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**Development of an Alternate Form
of the
Navy Officer Classification Battery**

William G. Mollenkopf

Educational Testing Service
under
Contract No. Nonr-694(00)

**Classification & Survey Research Branch
Personnel Analysis Division**

1 May 1954



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Abstract

Following specifications laid down by the Classification and Survey Research Branch, Personnel Analysis (formerly Research) Division, Bureau of Naval Personnel, staff members of the Educational Testing Service have developed an alternate form of the Navy Officer Classification Battery, and an additional form of the Mechanical Comprehension Test of this battery.

Test questions were tried out at the U. S. Naval School, Officer Candidate, at Newport. Item difficulty and item discrimination indices were then derived, and constituted an important element in the process of selecting items for use in the alternate forms of the tests.

After the tests had been printed by the government, the standardization of the tests was carried out by ETS with the further cooperation of the Officer Candidate School. As a final step in the project, conversion tables were prepared linking raw scores on each test to raw scores on the previous test form and to the Navy Standard Score scale.

Correlational and other statistical data obtained during the standardization indicated that a satisfactory alternate form of the battery and a satisfactory additional form of the Mechanical Comprehension Test had been prepared.

Acknowledgments

The cooperation of Captain Ralph B. Johnson, Commanding Officer, U. S. Naval Schools Command, Newport, Rhode Island, made possible the pretesting of test materials and the standardization of the new tests. His help is gratefully acknowledged.

Lieutenant Commander George B. Strother, OCS Interviewing Officer during most of the period covered by this report, made the arrangements for and supervised both of the pretest administrations as well as the testing required for the standardization of the five tests of Form 3 of the battery. Lieutenant Commander D. M. Letts, his successor as Interviewing Officer, arranged for and supervised the testing needed in the standardization of the Mechanical Comprehension Test Form 2 Revised. The help of Commanders Strother and Letts and the other officers and men of the Officer Candidate School who participated in the carrying out of this testing is also gratefully acknowledged.

Thanks are also due to Professor Nelson Beeler of the New York State Teachers College, Potsdam, New York, and to Professor Walter Johnson of Princeton University, who helped with the development of the three Mechanical Comprehension Tests.

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DEVELOPMENT OF AN ALTERNATE FORM
OF THE
NAVY OFFICER CLASSIFICATION BATTERY

Introduction

In the chapter on "Basic Tests for Officer Personnel" in Personnel Research and Test Development in the Bureau of Naval Personnel, there is reported the background for the development of the Officer Classification Battery currently in use by the Navy. The predecessor of this battery was the Officer Classification Test. A revision of the latter-named test, including the introduction of a Relative Movement section, was named the Officer Classification Battery. Hence the "first" form of the Battery was labelled Form 2.

The Battery consists of five tests, as follows:

I	Verbal Reasoning	75	five-choice items
II	Mechanical Comprehension	48	five-choice items
III	Mathematics	50	five-choice items
IV	Relative Movement	50	four-choice items
V	Spatial		
	A. Block Assembly	30	four-choice items
	B. Block Recognition	30	five-choice items

Late in 1951 the Classification and Survey Research Branch, Research Division, Bureau of Naval Personnel, and the Personnel and Training Branch, Psychological Sciences Division, Office of Naval Research, jointly agreed to support a research and development project to be carried out by Educational Testing Service. One of the major tasks to be accomplished under this contract was the development of an alternate form of the Officer Classification Battery.

Test Specifications

Specifications for the new set of tests were essentially given by the statement that an alternate form of each test was desired. To permit use of either Form 2 or the new Form 3 without major change in administrative procedures, it was specified to ETS that each of the various

tests in the new form of the battery should contain the same number of items as had that in Form 2, and that no drastic changes in directions or time limits should be contemplated.

After a thorough review of the existing test forms by members of the ETS Test Development staff, recommendations were made to the Classification and Survey Research Branch which led to the following additional specifications:

1. Verbal Reasoning Test

- a. While not to be strictly and solely of the science analogy type, items were to avoid words that were especially literary or artistic in flavor.
- b. The test directions were to be edited to improve clarity through minor changes in wording.
- c. The format of the items was to be modified to secure greater clarity.

2. Mechanical Comprehension Test

Whenever possible, all choices provided for a test item were to be presented in a single line.

3. Mathematics Test

Items were to be constructed which would emphasize aptitude rather than achievement in mathematics, for persons who had completed undergraduate work in college.

4. Relative Movement Test

- a. Items in the existing test were to be paralleled in the the new form by corresponding items requiring similar mental operations.
- b. Directions were to be edited to improve clarity. Definitions of certain terms, e.g., knot, were to be added.

5. Spatial Relations Test

It was specified that items in Form 3 of this test were to be of a somewhat greater average difficulty than those for Form 2. For best measurement, it seemed especially desirable to step up the difficulty of the Block Assembly section.

Development of the Alternate Form

Pretests. In order that a sufficient number of items of appropriate difficulty and discriminative power might become available, it was decided to develop and try out twice as many new items as would be required in the alternate form.

Items were prepared by members of the staffs of various sections of the ETS Test Development Department. In the case of Mechanical Comprehension items, the assistance of other professional help was enlisted, as noted in the Acknowledgments. Two sets of five booklets, coded AOCX1 and AOCX2 respectively, were then produced containing items deemed acceptable for try-out. Each booklet in each case contained the same number of items as had the corresponding test in Form 2 of the Officer Classification Battery. This latter fact permitted the try-out administrations to be carried out using the special IBM answer sheets which are employed with Form 2.

The AOCX1 pretests were administered to 682 men in Class 6 at the U. S. Naval School, Officer Candidate, Newport, Rhode Island, on July 21-22, 1952. Seven hundred and thirteen members of Class 7 at this school were given the AOCX2 pretests on August 22-23, 1952.

The time limits for several of these pretests were made somewhat longer than those used with the actual operational forms in order to ensure that most of the pretest group would have sufficient time to attempt every item in the test. When severe drop-out occurs in a try-out administration, item-analysis data for late-occurring items may be of dubious value or even misleading. The longer time limits were expected to guarantee freedom from any high degree of drop-out, and this expectation was in fact borne out.

The numbers of items contained in each of the pretests and the amounts of working time (exclusive of directions) for each are shown in Table 1.

Table 1

Numbers of Items in and Time Limits of
Officer Classification Battery Pretests

Pretest	No. of Items	Time Limit, Minutes
1. Verbal Reasoning	75	35
2. Mechanical Comprehension	48	40
3. Mathematics	50	75
4. Relative Movement	50	50
5. Spatial Relations:		
Block Assembly	30	18
Block Recognition	30	22

Item Analyses. In order that items might be selected for each new test which would measure the same ability or composite of abilities as was assessed by the existing test form, it was decided to use as one of the principal means of selecting items the correlation between performance on an item and the score on the corresponding Form 2 test. Answer sheets for Form 2 were supplied by the Officer Candidate School for men who had taken the pretests. After these had been arranged in alphabetical sequence, a spaced sample of 370 answer sheets was drawn.

A modification of the upper-lower group item-analysis procedure developed by Flanagan was employed. For each pretest, the responses on the answer sheets of the 100 men with highest and the 100 men with lowest scores on the corresponding Form 2 test were punched into IBM cards. The IBM tabulator was then used to print onto special item-analysis forms the number of persons in each of these groups marking each response to each item, the number omitting, and the number reaching and attempting the item.

From the proportions marking the correct response in the high and low groups, P_H and P_L , there were then obtained an item discrimination index, r , and an index of item difficulty, Δ . The discrimination index is the correlation which corresponds to the obtained values of P_H and P_L in a normal bivariate distribution in which the criterion score (the basis of selection of the upper- and lower-27-per-cent groups)

is plotted against the continuous variable assumed to underlie responses to the item.

Delta (Δ) is an index of item difficulty developed originally by C. R. Brolyer for use in the test development work of the College Entrance Examination Board. As employed in the current project, delta is defined as follows:

$$\Delta_i = 13 + 4 x_i$$

where

Δ_i = the delta index of item difficulty, and

x_i = the abscissal distance in sigma units from the mean to the point whose ordinate cuts off an area under the unit normal curve corresponding to the proportion of those attempting the item who mark the correct response.

In this equation, the sign of x_i is taken to be positive when $p < .50$, and negative when $p > .50$. The numbers 13 and 4 were chosen so as to yield an item-difficulty scale the values along which are positive numbers. The mean of the scale values is, of course, 13, and the standard deviation is 4. (See C. T. Fan's Item-Analysis Table, Educational Testing Service, 1952, for further description of this item-analysis technique.)

Since the item-analysis data for the first try-out form (AOCX1) were based upon a group different from that used for the second try-out form (AOCX2), there arose a need for considering whether difficulty values for one group would be comparable with those for the second group. Any differences in level and variability of talent from one group to the other would naturally be reflected in the item-analysis data.

Availability of the five Form 2 O.C.B. scores for each group made possible a comparison of the test performances of the item-analysis groups. The Officer Candidate School made available to ETS the average score on each of the five tests in the battery for all candidates tested over a year's time. From study of these data, which are summarized in Table 2, it became clear that the group tested with Form

AOCX2 had been somewhat superior to that tested with AOCX1, and that the AOCX2 group more closely resembled in mean score, test by test, the total group entering OCS in the year period.

Table 2
Means and Standard Deviations of
Raw O.C.B. Test Scores for Two Try-out Groups,
and Means for Entire-Year OCS Group

Test	AOCX1 Group		AOCX2 Group		Year Group
	M	σ	M	σ	
1. Verbal Reasoning	50.1	10.7	51.4	10.7	53
2. Mechanical Comprehension	29.0	6.8	29.4	6.9	29
3. Mathematics	27.0	6.1	29.3	7.2	29
4. Relative Movement	22.4	5.3	24.4	5.5	24
5. Spatial Relations					
Block Assembly	21.2	3.6	21.4	3.6	41 (total)
Block Recognition	18.4	5.2	19.2	5.1	

It was therefore decided to adjust the AOCX1 item-difficulty indices so as to make these comparable with those for AOCX2. The process for carrying out this operation will be illustrated using the data for the Verbal Reasoning try-out tests as an example.

First, there are computed the parameters a' and b' required for transforming the AOCX2 scores so that the converted scores have a mean and standard deviation of 13 and 4 respectively:

$$a' = \frac{4}{\text{AOCX2 Verbal mean}}$$

$$a' = \frac{4.0000}{10.6506} = .3756$$

$$b' = 13 - a' (51.3946) = -6.3038$$

The AOCX1 mean and standard deviation are next converted by use of the parameters a' and b'. The resulting values are estimates of the mean and standard deviation of the adjusted difficulty indices (deltas):

$$\begin{aligned}M_{\Delta'} &= a' (\text{Mean AOCX1 Verbal}) - b' \\ &= a' (50.1081) - b' \\ &= (.3756) (50.1081) - 6.3038 \\ &= 12.5168 \\ \sigma_{\Delta'} &= a' (\sigma \text{ AOCX2 Verbal}) \\ &= a' (10.7212) \\ &= (.3756)(10.7212) \\ &= 4.0269\end{aligned}$$

The values of $M_{\Delta'}$ and $\sigma_{\Delta'}$ are estimates of what the mean and standard deviation of the AOCX1 Verbal Reasoning difficulty indices would have been if the AOCX1 try-out group had paralleled the AOCX2 group in Form 2 Verbal Reasoning scores.

There is still needed a technique for adjusting the difficulty index for a single item. This requires the obtaining of values for parameters a and b in the equation

$$\Delta_i' = a \Delta_i + b \quad ,$$

in which

Δ_i = the difficulty value of a given item as observed for the AOCX1 try-out group, and

Δ_i' = the adjusted item difficulty: the item difficulty estimated for a group equal in Verbal Reasoning ability to the AOCX2 group.

The values of the parameters are computed as follows:

$$a = \frac{\sigma_{\Delta_1'}}{4}$$
$$= \frac{4.0269}{4.0000} = 1.01$$

$$b = M_{\Delta_1'} - 13 a$$
$$= 12.5168 - (1.01) (13)$$
$$= - 0.61$$

The conversion equation thus is

$$\Delta_1' = 1.01 \Delta_1 - 0.61$$

In Tables A-1 through A-7 of the Appendix there is presented detailed information on the item-analysis characteristics of all the items pretested. In these tables, the reported difficulty indices for AOCXI items have been adjusted by the procedure described above.

In the cases of the Verbal Reasoning and Relative Movement pretests, further item analyses were carried out, this time against the criterion of score on the particular pretest itself. Staff personnel responsible for development of these two tests believed this additional information would be helpful in the selection of items for the operational form.

Selection of Items. Items for inclusion in the new Form 3 were selected, largely on the basis of item-analysis characteristics, so as best to meet the specifications laid down for the alternate form. Naturally, the professional judgment of the test constructor with regard to the items also played an important role. This was especially true whenever more items having given combinations of characteristics were available than were required for Form 3.

Table 3
Parameters of Equations* for Adjusting
AOCX1 Difficulty Indices (Deltas) to AOCX2 Scale

Test	a	b
1. Verbal Reasoning	1.01	-0.61
2. Mechanical Comprehension	0.98	-0.02
3. Mathematics	0.84	0.81
4. Relative Movement	0.95	-0.78
5. Spatial Relations		
Block Assembly	1.02	-0.47
Block Recognition	1.02	-0.84

* Each equation is of the form

$$\Delta'_i = a \Delta_i + b$$

in which Δ_i = observed AOCX1 difficulty index

Δ'_i = adjusted difficulty index

In Tables A-1 through A-7 of the Appendix there are indicated the characteristics of the items selected for use, as contrasted with those for items not chosen for inclusion. Summary data on selected items, in the form of median item-analysis indices, are presented in Table 4.

Table 4
Median Item-Difficulty Indices and
Median Item-Discrimination Indices of
Items Selected for Form 3

Test	Median Δ	Median r	
		vs. score on Form 2 test	vs. score on pre- test
1. Verbal Reasoning	11.3	.34	.42
2. Mechanical Comprehension	12.1	.41	--
3. Mathematics	10.7	.42	--
4. Relative Movement	10.4	.23	.44
5. Spatial Relations	10.8	.44	--

Preparation of Test Copy and Reproduction. The selected items were arranged in order of difficulty. Photo-offset copy was then prepared and forwarded to the Bureau of Naval Personnel. Actual reproduction of the tests was carried out by the government.

Standardization

The standardization of the new Form 3 was carried out using as subjects 1067 members of Class 11 at the Officer Candidate School. Approximately half of the men were tested first with one form, then the second, and the other half tested with the forms reversed in order, as follows:

Test	Group A N = 527	Group B N = 540
1. Verbal Reasoning	Form 2 Form 3	Form 3 Form 2
2. Mechanical Comprehension	Form 2 Form 3	Form 3 Form 2
3. Mathematics	Form 2 Form 3	Form 3 Form 2
4. Relative Movement	Form 2 Form 3	Form 3 Form 2
5. Spatial Relations	Form 2 Form 3	Form 3 Form 2

Three testing periods were used: 0800-1100 and 1500-1700 on March 13 and 0800-1045 on March 14. Use of these spread-out periods, together with "breaks" during the periods, assured that fatigue would be kept from influencing the results in any appreciable way. Counterbalancing the order of presentation for the two approximate halves of the class made possible an evaluation of the practice effect, that is, the gain in score on a second form which might be attributed to having taken first another form of the test.

In Table 5 are presented the descriptive statistics for the five pairs of test forms for the two different sequences of administration. It is evident that the practice effect was quite small in the cases of the Verbal Reasoning Test and Mechanical Comprehension Test. For the other three tests, the practice effect ranged from a little less than a fifth to somewhat over a half of a standard deviation. There seemed to be a slight tendency, in the cases of these latter three tests, for the transfer from Form 3 to Form 2 to be a little higher than that from Form 2 to Form 3. It may be that this demonstrates that the attention devoted to improving clarity of test directions thus was reflected in test performances; the results cited are consistent with such a hypothesis.

Table 5

Raw-Score Means and Standard Deviations of O. C. B. Tests
for Form 2 - Form 3 and Form 3 - Form 2 Orders
of Administration During Standardization

Test		Order			
		Form 2-Form 3 N = 527		Form 3-Form 2 N = 540	
		M	S.D.	M	S.D.
1. Verbal Reasoning	Form 2	47.1	10.4	48.0	10.9
	Form 3	47.7	9.2	47.6	9.4
2. Mechanical Comprehension	Form 2	26.6	7.1	26.6	7.1
	Form 3	22.9	7.1	22.5	7.2
3. Mathematics	Form 2	24.7	7.2	26.4	8.0
	Form 3	25.3	8.3	23.3	7.7
4. Relative Movement	Form 2	22.9	5.5	26.2	6.2
	Form 3	27.1	6.9	25.0	6.3
5. Spatial Relations	Form 2	39.3	8.2	42.8	8.3
	Form 3	36.1	9.9	34.4	9.9

In Table 6 are given correlations between the two forms of each of the five O. C. B. tests for each order of administration. The observed inter-form correlation for the Relative Movement Test was the only one to go below .80. However, this finding is consistent with information which the Classification and Survey Research Branch has obtained regarding the reliabilities of the O. C. B. tests. For both an Annapolis and a General Line School sample, the reliability of this test was estimated as being approximately .70, using a Kuder-Richardson formula. The inter-form correlation, of course, represents an alternative method of assessing test reliability, providing the test forms are considered parallel. In the present instance, then, the lower inter-form correlation observed in the case of the Relative Movement Test should not come as any surprise. In fact, that the observed correlation is as high as it is gives added confidence that the two forms measure essentially the same composite of mental abilities.

Table 6
Correlations between Scores
on Forms 2 and 3 of O. C. B. Tests

Test	Correlation	
	Form 2-Form 3 N = 527	Form 3-Form 2 N = 540
1. Verbal Reasoning	.81	.82
2. Mechanical Comprehension	.80	.80
3. Mathematics	.86	.86
4. Relative Movement	.70	.71
5. Spatial Relations	.85	.83

It can in addition be pointed out that, as a precaution, another check on the new Relative Movement Test had already been carried out, using as subjects 1107 members of Class 10 at the Officer Candidate School. The correlations observed between the two forms were .71 and .69 for the Form 2 - Form 3 and Form 3 - Form 2 orders, respectively. The two sets of results were thus very consistent.

Conversion Tables. As the final step in the development of an alternate form of O. C. B. there remained the construction of tables for the conversion of raw scores on the new test forms to the Navy Standard Score scale. There already existed, of course, a conversion table for this purpose for use with Form 2 scores; it was desired to link Form 3 raw scores into this table. The problem was consequently defined as that of determining what raw score on the newer Form 3 corresponded to a given raw score on Form 2. For this linking together of scores on two alternate forms, a linear model seemed distinctly appropriate. Thus, the problem became one of determining proper values for the constants a and b in the conversion equation

$$Y^* = aY + b \quad , \quad (1)$$

in which Y represents raw score on Form 3 and Y* is the converted score that corresponds to a given score on Form 2.

It was noted earlier that the order of administration was counter-balanced, Form 2 being given to half the group first and Form 3 being given to an equivalent half first, and that this testing arrangement made possible an estimate of the practice effect. The next problem was to estimate from the statistics at hand the means and standard deviations for tests in Forms 2 and 3 that would be found if there were no practice effect. The formulas used in obtaining the values are given below. In these formulas, statistics relating to the group taking test form X first are denoted by a single prime, whereas those relating to the group taking test form Y first are denoted by a double prime; X represents a raw score on Form 2; Y, a raw score on Form 3.

$$\bar{X} = \frac{1}{2} (\bar{X}' + \bar{X}'' - K_X) \quad . \quad (2)$$

$$\bar{Y} = \frac{1}{2} (\bar{Y}' + \bar{Y}'' - K_Y) \quad . \quad (3)$$

$$\frac{K_X}{S_X} = C \quad . \quad (4)$$

$$\frac{K_Y}{S_Y} = C \quad . \quad (5)$$

$$C = \frac{1}{2} \left(\frac{\bar{X}'' - \bar{X}'}{S_X} + \frac{\bar{Y}'' - \bar{Y}'}{S_Y} \right) \quad . \quad (6)$$

$$S_X^2 = \frac{1}{2} (S_{X'}^2 + S_{X''}^2) \quad . \quad (7)$$

$$S_Y^2 = \frac{1}{2} (S_{Y'}^2 + S_{Y''}^2) \quad . \quad (8)$$

In the above set of equations, equations (2) and (3) provide the best estimates of the mean of Form 2 and Form 3, respectively, taking into account both orders of administration. K_X and K_Y represent increments due to practice effect. Equations (4) and (5) state the assump-

tion that these increments are proportional to the standard deviations of the tests, and equation (6) provides a means for estimating the constant of proportionality. The assumption that the practice effect on each test is proportional to its standard deviation seems reasonable to make in this situation, wherein the pairs of tests are alternate forms.

By appropriate algebraic manipulations of equations (1) through (8), equation (1) can be restated as

$$Y^* = \frac{S_X}{S_Y} (Y - \frac{1}{2}\bar{Y}' - \frac{1}{2}\bar{Y}'') + \frac{1}{2}(\bar{X}' + \bar{X}'') \quad . \quad (9)$$

If we now define

$$A = \frac{S_X}{S_Y}$$

and

$$B = \bar{X} - A\bar{Y} \quad ,$$

we may then re-write (9) as

$$Y^* = AY + B \quad .$$

In Table 7 there are given the values of A and B for converting raw scores on each of the five Form 3 tests so as to make them comparable with raw scores on the corresponding Form 2 test. By use of the resulting conversion equations, it was possible to develop conversion tables for use with the new test forms. In these tables, not only are raw scores on the two forms linked, but also there are indicated the Navy Standard Scores corresponding to particular raw scores on either test form. In making these tables, the relationship between Form 2 test scores and Navy Standard Scores was carried over from tables already in existence, so that whatever meanings had been built up in the several years of experience in the use of Form 2 of the battery could be applied also to Navy Standard Scores derived from the new form of the battery. These conversion tables appear in the Appendix as Tables A-8 through A-12.

Table 7

Coefficients of Conversion Equations

Test	Form 2		Form 3		A	B
	\bar{X}	σ_X	\bar{Y}	σ_Y	(σ_X/σ_Y)	$(\bar{X} - A\bar{Y})$
1. Verbal Reasoning	47.5	10.7	47.7	9.3	1.1436	-6.9809
2. Mechanical Comprehension	26.6	7.1	22.7	7.1	0.9912	4.0780
3. Mathematics	25.6	7.6	24.3	8.0	0.9508	2.4809
4. Relative Movement	24.6	5.9	26.0	6.6	0.8844	1.5160
5. Spatial Relations	41.1	8.3	35.3	9.9	0.8353	11.5833

Additional Form of the Mechanical Comprehension Test

During the course of development of Form 3 of the Officer Classification Battery, the Navy expressed its need for a further form of the Mechanical Comprehension Test. Hence the process of development described above was repeated on a smaller scale to produce this additional test.

An examination of Table A-3 in the Appendix will reveal that following the selection of items for Form 3 of the Mechanical Comprehension Test there still remained some unused items from the try-out forms AOCX1 and AOCX2 which would be suitable for use in an operational test. To secure the additional items that would be required for a 48-item final form, further items were written. Following appropriate review, 60 of these items were then included in a try-out test booklet, called form BOCX1.

This try-out booklet was administered to part of Class 10 at the U. S. Naval School, Officer Candidate, on January 20, 1953. Item analysis, based on 370 of these cases, was carried out using as the criterion the score on Form 2 of the test. Difficulty indices were then brought into line with those for the earlier pretests so that all available items might legitimately be compared in difficulty.

Table A-13 in the Appendix gives information on the difficulty and discrimination indices of items chosen for inclusion in the Mechanical Comprehension Test, Form 2 Revised. As had been true with tests in Form 3, this test was reproduced by the government from photo-offset copy supplied by ETS as the contractor.

Standardization of this new test was carried out in the fall of 1953. Members of Class 14 at the Officer Candidate School served as subjects. Testing was accomplished on September 18. About half of the men (507) took the tests in the regular battery (Form 2) and then the new Mechanical Comprehension Test; the other half of the men (505) took the new Mechanical Comprehension Test in place of the Form 2 test, and then took the Form 2 test after the completion of the other five tests. Data from the standardization are provided in Table 8. The conversion table resulting from the standardization is Table A-14 in the Appendix.

Table 8

Statistical Data from the Standardization of
the Mechanical Comprehension Test, Form 2 Revised

	Form 2	Form 2, Revised
Raw Score Mean	28.84	29.68
Standard Deviation	7.32	7.82
Coefficient A	1.0666	
Coefficient B	-1.0819	
Intercorrelation	.82	

TABLE A-1

Item-Analysis Data: Verbal Reasoning
 Criterion: Score on Test 1, Form 2

Difficulty Index, Δ

Discrimination Index, r	Difficulty Index, Δ																	f used
	5.9 & below	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	16.0-16.9	17.0-17.9	18.0-18.9				
.55 and up							••••											
.50 - .54						••••		•		••••								8
.45 - .49				•		•												4
.40 - .44			••	•••••	•	••	•	•										12
.35 - .39				•	•	•••••	••	••										10
.30 - .34		••	•	••••	•	•••••	•••••	•••••	••••									20
.25 - .29				•	•	•••••	••	••	••	••••								11
.20 - .24			•	••		•••••	•	•	•	•								10
.15 - .19		•			•••••	•••••	•••••											0
.10 - .14		•	•		••••	••••	•	•	••••	•								0
.09 and lower			•	••	•	••••	••••	••••	••••	••••	••••	••••	••••	••••	••••	••••	••••	0
Not Comp.	••••																	0
f used	0	2	4	13	4	6	22	11	8	3	1	0	0	1	0	0	0	

• Item used in Form 3
 ○ Item not used in Form 3

TABLE A-2

Item-Analysis Data: Verbal Reasoning

Criterion: Score on Try-out Test

Difficulty Index, Δ

	Difficulty Index, Δ																f used
	5.9 & below	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	16.0-16.9	17.0-17.9	18.0-18.9			
.55 and up				••••			••••		••••		••••		••••				9
.50 - .54				••	•	••	••	••	••	••	••	••	••	••			11
.45 - .49				••••	•		••	••	••	••	••	••	••	••	••		8
.40 - .44			••	••	•	••	••	••	••	••	••	••	••	••	••		16
.35 - .39			••	••	••	••	••	••	••	••	••	••	••	••	••		14
.30 - .34		••	••	•	••	••	••	••	••	••	••	••	••	••	••		17
.25 - .29				•	••••	••	••	••	••	••	••	••	••	••	••		0
.20 - .24				••	•	••	••	••	••	••	••	••	••	••	••		0
.15 - .19				•	•	•	•	•	•	•	•	•	•	•	•		0
.10 - .14				•			•	•	•	•	•	•	•	•	•		0
.09 and lower			•		•				•••								0
Not Comp.	•••••																0
f used	0	2	4	11	5	12	16	12	9	3	0	1	0	0			

• Item used in Form 3
 ○ Item not used in Form 3

Discrimination Index, r

TABLE A-3

Item-Analysis Data: Mechanical Comprehension

Criterion: Score on Test 2, Form 2

Difficulty Index, Δ

	Difficulty Index, Δ																		f used
	5.9 & below	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	16.0-16.9	17.0-17.9	18.0-18.9					
.55 and up					••	••	•	•	••	••	••	••	••	••	••	••	••	••	5
.50 - .54				••	•	•	•	••	••	••	••	••	••	••	••	••	••	••	4
.45 - .49				•	•	•	•	••	••	••	••	••	••	••	••	••	••	••	10
.40 - .44				•	•	•	•	••	••	••	••	••	••	••	••	••	••	••	8
.35 - .39				•	•	•	•	••	••	••	••	••	••	••	••	••	••	••	10
.30 - .34			•	•	•	•	•	••	••	••	••	••	••	••	••	••	••	••	9
.25 - .29				•	•	•	•	••	••	••	••	••	••	••	••	••	••	••	2
.20 - .24	•				•	•	•	•	•	•	•	•	•	•	•	•	•	•	0
.15 - .19																			0
.10 - .14																			0
.09 and lower			••		•	•	•	•	•	•	•	•	•	•	•	•	•	•	0
Not Comp.																			0
f used	0	0	0	4	6	6	7	8	8	8	2	4	1	1	1	1	1	1	

• Item used in Form 3
 ○ Item not used in Form 3

Discrimination Index, r

TABLE A-4

Item-Analysis Data: Mathematics

Criterion: Score on Test 3, Form 2

Difficulty Index, Δ

Discrimination Index, r	Difficulty Index, Δ																		f used
	5.9 & below	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	16.0-16.9	17.0-17.9	18.0-18.9					
.55 and up					●●●●	●●	●				●							5	
.50 - .54			●●		●	●●												7	
.45 - .49				○	●				●	●								5	
.40 - .44			●	○	●	●●●●	○	●●	●									12	
.35 - .39		●		●●	●●	●●●●	○	○	○	○								12	
.30 - .34		○	●		○	○	○	○	○	○								6	
.25 - .29			○	○		○	○	○	○	○								0	
.20 - .24		○																0	
.15 - .19				○														0	
.10 - .14		○																0	
.09 and lower								○	○									0	
Not Comp.																		0	
f used	0	1	4	2	9	12	8	9	2	2	1	0	0	0	0	0	0		

● Item used in Form 3
○ Item not used in Form 3

TABLE A-5

Item-Analysis Data: Relative Movement

Criterion: Score on Test 4, Form 2

Difficulty Index, Δ

	Difficulty Index, Δ																f used
	5.9 & below	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	16.0-16.9	17.0-17.9	18.0-18.9			
.55 and up						•											1
.50 - .54						•											1
.45 - .49						•											2
.40 - .44		o				•											1
.35 - .39				•		••											3
.30 - .34		•	•			••			•								6
.25 - .29			•			••			•								5
.20 - .24		•				••			••								16
.15 - .19						••			••								8
.10 - .14			••			•			•								7
.09 and lower		o	o			o			o								0
Not Comp.									o								0
f used	0	2	4	4	8	16	6	5	2	3	0	0	0	0			

• Item used in Form 3
o Item not used in Form 3

Discrimination Index, r

TABLE A-6

Item-Analysis Data: Relative Movement

Criterion: Score on Try-out Test

Difficulty Index, Δ

Discrimination Index, r	Difficulty Index, Δ																f used
	5.9 & below	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	16.0-16.9	17.0-17.9	18.0-18.9			
.55 and up					••	••••	••••	••••	••	•	••••	••••	••••	••••	••••	••••	5
.50 - .54		••	•	•	•	••••	••••	••••	••	••	••	••	••	••	••	••	10
.45 - .49			•	••	•	••••	••••	••	•	•	•	•	•	•	•	•	9
.40 - .44			•	••	••	••••	••••	••	••	••	••	••	••	••	••	••	12
.35 - .39			•	••	••	••••	••••	••	••	••	••	••	••	••	••	••	8
.30 - .34			•	••	••	••••	••••	••	••	••	••	••	••	••	••	••	6
.25 - .29			•	••	••	••••	••••	••	••	••	••	••	••	••	••	••	0
.20 - .24			••••	••	••	••	••	••	••	••	••	••	••	••	••	••	0
.15 - .19			••••	••	••	••	••	••	••	••	••	••	••	••	••	••	0
.10 - .14			•	•	•	•	•	•	•	•	•	•	•	•	•	•	0
.09 and lower																	0
Not Comp.	•																0
f used	0	2	4	4	8	16	6	5	2	3	0	0	0	0	0	0	

• Item used in Form 3
 ○ Item not used in Form 3

TABLE A-7

Item-Analysis Data: Spatiol Relations
 Criterion: Score on Test 5, Form 2

Discrimination Index, r	Difficulty Index, Δ																	f used
	5.9 & below	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	16.0-16.9	17.0-17.9	18.0-18.9				
.55 and up				•	••••	••	••	••••	••••	••	••••	•					12	
.50 - .54			•	•	••••	••••	••	••									6	
.45 - .49			•	•	••	••	••	••	••	••	••	••	••	••	••	••	11	
.40 - .44		••••	•	••	••	••	••	••	••	••	••	••	••	••	••	••	14	
.35 - .39			••	•	••	••	••	••	••	••	••	••	••	••	••	••	12	
.30 - .34		•	•••••	•					•	•							4	
.25 - .29			••	•	••	••	••	••	••	••	••	••	••	••	••	••	0	
.20 - .24						•											0	
.15 - .19				••	••				••	••							0	
.10 - .14																	0	
.09 and lower																	0	
Not Comp.	•	••••••••	••														1	
f used	1	4	4	5	8	6	9	7	5	1	0	0	0	0	0	0		

• Item used in Form 3
 ○ Item not used in Form 3

TABLE A-9

Conversion Table

OCB Forms II and III - Part II - Mechanical Comprehension Test

	<u>Raw Scores</u>		<u>Standard Score</u>
	<u>Form II</u>	<u>Form III</u>	
	47-48.....	43-48.....	82
	46.....	42.....	81
	45.....	41.....	78
<u>GROUP 1</u>	44.....	40.....	77
High	43.....	39.....	76
Includes highest	42.....	38.....	74
7% of officers	41.....	37.....	72
	40.....	36.....	70
	39.....	35.....	68
	38.....	34.....	67
	37.....	33.....	65
	36.....	32.....	64
<u>GROUP 2</u>	35.....	31.....	62
Above Average	34.....	30.....	60
Includes next	33.....	29.....	59
24% of officers	32.....	28.....	58
	31.....	27.....	57
	30.....	26.....	56
	29.....	25.....	55
	28.....	24.....	53
<u>GROUP 3</u>	27.....	23.....	51
Average	26.....	22.....	50
Includes middle	25.....	21.....	49
38% of officers	24.....	20.....	47
	23.....	19.....	45
	22.....	18.....	43
<u>GROUP 4</u>	21.....	17.....	41
Below Average	20.....	16.....	40
Includes next lowest	19.....	15.....	38
24% of officers	18.....	14.....	37
	17.....	13.....	36
	16.....	12.....	35
	15.....	11.....	34
<u>GROUP 5</u>	14.....	10.....	33
Low	13.....	9.....	32
Includes lowest	12.....	8.....	31
7% of officers	11.....	7.....	30
	10.....	6.....	29
	0-9.....	0-5.....	28

TABLE A-11

Conversion Table

OCB Forms II and III - Part IV - Relative Movement Test

	Raw Scores		Standard Score
	Form II	Form III	
	50.....	50.....	87
	49.....	49.....	86
	48.....	48.....	84
	47.....	47.....	82
<u>GROUP 1</u>	46.....	50.....	81
High	45.....	49.....	79
Includes highest	44.....	48.....	78
7% of officers	43.....	47.....	76
	42.....	46.....	74
	41.....	45.....	72
	40.....	43-44.....	71
	39.....	42.....	70
	38.....	41.....	68
	37.....	40.....	66
	36.....	39.....	65
	35.....	38.....	64
<u>GROUP 2</u>	34.....	37.....	62
Above Average	33.....	36.....	60
Includes next	32.....	34-35.....	59
24% of officers	31.....	33.....	58
	30.....	32.....	56
	29.....	31.....	54
	28.....	30.....	53
<u>GROUP 3</u>	27.....	29.....	52
Average	26.....	28.....	50
Includes middle	25.....	26-27.....	48
38% of officers	24.....	25.....	47
	23.....	24.....	46
	22.....	23.....	44
<u>GROUP 4</u>	21.....	22.....	42
Below Average	20.....	21.....	41
Includes next lowest	19.....	20.....	40
24% of officers	18.....	19.....	38
	17.....	17-18.....	36
	16.....	16.....	35
	15.....	15.....	34
<u>GROUP 5</u>	14.....	14.....	32
Low	13.....	13.....	30
Includes lowest	0-12.....	0-12.....	29
7% of officers			

TABLE A-12

Conversion Table

OCB Forms II and III - Part V - Spatial Relations Test

	<u>Raw Scores</u>		<u>Standard Score</u>
	<u>Form II</u>	<u>Form III</u>	
	60.....	58-60.....	77
	59.....	57.....	76
	58.....	55-56.....	75
<u>GROUP 1</u>	57.....	54.....	74
High	56.....	53.....	73
Includes highest	55.....	52.....	71
7% of officers	54.....	51.....	70
	53.....	49-50.....	69
	52.....	48.....	68
	51.....	47.....	67
	50.....	46.....	65
	49.....	45.....	64
	48.....	43-44.....	63
<u>GROUP 2</u>	47.....	42.....	62
Above Average	46.....	41.....	61
Includes next	45.....	40.....	59
24% of officers	44.....	39.....	58
	43.....	38.....	57
	42.....	36-37.....	56
	41.....	35.....	55
	40.....	34.....	53
	39.....	33.....	52
<u>GROUP 3</u>	38.....	32.....	51
Average	37.....	30-31.....	50
Includes middle	36.....	29.....	49
38% of officers	35.....	28.....	47
	34.....	27.....	46
	33.....	26.....	45
	32.....	24-25.....	44
	31.....	23.....	43
<u>GROUP 4</u>	30.....	22.....	41
Below Average	29.....	21.....	40
Includes next lowest	28.....	20.....	39
24% of officers	27.....	18-19.....	38
	26.....	17.....	36
	25.....	16.....	35
	24.....	15.....	34
	23.....	14.....	33
	22.....	12-13.....	32
<u>GROUP 5</u>	21.....	11.....	30
Low	20.....	10.....	29
Includes lowest	19.....	9.....	28
7% of officers	18.....	8.....	27
	17.....	6-7.....	26
	16.....	5.....	24
	0-15.....	0-4.....	23

TABLE A-13

Item-Analysis Data: Mechanical Comprehension Form 2 Revised

Criterion: Score on Test 2, Form 2

(Data from AOCX1, AOCX2, EOCX1)

Difficulty Index, Δ

Discrimination Index, r	Difficulty Index, Δ																	f used
	5.9 & below	6.0-6.9	7.0-7.9	8.0-8.9	9.0-9.9	10.0-10.9	11.0-11.9	12.0-12.9	13.0-13.9	14.0-14.9	15.0-15.9	16.0-16.9	17.0-17.9	18.0-18.9				
.55 and up						•											1	
.50 - .54				•		••											4	
.45 - .49				•	•	•••	••	••									10	
.40 - .44					••	•		•									5	
.35 - .39				•	••	•	•••••	••	•								13	
.30 - .34					•	••		•		•							7	
.25 - .29											•••	••					8	
.20 - .24																	0	
.15 - .19																	0	
.10 - .14																	0	
.09 and lower																	0	
Not Comp.																	0	
f used	0	0	1	3	6	11	7	11	6	3	0	0	0	0				

Discrimination Index, r

TABLE A-14

Conversion Table

OCB Forms II, III and Form II Revised - Part II -
Mechanical Comprehension Test

	<u>Raw Scores</u>		<u>Standard Score</u>
	<u>Form II</u>	<u>Form III</u>	
	47-48.....	43-48.....	82
	46.....	42.....	81
	45.....	41.....	78
<u>GROUP 1</u>	44.....	40.....	77
High	43.....	39.....	76
Includes highest	42.....	38.....	74
7% of officers	41.....	37.....	72
	40.....	36.....	70
	39.....	35.....	68
	38.....	34.....	67
	37.....	33.....	65
	36.....	32.....	64
	35.....	31.....	62
<u>GROUP 2</u>	34.....	30.....	60
Above Average	33.....	29.....	59
Includes next	32.....	28.....	58
24% of officers	31.....	27.....	57
	30.....	26.....	56
	29.....	25.....	55
	28.....	24.....	53
<u>GROUP 3</u>	27.....	23.....	51
Average	26.....	22.....	50
Includes middle	25.....	21.....	49
38% of officers	24.....	20.....	47
	23.....	19.....	45
	22.....	18.....	43
<u>GROUP 4</u>	21.....	17.....	41
Below Average	20.....	16.....	40
Includes next lowest	19.....	15.....	38
24% of officers	18.....	14.....	37
	17.....	13.....	36
	16.....	12.....	35
	15.....	11.....	34
<u>GROUP 5</u>	14.....	10.....	33
Low	13.....	9.....	32
Includes lowest	12.....	8.....	31
7% of officers	11.....	7.....	30
	10.....	6.....	29
	0-9.....	0-5.....	28