASVAB score distributions across the JOOD Legacy ratings that showed the BM's Armed Forces Qualification Test (AFQT) scores (percentile scores formed from the ASVAB Verbal, Arithmetic Reasoning, and Mathematics Knowledge tests) to be much lower than found for the other LCS source ratings despite the current positive recruiting market; (2) The large annual throughput for the BM rating relative to the other JOOD Legacy ratings; (3) The difficulty of the individual and team training that takes place at the San Diego Shore Based Training Facility (SBTF). The ASVAB standards for the LCS JOOD are expected to improve training time and outcomes and also Bridge Team performance.

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Introduction

The Office of Naval Research (ONR) supported an applied research effort (6.3 R&D funds) to improve the understanding of how to man and train personnel assigned to a Littoral Combat Ship (LCS). There were three threads of research for this project. The first thread was an investigation of the efficiency and effectiveness of training pipelines associated with each of the LCS billets post initial training for their legacy billets (Navy ratings). The second thread involved assessing teamwork requirements for the LCS crews and identifying methods for improving the acquisition rate of teamwork skills. The third thread of the project was the conceptualization and development of a battery of tests that could be used for LCS crew selection, which would include methods for setting LCS aptitude/ability standards.

This report fits within the third thread of the research, and specifically considers whether a floor aptitude/ability standard should exist for LCS billet assignments using the Armed Services Vocational Aptitude Battery (ASVAB), the military's primary selection and job classification instrument. Such a floor aptitude/ability standard would help ensure that the LCS crew members would not have extreme difficulty learning and executing the technical aspects of their individual roles. An LCS ASVAB standard could immediately become operational while other LCS specific selection instruments are in the development and validation phases. This report considers an ASVAB LCS standard that would be modeled after the ASVAB standards developed for the Submarine community. The non-technical Submarine Community's ratings (Culinary Specialist; Storekeeper; and Yeoman) and Seaman must meet the Submarine ASVAB "floor" standard in order to pass their submarine based training that deals with the technical and systems aspects of their submarines. With the limited number of crew members, like LCS, all must be knowledgeable and prepared to deal with at least the basic submarine technical issues that could arise while at sea.

This report focuses on the Junior Officer of the Deck (JOOD) billet aboard LCS and the specific duty of Bridge operator (the enlisted complement to the officer as a 2-member team). The Bridge Team is responsible for a host of technically complex and coordinated tasks that drive the ship and the training at both the individual and team level is non-trivial. The JOOD billet is currently filled by Sailors from any of five ratings: Boatswain's Mate (BM); Quartermaster (QM); Gas Turbine Systems Technician (Mechanical) (GSM); Gas Turbine Systems Technician (Electrical) (GSE); and Damage Controlman (DC). These ratings have different ASVAB standards that may impact a Sailor's preparedness to absorb and operationalize the Bridge Team portion of the JOOD billet training.

As background, at the start of the NPRST LCS project, there were two LCS ships afloat, each built by different purveyors but configured and geared to carry out, interchangeably, three specific missions: Mine Warfare (MIW), Surface Warfare (SUW), and Anti-Submarine Warfare (ASW). The LCS is a minimally manned platform (as are submarines) staffed with a small core crew and additional mission module (MM) crews that "plug in" to carry out only one of the three missions. Each mission module is staffed with enlisted personnel (E4-E6) from preselected ratings.

Because the experiences, aptitudes/abilities, skill sets, and training differ among the core LCS crew and the Mission Module (MM) teams, intensive training is scheduled to bring every LCS team member to proficiency. Because not all Navy Sailors are equal in absorbing every aspect of Navy training at the same rate, there may be differences in proficiencies among the LCS crew members. Given individuals' differences the question becomes how LCS Sailors should be selected to ensure LCS job proficiency. Recently, the ASVAB standards were reviewed and changed for the Mineman (MN) rating in anticipation of many of the rating's personnel migrating from the Mine Counter Measures (MCM) ships to the LCS and with more technically challenging training and job tasks both in their legacy jobs and on the LCS (Held, 2012), a project that could extend to the LCS.

The MN rating is considered by some to be the original "Hybrid" Sailor because it has been the subject of a large scale consolidation of other Navy ratings' job functions [Boatswain's Mate (BM); Quarter Master (QM); Gunner's Mate (GM), and Sonar Technician, Surface (STG)].[1] Likewise the LCS Sailor is considered a hybrid Sailor with LCS "Composite" duties that were formed from various ratings to address requirements imposed by the reduced manning concept. In fact, the term "Hybrid" Sailor, which refers to not only multiple job duties but an extensive cross-rating training requirement, was often used to describe the LCS Sailor in the early days of the program.[2]

Combining duties from several ratings into one rating has the potential to exponentially increase the complexity of that rating, especially when multi-tasking (or serial planning and execution) is required in autonomous or team environments. Many of the complex technical functions on the LCS have been automated into integrated electronic systems. Automation seemingly reduces the aptitude/ability requirements for an LCS rating; however, the question becomes how much aptitude/ability (quick study attributes) must a Sailor possess in order to instantaneously and effectively engage in an impending emergency. It is difficult to assess the trade-offs that arise from increased automation (conceptually allowing for lower aptitude requirements) with respect to individual and team performance on the LCS. Therefore, for the purposes of this report, automation's role will be underplayed in assessing aptitude/ability requirements for the LCS JOOD billet that may be reflected in the ASVAB.

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[1] MN enlisted members comprise 40-60 percent of the MCM ship billets. The MN community views themselves as the original "Hybrid" Sailor in that they must perform so many of the traditionally manned larger ships' rating duties. Of course not every MN is required to perform all of the MN MCM crew duties, rather the duties are parsed out in the billet assignments. For example, A MN in charge of weapons would not also be manning sonar systems. Still, many MN perform a broad spectrum of duties and all MN must pass the technically complex A-School course that covers all of the MCM technical job areas (for instance, sonar and electronics systems troubleshooting).

[2] As further background, early work conducted by the Naval Postgraduate School addressed which Navy ratings should be considered for the LCS billets (initially estimated for a Core crew of about 40 to 75) (Douangaphaivong, 2004). Also, a report by CNA Analysis & Solutions examined the potential for cross training the three MM teams so that individuals or crews would be interchangeable. The interchangeability of MM personnel was thought potentially to save personnel dollars; however the authors cited obvious tradeoffs (Sayala, Miller, & Stoloff, 2011). We refer the reader to these two reports and their cited references for a full background of the LCS development and issues involved in manning the LCS.

This report is organized into the following sections: (1) LCS Bridge Team, Composition, Roles and Responsibilities, and Training; (2) Measurement of Bridge Training Performance; (3) The ASVAB and use for the Submarine Community; (4) The ASVAB's Validity in Predicting Training Performance; (5) Relative Stringency of ASVAB Standards for the LCS JOOD Legacy Ratings; (6) A potential Reversal of Navy ASVAB Score Level; (7) Recommendation; and (8) References. The report concludes with five appendices pertinent to the ASVAB validation/standards process.

LCS Bridge Team

Composition

The LCS Bridge Team is comprised of the Officer of the Deck (OOD) and the Junior Officer of the Deck (JOOD). The LCS JOOD is filled with Sailors from several sources ratings, as noted earlier, but with some variation between the two LCS platforms (BM, QM for LCS1, USS FREEDOM; QM, GSE, GSM, and DC for LCS2, USS INDEPENDENCE). Only E6, E7 and E8s are designated as JOOD.

The OOD, the lead of the Bridge Team, can come from any Navy community (0-2 and 0-3). The OOD is trained at the Surface Warfare Officer's Schools (SWOS) and then at sites that support the LCS OOD training.

Roles and Responsibilities

The OOD aboard LCS performs the traditional OOD role on larger ships (i.e., ensuring the safety and proper navigation of the ship) but has only the support of the JOOD. In contrast, as many as 18 watchstanders are assigned bridge duty on larger ships with intentional built-in redundancies in personnel capabilities. The advanced computerized technology (navigation, charts, etc.) of the LCS Integrated Bridge Systems (IBS) enables only two watchstanders to perform the requisite duties, but it is currently not known to what extent the team can fully address a bombardment of Bridge operational issues if the JOOD is not fully proficient (that is, there are not built-in backup personnel on the Bridge to help handle a crisis).

Because the focus of this report is the role of the JOOD for LCS1 (the subject platform for this report), it is useful to examine the JOOD responsibilities more specifically. The JOOD has four areas of responsibility: (1) navigation; (2) operation of the Voyage Management System (VMS); (3) lookout duties; and (4) Boatswain's Mate of the Watch (BMOW) duties. Conceptually, the combined duties of the BM and QM ratings make up the responsibilities of the LCS JOOD. That is, navigation and VMS operations would logically fall under the QM rating's traditional duties, while lookout and BMOW duties would belong to the BM rating. As explained earlier, some of the legacy ratings' duties are performed by computerized systems (e.g., VMS automatically performs some of the QM-related calculations needed for safe navigation of the ship). Nevertheless, it is useful to know the scope of the legacy ratings' major job duties because automated systems can fail or produce some error thereby requiring the JOOD to act and recover from a situation.

Table 1 provides a list of the JOOD duties as documented on the Recruiters' BM and QM rating cards that are available to Navy applicants during the classification sessions that take place at the Military Entrance Procession Stations (MEPS).

Table 1
Major BM and QM Job Duties Listed on the Recruiters' Rating Information Cards

Legacy BM Rating Major Job Duties
Stand watch as helmsman, lookouts, and Boatswain Mate of the Watch
Stand security watches while in port and underway
Serve as Search and Rescue Swimmer
Serve as member of damage control, emergency and security alert teams
Serve as flight deck crew during helicopter operations
Teach seamanship to other enlisted
Conduct underway replenishments (transfer supplies from ship to ship)
Conduct amphibious and flight deck operations
Operate sound-powered telephone systems
Operate small boats
Supervise deck crew in cleaning, painting and maintaining ships/equipment
Direct boat crews in landing and rescue operations
Take Command of tugs, barges, and other small craft
Repair, maintain and stow equipment in preparation for underway operations
Legacy QM Rating Major Job Duties
Stand watch as assistants to Officers of the Deck and navigator
As helmsman, perform ship control, navigation, and bridge watch duties
Render "honors and ceremonies" in accordance with national observance and foreign customs
Send and receive visual messages
Manage tugs, self-propelled barges and other yard and district craft
Maintain navigational instruments and keep correct navigational time
Procure, correct, use, and stow navigational and oceanographic publications and maps

The major job duties in Table 1 have little overlap between the BM and QM ratings and therefore result in a broad range of duties in the aggregate. The BM rating has the largest number of job duties, but they are the least technically complex. It is unknown, however, whether the BM job requires more multi-tasking than the other ratings, which in and of itself, may not require an ASVAB floor standard. Moreover, it is unknown if total relinquishment of the technical aspects of some portion of the legacy rating duties to automated technology totally relieves the LCS JOOD of knowing the technical underpinnings in cases of emergency.

Training

Legacy rating A- and C-School courses taken before LCS assignments are evaluated by the LCS Detailers to establish LCS preparatory training gaps. Additional needed training is scheduled at various training sites. San Diego offers LCS Capstone training and C-Schools (also offered at other sites). The San Diego Shore Based Training Facility (SBTF) houses a high fidelity mock-up of the Bridge and Mission Control Center (MCC) stations for both LCS platforms (LCS1 and LCS2). The simulator training is preceded by classroom training and then scenario preparation.

Bridge knowledge-based training is conducted in the classroom at the SBTF with multimedia supplementation of lessons learned from real ship disaster events. The classroom training takes place in a different part of the facility away from the secured simulators. The SBTF staff instructors are highly qualified with experience in Navy surface warfare and deep knowledge of the surface ship systems. Most of the LCS Bridge Team simulation exercises are graded using a clinical approach, with instructors taking extensive notes during the course of the training session, giving guidance, and upon completion of the simulation scenarios, providing full team debriefs.

Measurement of Bridge Training Performance

The SBTF instructors are highly attuned to the Navy's requirements to obtain "Metrics, Measures, and Standards" for LCS training performance. The classroom and simulator environments are non-threatening and purposely developed to encourage learning (as opposed to "teaching to the test"). Therefore, the development of measures, metrics, and standards should respect this educational philosophy and be unobtrusively captured, with the exception of providing diagnostics and feedback.

Some potential "Metrics" for measuring the impact of LCS Bridge Team simulation based training on performance might be the following:

- A "Cost" metric to capture the impact of ship mishaps occurring from LCS Bridge Team errors. The cost could be calculated during a simulation scenario (as a developed adjunct capability) capturing estimated injuries, ship damage, external damages, etc. and would serve a feedback mechanism parallel to the classroom dissection of historical at sea mishaps.
- An "Individual Performance" metric. Currently, the simulator performance assessment is at the "team" level, not the individual level, although a full clinical assessment of team performance with attribution to individuals is sent to the Commanding Officer.
- A "Training Resource Allocation" metric could be developed to tie number of training sessions required to achieve acceptable levels of performance and how that converts to instructional hours required of the training staff.

Some potential "Measures" of LCS Bridge Team performance at the JOOD level for feedback purposes and to serve as performance criteria for the purpose of developing LCS selection standards might be the following:

- Test scores earned in classroom training
- Improvement in test scores from remediation
- Time to complete the training pipeline
- Number of errors made in the simulator
- Severity of errors made in the simulator

Some potential "Standards" for LCS training performance might be the following:

- An acceptable percentage of knowledge/procedure questions answered on tests that are administered at least twice at appropriate time intervals to establish test/retest reliabilities (stability of the measure) and retention of material over time (instantiation of knowledge into long term memory).
- An acceptable performance level for "Time to Qualify" (T2Q) requirements developed by Subject Matter Experts (SMEs).

The ASVAB and use for the Submarine Community

The Armed Services Vocational Aptitude Battery (ASVAB), described in Appendix A, is the primary joint-service cognitive (mental ability in contrast to moral and physical) selection and classification instrument. The ASVAB measures verbal, math, science, mechanical, electronics, automotive/shop, and spatial ability constructs. The ASVAB is not yet complete in covering all of the relevant military performance construct domains and will soon include a working memory test that may be highly relevant for predicting proficient multitasking and therefore classifying Sailors to the Navy's Air Traffic Control (AC) rating among others, but also for certain LCS billets (other LCS specific aptitude/ability tests may follow in future classification test development efforts).

The Navy's ASVAB classification composites, described in Appendix B, are used to qualify recruits at the time of enlistment to a Navy rating. (Appendix C describes the process linkage in establishing/revising ASVAB standards.) As discussed earlier, the Submarine Community requires their non-technical ratings to qualify on a Submarine ASVAB standard in addition to the ratings' specific ASVAB standards. The Submarine first hurdle ASVAB standard was developed from validating ASVAB scores in predicting training grades and outcomes in the Basic Enlisted Submarine School (BESS). The BESS is about 30 days and provides a learning platform to assess candidates' adaptability, reliability, and performance. As with LCS, every member of the submarine crew is a critical team member and must know how to perform more than their rating specific duties.

The Submarine ASVAB validation/standards study (Held & Johns, 2001) provided alternative standards for BESS that are the composites VE+AR+MK+MC and AR+MK+EI+GS, each composite used as alternatives with a 200 cutscore. (VE is

Verbal; MK is Mathematic Knowledge; EI is Electronics Information; GS is General Science; AR is Arithmetic Reasoning; MC is Mechanical Comprehension - see Appendix A for the ASVAB test descriptions and Appendix B for the Navy's composites).

The ASVAB's Validity in Predicting Training Performance

The validity of the ASVAB in predicting training success (final school grade that is tied to academically related pass/fail status) varies across Navy ratings. If the training is academically or technically difficult, the ASVAB validity coefficient (correlation) is larger than if the training is not-academically/technically related. The larger the ASVAB validity coefficient, the more accurately a cutscore will be in reducing the acceptance of poor performers into a rating, all other things being equal. The two ASVAB Submarine classification composites are also used for the Nuclear Field (NF) rating as alternatives and the validity coefficients for each are very high (about .80 - .85), meaning a substantially accurate prediction of the final school grade can be made from knowledge of an individual's ASVAB scores (Held, Alderton, & Britton, 2010). In this highly accurate prediction setting lowering the operational ASVAB cutscore, even five score points would have noticeable negative impact on the NF schools' graduation rates, all other things equal.[3]

In contrast to the NF ratings, the two optimally determined Navy SEAL ASVAB classification composites' validity coefficients are very small (about .20 - .25) meaning a very inaccurate prediction of the SEAL training performance measure is made from knowledge of an individual's ASVAB scores (Held, 2011). In this highly inaccurate prediction setting lowering the operational ASVAB cutscore, even a large number of score points would not have an extreme negative impact on the SEAL school's graduation rates, all other things equal. However, the SEAL training performance measure is almost totally non-academically based but rather physically and mentally challenging based [Basic Underwater Demolition/SEALs (BUD/S) training]. Most of the students who drop cannot or will not persist in the arduous training setting. Complicating the standards setting for SEALs is that there are small academic portions of the training (mainly diving gear/pressure calibration) but more importantly, intelligence and quick strategic decision making required to perform the SEAL job (as with LCS, in individual and team multitasking environments).

Although the ASVAB validity coefficients for predicting SEAL performance in BUD/S is a small .25 and for NF and other technically challenging ratings, a large .85, the average ASVAB validity for predicting training grades across Navy ratings is about .55. For predicting Air Traffic Control training performance, the ASVAB validity coefficient is considered a relatively large .70 (Held, 2006) with the AC A-School final grade measuring highly academic curriculum content (including the FAA certification test). The AC A-School, however, also maintains simulation based equipment - a mock-up of an Air Traffic Control Tower. The AC rating's simulation based training is similar in concept (hands on job sample) to the LCS simulator trainer. Because there are many

[3] It was estimated in the NF ASVAB standards study that it costs the Navy at least $100,000 to fully train a Nuclear Field candidate. Costs also accrue to the Sailor who fails training in terms of personal and career setbacks.

similarities to the complexity of the AC A-School and LCS Bridge training, including a mix of academic and simulation based training, the AC's ASVAB validity estimate of .70 might generalize to the LCS JOOD. An empirically based estimate of an ASVAB composite's validity coefficient for LCS billets' training cannot be made because (1) training performance scores to this point are largely not available ("Metrics" and "Measures" are not as yet fully developed) and (2) the sample size for the JOOD billet in particular is too small to produce statistically robust results.

Figure 1 is a visual aid that shows, at a fundamental level, how to interpret the validity coefficient's impact on training performance when that performance is measured by pass/fail outcomes tied to final school grade.

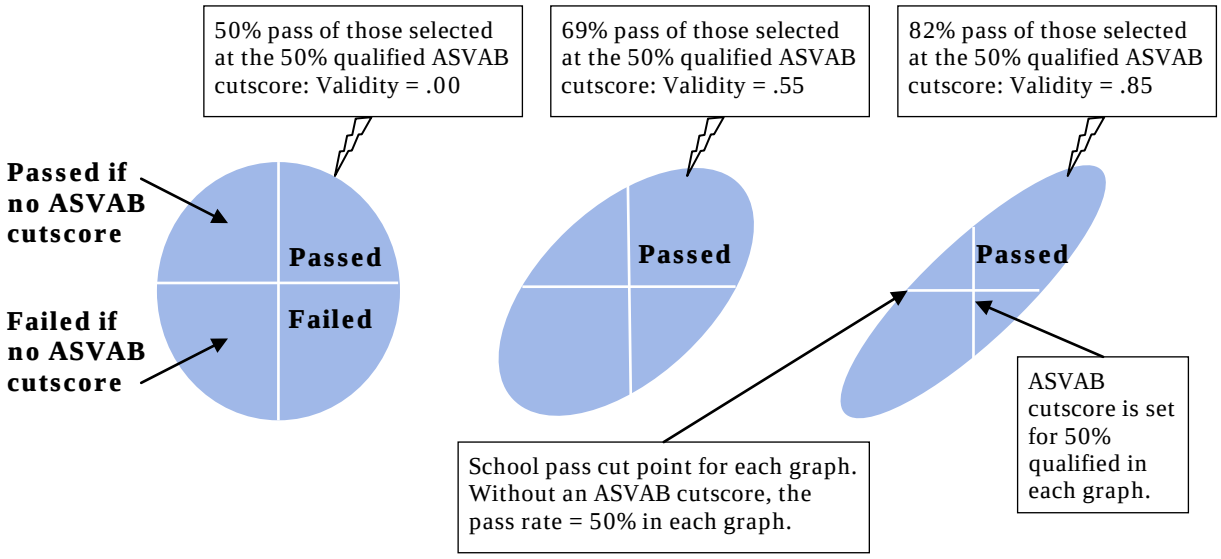

Figure 1. School pass rate improvement as a function of the ASVAB validity coefficient.

The three graphs in Figure 1 reflect correlations (predictive validities – ASVAB predicting final school grade) of magnitudes .00, .55, and .85. These validity levels would mainly be a function of the mapping of ASVAB constructs to the underlying curriculum constructs (no linkage vs. moderate and very complete linkages), but would also be a function of the adequacy of the final school grade measure.

Figure 1 requires the reader as a first step to ignore the vertical ASVAB cutscore line in each of the three graphs to see that with all applicants accepted, or a random sample of applicants to meet a Navy rating's annual recruiting goal, the upper and lower halves of each graph represent a 50/50 split of pass and fail students. This 50/50 split occurs regardless of the validity of the selection instrument waiting in the wings to be utilized. The three bivariate shapes reflect a range of validity coefficient magnitudes. That is, the graph shapes range from a circle to a narrow ellipse depending upon the strength of the correlation between the applicants' ASVAB scores and training grades. Appendix E provides a discussion on the process for estimating the ASVAB's validity coefficient for

the applicant population, the group for which, theoretically, future similar recruits will be classified to Navy ratings.

The situation for the far left graph in Figure 1 reflects either randomly selected recruits (no ASVAB selection instrument applied) or an ASVAB validity of zero (that does not occur for Navy ratings). In either case, there is no relationship between ASVAB scores and training performance scores so that no matter how far to the right the ASVAB cutscore is set there will be no improvement in the initial 50 percent pass rate. For the middle graph where the ASVAB validity coefficient is .55, the same 50 percent qualified cutscore improves the pass rate from 50 percent (for zero validity or random assignment) to 69 percent.

For the graph on the right in Figure 1 where the ASVAB validity coefficient is a large .85, the pass rate from establishing a 50 percent qualified ASVAB cutscore improves the pass rate even further to 82 percent. Obviously, the ASVAB cutscore could be raised to further realize even greater improvements in the pass rate, but at the cost of excluding applicants, some of whom who would have passed (inaccurate rejection decision), but also some of whom would have failed (accurate rejection decision). The analytical exercise for setting a rating's ASVAB standard is to consider the academic complexity of the rating's training, the pass rate, the validity coefficient, training resources, and the aptitudes/abilities of the recruit population each year available to fill the Navy's rating goals across all ratings with the expectation that most recruits will pass their training.

At this point in time, ASVAB standards are set only for the LCS legacy ratings and it is assumed that first term enlistment training and beyond with sea tour experience provides the technical knowledge and abilities for the JOOD to succeed in Bridge Team training and on the job. As such, the SBTF accepts the Bridge Team as composed and trains in evolutions geared to steadily improve team performance. Thus, unlike the graphs in Figure 1, all JOODs "pass" the training and insufficient performance is addressed through homework and future evolutions of the training and practice. It is not clear at this point if LCS assignees are weeded out on performance-based measures prior to SBTF training during initial LCS training. This LCS initial training could include specific C-Schools.

Relative Stringency of ASVAB Standards for the LCS JOOD Legacy Ratings

The Department of Defense (DoD) has benchmarks for military qualifications that may be impacted if the military experiences a downturn in the recruiting environment. The DoD benchmarks involve the Armed Forces Qualification Test (AFQT), which is the ASVAB test combination of 2VE+AR+MK (see Appendix A for test descriptions) and high school diploma graduate (HSDG). The benchmarks "categories" (see Appendix D) are tied to enlistment incentives but also to recruiting costs. The greatest costs historically have been associated with the A-Cell category of AFQT greater than or equal to 50 and HSDG.[4] It is useful to examine these AFQT benchmark categories for the LCS JOOD billet filled by the LCS legacy ratings (BM, QM, GSM, GSE, and DC). The focus is

[4] The DoD benchmarks obviously do not include moral and physical factors, which are managed by each Service.

on AFQT category because the Navy currently accesses about 97 percent HSDG youth in the recent positive recruiting environment but that may become a smaller in the future.

Table 2 lists the percentage of FY09/10 Navy accessions broken out by the DoD AFQT benchmark categories across the five LCS legacy ratings that serve as the JOOD across the two LCS platforms, but also for the Nuclear Field (NF) rating for comparison.

Table 2
Percentage of FY09/10 BM, QM, GSM, GSE, DC Rating Accessions within DoD AFQT Categories Compared to Nuclear Field (NF)

AFQT Categories	BM (%)	QM (%)	GSM (%)	GSE (%)	DC (%)	NF (%)
I: 93-99	0	1	0	3	2	50
II: 65-92	3	11	17	38	32	50
IIIa: 50-64	14	38	41	43	49	0
IIIb: 35-49	***81***	***50***	***42***	***16***	***17***	***0***
IIIb: 31-34	2	0	0	0	0	0
Total %	100	100	100	100	100	100
Sample Size	N = 959	N = 253	N = 583	N = 377	N = 546	N = 3,712

Note. The Navy does not enlist applicants with lower than a 35 AFQT, however there are exceptions to policy (which occurred for the BM rating) that depend on a multitude of other evaluation factors.

Table 2 shows a large difference in the percentage of BM accessions in the second to lowest AFQT 35-49 category (81%) compared to the percentages for the other ratings (50% for QM; 42% for GSM; 16% for GSE; 17% for DC, and 0% for NF).[5] (Navy policy is not to recruit to the AFQT 31-34 category, but we include this category because there were 2 exceptions for BM.) Except for the 2-case anomaly for BM in the AFQT 31-34 category, all other accessions across ratings were in higher AFQT categories. The NF rating, due to extremely high ASVAB classification composite cutscores, had accessions only in the top two AFQT categories (equally spread in AFQT 65 – 92 and AFQT 93 – 99). The large 81 percent of the BMs in the lowest AFQT category approved by Navy occurs because there are only a few ratings with very low ASVAB standards and so Navy recruits who marginally qualify on AFQT tend to get classified to these ratings.

Table 2 also shows that, of the five LCS JOOD legacy ratings, BM had the largest annual throughput (959 for the combined FY09/10 timeframe). The larger BM recruiting goal and the lower ASVAB standard compared to the other LCS JOOD legacy ratings could result in a disproportionate Navy dependency on the BM rating for filling

[5] We stress that the AFQT was not the classification instrument for the ratings, but because the AFQT is correlated with the ASVAB classification composites (to varying degrees depending upon the tests in the composite) the AFQT score distributions are incidentally reflective of the ASVAB standards' stringency.

LCS JOOD billets in the future. Further, if there is a recruiting downturn, more recruits will likely assess with ASVAB scores closer to the ratings' ASVAB cutscores, including the BM rating where ASVAB scores are already considered skewed.

In summary, because the BM rating's ASVAB standard is one of the lowest of all Navy ratings and with a large annual goal relative to the other LCS JOOD legacy ratings, a recruiting downturn might negatively impact the LCS JOOD billet Bridge Team capabilities due to (1) lower ASVAB scores for the recruit population, (2) the LCS ramp up in ships requiring more JOODs, (3) the uncertainty of hiring more LCS trainers of the current high caliber to address training needs and tailored training, and (4) budget constraints that may impact LCS training resources.

A Potential Reversal of Navy ASVAB Score Levels

Understanding the applicable recruiting environment and the propensity for high aptitude/ability youth to join the Navy are key factors in being able to fill the Navy's recruiting goals in any given fiscal year. If the recruiting environment is favorable, all ratings benefit from a larger proportion of Sailors with high aptitude/ability. Conversely, if the recruiting environment is poor, more youth will be recruited at the margin of each rating's ASVAB composite cutscore with shrinkage in the proportion of high ASVAB scorers for all. Aptitudes and abilities obviously relate to training performance, and by extension to job performance, depending on the measure (motivation and conscientious behavior are not predicted by the ASVAB).The Navy's upward trend of ASVAB scores as a result of the recent positive recruiting environment is depicted in Figure 2.

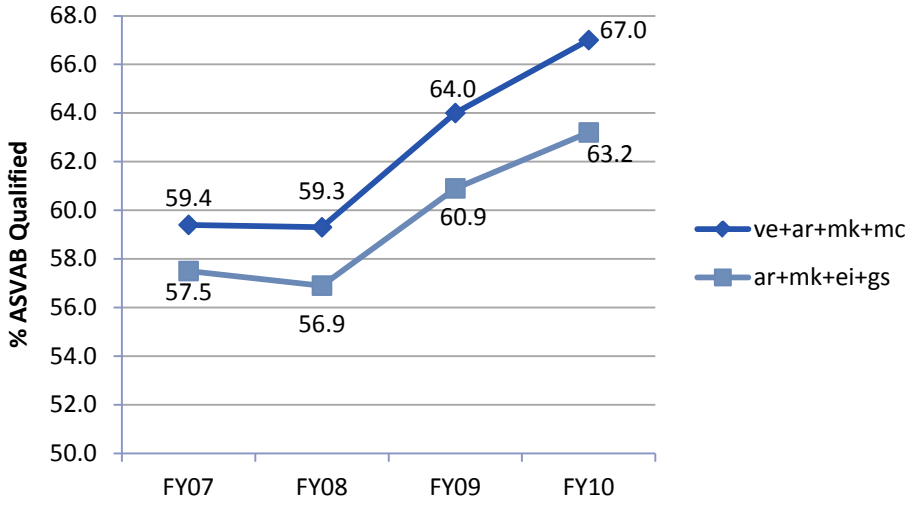

Figure 2. Navy accession ASVAB qualification rates at a 210 cutscore over fiscal years.

Figure 2 shows a substantial increase for the last two years that applied to the study (FY09 and FY10) and the ASVAB qualification rates for two ASVAB composites used for many Navy ratings (VE+AR+MK+MC and AR+MK+EI+GS – see Appendices A and B).

Figure 2 was developed with a 210 cutscore applied to each composite (used for the GSE rating, and recently approved for the MN rating). The increase in qualified recruits for FY09, and even larger for FY10, may be attributed to number of factors that make up a positive recruiting environment including (1) the persistently poor private sector job market and high unemployment rate, (2) the increasing costs of college for those predisposed to attend but who cannot afford to, (3) the recent military enhancement of the GI Bill (college tuition paid on completion of military service), and (4) the increased opportunities for education certification while in the military.

It is not clear how long the Navy will be able to recruit exceedingly high aptitude/ability youth, so there should be an LCS plan for an eventual recruiting downturn. It is also not clear what should be the actual ASVAB floor standard for the LCS JOOD, nor would it ever be known due to the small sample size issue that precludes statistically sound analyses. The LCS community could adopt the same ASVAB floor standard used by the Submarine community for only the JOOD billet or for all billets so as not to explicitly target the BM rating (stigmatizing BMs).

The Submarine community ASVAB alternative standards for the non-technical ratings and Seaman non-designated Sailors are restated again as VE+AR+MK+MC = 200 "or" AR+MK+EI+GS = 200 (qualified if either cutscore is met). As single standards, VE+AR+MK+MC ≥ 200 qualified 83.5 percent of the combined FY09/10 Navy accession data used in this study to develop Table 2 (N = 75,778) whereas AR+MK+EI+GS ≥ 200 qualified a lower 78.5 percent. Used as alternatives, the ASVAB standards qualified a larger 87.1 percent (than either standard alone). In contrast, the ASVAB single standard for the BM rating, VE+AR+MK+AS = 175, qualified 100 percent of accessions. Essentially all incoming Navy recruits qualify for the LCS JOOD billet during this stellar Navy recruiting environment.

The LCS community should consider if there is a mismatch in the aptitude/ability level (at least for the BM ASVAB standard) and the technical requirements of the JOOD as part of the LCS Bridge Team. If it is decided that there is a risk of an unbalanced Bridge Team in the event of a recruiting downturn, the Submarine ASVAB standards could be implemented. It may be, however, that the risk of an unbalanced Bridge Team may only be apparent after a negative event has occurred. The LCS training staff in San Diego has and is preemptively addressing any potential for a negative event by providing an excellent multifaceted training program that reinforces at every point "rules of the road". Other training enhancements are also being explored including a tool developed by NPRST called the Pillars of Operational Excellence Test (POET) (Vargheese, Brou, Walker, & Dickason in preparation). Any enhancements to the LCS training (including instructor staffing priorities) and screening (aptitude/ability) for LCS manning plans would be prudent steps to take to lessen training burdens in the event of a sudden recruiting downturn as there will be high demand/competition for high aptitude/ability recruits across all highly technical Navy ratings.

Recommendations

The following recommendations regarding the possibility to apply an ASVAB standard for the LCS JOOD billet are addressed to CNO-13, the LCS Community and Detailers, and also to N132G who maintains and promulgates ASVAB standards policy.

1) Instate the ASVAB standards (VE+AR+MK+MC = 200 and AR+MK+EI+GS = 200) used as "alternatives" for the LCS JOOD billet as is used for all Submarine non-technical ratings and Seaman and to be managed by the LCS Detailers in the LCS crew selection process.
2) Consider the above standards for LCS billets depending upon the source rating's ASVAB standard, the technical nature of the rating, and job related experience and performance assessments.
3) Work with the instructors at the SBTF to develop tangible training performance measures to assess aptitude/ability standards for the JOOD and other critical billets.

NPRST is continuing to develop aspects of the LCS project that will be important integrators of a multi-dimensional evaluation system that includes training efficiencies, training performance evaluation tools, and assessments of predictors of LCS individual and team performance levels that could improve the LCS Fleet performance and readiness levels. Other documents in this LCS series describe these efforts.

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Appendix A
Description of the ASVAB Tests

Table A lists the ASVAB tests and the Navy special classification test, Coding Speed, along with brief test descriptions.

Table A
Description of the ASVAB and Coding Speed Tests

Test Name and Abbreviation	Test Description
General Science (GS)	Knowledge of physical and biological sciences
Arithmetic Reasoning (AR)	Ability to solve arithmetic word problems
Word Knowledge (WK)[a]	Ability to select the correct meaning of words presented in context and correct synonyms
Paragraph Comprehension (PC)[a]	Ability to obtain information from written passages
Mathematics Knowledge (MK)	Knowledge of high school mathematics principles
Electronics Information (EI)	Knowledge of electricity and electronics
Auto and Shop Information (AS)	Knowledge of automobile, tool, shop terminology and practices
Mechanical Comprehension (MC)	Knowledge of mechanical and physical principles
Assembling Objects (AO)[b]	Ability to determine correct spatial forms from their separate parts and connection points
Coding Speed (CS)[b]	Ability to quickly identify correct word/number pairings from a key with many options

[a]WK and PC are combined to form the Verbal (VE) composite that is a component of the AFQT and several Navy ASVAB classification composites. [b]Not all recruits enter the Navy with AO and CS test scores. CS is only given at the MEPS at the end of the CAT-ASVAB. AO is given to all applicants except high school students taking the paper and pencil version of the ASVAB under the Career Exploration Program (CEP).

In Table A, WK and PC are combined to form the Verbal (VE) composite, with WK weighted approximately 2/3 and PC 1/3. VE is used in many Navy classification composites and also in the Armed Forces Qualification Test (AFQT) that qualifies military applicants for service. AFQT is scored by the percentile metric (from 1 to 99). The ASVAB individual tests are scored on a standard score scale that was derived to have a mean of 50 and standard deviation of 10 developed for the ASVAB normative youth population, Profile of American Youth, 1997, or PAY97 (Segall, 2004).

Coding Speed (CS) is a Navy special test administered immediately after the ASVAB in a computerized format. CS measures perceptual speed and accuracy but is thought also to measure some degree of intrinsic motivation (Segal, 2012). The Navy maintains CS as a Navy special classification test used in two ASVAB composite.

Appendix B
Description of the Navy's ASVAB Classification Composites

Appendix A provides a description of the ASVAB tests whereas Appendix B provides the Navy's list of ASVAB classification composites, including two composites that contain the Navy's special classification test, Coding Speed.

Table B
ASVAB and ASVAB/CS Classification Composites

Composite Tests	Composite Names
General Technical	VE+AR
Administration	VE+MK
Hospitalman	VE+MK+GS
Electronics	**AR+MK+EI+GS**
Basic Electricity & Electronics	AR+2MK+GS
Nuclear Field	**VE+AR+MK+MC**
Engineering	VE+AR+MK+AS
Special Operations	GS+MC+EI
Mechanical	AR+MC+AS
Mechanical_2	MK+AS+AO
Operations	VE+AR+MK+AO
Business/Clerical	VE+MK+CS
Air Traffic Control	VE+MK+MC+CS

Two of the classification composites in Table B, recommended for the LCS JOOD billet, are in bold to highlight their use for many Navy technical ratings including the Nuclear Field Community Machinist's Mate(MM), Electrician's Mate (EM), and Electronics Technician (ET), the Surface Community EM, ET and Gas Turbine Systems Technician (Electrical) (GSE) ratings, and the Submarine Community ratings (Missile Technician (MT), Fire Control Technician (FT), and Sonar Technician Submarine (STS). Different cutscores are applied to these ASVAB composites according to (1) their validity in predicting training outcomes for a particular rating, (2) the overall academically related fail rates in the schoolhouse, (3) the potential for additional cost effective training in the form of specific modules to sufficiently augment the learning process, and (4) the Navy's overall ability to fill all Navy ratings under the system of operational ASVAB standards.

Appendix C
Process for Establishing ASVAB Standards

Not all individuals are equally able to digest complex and difficult Navy training, even after many trials. The Navy understands that concept and supports an operational ASVAB Validation/Standards program for the purpose of setting ASVAB standards that manage academically related training failures. The development of ASVAB standards for Navy ratings is not conducted in a vacuum, as the process indicates in Figure C.

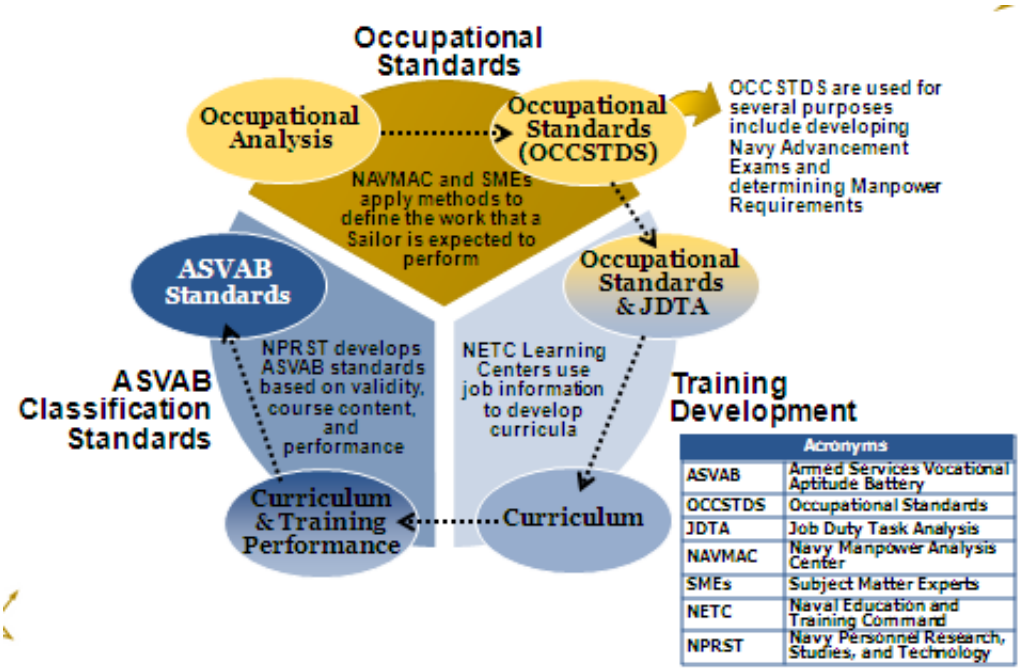

Figure C. The interlinking processes between job, training, and ASVAB requirements.

Figure C shows the interlinking Commands and process of developing rating job requirements, training requirements to address the job requirements, and the ASVAB standards that are developed so that most recruits can meet the training requirements, and by extension, the job requirements (cognitively related). Navy Manpower Analysis Center (NAVMAC) with subject matter experts (SMEs) develops the occupational standards (OCCSTDS) that define the work Sailors are expected to perform in their ratings.

The OCCSTDS are not used solely to develop manpower requirements, but also to inform Naval Education and Training Command (NETC) in their development of the Navy Advancement Exams and the Navy ratings' training curricula. NETC, however, has the main input to curriculum development through Job Duty Task Analysis (JDTA) teams that meet periodically to drill down to the more specific levels of training requirements than are provided by the OCCSTDS development process. The finalized curriculum for each rating is deployed to the schoolhouse via the various Learning Centers responsible for the training of their community ratings.

Finally, the NPRST ASVAB validation/standards team develops a rating's ASVAB standard through processes that include (1) schoolhouse visits and meetings with instructors and the Training Director to understand aptitude/ability issues noted in their students, (2) observations of the mode of curriculum delivery (e.g., computer-based self-paced training, instructor led group-paced, or blended solutions), (3) observed classroom instruction and the simulation-based or hands on laboratories, (4) collection of the training grades, both at the module level and final school grades, the curriculum, and the testing plan, and (5) data analyses and the development of a report that is then submitted to the cognizant officials for review (N132G, Navy Selection and Classification Office, the Enlisted Community Manager, and the Training Director). The finalized report is chopped at NPRST and sent to N132G for disposition. N132G upon approval promulgates the policy for an ASVAB standards change and issues a change directive letter to all commands that maintain ASVAB standards (e.g., the Navy Recruiting Command to update the Recruiting Manual).

Figure C applies to any "new" Navy rating as well as current ratings that are subjected to a cycle of ASVAB standards reviews. For new platforms like LCS, NAVMAC does not conduct an OCCSTDS for the ship's ratings until the job duties are fully realized (duties and responsibilities work out). Therefore, a lag in OCCSTDS development occurs that may be especially long for new platforms with reduced manning because it takes time to determine the exact rating configuration of duties and responsibilities. The OCCSTDS process for merged ratings is less onerous and includes a working document as part of the Navy Enlisted Manpower and Personnel Classifications and Occupational Standards (NEOCS) package, which provides for a more decisive analysis of rating commonalities and proposed work.

Flags for an ASVAB review could be any of a constellation of factors that leads to unacceptable training performance such as a major change in the curriculum, shortened training time, or unavailability of recruits with adequate ASVAB scores so that there is a spike in academic failure rates. In the case of lower ASVAB scores in the recruit population and difficulty filling rating goals, a recommendation may be for ASVAB waiver tolerance levels rather than lowering the ASVAB standard, which may trigger a need to allocate more resources for training, including increased training time.

Appendix D
DoD Recruit Quality Matrix for AFQT and Education

Figure D shows six cells partitioned by AFQT and High School Diploma Graduate (HSDG) status.

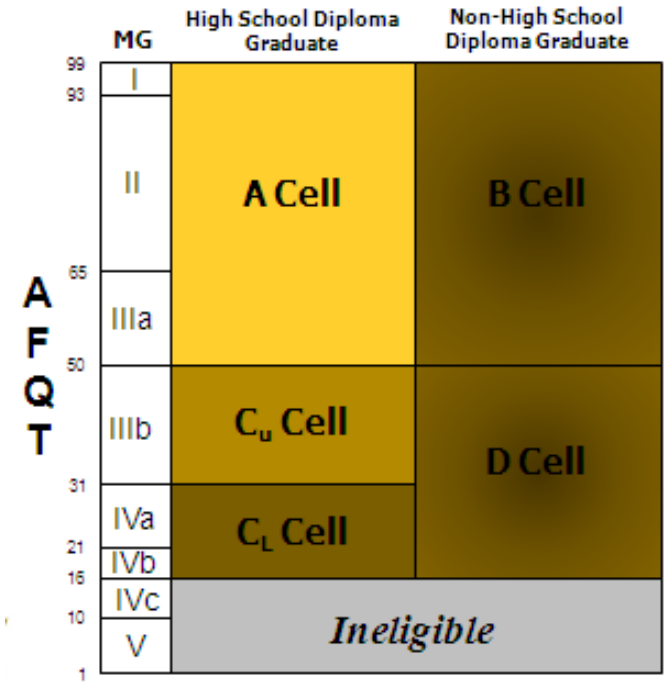

Figure D. DoD Quality Matrix that incorporates AFQT and HSDG.

AFQT score ranges are listed in the left column of Figure D categorized by their assigned Mental Group (MG) (I through V). MGs IVc and V are ineligible for military service regardless of HSDG status. The Navy's Category I goal has been over 95 percent during the recent positive recruiting environment [97 percent HSDG and 79 percent Upper MG (1-IIIa)] even though DoD recruit quality benchmarks are a lower 90 percent HSDG and 60 percent UMG.

Appendix E
Estimating the ASVAB Validity for the Applicant Population

The objective of an ASVAB predictive validity analysis is to determine the magnitude of the validity coefficient having an ASVAB restricted in range school sample. Restriction in range of ASVAB score variance occurs because an ASVAB standard (composite with cutscore) is used in the rating classification process. Figure E shows such a situation with a cutscore applied to the ASVAB composite VE+AR+MK+AS.

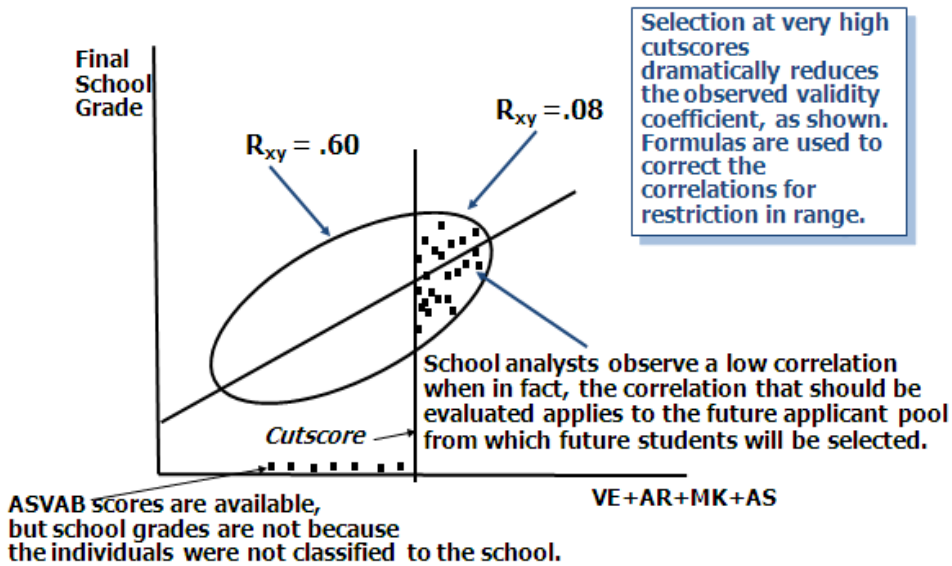

Figure E. Effects of an operational ASVAB standard on the validity coefficient.

The truncated ellipse in Figure E due to an ASVAB cutscore shows that the restricted ASVAB validity coefficient in predicting final school grade is very small, R_{xy} = .08. The goal is to estimate the validity coefficient for the full range population from which future recruits will be classified for Navy ratings. An estimate of the validity for an "unrestricted population" is obtained using a multivariate range correction procedure (Lawley, 1943). The underlying assumptions for using these formulas is that the full ellipse actually depicts the population ASVAB/performance relationship with linearity across the total predictor (ASVAB) score range and with uniform standard errors of prediction (final school grade), but also that selection occurred solely on the ASVAB (covariances among the predictors also not dependent upon predictor scores). The multivariate range correction procedure is standard for evaluating the validity of the ASVAB but would not be used for future the LCS performance data because, besides the small sample issue, selection has occurred on other than ASVAB in the assignment of LCS billets. For those interested in the formulas used in a military/ASVAB applied research context see Held and Foley (1994).

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