ASVAB Validation Technical Report

Interior Communications Electrician/ Advanced Technical Field (IC/ATF) Rating

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14. ABSTRACT The Armed Services Vocational Aptitude Battery (ASVAB) is a joint-service battery used by the U.S. military services for enlistment selection and occupational classification decisions. All of the military services validate the ASVAB from time to time to ensure that the composites of ASVAB tests they use to classify their enlisted members to occupations are the most predictive of military performance, and that cut-scores are set to manage academically related training setbacks and failures. Navy Selection and Classification Office (OPNAV N-132G) has stood up a process to re-evaluate the ASVAB entry standards for enlisted accession programs and ratings, with the intent to revisit every rating on a recurring basis. This paper presents a summary of the updated analysis that was originally performed in 2020 for the Interior Communications Electrician/Advanced Technical Field (IC/ATF) rating. Another focus of the evaluation was to identify possible alternative entry standards to minimize adverse impact, that is, to open the qualification "aperture" such that promising individuals may qualify using alternative standards.					
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I. Introduction

Navy Selection and Classification Office (OPNAV N132G) has stood up a process to re-evaluate the Armed Services Vocational Aptitude Battery (ASVAB) entry standards for enlisted accession programs and ratings, with the intent to revisit every rating (i.e., job) on a recurring basis. This evaluation takes the form of an analysis of observed training outcomes (for initial skills training) in the rating, and an assessment of the effects of possible alternative entry standards on qualification rates, training outcomes, and adverse impact (i.e., rating qualification differences by gender, race, and ethnicity).

The primary goal for a review or re-evaluation of ratings' ASVAB standards is to ensure standards are set in a manner that will fairly and accurately measure the individual's aptitude/ability to adequately perform in a rating's technical training course, thus minimizing failure or academic setback rates. Setting effective ASVAB standards not only reduces the burden on recruiting to re-fill the class seats that were occupied by those who did not perform, but also allows for improvement of the person-job fit for Sailors, specifically if the operational ASVAB composite (i.e., the composite currently in use) is replaced or augmented with one that measures more relevant training and job factors.

As mentioned above, another focus of the evaluation is to identify possible alternative entry standards to minimize adverse impact, that is, to open the qualification "aperture" such that promising individuals may qualify using alternative standards. The ASVAB is a timed, multi-aptitude test that is dominated by verbal and math tests as well as technical tests of Crystallized Intelligence (Ree & Carretta, 1994) based on education that may be gender- or culture-bound. On the other hand, Fluid Intelligence, or the ability to think logically and solve problems in novel situations independent of knowledge acquired through education, is thought to be a culture-free fundamental core factor in intelligence. Two ASVAB tests, Assembling Objects (AO) to measure spatial ability and Coding Speed (CS) to measure speed/accuracy/intrinsic motivation are being added by the Navy as two indicators of Fluid Intelligence that may improve the ASVAB predictive validity while lowering the adverse impact on qualification of subgroups.

This paper presents a summary of the updated analysis that was originally performed in 2020 for the Interior Communications Electrician/Advanced Technical Field (IC/ATF) rating. The primary purposes of the report are to present the usefulness of ASVAB composites (both current and alternative) in opening the qualification 'aperture', providing more diversity, and in predicting training success.

II. Methods, Analyses, and Results

The study is organized into the following sections: (1) Description of the ASVAB, (2) Linkage of the ASVAB to the IC/ATF rating job description, (3) Data collection for predictive validity/diversity assessment, (4) ASVAB composite validation and adverse impact, (5) ASVAB composite cut-score analysis, (6) Preliminary real-world evaluation of the use of the current and alternative standards, and (7) Summary and conclusions. The last section contains recommendations.

Description of the ASVAB

The Armed Services Vocational Aptitude Battery (ASVAB) is a mix of aptitude/ability/ knowledge-based tests that are used by all the military services as their primary cognitive instrument for selecting military applicants and classifying them into enlisted occupations. The ASVAB was developed to predict training performance, and new tests are now being considered as additions to the ASVAB as technology and military jobs change. Appendix A gives a brief description of the current nine single ASVAB tests, the ASVAB Coding Speed (CS) test that is now a Navy special classification test, and four other special tests administered only to certain candidates (e.g., Nuclear field candidates).

Each ASVAB and CS test listed in Appendix A have their scores referenced to the ASVAB normative youth population of the US (PAY97) and is standardized to have a mean score of 50 and standard deviation (SD) of 10. The bulk of ASVAB test scores are in the range of 20 to 80. ASVAB test scores are combined into composite scores that indicate the type of job for which the candidate might be most qualified. The Navy ASVAB composite scores are simply sums of the scores of the individual ASVAB tests that form the composite.

Scores on Word Knowledge (WK) and Paragraph Comprehension (PC) tests are combined to form the Verbal Expression (VE) composite (also with a mean 50 and SD of 10). VE, along with Arithmetic Reasoning (AR) and Mathematics Knowledge (MK) is part of the Armed Forces Qualification Test (AFQT) used to qualify military applicants for service (2VE+AR+MK). The AFQT is scaled as a uniform percentile distribution with scores ranging from 1-99.

Linkage of the ASVAB to the IC/ATF Rating Job Description

One of the first steps in re-evaluating the ASVAB for the IC/ATF rating was to establish that ASVAB tests have content validity, that is, contain subject matter related to the skills needed for the IC/ATF job. Because of the multitude of Navy ASVAB tests, the list was narrowed down for IC/ATF rating analysis by a rational mapping of the constructs measured by the ASVAB tests to IC/ATF rating job requirements. The Navy rating's job description was obtained from the military web site, https://cool.osd.mil/usn/enlisted/ic.htm. The overall description of the Navy IC rating from the website is as follows:

"Interior Communications Electricians (IC) operate, coordinate, and perform organizational and intermediate maintenance on alarm, warning, and indicating systems, interior communication systems, ship's speed and steering control systems, power generation and distribution systems, data conversion and distribution systems, aviation monitoring and landing aids, information and training systems, gyroscopic navigation systems, and environmental systems; interpret and analyze ship's blueprints and system interface diagrams; inspect, test, analyze, and make detailed casualty analysis; and direct repair of electrical, electronic, fiber optic, hydraulic, mechanical, and synchro and servo systems." The rating information card states, "It is important that people in this rating have manual dexterity with tools, equipment and machines; above average math skills; resourcefulness; an interest in ideas and information; and the ability to express ideas clearly in speaking to others."

There are two accession/training paths for the IC rating: SG (School Guarantee) and ATF (Advanced Technical Field), whereby IC/ATF Sailors take 4 months of additional advanced training at C-School (CDP 19SV) after core training at A-School (CDP 10N3).

Our subject matter experts linked ASVAB tests and their underlying constructs to the different skill requirements of the IC/ATF rating. As shown in Table 1, eleven of the tests or the VE test combination linked to the rating. The EI (Electronics Information) test had the most check boxes (6). The current operational composite used to qualify for the IC/ATF rating is a summation of the tests AR+MK+EI+GS (Arithmetic Reasoning—2 checks, Mathematics Knowledge—2 checks, Electronics Information—6 checks, and General Science—2 checks). Other tests that received 3 or more checks were AO (Assembling Objects), and MC (Mechanical Comprehension).

Table 1. ASVAB Test Linkages to the AC/ATF Rating

IC/ATF Rating Skills/Qualifications	AO	AR	AS	CS	EI	GS	MC	MK	PC	VE	WK
Maintaining and repairing interior communications systems		X			X			X			
Preparing and interpreting blueprints, wiring diagrams and sketches	X				X	X			X	X	X
Installing and inspecting dry cell and storage batteries					X						
Recharging wet cell batteries					X						
Testing interior communications and gyrocompass equipment	X						X				
Installing telephone and other communications circuits, boxes, switchboards and bell buzzer systems					X						
Maintaining plotters and dead reckoning equipment							X				
Maintaining and operating TV systems					X						
Maintaining and repairing shipboard navigation equipment	X						X				
Requires above average math skills		X						X			
Ability to express ideas clearly in speaking to others									X	X	X
Writing and record-keeping skills				X					X	X	X
Manual dexterity with tools, equipment and machines			X				X				
An interest in ideas and information						X					

Data Collection for Predictive Validity/Diversity Assessment

Beyond content validity of the ASVAB, the validity of ASVAB composites in predicting training outcomes and increasing diversity are important objectives of this report. Data for predictive validity assessment were collected from the Navy's Career Waypoints (C-WAY) system through Selection and Classification of Recruits Evaluator (SCORE, OPNAV N-132G's analysis tool), but originally came from PRIDE-MOD (Sailor data) and CeTARS (training event data). Sailor demographic and initial rating training data were collected for 267,000 enlisted Sailors for whom data were available (those accessed FY11-FY18). At the initial step, Sailors' data were removed if any of their ASVAB test scores were outside the 11-89 range, or if all their test scores were the same value, leaving 265,000 valid Sailor records. Of these, 2224 were accessed into the IC rating. Because of the differences in training paths, we conducted separate analysis for IC/SG and IC/ATF Sailors. IC/SG results are presented in a previous report (Crookenden, Gobran, & Blanco, 2019).

The group of interest for the present report comprised 968 IC/ATF Sailors. Each Sailor was classified as to whether they:

- Graduated with no academic setbacks or failures
- Suffered an academic failure or setback
- Did not graduate due to a non-academic failure (e.g., medical reason), yet had no prior academic setback
- Have not completed the class and is still in training, but has not suffered a failure or academic setback

Sailors in the last two categories were ignored because of our interest in an observed academic training outcome, as appropriate for an ASVAB-related study. The remaining Sailors were assigned a 'First Pass Pipeline Success' (FPPS) value of 1 for graduating with no academic setbacks or failures, or a 0 if they experienced any academic setback or failure.

The final group of 968 was composed of 706 Sailors with an FPPS=1 (72.9%), and 262 Sailors with an FPPS=0 (29.1%). Males composed 63.1% (n=611) and females composed 36.9% (n=357). Not all recruits enter the Navy with AO and CS test scores and therefore, some analyses involving these ratings have reduced sample sizes. AO is not given to high school students taking the paper and pencil ASVAB (15% do not have an AO test score). At the time of this study, CS was only given at the MEPS at the end of the CAT-ASVAB (39.4% do not have a CS test score).

ASVAB Composite Validation and Adverse Impact

The validity of 11 of the Navy's composites operational at the time of this study were examined as predictors of IC/ATF training success using 823 of the 968 Sailors. Not all Sailors have the opportunity to take the AO test, and therefore, the composite validation was conducted on the 823 with all tests. Two composites that include CS were not part of these analyses because 39% of applicants did not take the CS special test, and CS only linked to one of the skills/ requirements of the IC/ATF rating. The following broadly stated methods were used to conduct the validation; more details of this process can be found in Appendix B:

- Calculate the bivariate correlation between each ASVAB composite score and FPPS for the 823 IC/ATF trainees;
- Correct this correlation for multivariate range restriction (MRR) against the entire Applicant population data to undo bias from selection into the rating by the current operational composite, and against the PAY97 normative data to undo bias from selection into the Navy by the AFQT cutoff;

- Calculate the presumed validity for prediction of FPPS by correcting the previous value for the dichotomous (binary) FPPS measure because of the uneven proportion between FPPS dichotomies (Kemery, Dunlap, & Griffeth, 1988; Cohen, 1988).

Adverse impact for each composite based on Cohen's d effect size was calculated using the Applicant data from CY2018 with 51,673 Navy applicants with AO test scores. Cohen's d was calculated as the mean score of the minority group minus the mean score of the majority group, then divided by the standard deviation of the pooled groups' scores. The larger the absolute value, the more negative the adverse impact.

Predictive validity for FPPS and adverse impact results are shown in Table 2 for 11 selected operational composites. The VE+AR+MK+AO composite, or "AO" composite (green highlight) had larger observed and corrected validity coefficients than the current AR+MK+EI+GS operational composite (yellow highlight), while at the same time yielded relatively low adverse impact. All adverse impact scores had negative signs, indicating adverse impact for minorities. For the AO composite, the Cohen's d of -0.27 for female-male differences, and -0.26 for Hispanic-White differences correspond to small effect sizes (Cohen, 1988), suggesting relatively low disparate impact. The value of -0.59 for African American-White differences would be considered a medium effect size. An effect size of this magnitude means the score of the average person in the White group is 0.59 standard deviations above the average person in the African American group. This medium effect size is still better than the large effect size (-.80) for the current operational composite.

Table 2: IC/ATF – Validity of 11 ASVAB Composites Predicting FPPS

	Predictive Validity					Adverse Impact (Standardized Mean Differences/Cohen's d)		
	r	*r*	*r*	*r*	*r*	*d*	*d*	*d*
ASVAB Composite	Observed	Applicant MRR	PAY97 MRR	Applicant MRR+DC	PAY97 MRR+DC	*Female-Male*	*African Am-Wt*	*Hisp-White*
VE + AR + MK + AO	**0.24**	**0.44**	**0.58**	**0.59**	**0.78**	**-0.27**	**-0.59**	**-0.26**
AR + 2MK + GS	0.23	0.44	0.58	0.59	0.78	-0.34	-0.67	-0.31
VE + AR + MK + MC	0.20	0.42	0.56	0.57	0.76	-0.51	-0.80	-0.41
VE + AR + MK + GS	0.20	0.42	0.57	0.57	0.76	-0.44	-0.74	-0.40
VE + MK	0.19	0.41	0.56	0.55	0.75	-0.25	-0.57	-0.36
MK + AS + AO	0.17	0.39	0.52	0.52	0.70	-0.41	-0.64	-0.28
AR + MK + EI + GS	0.16	0.41	0.56	0.55	0.75	-0.59	-0.80	-0.43
VE + MK + GS	0.16	0.40	0.56	0.54	0.75	-0.41	-0.70	-0.42
VE + AR + MK + AS	0.16	0.40	0.55	0.54	0.74	-0.60	-0.85	-0.47
VE + AR	0.15	0.39	0.54	0.52	0.72	-0.43	-0.68	-0.39
AR + MC + AS	0.08	0.33	0.46	0.45	0.62	-0.80	-0.95	-0.48

ASVAB Composite Cut-score Analysis

The fully corrected validity coefficients above are not the only method to gauge the power of an ASVAB composite to predict performance outcomes. Graphing the relationship between the observed ASVAB composite predictor and the FPPS training criterion is useful in observing co-occurring changes. Figure 1 shows FPPS success as a function of qualification scores under the current qualification composite, AR+MK+EI+GS for IC/ATF trainees. The vertical axis represents first pass pipeline success and the horizontal axis represents qualification scores, or potential cut-points. The FPPS generally increases as the cut-score increases (because more well qualified individuals enter the rating) and decreases as the cut-score decreases in a clear linear relationship. Those qualifying at 213 (the current composite cut-score) had about a 73% FPPS success, whereas those qualifying at the high end at 237 had an observed 90.5% FPPS success rate. However, it is important to keep in mind that qualification rates and training success are trade-offs that must be managed in a challenging recruiting environment.

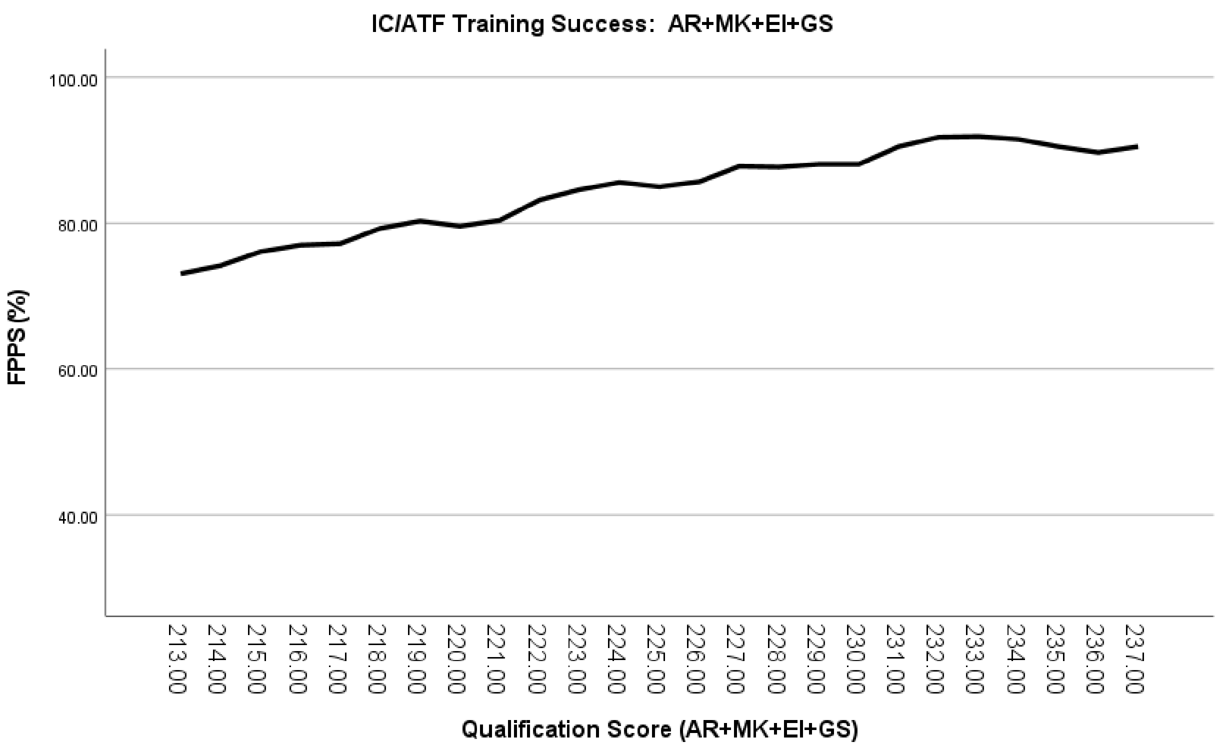

Figure 1

Because the VE+AR+MK+AO composite performed well in terms of validity and adverse impact (see Table 2 above), we chose it in subsequent analyses as a candidate alternative composite to consider as an addition and comparison to the operational composite, AR+MK+EI+GS, for the IC/ATF rating.

To evaluate cut-scores for both the operational and 'AO' composite, we first conducted a stepwise logistic regression analysis with the IC/ATF training sample using nine single ASVAB tests: WK, AR, AS, EI, GS, MC, MK, PC, and AO. FPPS was regressed onto this set of predictor tests for 824 Sailors who had all tests. This approach was used instead of regressing composites because composites overlap in their tests, and because we wanted to arrive at one single predicted FPPS estimate. AR, MK, GS, and AO tests remained in the model as independent and significant predictors of FPPS. This model is shown in Appendix C, along with the area under the ROC curve (.677). The resulting model was then applied to the entire CY18 Applicant population for all that had an AO test score (N=51,673), obtaining predicted FPPS probabilities.

Table 3 below shows the unadjusted qualification rate and the predicted FPPS probability for those Applicants meeting the operational standard (AR+MK+EI+GS), as well as for those meeting the standard of the composite of interest (VE+AR+MK+AO). Three different cut-scores were tested for each composite: (a) for AR+MK+EI+GS, 213 (the current cut-point), 201 (the waiver cut-point), and 218 (the cut-point at about one-fourth standard deviations from the mean score of the composite); and (b) for VE+AR+MK+AO, 218 (the proposed cut-point), 206 (the waiver cut-point for this composite), and 224 (the cut-point at about one-quarter standard deviations from the mean score of the composite).

Table 3 shows that the current operational composite, AR+MK+EI+GS, and the proposed AO composite yielded somewhat similar predicted FPPS probabilities at each cut-point tested. Qualification rates were higher for the AO composite particularly at the lower cut-points. There is a clear tradeoff between composite score/FPPS probability and qualification rate. The combined use of the AO composite (with a cut-score of 218) with the current operational composite opened the qualification aperture from 46.3% to 55.1%. However, this increase was at the expense of a slightly lower predicted FPPS level (from 82.5 to 80.4).

Table 3: Unadjusted Cut-score Analysis Applied to CY18 Navy Applicant Data: FPPS Predicted from Four Single ASVAB Tests

AR+MK+EI+GS			VE+AR+MK+AO			Either	
Comp Score	Predicted FPPS Prob	Qual Rate	Comp Score	Predicted FPPS Prob	Qual Rate	Predicted FPPS Prob	Qual Rate
201	76.8	65.9%	206	75.6	70.8%	74.1	77.2%
213	**82.5**	**46.3%**	**218**	**82.6**	**48.1%**	**80.4**	**55.1%**
218	85.0	38.6%	224	85.9	37.7%	83.5	45.3%

To decrease potential bias in predicted FPPS probability in the Applicant pool, the analysis in Table 3 was repeated after predicted probabilities were adjusted by subtracting the mean of the

Applicant pool predicted FPPS rate for those who met the operational cut-point standard (82.5%) from the mean observed trainee FPPS rate (72.9%), and the difference (-.0965) added as a constant to each probability score in the Applicant pool. This intercept adjustment served to match the Applicant pool FPPS rate to that of the trainee data (Shewach & Ingerick, 2021),

Table 4 presents results of the intercept adjusted analysis with the Applicant pool. Predicted FPPS probabilities were lower than in Table 3, as expected, but still over 70% using either composite at its current or recommended cut-score.

Table 4: Intercept Adjusted Cut-score Analysis Applied to CY18 Navy Applicant Data: FPPS Predicted from Four Single ASVAB Tests

AR+MK+EI+GS			VE+AR+MK+AO			Either	
Comp Score	Predicted FPPS Prob	Qual Rate	Comp Score	Predicted FPPS Prob	Qual Rate	Predicted FPPS Prob	Qual Rate
201	67.1	65.9%	206	66.0	70.8%	64.5	77.2%
213	**72.9**	**46.3%**	**218**	**73.0**	**48.1%**	**70.8**	**55.1%**
218	75.4	38.6%	224	76.2	37.7%	73.9	45.3%

The proposed alternative standard of AR+MK+EI+GS ≥ 213 *or* VE+AR+MK+AO ≥ 218 also improves the adverse impact for Females, African Americans, and Hispanics in terms of qualification rates. Table 5 below presents adverse impact ratios, i.e., ratios of qualification rates between minority and majority groups using the CY18 Navy Applicant population. A ratio of 1.00 would indicate equal qualification rates of the two groups. Ratios under the current standard are well under 1.00, with minority groups at a disadvantage. Ratios under the alternative composite are also under 1.00, but all three are higher (7-14 points higher).

Table 5: Adverse Impact Qualification Ratios Under Current and Alternative Standard Applied to CY18 Navy Applicant Data

Impact Ratio	AR+MK+EI+GS ≥ 213 (current)	AR+MK+EI+GS ≥ 213 or VE+AR+MK+AO ≥ 218 (alternative)
Female: Male	0.54	0.68
African American: White	0.41	0.48
Hispanic: White	0.67	0.76

Initial "Real World" Evaluation of Use of the Current and Alternative Standards

Table 6 presents training outcomes for the small sample of 106 IC/ATF trainees qualifying under the new standard of either AR+EI+GS+MK ≥ 213 or VE+AR+MK+AO ≥ 218, available at the time of this report. The overall observed training success (FPPS) rate of 83% exceeds that predicted above in the Applicant data (in fact, the FPPS success rates for the two single composites shown below exceeded those predicted). FPPS rates for all groups were higher than the Not Qualified group (75%), although the Qualified Only under VE+AR+MK+AO ≥ 218 was close to the Not Qualified group at 76.5%. Logically, the same pattern was seen for the setback rate in which Not Qualified (25%) and Qualified Only under VE+AR+MK+AO ≥ 218 (23.5%) had the highest setback rates. Graduation rates were generally high for all groups and the flipside, failure rates, were generally low. Chi-square analysis conducted on the last four independent groups listed on the table for graduation rate, setback rate, and FPPS were not statistically significant, indicating no reliable differences among groups. However, this is not the same as "equivalence" among the groups, and the groups' sizes are small. Therefore, additional analyses with larger group sizes need to be conducted to determine the association of the new expanded two-composite standard on academic training for IC/ATF.

Table 6: Academic Training Performance by Qualification Standards for IC/ATF Rating

IC/ATF Trainees	# Students	Observed FPPS (%)	Grad Rate	Setback Rate	Failure Rate
Total Sample	106	83.02%	0.9608	0.1604	0.0392
Qual New Standards (one or both)	90	84.44%	0.9545	0.1444	0.0455
Qual New only AR+MK+EI+GS ≥ 213	29	86.21%	0.9310	0.1034	0.0690
Qual New only VE+AR+MK+AO ≥ 218	34	76.47%	0.9688	0.2353	0.0313
Qual New Standards (both)	27	92.59%	0.9630	0.0741	0.0370
Not Qual New Standards	16	75.00%	1.0000	0.2500	0.0000

III. Summary and Conclusions

ASVAB tests linked well to skill requirements of the IC/ATF rating, showing good content validity in that it covered the range of elements required of the job. Likewise, the current operational composite (AR+MK+EI+GS) and the primary alternative composite of interest (VE+AR+MK+AO) each provided strong linkages to the rating (i.e., EI, AO, VE).

The proposed alternative additional composite, VE+AR+MK+AO (i.e., AO), demonstrated higher predictive validity of training success and lower adverse impact (i.e., lower differences in mean composite scores) than the current operational composite for the IC/ATF rating. Female/male and Hispanic/White differences were considerably improved by the AO composite, although African American/White adverse impact is still problematic and needs solutions. Use of a cut-score of 218 for this AO composite as an alternate qualification standard for entry to the IC/ATF school along with the current operational composite and cut-score (AR + MK + EI + GS ≥ 213) opened the qualification "aperture" from 46.3% to 55.1%. However, this increase was at the expense of a slightly lower predicted training success rate (from 72.9% intercept adjusted FPPS to an estimated 70.8%). The proposed alternative standard of AR+MK+EI+GS ≥ 213 *or* VE+AR+MK+AO ≥ 218 also improves the adverse impact for Females, African Americans, and Hispanics in terms of qualification rates. A real-world evaluation of the combined use of the two composites with 106 Sailors showed no statistical differences in their training success, but the sample size was small and equivalence in outcomes needs to be evaluated.

IV. Recommendations

1. The following recommendations were presented to the ASVAB Validation Review Committee on 06 May 2020 and implemented as operational standards on 01 June 2020.

It is recommended that the Navy adopt VE+AR+MK+AO ≥ 218 as an alternate qualification standard to the current operational standard of AR + MK + EI + GS ≥ 213 for the IC/ATF rating. Thus, the new rating entry requirement for IC/ATF rating would be:

AR + MK + EI + GS ≥ 213

or VE+AR+MK+AO ≥ 218

2. Effects of this change on qualification rates and training outcomes should be monitored, including outcomes by whether individuals entered under the original, the alternative, or both standards.

3. Collect sufficient training outcome data to evaluate the accuracy of the prediction models.

4. Adverse impact should continue to be measured and strategies explored to make more equitable tests and foster diversity while maintaining validity. These strategies might include the use of additional cognitive tests (e.g., attention control), (Burgoyne, Mashburn, Engle, 2021), non-cognitive tests, and broadening recruitment approaches.

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Appendix A: Description of the Armed Services Vocational Aptitude Battery (ASVAB) and Special 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 correct meaning of words
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 and shop technologies, tools, 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
Defense Language Aptitude Battery (DLAB)[b]	Aptitude for learning languages
Navy Advanced Placement Test (NAPT)[b]	Knowledge of advanced physics, mathematics, and chemistry
Information and Communication Technology Literacy (ICTL)[b]	Ability to use computers and their diverse applications
Mental Counters (MC_t)[b]	Working memory test (in research and testing)

[a]WK and PC are combined to form the Verbal composite (VE) that is a component of the Armed Forces Qualifying Test (AFQT) and several Navy ASVAB classification composites.

[b]Not all recruits enter the Navy with AO and CS test scores. AO is not given to high school students taking the paper and pencil ASVAB. At the time of this study, CS, ICTL, and MC_t, was only given at the MEPS at the end of the CAT-ASVAB. DLAB was only given at the MEPS at the time of this study, as well. NAPT is given only to high aptitude candidates applying for the Nuclear Field.

Appendix B: Details of Validation Process for IC/ATF

1. Clean Training Data

Start with a search for any data outliers that may skew results. This may include numbers that do not make sense (e.g., 999 for one test, or other data entry errors). In the IC Data, there were none. The next step would be to remove the entire case for any applicant/Sailor who has any test scores outside the normal range of 11-89.

Consider excluding any dates that should not be included in the study (depending on the study). For example, if doing analyses for just the past 5 years, be sure to remove the data for anything beyond that timeframe at this stage of data cleaning.

2. Analyze the Observed Validity

Create the composite variables (calculating the composite scores to prepare for the correlations). Conduct the validity analyses by creating a sample correlation matrix among all of the tests and composites and FPPS.

3. Correct the Observed Validity for Range Restriction

Run the Lawley Correction for Multivariate Range Restriction Program (see Lawley, 1943, for details of process), indicating in the program the names of the files for the sample correlation matrix, the population matrices (both PAY97 and Applicant), and the variable list (which also corresponds with the variable order in both matrices). Do this separately for each population (PAY97 and Applicant). The output files produce the corrected correlations for both PAY97 and Applicant populations.

4. Correct the New Values for Dichotomization

Calculate the FPPS rate for the IC/ATF sample. The FPPS is 72.9%. With this information, refer to the Table of Normal Deviates and Ordinates (https://link.springer.com/content/pdf/bbm%3A978-1-4613-8740-4%2F1.pdf) and locate the ordinate that matches the FPPS. In this case, refer to the 3rd column in the table below (“B Area in the larger portion”). The area in the larger portion that best matches the FPPS rate of 0.729 can be found on the second row of the second to last section in the chart below). Then, refer to the last column for the y ordinate that corresponds to the FPPS rate. The y ordinate is 0.3312 for 0.729 in the example (see below).

After locating the ordinate corresponding to the FPPS rate, complete the following:

1. Insert the FPPS (P) and the ordinate in a chart in Microsoft Excel.
2. Calculate Q, the remainder of the sample who did not accomplish FPPS (1 minus P).
3. Multiply P and Q.
4. Calculate the square root of P*Q.
5. Take the square root of P*Q and divide by the ordinate.
6. This final value is to be used for correction.

(1) z Standard score $\left(\frac{x}{\sigma}\right)$	(2) A Area from mean to $\frac{x}{\sigma}$	(3) B Area in larger portion	(4) C Area in smaller portion	(5) y Ordinate at $\frac{x}{\sigma}$
0.28	.1103	.6103	.3897	.3836
0.29	.1141	.6141	.3859	.3825
0.30	.1179	.6179	.3821	.3814
0.31	.1217	.6217	.3783	.3802
0.32	.1255	.6255	.3745	.3790
0.33	.1293	.6293	.3707	.3778
0.34	.1331	.6331	.3669	.3765
0.35	.1368	.6368	.3632	.3752
0.36	.1406	.6406	.3594	.3739
0.37	.1443	.6443	.3557	.3725
0.38	.1480	.6480	.3520	.3712
0.39	.1517	.6517	.3483	.3697
0.40	.1554	.6554	.3446	.3683
0.41	.1591	.6591	.3409	.3668
0.42	.1628	.6628	.3372	.3653
0.43	.1664	.6664	.3336	.3637
0.44	.1700	.6700	.3300	.3621
0.45	.1736	.6736	.3264	.3605
0.46	.1772	.6772	.3228	.3589
0.47	.1808	.6808	.3192	.3572
0.48	.1844	.6844	.3156	.3555
0.49	.1879	.6879	.3121	.3538
0.50	.1915	.6915	.3085	.3521
0.51	.1950	.6950	.3050	.3503
0.52	.1985	.6985	.3015	.3485
0.53	.2019	.7019	.2981	.3467
0.54	.2054	.7054	.2946	.3448
0.55	.2088	.7088	.2912	.3429
0.56	.2123	.7123	.2877	.3410
0.57	.2157	.7157	.2843	.3391
0.58	.2190	.7190	.2810	.3372
0.59	.2224	.7224	.2776	.3352
0.60	.2257	.7257	.2743	.3332
0.61	.2291	.7291	.2709	.3312
0.62	.2324	.7324	.2676	.3292
0.63	.2357	.7357	.2643	.3271
0.64	.2389	.7389	.2611	.3251
0.65	.2422	.7422	.2578	.3230
0.66	.2454	.7454	.2546	.3209
0.67	.2486	.7486	.2514	.3187
0.68	.2517	.7517	.2483	.3166
0.69	.2549	.7549	.2451	.3144

Correction Chart

Type	Value
Ordinate	0.3312
P (FPPS =1)	0.729
Q (FPPS=0)	0.271
P*Q	0.197559
Square Root of P*Q	0.444476
Correction Value------>	1.342017

Next, take each correlation coefficients (all of the observed, Applicant and PAY 97 correlation coefficients) and multiply each by the correction value. This gives the corrected value for dichotomization.

For example in this report, VE+MK (already corrected for multivariate range restriction for PAY 97) was r=0.56. Multiplied by 1.342017, the correlation coefficient corrected for range restriction and dichotomization is now r=0.75 (rounded).

Appendix C: Logistic Regression Equation and AUC (.677) for 823 IC/ATF Trainees

Variables in the Equation

	B	S.E.	Wald	df	Sig.	Exp(B)	95% C.I.for EXP(B)	
							Lower	Upper
AO	.032	.012	7.707	1	.005	1.033	1.009	1.056
AR	.048	.019	6.224	1	.013	1.049	1.010	1.090
GS	.053	.018	8.912	1	.003	1.055	1.018	1.092
MK	.097	.021	22.349	1	.000	1.102	1.059	1.148
Constant	-11.796	1.972	35.786	1	.000	.000