Navy Personnel Research and Development Center
San Diego, California 92152-6800 TR-92-5 December 1991

Validation Study of Armed Services Vocational Aptitude Battery (ASVAB) Selector Composites: Gas Turbine System Technician Rating, Electrical (GSE) and Mechanical (GSM), for 4- and 6-Year Obligor Programs

Janet D. Held
Paul P. Foley

NPRDC-TR-92-5 December 1991

Validation Study of Armed Services Vocational Aptitude Battery (ASVAB) Selector Composites: Gas Turbine System Technician Rating, Electrical (GSE) and Mechanical (GSM), for 4- and 6-Year Obligor Programs

Janet D. Held
Paul P. Foley

Reviewed and approved by
W. A. Sands

Released by
Thomas F. Finley
Captain, U.S. Navy
Commanding Officer
and
Richard C. Sorenson
Technical Director (Acting)

Navy Personnel Research and Development Center
San Diego, California 92152-6800

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. AGENCY USE ONLY (Leave blank)	2. REPORT DATE	3. REPORT TYPE AND DATE COVERED
	December 1991	Final: Oct 86-Sep 88

4. TITLE AND SUBTITLE
Validation Study of Armed Services Vocational Aptitude Battery (ASVAB) Selector Composites: Gas Turbine System Technician Rating, Electrical (GSE) and Mechanical (GSM), for 4- and 6-Year Obligor Programs

5. FUNDING NUMBERS
Program Element 090000N
Work Unit WRB1008

6. AUTHOR(S)
Janet D. Held, Paul P. Foley

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Navy Personnel Research and Development Center
San Diego, California 92152-6800

8. PERFORMING ORGANIZATION REPORT NUMBER
NPRDC-TR-92-5

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
Bureau of Naval Personnel (PERS-234)
Navy Department
Washington, DC 20350-2000

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11. SUPPLEMENTARY NOTES

12a. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT *(Maximum 200 words)*

This study validated Armed Services Vocational Aptitude Battery (ASVAB) selector composites against school performance measures for the Navy Gas Turbine System Technician rating, Electrical (GSE) and Mechanical (GSM), 4- and 6-year obligor (4YO/6YO) programs. The ASVAB consists of the following ten tests: General Science (GS), Arithmetic Reasoning (AR), Word Knowledge (WK), Paragraph Comprehension (PC), Numerical Operations (NO), Coding Speed (CS), Auto and Shop information (AS), Mathematics Knowledge (MK), Mechanical Comprehension (MC), and Electronics Information (EI).

The study recommends that (1) GSE 4YO retain the operational composite, AR+MK+EI+GS, but raise the minimum qualifying score (MQS) from 200 to 204, (2) GSM 4YO replace the operational composite, MK+AS, with AR+MK+EI+GS, the GSE 4YO program operational composite, and use the 204 MQS recommended for the GSE 4YO program, and (3) GSE/GSM 6YO programs eliminate MK+AS, one of two operational composites, retain the other, AR+MK+EI+GS, lower the MQS from 218 to 210, and eliminate the MK+EI+GS=156 requirement. Adopting these recommendations should (1) reduce attrition for the 4YO programs, (2) increase the number of qualified recruits for the 6YO programs, and (3) reduce the number of selector composites used by the GS rating from two to one.

14. SUBJECT TERMS	15. NUMBER OF PAGES
ASVAB, validation, selection, composite	25
	16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UNLIMITED

FOREWORD

This study was conducted in response to a request from the Bureau of Naval Personnel (PERS-23) to validate the Armed Services Vocational Aptitude Battery (ASVAB) selection criteria for the Gas Turbine System Technician rating, Electrical (GSE) and Mechanical (GSM), for both the 4- and 6-year obligor (4YO/6YO) programs. Concerns included that (1) the ASVAB requirements for the GSM 6YO program were too high, while those for the GSM 4YO program were too low, and (2) the ASVAB requirements for the GS rating had been established without a formal validation study.

This effort was sponsored by PERS-234 and funded by program element 090000N, work unit WRB1008. Results are intended for use by BUPERS, the GS school personnel, and the research community.

THOMAS F. FINLEY
Captain, U.S. Navy
Commanding Officer

RICHARD C. SORENSON
Technical Director (Acting)

SUMMARY

Problem

This study was conducted in response to a request Bureau of Naval Personnel (PERS-23) to validate the Armed Services Vocational Aptitude Battery (ASVAB) selection criteria for the Gas Turbine System Technician rating, Electrical (GSE) and Mechanical (GSM), for both the 4- and 6-year obligor (4YO/6YO) programs. Concerns included that (1) the ASVAB requirements for the GSM 6YO program were too high, while those for the GSM 4YO program were too low, and (2) the ASVAB requirements for the GS rating had been established without a formal validation study.

Objectives

The objectives of this research were to (1) validate the ASVAB operational selector composites against Class "A" school performance measures for the GSE and GSM 4YO and 6YO programs, (2) identify and evaluate alternative ASVAB composites that would be more effective for determining qualification for "A" school assignment, (3) reduce, if analyses support, the number of selector composites for the 6YO programs from two to one, (4) determine minimum qualifying scores for recommended 4YO selector composites that would reduce attrition, and (5) determine minimum qualifying scores for recommended 6YO composites that would increase the percentage of qualified recruits without a significant increase in attrition.

Approach

Each of the four GS school samples was randomly divided into a test selection sample and a hold-out sample. Two methods, both using a multiple regression procedure, were used with the test selection sample to determine the most valid ASVAB selector composite. The first, Method I, did not correct for restriction in range of ASVAB test scores used to select students, while the second, Method II, did. The experimental composites identified in the test selection sample and operational selector composite were then validated in the hold-out sample and validities were compared after correcting for restriction in range. When replacing the operational composite was warranted, as assessed by the expected increase in validity and/or the expected improvement in the "A" school graduation rate, one (or more) of the 11 Navy operational composites most similar to the experimental composites was chosen as a candidate replacement. If the validities of the candidate and experimental composites were comparable, the candidate composite was recommended as a replacement.

Minimum qualifying scores for recommended composites and for operational composites that were adequate were evaluated on the basis of (1) attrition rate, (2) waiver rate, (3) yearly input requirement, (4) percentage of the recruit population qualifying for school selection, and (5) number of school graduates disqualified from school selection.

Results and Conclusions

For the GSE 4YO program, the operational composite, AR+MK+EI+GS, was adequate. However, raising the minimum qualifying score reduced attrition without an appreciable loss in the number of school qualified recruits.

For the GSM 4YO program, the validity of the operational composite, MK+AS, was lower than the validity of AR+MK+EI+GS, the operational composite for the GSE 4YO program. The same AR+MK+EI+GS minimum qualifying score was appropriate for both 4YO programs.

For both 6YO programs, one of two operational composites, AR+MK+EI+GS, was adequate. For the GSE 6YO program, the validity for the second operational composite, MK+AS, was lower than for AR+MK+EI+GS. Lowering the AR+MK+EI+GS minimum qualifying score for the 6YO programs increased the number of school qualified Navy recruits without increasing attrition.

The MK+EI+GS=156 requirement for the 6YO programs was ineffective in screening recruits, as was the MK+AS=96 requirement.

Recommendations

The following recommendations are addressed to PERS-23:

1. The GSE 4YO program should (a) retain the operational selector composite, AR+MK+EI+GS, and (b) raise the minimum qualifying score from 200 to 204 to reduce attrition.

2. The GSM 4YO program should (a) replace the operational selector composite, MK+AS, with AR+MK+EI+GS, the operational selector composite for the GSE 4YO program and (b) use the 204 minimum qualifying score recommended for the GSE 4YO program.

3. The GSE/GSM 6YO programs should (a) retain one of two operational selector composites, AR+MK+EI+GS, and eliminate the other, MK+AS, (b) lower the minimum qualifying score for AR+MK+EI+GS from 218 to 210, and (c) eliminate the MK+EI+GS=156 requirement.

Adopting these recommendations should (1) reduce attrition for the 4YO programs, (2) increase the number of qualified recruits for the 6YO program, and (3) reduce the number of ASVAB selector composites used by the GS rating from two to one.

CONTENTS

	Page
INTRODUCTION	1
Background and Problem	1
Objectives	1
APPROACH	3
Predictors	3
Criterion	3
Samples	3
Data Analyses	4
RESULTS AND CONCLUSIONS	5
Composite Validity	5
Candidate Composite Selection and Evaluation: GSE/GSM 4YO Programs	7
Minimum Qualifying Scores: GSE/GSM 4YO Programs	8
Minimum Qualifying Scores: GSE/GSM 6YO Programs	8
Evaluation of MK+EI+GS and MK+AS Minimum Qualifying Scores: 6YO Program	8
RECOMMENDATIONS	9
REFERENCES	11
APPENDIX A--CORRECTION PROCEDURE USED IN METHOD II	A-0
APPENDIX B--MULTIPLE REGRESSION FOR METHODS I AND II	B-0
APPENDIX C--EXPECTANCY TABLES FOR THE GSE 4YO, GSE 6YO, AND GSM 6YO PROGRAMS	C-0
DISTRIBUTION LIST	

LIST OF TABLES

1. Content of ASVAB Tests	2
2. Navy Operational ASVAB Selector Composites	3
3. Attrition Rates for Expectancy Data	4
4. Experimental Composites Identified for the GS Test Selection Samples	6
5. Validities for the Operational and Experimental Composites for the GS Hold-out Samples	7

INTRODUCTION

Background and Problem

This study was conducted in response to a request from the Bureau of Naval Personnel (PERS-23) to validate the Armed Services Vocational Aptitude Battery (ASVAB) selection criteria for the Gas Turbine System Technician rating, Electrical (GSE) and Mechanical (GSM), for both the 4- and 6-year obligor (4YO/6YO) programs. Concerns included that (1) the ASVAB requirements for the GSM 6YO program were too high, while those for the GSM 4YO program were too low, and (2) the ASVAB requirements for the GS rating had been established without a formal validation study.

The 10 tests of the ASVAB are listed in Table 1 with abbreviations and descriptions. Various combinations of between two and four tests form composites used to select Navy recruits into Class "A" schools. The Navy has 11 operational ASVAB selector composites, listed in Table 2. Periodically, studies are conducted to correlate (validate) ASVAB composites with school performance measures to determine if the school is using the most effective operational selector composite. When there is more than one ASVAB requirement (multiple composites), analyses must support their use as screening instruments that do not eliminate valuable Navy talent from school assignment.

The ASVAB operational selector composite and minimum qualifying score for the GSE 4YO program is AR+MK+EI+GS=200 (see Table 1 for complete test names); for the GSM 4YO program, MK+AS=96. The ASVAB selector composites and minimum qualifying scores for the GSE/GSM 6YO programs are AR+MK+EI+GS=218 and MK+AS=96. There is also a score requirement of 156 for MK+EI+GS.

The Navy Integrated Training Resources and Administration System (NITRAS) reported the following attrition rates for the four GS programs for fiscal year (FY) 1988: GSE/GSM 4YO, 34 and 33 percent, respectively, and GSE/GSM 6YO, 17 and 13 percent, respectively. High 4YO attrition is more important for GSM than for GSE because more recruits are needed for GSM. The input requirement (school seats to be filled) for FY 1989 for GSE 4YO was only 62; while for GSM 4YO, it was 456 (GSE 6YO and GSM 6YO input requirements were 185 and 487, respectively).

Objectives

The objectives of this research were to (1) validate the ASVAB operational selector composites against Class "A" school performance measures for the GSE and GSM 4YO and 6YO programs, (2) identify and evaluate alternative ASVAB composites that would be more effective for determining qualification for "A" school assignment, (3) reduce, if analyses support, the number of selector composites for the 6YO programs from two to one, (4) determine minimum qualifying scores for recommended 4YO selector composites that would reduce attrition, and (5) determine minimum qualifying scores for recommended 6YO composites that would increase the percentage of school qualified recruits without a significant increase in attrition.

Table 1

Content of ASVAB Tests

Test	Abbreviation	Description
General Science	GS	A 25-item test of knowledge of the physical (13 items) and biological (12 items) sciences--11 minutes.
Arithmetic Reasoning	AR	A 30-item test of ability to solve arithmetic word problems--36 minutes.
Word Knowledge[a]	WK	A 35-item test of knowledge of vocabulary, using words embedded in sentences (11 items) and synonyms (24 items)--11 minutes.
Paragraph Comprehension[a]	PC	A 15-item test of reading comprehension --13 minutes.
Numerical Operations	NO	A 50-item speed test of ability to add, subtract, multiply, and divide one- and two-digit numbers--3 minutes.
Coding Speed	CS	An 84-item speed test of ability to recognize numbers associated with words from a table--7 minutes.
Auto and Shop Information	AS	A 25-item test of knowledge of automobiles, shop practices, and use of tools--11 minutes.
Mathematics Knowledge	MK	A 25-item test of knowledge of algebra, geometry, fractions, decimals, and exponents--24 minutes.
Mechanical Comprehension	MC	A 25-item test of knowledge of mechanical and physical principles--19 minutes.
Electronics Information	EI	A 20-item test of knowledge of electronics, radio, and electrical principles and information--9 minutes.

[a]Verbal score: VE = WK + PC (raw scores).

Table 2

Navy Operational ASVAB Selector Composites

Composite	Composite Name
VE+AR	General Technical
VE+MC+AS	Mechanical
AR+MK+EI+GS	Electronics
VE+NO+CS	Clerical
AR+2MK+GS	Basic Electricity & Electronics
MK+AS	Engineering
VE+AR+NO+CS	Cryptologic Technician
VE+MK+GS	Hospitalman
AR+MC+AS	Machinery Repairman
VE+AR+MC	Submarine
VE+MK+CS	Business/Clerical[a]

Note. See Table 1 for complete test names.
[a]Student Testing Program composite implemented July 1987.

APPROACH

Predictors

The predictors for this study were the 10 tests of ASVAB (Table 1). A technical description of ASVAB Forms 11, 12, 13, introduced in October 1984 to replace Forms 8, 9, 10, can be found in Prestwood, Vale, Massey, and Welsh (1985).

Criterion

The criterion provided by the GS "A" school, was the final school grade (FSG), which is the average of test scores (usually weekly) and includes a final comprehensive exam. Although FSG is scaled from 0 to 100, passing scores usually are between 70 and 100.

Samples

Normally, validity and expectancy analyses are performed on the same data. For GS "A" school, however, some data could not be retrieved from the school's computer, making it necessary to analyze two samples for each program. The validity analysis was conducted for school graduate data that included the required criterion, FSG; while the expectancy (cutscore) analysis was conducted for graduate and attrite data obtained from NITRAS. The NITRAS data, extracted for

the study period (October 1886 to July 1988), contains the Student Action Code (SAC) (designating pass, academic failure, and nonacademic failure status) required for expectancy analysis.

Sample sizes for the validity analyses were as follows: (1) GSE 4YO, 84, (2) GSM 4YO, 210, (3) GSE 6YO, 243, and (4) GSM 6YO, 388. Table 3 gives the sample sizes for the expectancy analyses and the percentage breakdowns of academic and nonacademic attrition. All four GS programs had substantial nonacademic attrition (medical, motivation, discipline, etc.) that may not be related to the ASVAB.

Table 3

Attrition Rates for Expectancy Data

Program	Percent Attrition			Sample Size
	Academic	Nonacademic	Total	
GSE 4YO	5	20	25	178
GSM 4YO	8	13	21	296
GSE 6YO	3	13	16	383
GSM 6YO	1	13	14	495

Data Analyses

For each of the four GS validity samples, students were randomly assigned to a test selection sample (60% of the students) and a hold-out sample (40% of the students). The test selection and hold-out samples had equal percentages of graduates, academic attrites, and nonacademic attrites.

Two methods were used with the test selection sample to determine the ASVAB composite most predictive of FSG. Both methods use a forward stepwise multiple regression procedure in which the prediction equation starts with the ASVAB test that has the highest correlation with FSG followed by tests that provide the largest increase in the multiple correlation.[1] The first four tests to enter the equation were designated as the experimental selector composite. Method I did not correct for restriction in range of scores for ASVAB tests used to select students, while Method II did. The correction procedure, which estimates the validity for a recruit applicant population rather than for a selected sample, uses multivariate formulas (Lawley, 1943) and is explained in Appendix A using GSM 6YO data. Multiple regression results for both Methods I and II (also using GSM 6YO data) are given in Appendix B.

[1]For the multiple regression, Word Knowledge (WK) and Paragraph Comprehension (PC) were combined into the ASVAB Verbal (VE) composite.

For each GS program, the experimental composites identified by Methods I and II, and the operational selector composite were cross-validated in the hold-out sample using a unit weight for each test (unit weights add stability and can be generalized to future samples more successfully than exact regression weights, which are sample specific).

Composite validities were compared after correcting for restriction in range. Replacing the operational selector composite was recommended when the experimental composite demonstrated (1) a .05 increase in validity, or (2) a 2-percent reduction in attrition or improvement in the graduation rate.[2]

When replacing an operational composite was warranted, candidate replacements were chosen for evaluation from the existing Navy operational selector composites (see Table 2) based on their similarity to the experimental composites. The choice is limited to existing Navy operational selector composites because, over the course of numerous validation studies, implementing a statistically derived composite could result in an unmanageable number of highly correlated operational selector composites, which does not improve classification efficiency.[3]

Finally, minimum qualifying scores were evaluated for adequate operational composites and for candidate replacement composites. Expectancy tables using school data were developed for operational composites, while theory-based tables (Taylor & Russell, 1939) were developed for candidate replacements. (A replacement composite cannot be accurately evaluated for a sample selected by the operational composite; it is analyzed as a second screen, and, therefore, improvements in the graduation rate may be inflated.) Factors considered in recommending minimum qualifying scores were (1) attrition rate, (2) waiver rate, (3) yearly input requirement, (4) percentage of the recruit population qualifying for school selection, and (5) number of school graduates disqualified from school selection.

RESULTS AND CONCLUSIONS

Composite Validity

The experimental composites identified for the test selection samples by both Methods I and II for each GS program are listed in Table 4.

---

[2]The Taylor Russell tables (1939) translate increased validity into expected improvement in the graduation rate for a fixed base rate (proportion of persons graduating before use of the new selector) and selection ratio (proportion of applicants selected).

[3]A new composite could be implemented for the Navy, as was the case of the Business/Clerical composite (Table 2), if an experimental composite was consistently derived for a number of schools within an occupational group but was not one of the existing Navy operational selector composites.

Table 4

Experimental Composites Identified for the GS Test Selection Samples

Program	Method I		Method II
GSE 4YO	MK+CS+EI+VE		MK+CS+EI+AS
GSM 4YO	AR+VE+CS+MK	<———>	AR+VE+CS+MK
GSE 6YO	AR+MK+GS+MC	<———>	AR+MK+GS+MC
GSM 6YO	AR+MK+MC+NO	<———>	AR+MC+NO+MK

Notes.
1. See Table 1 for complete test names.
2. Arrows indicate that Methods I and II identified the same composite.

Table 5 lists the validities for the operational and experimental composites, both uncorrected and corrected for restriction in range (r_u and r_c, respectively), for the GS hold-out samples. Corrected validities were compared for this study.

For the GSE 4YO program, the validity of .81 for the most valid experimental composite, MK+CS+EI+VE, was .08 higher than the validity of .73 for the operational composite, AR+MK+EI+GS. This gain in validity translates into an approximate 3-percent reduction in attrition, which suggests that replacement of the operational composite is warranted.

For the GSM 4YO program, the validity of .50 for the one experimental composite, AR+VE+CS+MK, was the same as the validity for the operational composite, MK+AS, which suggests that MK+AS is adequate.

For the GSE 6YO program, the validity of .70 for one experimental composite, AR+MK+GS+MC, was comparable to the validity of .71 for the operational composite, AR+MK+EI+GS, which suggests that AR+MK+EI+GS is adequate. The validity of .57 for the other operational composite, MK+AS, was .14 lower than the validity for AR+MK+EI+GS, which suggests that MK+AS should be eliminated.

For the GSM 6YO program, the validity of .32 for the one experimental composite, AR+MK+MC+NO, was the same as the validity for the operational composite, MK+AS, and only .02 higher than the validity of .30 for the operational composite, AR+MK+EI+GS. The low validities for both operational composites suggest that eliminating MK+AS for the GSM 6YO program could be warranted, if it is eliminated for the GSE 6YO program.

There was sufficient gain in validity using the experimental composite to warrant examining candidate replacement composites for the operational composite, AR+MK+EI+GS, only for the GSE 4YO program. However, because both 4YO programs have similar aptitude requirements, composites evaluated for the GSE 4YO program (including the GSE 4YO operational composite) were also evaluated for the GSM 4YO program.

Table 5

Validities for the Operational and Experimental Composites for the GS Hold-out Samples

Operational and Experimental Composites for GS Programs	Validities[a]	
	r_u	r_c
GSE 4YO		
AR+MK+EI+GS (Operational)	.51	.73
MK+CS+EI+VE (Experimental-Method I)	.67	.81
MK+CS+EI+AS (Experimental-Method II)	.59	.77
GSM 4YO		
MK+AS (Operational)	.24	.50
AR+VE+CS+MK (Experimental-Methods I & II)	.32	.50
GSE 6YO		
AR+MK+EI+GS (Operational)	.43	.71
MK+AS (Operational)	.21	.57
AR+MK+GS+MC (Experimental-Methods I & II)	.39	.70
GSM 6YO		
AR+MK+EI+GS (Operational)	.18	.30
MK+AS (Operational)	.19	.32
AR+MK+MC+NO (Experimental-Methods I & II)	.21	.32

Note. See Table 1 for complete test names.
[a]Both r_u and r_c (validities uncorrected and corrected for restriction in range, respectively) are Pearson product-moment correlations. Multivariate formulas were used for corrections.

Candidate Composite Selection and Evaluation: GSE/GSM 4YO Programs

Examination of the Navy operational composites (see Table 2) for the GSE 4YO program showed the Business/Clerical composite, VE+MK+CS, was a candidate replacement for the operational composite, AR+MK+EI+GS, because it contains three of the four tests of the experimental composite, MK+CS+EI+VE. The validity of .77 for VE+MK+CS (hold-out sample validity corrected for restriction in range) was .04 higher than the validity of .73 for the operational composite, AR+MK+EI+GS, which translates into an approximate 1-percent reduction in attrition. The low gains in validity and graduation rate suggest that replacing AR+MK+EI+GS with VE+MK+CS is not warranted unless analyses showed VE+MK+CS should be used for the GSM 4YO program.

For the GSM 4YO program, the validity of .44 for VE+MK+CS was .06 lower than the validity of .50 for the operational composite, MK+AS. The validity of .61 for AR+MK+EI+GS, the GSE 4YO operational composite, was .11 higher than the validity for MK+AS. This gain in validity translates into an approximate 2-percent reduction in attrition, which suggests that use of AR+MK+EI+GS for the GSM 4YO program as well as for the GSE 4YO program is warranted.

Minimum Qualifying Scores: GSE/GSM 4YO Programs

For the GSE 4YO program, where the operational composite, AR+MK+EI+GS, was considered adequate, the impact of raising the minimum qualifying score was evaluated using expectancy tables developed from the school data. These tables are in Appendix C and give (1) a partial composite score distribution that includes the school's current minimum qualifying score and (2) graduation and attrition rates for each composite score for both the school sample and the recruit population (population rates are based on the school sample rates). From Table C-1, raising the minimum qualifying score for AR+MK+EI+GS from 200 to 204 would have reduced attrition by 3 percent (from 24% to 21%), while reducing the recruit population qualified for the GSE 4YO program by only 5 percent (61% - 56%). Raising the minimum qualifying score further did not reduce attrition appreciably; however, it did eliminate large numbers of potentially successful students from qualifying for the GSE 4YO program.

For the GSM 4YO program, minimum qualifying scores for AR+MK+EI+GS (replacement composite) would normally be evaluated using the theoretically-based Taylor Russell tables (1939). However, one was not developed for this study because it was inappropriate to assume that the validities obtained from the school data, which did not include attrites, could be generalized to the expectancy data, which included attrites. Instead, a rough estimate of 6-percent reduced attrition was made using AR+MK+EI+GS=204; 3 percent for raising the GSM 4YO selection standard from MK+AS=96 to the current GSE 4YO standard (AR+MK+EI+GS=200), and an additional 3 percent associated with raising the AR+MK+EI+GS minimum qualifying score from 200 to 204.

Using AR+MK+EI+GS=204 would be expected to have a greater impact on attrition for the GSM 4YO program than for the GSE 4YO program because (1) the GSM 4YO program currently has a less stringent ASVAB requirement than the GSE 4YO program (74% of the recruit population qualify for the GSM 4YO program with MK+AS=96; 61% qualify for the GSE 4YO program with AR+MK+EI+GS=200) and (2) academic attrition is higher for the GSM 4YO program than for the GSE 4YO program (8% versus 5%, respectively, from expectancy data; 14% versus 10%, respectively, from the NITRAS data).

Minimum Qualifying Scores: GSE/GSM 6YO Programs

For both the GSE 6YO and GSM 6YO programs (Tables C-2 and C-3, respectively), lowering the minimum qualifying score for AR+MK+EI+GS from 218 to 210 would have qualified 10 percent more of the recruit population than now qualify for the programs (from 39% to 49%) without increasing attrition (graduation rates remain stable at 85% for GSE 6YO; 86% for GSM 6YO).

Evaluation of MK+EI+GS and MK+AS Minimum Qualifying Scores: 6YO Program

For the GSE/GSM 6YO programs, data from the recruit population were analyzed to evaluate the MK+EI+GS=156 and MK+AS=96 requirements. Of recruits qualified for the 6YO programs with an AR+MK+EI+GS score of 218 or above, 99.8 percent scored 156 or above on MK+EI+GS, while 99.4 percent scored 96 or above on MK+AS, which suggests that neither requirement was an effective screen for the programs.

RECOMMENDATIONS

The following recommendations are addressed to PERS-23:

1. The GSE 4YO program should (a) retain the operational selector composite, AR+MK+EI+GS, and (b) raise the minimum qualifying score from 200 to 204 to reduce attrition.

2. The GSM 4YO program should (a) replace the operational selector composite, MK+AS, with AR+MK+EI+GS, the operational selector composite for the GSE 4YO program and (b) use the 204 minimum qualifying score recommended for the GSE 4YO program.

3. The GSE/GSM 6YO programs should: (a) retain one of two operational selector composites, AR+MK+EI+GS, and eliminate the other, MK+AS, (b) lower the minimum qualifying score for AR+MK+EI+GS from 218 to 210, and (c) eliminate the MK+EI+GS=156 requirement.

Adopting these recommendations should: (1) reduce attrition for the 4YO programs, (2) increase the number of qualified recruits for the 6YO programs, and (3) reduce the number of ASVAB selector composites used by the GS rating from two to one.

REFERENCES

Lawley, C. (1943-1944). A note on Karl Pearson's selection formulae. *Royal Society of Edinburgh, Proceedings, Section A, 62*, 28-30.

Prestwood, J. S., Vale, C. D., Massey, R. H., & Welsh, J. R. (1985). *Armed Services Vocational Aptitude Battery equating and implementation of Forms 11, 12, and 13 in the 1980 youth population metric* (AFHRL-TP-85-21). Brooks AFB, TX: Air Force Human Resources Laboratory, Manpower and Personnel Division.

SPSS^{x} user's guide. (1983). New York: McGraw-Hill.[4]

Taylor, H. C., & Russell, J. T. (1939). The relationship of validity coefficients to the practical effectiveness of tests in selection: Discussion and tables. *Journal of Applied Psychology, 23*, 565-578.

[4]Cited in Appendix B.

APPENDIX A

CORRECTION PROCEDURE USED IN METHOD II

CORRECTION PROCEDURE USED IN METHOD II

In order for the regression analysis used to derive the ASVAB composite most predictive of final school grade (FSG) not to be biased against ASVAB tests used for school selection, ASVAB correlations with FSG are first corrected for restriction in range. The ASVAB/FSG intercorrelation matrix for the test selection sample and the ASVAB intercorrelation matrix for the Navy applicant population are used in a multivariate correction procedure (Lawley, 1943) to produce estimated population ASVAB/FSG correlations (used to complete the population matrix). The population ASVAB/FSG intercorrelation matrix is then used, as in Method I, to identify the ASVAB composite most predictive of FSG.

The data used in the multivariate correction procedure and the population ASVAB/FSG validity vector are presented on the next page for the GSM 6YO program.

GSM 6YO Test Selection Sample Intercorrelations with Means and Standard Deviations

	GS	AR	NO	CS	AS	MK	MC	EI	VE	FSG	Mean	SD
GS	1.000	.078	-.057	-.103	.338	.085	.401	.330	.583	.010	58.52	4.96
AR		1.000	.251	.073	.150	.356	.288	.042	.200	.305	55.39	5.25
NO			1.000	.584	-.177	.302	-.116	-.222	-.059	.205	51.35	7.11
CS				1.000	-.166	.100	-.065	-.110	.006	.127	51.67	6.11
AS					1.000	-.172	.476	.458	.346	.068	61.26	6.23
MK						1.000	.181	-.098	.033	.244	54.85	6.03
MC							1.000	.360	.334	.218	59.25	6.18
EI								1.000	.357	.049	60.89	5.16
VE									1.000	.092	55.33	4.55
FSG										1.000	90.43	4.24

Population (Applicant FY87) Intercorrelations with Means and Standard Deviations

	GS	AR	NO	CS	AS	MK	MC	EI	VE	Mean	SD
GS	1.000	.607	.231	.228	.511	.596	.648	.667	.786	51.88	8.48
AR		1.000	.452	.380	.410	.751	.642	.535	.634	51.45	8.49
NO			1.000	.611	.033	.452	.228	.144	.310	53.12	7.56
CS				1.000	.048	.368	.230	.166	.333	52.72	7.67
AS					1.000	.274	.629	.656	.454	52.91	9.14
MK						1.000	.576	.484	.562	51.20	8.74
MC							1.000	.664	.604	53.15	9.37
EI								1.000	.603	52.12	9.06
VE									1.000	52.33	7.02

Correlations (Validities) for Population from Multivariate Correction Program and above Matrices

	GS	AR	NO	CS	AS	MK	MC	EI	VE
FSG	.345	.544	.364	.301	.287	.500	.483	.371	.400

APPENDIX B

MULTIPLE REGRESSION FOR METHODS I AND II

MULTIPLE REGRESSION FOR METHODS I AND II

GSM 6YO Data
Method I (AR+MK+MC+NO)

TEST	STEP	MULTR	RSQ	F	FSIG	RSQCH	FCH	SIGCH	REG-DF	RES-DF
AR	1	.3050	.0931	23.70	.000	.0931	23.70	.000	1	213
MK	2	.3379	.1142	14.82	.000	.0211	5.49	.020	2	230
MC	3	.3597	.1294	11.34	.000	.0152	4.00	.047	3	229
NO	4	.3836	.1471	9.83	.000	.0177	4.74	.030	4	228

Recruit Applicant Population (FY87)
Method II (AR+MC+NO+MK)

TEST	STEP	MULTR	RSQ	RSQCH
AR	1	.5440	.2959	.2959
MC	2	.5714	.3264	.0305
NO	3	.5904	.3485	.0221
MK	4	.5955	.3547	.0061

The multiple regression results (SPSS^x, 1983) for Method I show that, in Step 2, the MK test was entered into an equation with AR to predict final school grade (FSG). The multiple correlation for the composite AR+MK is .3379, while the squared multiple correlation is .1142 (the proportion of FSG variance accounted for by the composite). The F statistic to determine the significance of the multiple correlation is 14.82, while the probability that the predictive relationship is due to chance is less than .001. The change in the squared multiple correlation upon entering the MK test into the equation is .0211. The F statistic for change is 5.49, while the probability that the change is due to chance is .020. The regression and residual degrees of freedom are 2 and 230, respectively.

Method II is based on corrected correlations. Since there are no appropriate significance tests for corrected correlations, the F tests do not apply.

APPENDIX C

EXPECTANCY TABLES FOR THE GSE 4YO, GSE 6YO, AND GSM 6YO PROGRAMS

EXPECTANCY TABLES FOR THE AC AND AW "A" SCHOOLS

The following tables show a range of operational selector composite scores for the GSE 4YO, GSE 6YO, and GSM 6YO "A" school samples that include the current and proposed minimum qualifying score. A breakdown for each score includes actual graduation and attrition rates for the school sample and expected rates (per 1,000) for the recruit population (FY87, N = 89,328).

Table C-1

Expectancy Table for the Operational Selector Composite (AR+MK+EI+GS) for the GSE 4YO "A" School Sample (N = 178)

Composite Score		School Sample Grad N	Drop N	Total N	Grad %	Drop %	At or Above Composite Score in Recruit Population (%)	Expectancies per 1,000 Recruits Total N	Grad N	Drop N
≥		134	44	178	75	25				
≥	.	.	.	.	.	.	.	.	.	.
≥	.	.	.	.	.	.	.	.	.	
≥	195	130	40	170	76	24	67	670	509	161
≥	196	139	40	169	76	24	66	660	502	158
≥	197	129	40	169	76	24	65	650	494	156
≥	198	129	39	168	77	23	64	640	493	147
≥	199	128	39	167	77	23	62	620	477	143
≥	**200[a]**	**126**	**36**	**165**	**76**	**24**	**61**	**610**	**464**	**146**
≥	201	125	36	161	78	22	60	600	468	132
≥	202	120	33	155	78	22	59	590	460	130
≥	203	115	32	147	78	22	58	580	452	128
≥	**204[b]**	**112**	**29**	**141**	**79**	**21**	**56**	**560**	**442**	**118**
≥	205	111	29	140	79	21	55	550	434	116
≥	206	107	29	136	79	21	54	540	427	113
≥	207	104	27	131	79	21	52	520	411	109
≥	208	102	25	127	80	20	51	510	408	102
≥	209	95	22	117	81	19	50	500	405	95
≥	210	90	22	112	80	20	49	490	392	98
≥	211	88	21	109	81	19	48	480	389	91
≥	212	84	21	105	80	20	46	460	368	92
≥	213	83	19	102	81	19	45	450	364	86
≥	214	82	18	100	82	18	44	440	361	79
≥	215	76	17	93	82	18	43	430	353	77
≥	.	.	.	.	.	.	.	.	.	.
≥	.	.	.	.	.	.	.	.	.	.

Note. Of the 13 students who scored below the minimum qualifying score of 200 (waivers), 8 (62%) were attrites (designated as drop). Waivers constituted approximately 7 percent of the sample.

[a]Current minimum qualifying score.

[b]Proposed minimum qualifying score.

Table C-2

Expectancy Table for the Operational Selector Composite (AR+MK+EI+GS) for the GSE 6YO "A" School Sample (N = 383)

Composite Score		School Sample Grad N	Drop N	Total N	Grad %	Drop %	At or Above Composite Score in Recruit Population (%)	Expectancies per 1,000 Recruits Total N	Grad N	Drop N
≥		322	61	383	84	16				
≥	.	.	.	.	.	.	.	.	.	.
≥	.	.	.	.	.	.	.	.	.	.
≥	203	321	61	382	84	16	58	580	487	93
≥	204	321	61	382	84	16	56	560	470	90
≥	205	320	60	380	84	16	55	550	462	88
≥	206	320	59	379	84	16	54	540	454	86
≥	207	320	59	379	84	16	52	520	437	83
≥	208	319	59	378	84	16	51	510	428	82
≥	209	318	59	377	84	16	50	500	420	80
≥	**210[a]**	**317**	**57**	**374**	**85**	**15**	**49**	**490**	**416**	**74**
≥	211	316	57	373	85	15	47	470	400	70
≥	212	316	57	373	85	15	46	460	391	69
≥	213	315	57	372	85	15	45	450	382	68
≥	214	314	57	371	85	15	44	440	374	66
≥	215	314	57	371	85	15	43	430	366	64
≥	216	313	57	370	85	15	42	420	357	63
≥	217	311	57	368	84	16	41	410	344	66
≥	**218[b]**	**310**	**55**	**365**	**85**	**15**	**39**	**390**	**332**	**58**
≥	219	302	53	355	85	15	38	380	323	57
≥	220	294	49	343	86	14	37	370	318	52
≥	221	284	46	330	86	14	36	360	310	50
≥	222	275	44	319	86	14	35	350	301	49
≥	223	269	43	312	86	14	33	330	284	46
≥	.	.	.	.	.	.	.	.	.	.
≥	.	.	.	.	.	.	.	.	.	.

Note. Of the 18 students who scored below the minimum qualifying score (218 (waivers), 6 (33%) were attrites (designated as drop). Waivers constituted approximately 4 percent of the sample.

[a]Proposed minimum qualifying score.

[b]Current minimum qualifying score.

Table C-3

Expectancy Table for the Operational Selector Composite (AR+MK+EI+GS) for the GSM 6YO "A" School Sample (N = 218)

Composite Score		School Sample Grad N	Drop N	Total N	Grad %	Drop %	At or Above Composite Score in Recruit Population (%)	Expectancies per 1,000 Recruits Total N	Grad N	Drop N
≥		425	70	495	86	14				
≥	.	.	.	.	.	.	.	.	.	.
≥	.	.	.	.	.	.	.	.	.	.
≥	203	414	65	479	86	14	58	580	499	81
≥	204	414	65	479	86	14	56	560	482	78
≥	205	414	64	478	87	13	55	550	478	72
≥	206	414	64	478	87	13	54	540	470	70
≥	207	412	64	476	87	13	52	520	452	68
≥	208	410	64	474	86	14	51	510	439	71
≥	209	407	63	470	87	13	50	500	435	65
≥	**210[a]**	**404**	**63**	**467**	**86**	**14**	**49**	**490**	**421**	**69**
≥	211	403	63	466	86	14	48	480	413	67
≥	212	400	63	463	86	14	46	460	396	64
≥	213	399	63	462	86	14	45	450	387	63
≥	214	394	63	457	86	14	44	440	378	62
≥	215	391	63	454	86	14	43	430	370	60
≥	216	390	63	453	86	14	42	420	361	59
≥	217	387	62	449	86	14	41	410	353	57
≥	**218[b]**	**380**	**62**	**442**	**86**	**14**	**39**	**390**	**335**	**55**
≥	219	363	60	423	86	14	38	380	327	53
≥	220	342	59	401	85	15	37	370	314	56
≥	221	331	56	387	86	14	36	360	310	50
≥	222	318	53	371	86	14	35	350	301	49
≥	223	295	50	345	86	14	33	330	284	46
≥	.	.	.	.	.	.	.	.	.	.
≥	.	.	.	.	.	.	.	.	.	.

Note. Of the 53 students who scored below the minimum qualifying score of 218 (waivers), 8 (15%) were attrites (designated as drop). Waivers constituted approximately 11 percent of the sample.

[a]Proposed minimum qualifying score.

[b]Current minimum qualifying score.

DISTRIBUTION LIST

Distribution:
Chief of Naval Personnel (PERS-2), (PERS-23), (PERS-234)
Defense Technical Information Center (2)

Copy to:
Chief of Naval Technical Training (Code 00) (2)
Chief of Naval Education and Training (00)
Commander, Navy Recruiting Command
Superintendent, Naval Postgraduate School
Director of Research, U.S. Naval Academy
Commanding Officer, U.S. Coast Guard Research and Development Center, Avery Point, Groton, CT
Commander, U.S. ARI, Behavioral and Social Sciences, Alexandria, VA (PERI-POT-I)
Department of the Air Force, DET 5, Armstrong Laboratory Directorate, Brooks Air Force Base, TX
HQ USMEPCOM/MEPCPAT-A, North Chicago, IL