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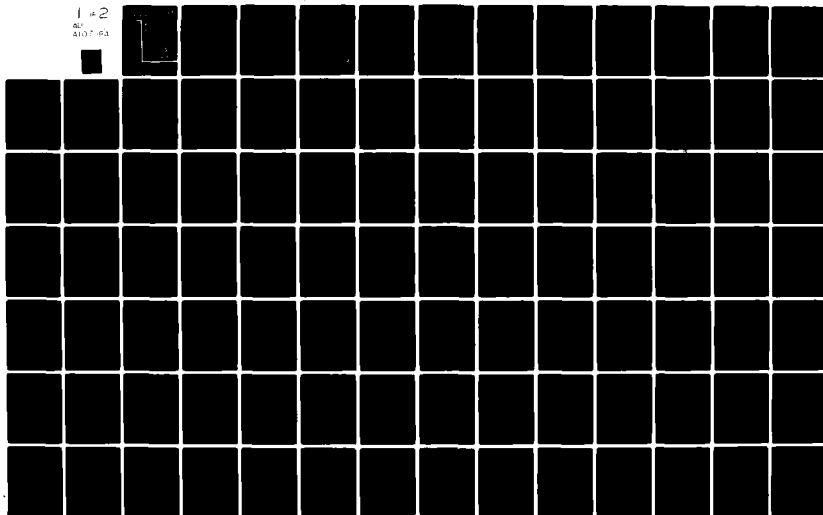
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HUMAN RESOURCES

ITEM ANALYSIS PROGRAM (IAP) FOR  
ACHIEVEMENT TESTS

By

Janos B. Koplyay

MANPOWER AND PERSONNEL DIVISION  
Brooks Air Force Base, Texas 78235

October 1981

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This paper has been reviewed and is approved for publication.

NANCY GUINN, Technical Director  
Manpower and Personnel Division

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Chief, Manpower and Personnel Division

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| 20. ABSTRACT (Continue on reverse side if necessary and identify by block number)<br><br>IAP is a computer-based, versatile and powerful item analysis package. The input consists of responses to achievement-type items. The output provides item/test parameters together with the parameters of the fitted normal ogive. $N(\mu, \sigma^2)$ . Among the many features, IAP can analyze multiple-response items and factor analyze the test for multidimensionality, and can be used for both power-test and speed-test. |                                     |                                                                                                  |

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ITEM ANALYSIS PROGRAM (IAP) FOR  
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By

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*This publication is primarily a working paper.  
It is published solely to document work performed.*

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## I. INTRODUCTION

The traditional approximations, formulas, and techniques used in item analysis (Kelley, 1939) were geared to save computational labor at the expense of accuracy and amount of information about achievement tests, items, and the individuals taking the test. In view of the available assistance of modern high speed computers it became possible to develop a more sophisticated, accurate and detailed mathematical approach (Baker, 1964, 1965) which provides test constructors with more flexibility, greater accuracy, and detailed additional information necessary to improve the evaluation and hence the quality of the items and tests.

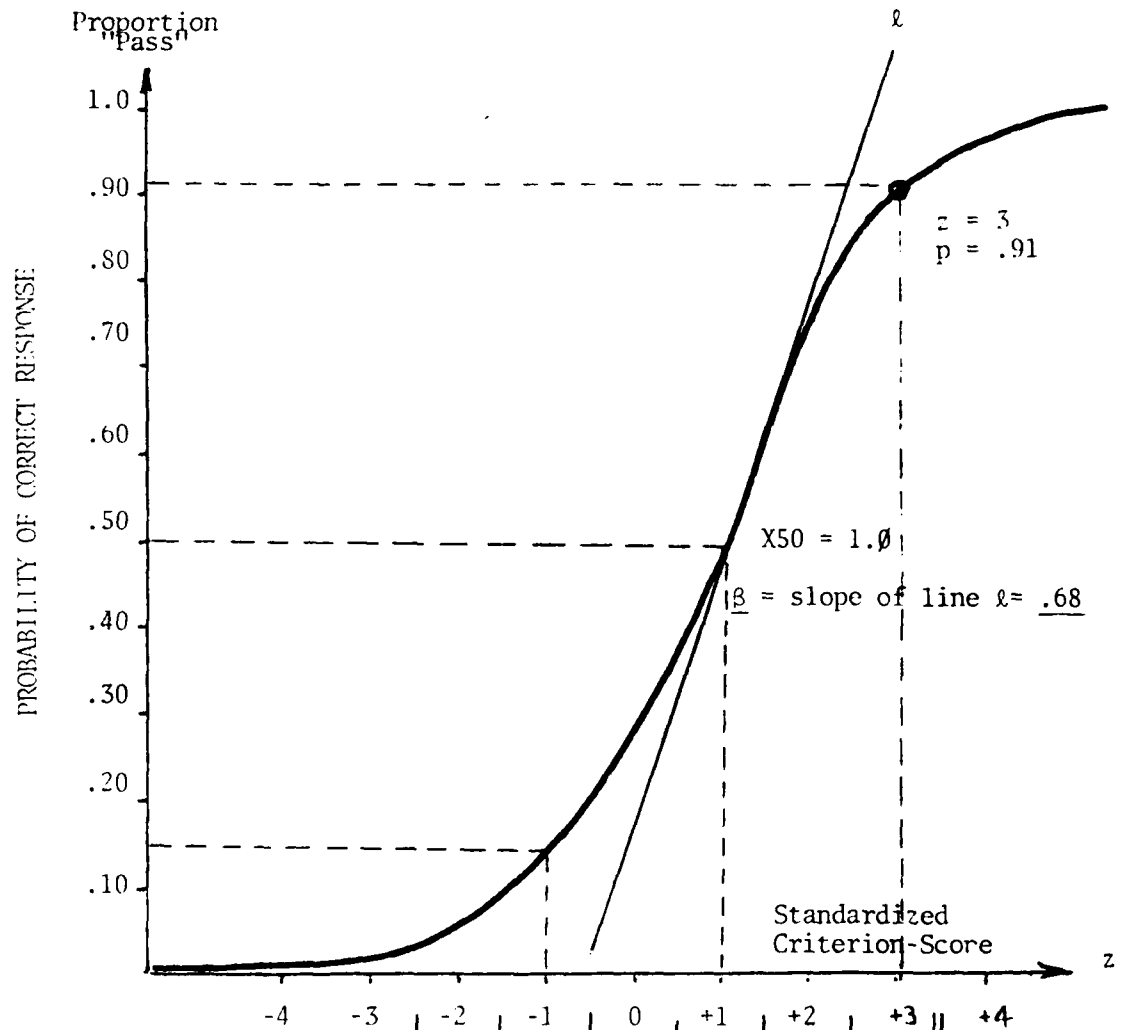
This paper describes the technical details that are required for the use of the IAP program as it is operational on a UNIVAC 1100/81 computer system at the Manpower and Personnel Division of the Air Force Human Resources Laboratory, Brooks Air Force Base, Texas. The basic concepts and general information are first provided. Detailed instructions for the preparation of IAP control cards by the user are provided in the next section. The appendices contain the computational formulas used, mathematical derivations including some proofs, and a sample run.

### Basic Concept of IAP

The basic concept in modern item analysis is the item characteristic curve (Binet and Simon, 1916) and its associated parameters (Tucker, 1946). The curve is essentially a line fitted through the points obtained by plotting the proportion of respondents to a particular item

or item-alternative against a given criterion score or "ability-score" expressed in standard z-scores. Figure 1 is an example of such an item characteristic curve. This curve is a cumulative distribution function of two parameters,  $X_{50}$  and  $\beta$ . Fitting a normal ogive through the points,  $X_{50}$  is the point at which 50% of the respondents passed the item. The corresponding z-score is the "ability" at which the item discriminates the best. Beta ( $\beta$ ) is an indicator of the strength of discrimination; i.e., the larger the  $\beta$ , the sharper the discrimination. Beta is conceptually the slope of the line drawn to the item characteristic curve at the point  $X_{50}$ . Mathematically it can be shown that  $\beta = 1/\sigma$ ; i.e., the reciprocal of the standard deviation of the normal ogive. The use of  $X_{50}$  and  $\beta$  provides the scientist with great versatility and flexibility. They enable one to draw specific inferences about a given individual and a given item, choose items which have optimum discrimination power at a certain ability level, screen-off a certain percent of a group of examinees, estimate the "true score" of an individual, and compute the probability of the correct response. The advantages are so numerous and broad that only through use can the program be fully realized and understood. Two of the many applications are briefly discussed below, referencing Figure 1.

Figure 1 EXAMPLE OF A TYPICAL ITEM CHARACTERISTIC CURVE  
 $X_{50} = 1.0$ ,  $\beta = .68$ , ITEM DIFFICULTY = .44 .



|                                            | -4           | -3           | -2            | -1            | 0             | +1            | +2 | +3 | +4 |
|--------------------------------------------|--------------|--------------|---------------|---------------|---------------|---------------|----|----|----|
| Total number of Respondents for this item  | 25           | 43           | 73            | 80            | 74            | 23            |    |    |    |
| Respondents who passed this item           | 1            | 6            | 19            | 40            | 54            | 21            |    |    |    |
| Corresponding proportions passing the item | 1/25<br>=.04 | 6/43<br>=.14 | 19/73<br>=.26 | 40/80<br>=.50 | 54/74<br>=.73 | 21/23<br>=.91 |    |    |    |

$$* \text{ ITEM DIFFICULTY } = \frac{141}{318} = .44$$

1. Probability of a correct response

The probability of correct response of an individual for the given item can be read directly from Figure 1 providing that the individual's criterion score is known. For example, the probability of a correct response for a respondent with  $z=3$  (abscissa value) is .91.

This probability can also be computed knowing  $X_{50}$ ,  $\beta$ , and  $z$ -score as follows (using  $X_{50}$  and  $\beta$  from Figure 1):

$$z = \beta(z \text{ score} - X_{50})$$

$$= .68 (3 - 1) = 1.36$$

From a cumulative normal distribution table, the area corresponding to  $z = 1.36$  equals approximately .91.

Thus, the probability that the individual with a criterion score  $z = 3$  will pass this item is  $P = .91$ .

Similar computations may be carried out for respondents with any given criterion score. Figure 1 shows these probabilities (proportions) for various standardized criterion scores ( $z$ -scores).

## 2. Selecting a certain percent of the examinees

Suppose an achievement test is administered to a group of individuals and subsequent item analysis provides the standard deviation (in standard score) of the test and, among other information, the X50 values for each item. Furthermore, suppose that the upper 16% of the examinees is desired to be selected from the rest of the group.

This can be accomplished by choosing items with certain X50 values. The upper 16% represents an area of  $(100-16) = 84$  percent. The corresponding standard score in the cumulative normal frequency distribution table is  $z = 1.0$ . The items to be chosen should be those which have  $X50 = (1.0) \sigma$ . If  $\sigma = 1.5$ , the items should have  $X50 = z \cdot \sigma = (1)(1.5) = 1.5$ .

The maximum number of discriminations occur at the point at which 50% of the examinees pass the item; i.e., between 84% and 100% in the above example; thus, the upper 16% is selected by maximum discrimination.

The traditional item-analysis technique provides only the item difficulty in terms of proportion of the total respondents who choose a particular response, and the item-criterion correlation, and no information is available describing how a particular item or item-alternative functioned.

## II. DESCRIPTION OF THE IAP PROGRAM

### General Information

The criterion upon which the program bases all the statistical analyses is specified by the user. This criterion may be either internal or external.

The internal criterion is the total test score of each individual taking the test. These scores may be used as raw scores or may be corrected for guessing according to the user's specification. All item and test statistics are calculated accordingly. An exception is made in the case of the frequency distribution of an internal criterion, where the user may specify either raw score-distribution or corrected for guessing score-distribution regardless of the user's specification for the type of scores to be used in the item analysis. However, if the user specifies the computation of phi-coefficients, the exception previously mentioned is not available and both the phi and the frequency distribution are based on the same criterion used in the computation of item statistics.

The external criterion is furnished by the user. If an external criterion is specified on the control card, the program will use it in the item analysis. The validity coefficient between the external criterion and the internal criterion is calculated using raw scores or corrected scores depending upon the user's specification.

The test may be graded and analyzed as a power test or as a speed test. In the latter case, only those respondents reaching a particular item will be

considered in the analysis of that item, including the item difficulty and response distribution. In addition, the mean and standard deviation of the population reaching the item will be given. Since the X50 represents a z-score of the population reaching the item, it is not necessarily comparable to an X50 obtained on another item from a different population. An equivalent X50 is computed by making a z-score transformation from the "item population" to the total population:

$$\text{Equivalent X50} = \frac{\sigma_i}{\sigma_t} \cdot \text{X50} + \frac{\bar{X}_i - \bar{X}_t}{\sigma_t}$$

where  $\sigma_t$  = standard deviation of total population

$\sigma_i$  = standard deviation of item population

$\bar{X}_t$  = mean of total population

$\bar{X}_i$  = mean of item population

X50 is based on the item population

This "Equivalent X50" is printed in the item analysis summary table.

The factor analysis is done on a tetrachoric inter-item correlation matrix. It is always based on the total number of cases regardless of whether or not all finished the test. An individual who does not reach an item is considered to have missed it in this portion of the program. The factor analysis is a principal component analysis with Varimax rotation and unit diagonal elements.

Computation of the tetrachoric matrix is the slowest part of the program, particularly if the number of items is large.

The test reliability is influenced by the sum of item variances  $\sum_{i=1}^N (p_i q_i)$ . Here, the proportion answering Item  $i$  correctly,  $p_i$ , is always based on all the cases. This makes interpretation of the reliability coefficient in the case of a speed test questionable. (The same can be said about the factor analysis part of the program.)

There is an option designed to handle test items for which there is more than one correct answer; in such cases the various responses receive different score points of credit. These items have alphanumeric responses in order to be able to handle a larger number of possible responses. This option would generally be used with multiple-response tests. The analysis of the items considers any credit achieved on an item as passing the item, and no credit at all as missing the item. This is rather arbitrary, and could be changed if desired. There is no correction for guessing on alphanumeric response items. The amount of credit to be received for a particular response to a particular item is read in on control cards (Card 5). This option could be used to weight responses differentially. Another option provides an Item Alternative Information Roster containing information about the validity and difficulty of each item-alternative. The validity is given as the point-biserial correlation between the particular alternative and the criterion. The difficulty is expressed as the proportion of the sample choosing a particular alternative. Additionally, the inter-correlation matrix of the alternatives within each item is provided.

### Preparation of Input Data

The input may be either card or tape, as indicated on Control Card 1, Col. 44. The FORTRAN logical unit number for the input unit is to be specified in Col. 6-7 of Card 1.

The format for reading in the data is specified by the user (Card 3). The restrictions on the input data are as follows:

The ID variable must be either the first or the last word read, as specified on Card 1, Col. 36.

The external criterion must be the word immediately preceding the responses, if there is an external criterion.

The ID is read in by "A" format; the numeric responses by "I" format; and the alphanumeric responses (if any) by "A" format. The external criterion is read in by "F" format.

If an item is not attempted, it is to be coded "0" for both numeric and alphanumeric items. This is important for tests that are to be corrected for guessing.

On a speed test, the first relevant item after the last attempted item is to be coded a "9" if the item is a numeric response item, and a "W" if the item is an alphanumeric response item. (Items coded "0" on Card 4, which are not considered on the test, do not apply here. See write-up for Card 4.) If desired, all items following the last attempted item can be so coded.

Card or Tape Output

If desired, the following information can be listed on cards or tape:

Test ID, case ID, score, corrected score, external criterion score, and 1/0's for pass/fail for each item. Non-applicable information will be written zero.

The format for card output is:

(A6, 2X, A6, 2X, I3, 2X, 2F8.2, 2X, 41I1/80I1/79I1)

The Format for tape output is:

(2A6, I3, 2F7.2, 200I1)

### III. Control Cards

#### Card 1 - Input Parameters

| <u>Card<br/>Column</u> | <u>Format</u> | <u>Source<br/>Listing<br/>Symbol</u> | <u>Description</u>                                                                                                                                                                 |
|------------------------|---------------|--------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1-3                    | I3            | NSTITM                               | Number of test items; may not exceed 200 items.                                                                                                                                    |
| 4                      | I1            | IUPLIM                               | Highest response choice (not including multiple-response answers) may not exceed 9. The response choices have to be consecutive positive integers, the largest of which is IUPLIM. |
| 5                      | I1            | NFM                                  | Number of format cards for input data.<br>Default when blank, NFM = 1.                                                                                                             |
| 6-7                    | I2            | K1                                   | FORTTRAN logical unit number for data input (may be card reader or tape unit). ALL FORTTRAN unit numbers should be greater than 9 on the UNIVAC 1100/81.                           |
| 8-9                    | I2            | KO                                   | FORTTRAN logical unit number for tape output, if applicable. May be left blank.                                                                                                    |
| 10-11                  | I2            | KS                                   | FORTTRAN logical unit number for scratch tape (serves as working storage for program).                                                                                             |

|       |    |    |                                                                                                                                                |
|-------|----|----|------------------------------------------------------------------------------------------------------------------------------------------------|
| 12-13 | I2 | NB | Number of bits in a word on the computer, not counting the sign bit. (NB is used in the word-packing routine.) If blank, NB will be set to 35. |
|-------|----|----|------------------------------------------------------------------------------------------------------------------------------------------------|

|       |      |      |                                                                                                                        |
|-------|------|------|------------------------------------------------------------------------------------------------------------------------|
| 14-15 | F2.2 | EASY | Specified difficulty level for identifying too-easy items, in percent (two digits with no decimal point). <sup>1</sup> |
|-------|------|------|------------------------------------------------------------------------------------------------------------------------|

|       |      |        |                                                                                                                |
|-------|------|--------|----------------------------------------------------------------------------------------------------------------|
| 16-17 | F2.2 | DIFFLT | Specified difficulty level for identifying too-difficult items, in percent (two digits with no decimal point). |
|-------|------|--------|----------------------------------------------------------------------------------------------------------------|

NOTE: Default when both EASY and DIFFLT are blank; EASY = .8 and DIFFLT = .2.

|    |    |        |                                                                                                               |
|----|----|--------|---------------------------------------------------------------------------------------------------------------|
| 18 | I1 | IALPHA | 0 if all items are single-response (numeric).<br>1 if one or more items are multiple-response (alphanumeric). |
|----|----|--------|---------------------------------------------------------------------------------------------------------------|

|    |    |        |                                          |
|----|----|--------|------------------------------------------|
| 19 | I1 | NSPEED | 0 if a power test.<br>1 if a speed test. |
|----|----|--------|------------------------------------------|

---

<sup>1</sup> This option and the next one (DIFFLT) prints out items whose difficulty is outside of the specified difficulty-range.

|       |      |        |                                                                                                                                                                                                                                                                                                                |
|-------|------|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 20    | 11   | ICORGS | <p>0 if scores are not to be corrected for guessing.</p> <p>1 if scores are to be corrected for guessing by either standard formula or Hamilton's (1950) formula (see column 45).</p> <p>If corrected scores are called for, they will be used in all item analysis, unless an external criterion is used.</p> |
| 21    | 11   | KIV    | <p>0 if negative corrected scores are not to be set to zero.</p> <p>1 if negative corrected scores are to be set to zero.</p>                                                                                                                                                                                  |
| 22    | 11   | ICRIT  | <p>0 if test score is to be used as the criterion.</p> <p>1 if an external criterion is to be used (in this case, all item analyses will be based on this criterion.)</p>                                                                                                                                      |
| 23-25 | F3.0 | OUT    | <p>Code for missing criterion score, in the case of an external criterion. Must be an integer value (no decimal point). Cases with missing criterion score will be excluded from the analysis and printed out.</p>                                                                                             |
| 26    | 11   | NOCASE | <p>0 if case scores are to be printed.</p> <p>1 if printing of case scores is to be suppressed.</p>                                                                                                                                                                                                            |

|    |    |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|----|----|-------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 27 | 11 | IPHI  | <p>0 if no phi correlation coefficient is desired.</p> <p>1 if phi based on median score for the sample is desired.</p> <p>2 if phi based on median is desired. (In case of a speed test, the mean will be computed based upon only those individuals who reached the particular item.)</p>                                                                                                                                                                                                                                                                                                                                                                               |
|    |    |       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| 28 | 11 | IFREQ | <p>0 if no frequency distribution of scores is desired.</p> <p>1 if frequency distribution is to be done with external criterion score (if applicable).</p> <p>2 if frequency distribution is to be done with corrected test scores (if applicable).</p> <p>3 if frequency distribution is to be done with raw test scores.</p> <p><u>NOTE:</u> If phi with median is called for, the frequency distribution will be done accordingly, regardless of user's specification, since the median is calculated from the frequency distribution. For example, if phi with median is desired, and an external criterion is being used, IFREQ will be set to 1 automatically.</p> |

|       |    |       |                                                                                                                                                                                                                                                                                                                                                      |
|-------|----|-------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 29    | 11 | IOVER | <p>0 if Henrysson's (1963) method for overlap correction of item analysis with internal criterion is to be used.</p> <p>1 if Guilford's (1953, 1965) method is to be used.</p> <p>2 if no overlap correction is desired.</p> <p><u>NOTE:</u> If overlap correction is called for, both the uncorrected and the corrected values will be printed.</p> |
| 30    | 11 | JPLOT | <p>0 if only the proportion of individuals passing each item at various z-score (standard score) levels is to be printed.</p> <p>(No plot .)</p> <p>1 if the (fitted) item characteristic curves are to be plotted.</p> <p><u>NOTE:</u> On a speed test, proportions will be based on only on those individuals who reached the particular item.</p> |
| 31-32 | 12 | NF    | <p>Number of factors to be extracted from tetrachoric inter-item correlation matrix.</p> <p>If NF is specified as zero, the inter-item correlation matrix will not be computed.</p> <p>Otherwise, NF must lie in the range:</p> <p><math>2 \leq NF \leq 10</math>.</p>                                                                               |

|       |      |        |                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
|-------|------|--------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 33-35 | F3.2 | EIGN   | <p>Eigenvalue to serve as stop criterion for factor analysis of tetrachoric correlation matrix, if applicable. If an eigenvalue falls below this value, no further factors are extracted. This value is put on the card as three digits, the last two of which are considered to be after the decimal point. For example, if an eigenvalue cutoff of 1.00 is desired, it should be specified on the card as 100. An eigenvalue of 1.00 is commonly used.</p> |
| 36    | 11   | IDEND  | <p>0 if identification variable (ID) precedes responses in input data.<br/>1 if ID follows responses.</p>                                                                                                                                                                                                                                                                                                                                                    |
| 37    | 11   | IRWIND | <p>0 if input data tape is to be rewound before processing test; 1 otherwise.<br/>If only one test is being processed, this option is irrelevant. If the same cases are to be used as were used in the previous test, IRWIND should be specified as 0, and the input format should pick up the fields on the tape that correspond to the present test.</p>                                                                                                   |

|       |    |       |                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------|----|-------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 38    | I1 | IOUT  | <p>0 if no tape or card output is requested.</p> <p>1 if tape output is requested.</p> <p>2 if card output is requested.</p> <p>The output will consist of a test ID, the case ID, score, corrected score, external criterion score, and 1/0's for pass/fail for each item. Any non-applicable information (such as the external criterion score for an internal criterion test run) will be written zero.</p> |
| 39-42 | A4 | ATEST | <p>Test ID for tape or card output, if applicable.</p>                                                                                                                                                                                                                                                                                                                                                         |
| 43    | I1 | IALT  | <p>0 if scores are not to be corrected for guessing; or, if each item has the same number of response choices, and this number is equal to IUPLM as specified in Col. 4.</p> <p>1 only if correction for guessing is called for; and, in addition, at least one item does not have the number of response choices equal to IUPLM; if this is the case, additional card(s) will be necessary (card no. 6).</p>  |
| 44    | I1 | ICARD | <p>0 if input data are on tape.</p> <p>1 if input data are on cards.</p>                                                                                                                                                                                                                                                                                                                                       |

|       |    |      |                                                                                                                                                                                                                                                                                                                                                   |
|-------|----|------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 45    | 11 | IHAM | 1 of scores are to be corrected with Hamilton's (1950) formula; 0, otherwise. IALT <u>must</u> be 0; ICORGS <u>must</u> be 1.                                                                                                                                                                                                                     |
| 46-48 | 13 | NERR | Maximum number of permissible input data errors specified by user (i.e. data do not match format editing code type; like reading alphanumeric with an I format.) If the number of errors equals or exceeds this number, the program will terminate. The case number and ID of each case with this type error will be printed. (See KERR Col. 58). |
| 49-52 | 14 | NBIK | Blocksize if the input data file on unit K1 is COBOL (max blocksize = 1203).                                                                                                                                                                                                                                                                      |
| 53-55 | 13 | LRL  | Logical record length if data file on unit K1 is COBOL. Both this field and the preceding one must be non-zero if the file is in COBOL (max LRL = 250).                                                                                                                                                                                           |
| 56-57 | 12 | KS2  | Unit ID for temporary file <u>needed when</u> 'Item Alternative Information Roster' is requested (0 or blank indicates the above roster is not requested).<br><br>This file need not be assigned because the system will assign a temporary file of sufficient size.                                                                              |

58

11

KERR

Data read error switch;

0 = system (FORTRAN) error exit routine,

1 = program error exit routine (see also

NERR, Col. 46-48).

NOTE: The system error exit will translate

the error input character(s) into zeroes

and print the system error message. The

case is retained. The IAP program error

exit will print the error case (see NERR)

and reject the case.

#### Card 2 - Title Card

Any title less than or equal to 72 characters, starting in Col 1.

#### Card 3 - Input Data Format Card(s)

The ID will be read in "A" format with a field width of not more than six characters.

Responses to items with numeric answers will be read in "I" format.

Responses to items with alphanumeric answers (multiple-response items), if any, will be read in "A" format.

Skipped fields are indicated by "X". The format should begin with a left parenthesis and end with a right parenthesis. If more than one card is necessary, simply continue the format on additional cards. The number of format cards is specified on Card 1, Col 5. Each card of the format is read through Col 72 only.

As mentioned above under "Data Specification," the ID must be either the first or the last word read, and the external criterion (if any) must always precede the responses. The external criterion will be read in "F" format.

If a case requires more than one record (e.g., more than one card), a slash (/) in the format will cause the next record to be read.

Examples:

1.

|   |         |   |    |   |         |   |         |   |         |   |       |   |
|---|---------|---|----|---|---------|---|---------|---|---------|---|-------|---|
| ( | 5X      | , | A6 | , | 30X     | , | 20I1    | , | X       | , | A1    | ) |
|   | ↑       |   | ↑  |   | ↑       |   | ↑       |   | ↑       |   | ↑     |   |
|   | 5       |   |    |   | 30      |   | 20      |   | 1       |   | 1     |   |
|   | Skipped |   | ID |   | Skipped |   | Numeric |   | Skipped |   | Alpha |   |

---

2.

|   |         |   |      |   |         |   |       |   |      |   |         |   |         |   |    |                     |
|---|---------|---|------|---|---------|---|-------|---|------|---|---------|---|---------|---|----|---------------------|
| ( | I1      | , | X    | , | 3I1     | , | 4A1   | , | 50X  | , | 3I1     | / | 20I1    | , | A6 | )                   |
|   | ↑       |   | ↑    |   | ↑       |   | ↑     |   | ↑    |   | ↑       | ↑ | ↑       |   | ↑  |                     |
|   | 1       |   | 1    |   | 3       |   | 4     |   | 50   |   | 3       | : | 20      |   | ID |                     |
|   | Numeric |   | Skip |   | Numeric |   | Alpha |   | Skip |   | Numeric |   | Numeric |   |    |                     |
|   |         |   |      |   |         |   |       |   |      |   |         |   |         |   |    | Skip to next Record |

---

3.

|      |   |    |   |      |           |      |         |      |         |
|------|---|----|---|------|-----------|------|---------|------|---------|
| (X   | , | A6 | , | 3X,  | F6.2,     | 5X,  | I1,     | X,   | 20I1)   |
| ↑    |   | ↑  |   | ↑    | ↑         | ↑    | ↑       | ↑    | ↑       |
| 1    |   |    |   | 3    | Ext.      | 5    | 1       |      | 20      |
| Skip |   | ID |   | Skip | Criterion | Skip | Numeric | Skip | Numeric |

---

4.

(X, F7.1, 11, 2X, 3A1, X, 2011, etc., X, 11, Card 1

2X, 3A1, X, 511) Col 70 Card 2

---

Here, two format cards are required to read one record since the format required more than 72 columns. In Example 2, one format card was needed to read two records.

---

#### Card(s) 4 - Answer Key for Numeric Items

The first three columns of the card(s) are not read, so anything may be written there (such as "KEY").

Starting in Col. 4, each column corresponds to an item specified in the "Format" statement, excluding the ID and the external criterion. For numeric items, the correct answer should be specified in the corresponding column. For alphanumeric (multiple-response) items, a "9" should be specified in the corresponding column. (A special key will be read in for alphanumeric items). Each "answer key" card contains keys for up to 77 items; 200 items will require three cards.

If desired, items can be omitted from analysis without changing the format. This is done by specifying a "0" in each of the columns corresponding to those items. The remaining items will be referred to in the output by the same numbers that they would be without any 0's in the key.

Examples:

KEY2341511357

This is a 10-item test in which all responses are numeric. The correct answer to item 1 is 2, and the correct answer to item 10 is 7.

KEY2341000057

This is a key for the same test as before, but items 5 through 8 are removed from the test by replacing the correct alternative with zero. The remaining items will be referred to as before, so items 1, 2, 3, 4, 9, and 10 are listed in the output.

Note that the same thing could have been accomplished by changing the format to "X" out items 5 through 8, and having the key changed to KEY234157. However, the items would now be referred to as items 1, 2, 3, 4, 5, and 6.

KEY1235499221

Here, items 6 and 7 are alphanumeric (multiple-response), and the correct answers to these items will be read in on the next card.

Card(s) 5 - Answer Key for Alphanumeric Items

This card is optional and is included only if "ALPHA" was specified as 1 (Card 1, Col 18).

There are 33 possible multi-response codes. In order that each response occupy only one character in the data file, these responses are coded alphanumerically, using the numbers 1 through 9 and all letters of the alphabet except W and Y. These characters are converted to integers by a method that is machine-dependent; on machines other than the Univac 1100/81 a few changes will probably be necessary.

The codes for each alphanumeric character are as follows:

| <u>Alphanumeric Character (Response)</u> | <u>Code</u> |
|------------------------------------------|-------------|
| 1                                        | 1           |
| 2                                        | 2           |
| 3                                        | 3           |
| 4                                        | 4           |
| 5                                        | 5           |
| 6                                        | 6           |
| 7                                        | 7           |
| 8                                        | 8           |
| 9                                        | 9           |

| <u>Alphanumeric Character (Response)</u> | <u>Code</u> |
|------------------------------------------|-------------|
| A                                        | 10          |
| B                                        | 11          |
| C                                        | 12          |
| D                                        | 13          |
| E                                        | 14          |
| F                                        | 15          |
| G                                        | 16          |
| H                                        | 17          |
| I                                        | 18          |
| J                                        | 19          |
| K                                        | 20          |
| L                                        | 21          |
| M                                        | 22          |

| <u>Alphanumeric Character (Response)</u> | <u>Code</u> |
|------------------------------------------|-------------|
| N                                        | 23          |
| O                                        | 24          |
| P                                        | 25          |
| Q                                        | 26          |
| R                                        | 27          |
| S                                        | 28          |
| T                                        | 29          |
| U                                        | 30          |
| V                                        | 31          |
| X                                        | 32          |
| Z                                        | 33          |

Any other response will be considered as an omit.

Correction for guessing is not made on alphanumeric items.

The character "w" is reserved for indicating the item after the last item attempted by a subject on a speed test with alphanumeric responses.

The card(s) are prepared as follows: Each response-item combination will occupy six card columns. The first three columns will contain the item number; the next two columns will contain the code for the response as given above; and the last column will contain the number of points credit to be given that response. Any response not listed will receive no credit. Up to 13 responses may be listed per card (Cols 1-78). If more than 13 item-response combinations are necessary, continue the same procedure on subsequent cards. Each item-response combination listed must immediately follow the preceding. The six columns following the last combination must contain 999999. If a frequency distribution of scores is to be made, the maximum total score must not exceed 1000.

Example:

Suppose that items 3 and 5 have alphanumeric responses, and that each one has two possible responses that are to receive credit--a "2" to receive 1 point, and a "B" (code "11") to receive 2 points. The card would appear:

|               |               |               |               |         |
|---------------|---------------|---------------|---------------|---------|
| 003021        | 003112        | 005021        | 005112        | 999999  |
| Item Number   | Item Number   | Item Number   | Item Number   |         |
| Response Code | Response Code | Response Code | Response Code |         |
| Credit        | Credit        | Credit        | Credit        | 6 nines |

Card(s) 6 - Alternate Response Cards

This card is optional and is included only if "IALT" (Col 43 of Card 1) was "1".

The purpose of the card is to indicate the number of choices for each item (if any different from "IUPLIM" in Col 4 of Card 1) so that the proper correction for guessing can be made.

The first three columns are not read and may contain anything (such as "ALT"). Starting in Col 4, each column contains the number of alternate response choices for the corresponding item. If there are more than 77 items, continue on a second card (skipping the first three columns again). If an item is alphanumeric, its corresponding column may be left blank, or may contain any integer, since it is not used.

Example:

ALT444555333

Here, there were nine items. The first three items had four alternatives; items 4 through 6 had five alternatives; and items 7 through 9 had three alternatives.

Note:

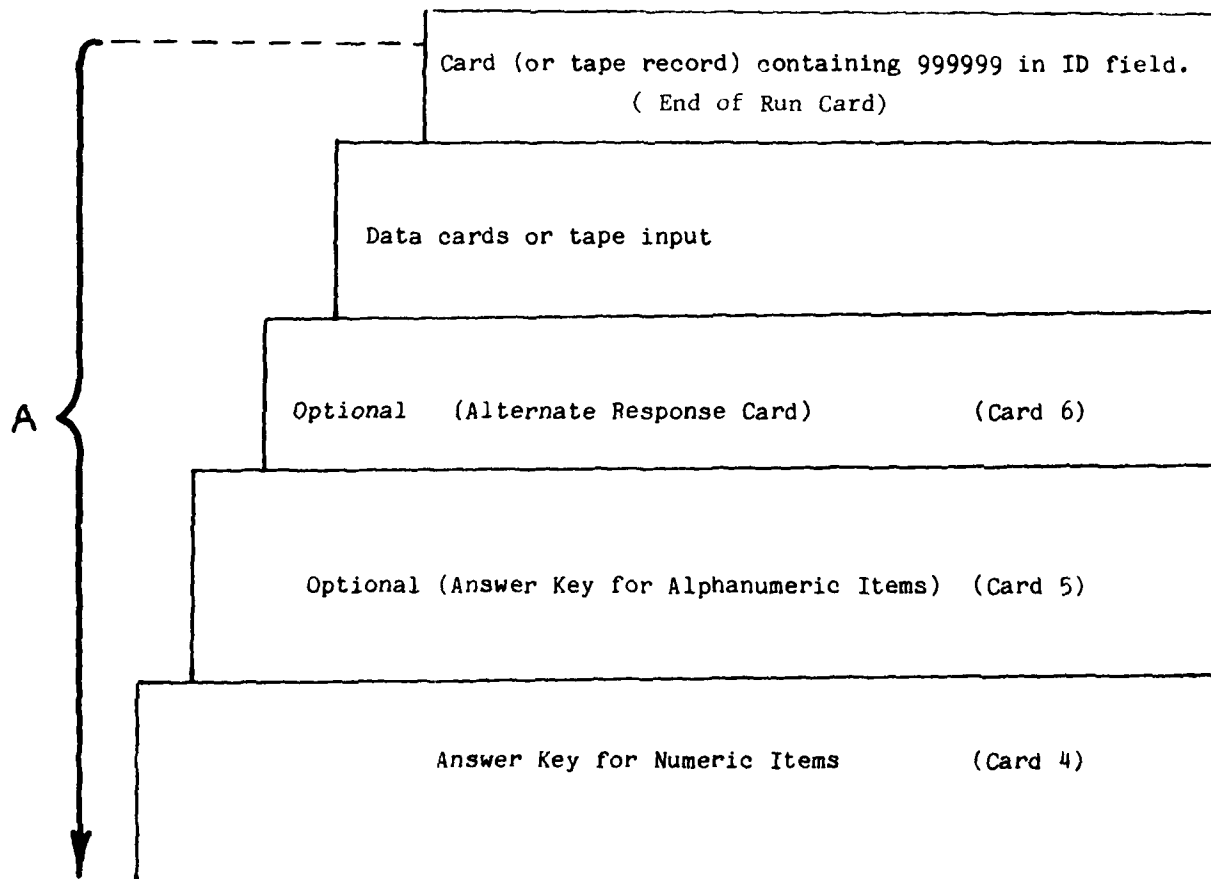
Following the last control card for the last job there must be a card containing "999" in Cols 1-3.

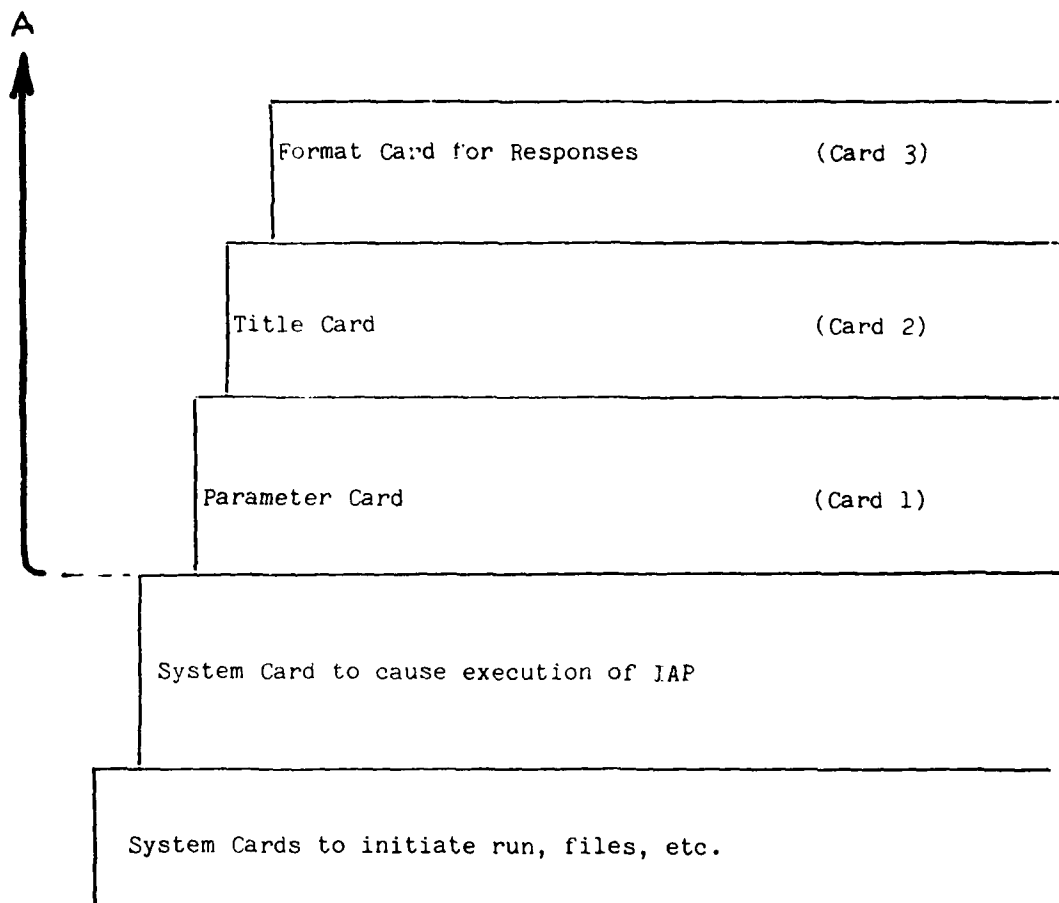
Card - Input Sequence ( in reverse order).

Stop (System Cards)

999 ( End of Job Card )

The cards in brace "A" below may be repeated for any successive jobs.





NOTE: The term "card" refers to the type of card(s). There may be more than one physical card per card type. (See detailed description of card preparations.)

#### IV. SUMMARY

This report describes the development and implementation of a state-of-the-art computer-based item analysis technique. It deviates from traditional techniques by providing detailed information about the characteristics of achievement test items, particularly the ability level at which a given item discriminates most and the degree of discrimination. Here discrimination is independent of item difficulty, unlike traditional methods where the discrimination index is a function of the difficulty. This paper includes all information necessary for potential users and provides all formulas and mathematical derivations upon which the algorithm is based. The computer program has been written in FORTRAN V on the UNIVAC 1100/81 computer system and is easily convertible to other systems. An exception is the plotting subroutine for the item characteristic curves. This subroutine is written in COBOL and is machine-specific. However, the program can be used without the plot-routine since one of the options provides all numerical information about the item characteristic curves and permits manual graphing with ease.

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## APPENDIX A

### COMPUTATIONAL FORMULAS AND MATHEMATICAL DERIVATIONS

1. Raw Score - number of correctly answered items.

2. Correction for Guessing Formulas.

a. Standard correction (Guilford, 1965, p. 489.)

$$\text{Corrected Score} = (\text{number correct}) - \sum_{i=1}^n \frac{1}{(K_i - 1)}$$

Where  $K_i$  = the number of choices for item  $i$ ,

$n$  = number of items included in the item analysis,

and the sum is taken over those items to which a wrong response was given.

If  $K_i = K$  for all  $i$ , then this reduces to

$$(\text{number correct}) - \frac{\text{number wrong}}{K - 1}$$

For items with more than a single correct answer (multiple-response), no correction for guessing is made.

b. Hamilton Correction (Hamilton, 1950)

$$\text{Corrected Score} = a + (b) \cdot (\text{raw score})$$

where a and b are the coefficients of the linear regression of the corrected score on the raw score.

$$a = \frac{\bar{R}\bar{W} - n\sigma_r^2}{(k-1)\sigma_r^2} \quad \text{and} \quad b = \frac{k\sigma_r^2 - \bar{W}}{(k-1)\sigma_r^2}$$

where:  $\bar{R}$  = mean number of questions answered correctly

$\bar{W}$  = mean number of incorrect answers

n = number of items in the test

k = number of alternatives per item

$\sigma_r^2$  = variance of the raw scores

The squared correlation coefficient between the corrected scores and raw scores is:

$$r^2 = \frac{k\sigma_r^2 - n + \bar{R}}{k\sigma_r^2}$$

NOTE: For multiple-response items (more than one correct answer), no correction for guessing is made.

3. Mean :  $\bar{X} = \sum_{i=1}^N \frac{X_i}{N}$  where N = the number of scores being considered.

4. Variance :  $\sigma^2 = \frac{\sum_{i=1}^N X_i^2 - (\sum_{i=1}^N X_i)^2 / N}{N-1}$

5. Standard Deviation :  $\sigma = \sqrt{\sigma^2}$

6. Standard Error of the Mean :  $\frac{\sigma}{\sqrt{N}}$

7. Skewness :  $\frac{N}{(N-2)(N-1)} \cdot \frac{S3}{\sigma^3}$

where  $S3 = \sum X^3 - 3(\sum X/N) \sum X^2 + 2(\sum X/N)^2 \sum X$

8. Kurtosis :  $Q4 / \sigma^4$

where  $Q4 = \frac{N}{(N-1)(N-2)(N-3)} \left[ (N+1) \sum X^4 - 4(\sum X/N) \sum X^3 + \right.$

$\left. 6(\sum X/N)^2 \sum X^2 - 3(\sum X/N)^3 \sum X - 3((N-1)/N) \cdot (\sum X^2 - \frac{(\sum X)^2}{N}) \right]$

$$9. \text{ Standard Error of the Standard Deviation } = \sqrt{\frac{\sigma^2}{N} \cdot (.5 + .25Q_4/\sigma^4)}$$

$$10. \text{ Standard error of Skewness } = \sqrt{\frac{6N(N-1)}{(N-2)(N+1)(N+3)}}$$

$$11. \text{ Standard Error of Kurtosis } = \sqrt{\frac{24N(N-1)^2}{(N-3)(N-2)(N+3)(N+5)}}$$

$$12. \text{ z-score } = \frac{X - \bar{X}}{\sigma}$$

$$13. \text{ T score } = (z \text{ score}) \cdot (10) + 50$$

$$14. \text{ Item Standard Deviation } = \sqrt{pq}$$

where  $p$  = the proportion of examinees answering the item correctly.

$q$  = the proportion of examinees answering the item incorrectly,

where, necessarily  $q = 1 - p$ .

15. Point Biserial Correlation (between item and total test score).

$$r_{pbis} = \frac{M_p - M_q}{s} \sqrt{pq}$$

where  $M_p$  is the mean test score for persons answering the item correctly,  $M_q$  is the mean test score for persons answering the item incorrectly.

16. Biserial correlation.

$$r_{bis} = \frac{M_p - M_q}{s} \cdot \frac{pq}{y}$$

where  $y$  is the ordinate at the point of dichotomy in a standard normal distribution (see 25, below).

17. t-test to test the significance of the correlation coefficient.

$$t = \frac{r \sqrt{N-2}}{\sqrt{1-r^2}}$$

where  $r$  is the correlation coefficient and the resulting  $t$  has  $(N - 2)$  degrees of freedom.

$$18. \quad X_{50} = \frac{X}{r_{bis}}$$

where  $X$  : the abscissa value at the point of dichotomy in a standard normal distribution (see 25 below).

$X_{50}$  specifies the z-score on the (fitted) item characteristic curve at which 50% of the persons having the z-score chose the correct response. The item characteristic curve is a cumulative normal ogive fitted to the distribution of z-scores versus the proportion passing the item at each z-score level.

19.  $\beta = \frac{r_{bis}}{\sqrt{1 - r_{bis}^2}}$  measure of the discrimination power of the item.

In non-technical terms  $\beta$  may be thought of as the slope of the item characteristic curve at X50. Mathematically it is the inverse of the standard deviation of the normal (fitted) ogive.

20. Reliability index of the item.

$RI = (r_{pbis}) \cdot \sqrt{pq}$  = the contribution of the item variance to the total test variance (Gulliksen, 1950, pp. 375-378).

21. Kuder Richardson Formula 20 (test reliability).

$$r = \frac{n}{n-1} \cdot \frac{S_x^2 - \sum_{i=1}^n p_i q_i}{S_x^2}$$

where n = number of test items.

$S_x^2$  : variance of scores on test,

$p_i$  : proportion of examinees passing item i (difficulty of item),

$q_i$  : proportion of examinees failing item i where  $q_i = 1 - p_i$

22. Phi Coefficient = 
$$\frac{BC - AD}{\sqrt{(A + B)(C + D)(A + C)(B + D)}}$$

where the terms of the equation are defined as follows :

Test Scores

|      | Lower 50% | Upper 50% |       |
|------|-----------|-----------|-------|
| Pass | A         | B         | A + B |
| Fail | C         | D         | C + D |
|      | A + C     | B + D     |       |

### 2.3. Computing the Tetrachoric Correlation

The tetrachoric correlation is an estimation of the correlation between two variables that are assumed to be from a bivariate normal distribution (i.e., marginal distributions normal, and linearity of regression) when the only actual information given about the distribution is dichotomous (i.e., four-fold frequency table, where the lines of dichotomy are necessarily the medians).

To be more specific, the procedure is:

- (1) Determine, for each variable, what the point of dichotomy should be in a standard normal distribution to produce the observed proportions above and below the dichotomy for that variable. This is simply the inverse function for the normal distribution, whose computation is described above.
- (2) Determine what correlation in a bivariate normal distribution will give the observed proportions in the four regions described by the four-fold table. This involves two problems:
  - a. The bivariate normal distribution must be represented as a function of  $r$ , the correlation, and equated to the observed proportion in a given region.
  - b. This equation must be solved for  $r$ . An iteration scheme must be used, since the bivariate normal distribution is an integral that must be computed numerically or written in a series expansion; if written as a series expansion, a polynomial equation of high degree must be solved, which requires iteration.

The usual approach is to use the series expansion and solve by iteration. However, for even a moderately large  $r$ , the series converges very slowly; and for each iteration, it must be recomputed.

What is needed then is:

- (1) A better method for computing the bivariate normal distribution.
- (2) A scheme requiring the fewest possible iterations, since the slowest part of the computation is the bivariate normal.

The method used for computing the bivariate was based on the *T-function* of Owen (1956, p. 1075). The error in the program is less than  $5 \times 10^{-8}$  for all correlations and upper limits.

The equation was solved in a manner similar to Newton's (Acton, 1970) method, but with higher order terms included. This was done because the higher order derivatives can be obtained very simply, and are much cheaper than further iterations. (It was found that, using the Cosine-Pi formula of Pearson as a starting approximation, usually only one iteration was necessary to produce the maximum available accuracy, and at most two.)

The series was developed as follows:

$$\text{Let } B(h, k, r) = \frac{1}{2\pi\sqrt{1-r^2}} \int_{-\infty}^h \int_{-\infty}^k e^{-\frac{1}{2}\left(\frac{x^2+y^2-2yxr}{1-r^2}\right)} dx dy$$

If B is differentiated with respect to r, then the double integration can be performed, leaving

$$\frac{dB}{dr} = \frac{1}{2\pi\sqrt{1-r^2}} e^{-\frac{1}{2}\left(\frac{h^2+k^2-2hkr}{1-r^2}\right)}$$

Therefore:

$$\frac{dr}{dB} = 2\pi(1-r^2)^{\frac{1}{2}} e^{+\frac{1}{2}\left(\frac{h^2+k^2-2hkr}{1-r^2}\right)}$$

Let

$$z(r) = 2\pi e^{+\frac{1}{2}\left(\frac{h^2+k^2-2hkr}{1-r^2}\right)}$$

Then

$$\frac{dr}{dB} \text{ can be rewritten as follows:}$$

$$\frac{dr}{dB} = z(r)(1-r^2)^{\frac{1}{2}}$$

Furthermore

$$\begin{aligned} \frac{d^2r}{dB^2} &= \left[ \frac{d}{dr} \left( \frac{dr}{dB} \right) \right] \frac{dr}{dB} = \left[ -r(1-r^2)^{-\frac{1}{2}} z(r) + (1-r^2)^{\frac{1}{2}} \frac{dz}{dr} \right] \frac{dr}{dB} \\ &= z^2(r) \left[ (h^2+k^2-2hkr)(r)(1-r^2)^{-1} - hk - r \right] \end{aligned}$$

$$\frac{d^3 r}{d B^3} = \left[ \frac{d}{dr} \left( \frac{d^2 r}{d B^2} \right) \right] \frac{dr}{d B} =$$

$$\begin{aligned} & \frac{dr}{d B} \left\{ 2 Z \frac{d Z}{d r} \left[ (h^2 + k^2 - 2 h k r)(r)(1-r^2)^{-1} - h k - r \right] \right. \\ & + Z^2 \left[ (h^2 + k^2 - 2 h k r)(1-r^2)^{-1} \right. \\ & \left. \left. - 2 h k r(1-r^2)^{-1} + 2 r^2(1-r^2)^{-2}(h^2 + k^2 - 2 h k r) - 1 \right] \right\} \end{aligned}$$

$$\begin{aligned} & = Z^3(r) \left\{ \left[ \left\{ (h^2 + k^2 - 2 h k r)(r)(1-r^2)^{-1} \right\} \right. \right. \\ & \quad \left. \left\{ (h^2 + k^2 - 2 h k r)(r)(1-r^2)^{-1} - 2 h k \right\} \right. \\ & \quad \left. \left. + \frac{1}{2} (h^2 + k^2 - 2 h k r) + h^2 k^2 \right] \div \frac{1}{2} \sqrt{1-r^2} \right\} - \sqrt{1-r^2} \end{aligned}$$

By assigning constants as follows, these three terms can be further simplified.

Let

$$C_0 = hk$$

$$C_1 = 1 - r^2$$

$$C_2 = \sqrt{C_1}$$

$$C_3 = 2C_0$$

$$C_4 = h^2 + k^2 - C_3 r$$

$$C_5 = C_4 / C_1$$

$$C_6 = r C_5$$

$$Z = (2\pi) \exp \left( \frac{1}{2} C_5 \right)$$

$$D_2 = C_6 - C_0 - r$$

$$D_3 = 2 \left[ C_6 (C_6 - C_3) + \frac{1}{2} C_4 + C_0^2 \right] / C_2 - C_2$$

Then:

$$\frac{dr}{dB} = C_2 Z$$

$$\frac{d^2 r}{dB^2} = D_2 Z^2$$

$$\frac{d^3 r}{dB^3} = D_3 Z^3$$

No attempt was made to develop higher order terms, because three seemed to give maximum accuracy with only one iteration in most cases; higher terms could be generated in a straightforward manner, with considerable labor.

A first approximation is made with Pearson's Cosine-Pi formula. With this  $r$ , the proportion in any one of the four regions is computed using the scheme mentioned above. The difference between this proportion and the desired one in the region is computed, called, say,  $A \ B$ .

Let  $X = Z(A \ B)$ . Then  $r$  is corrected as follows:

$$r_{\text{corrected}} = r + X \left[ C_2 + x (1/2 D_2 + 1/6 D_3 x) \right]$$

If one iteration does not produce agreement to within  $5 \times 10^{-8}$  in the proportion, another iteration is performed. In this way, the desired correlation is reached.

The accuracy obtained in the correlation itself varies. For certain distributions (correlations very nearly 1.0, or very large or small  $h$  and  $k$ ),  $dB/dr$  is nearly zero, so that a small error in the proportion corresponds to a large error in the correlation. However, the correlation given by the program does reproduce the four-fold table with an error of not more than  $5 \times 10^{-8}$ , which is a reasonable measure of the accuracy of the correlation. It should also be noted that in the exceptional ranges mentioned, a small error in the input causes a very large error in the correlation, making it highly unreliable. (These are the cases where the standard error is largest, for a given  $N$ .)

24. If there is an outside criterion, a validity coefficient is computed which is Pearson's  $r$ .

$$r_{xy} = \frac{\sum_{i=1}^N \frac{(x_i - \bar{x})(y_i - \bar{y})}{N \sigma_x \sigma_y}}$$

where  $r_{xy}$  = correlation between X and Y.

$x_i$  = internal criterion scores.

$\bar{x}$  = mean of X values.

$y_i$  = external criterion scores.

$\bar{y}$  = mean of Y values.

$\sigma_x$  = standard deviation of the distribution of X scores.

$\sigma_y$  = standard deviation of the distribution of Y scores.

25. Calculation of abscissa and ordinate of standard normal distribution at dichotomy.

The abscissa (X) and the proportion passing item (p) are related as follows:

$$p = \frac{1}{\sqrt{2\pi}} \int_x^{\infty} e^{-\frac{1}{2}u^2} du$$

The ordinate (y) is then computed as:

$$y = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}x^2}$$

x is obtained in the manner discribed in 26 below.

26. Computation of the Inverse Normal Distribution Function.

The inverse normal (cumulative) distribution function  $x(q)$  is defined by the equation

$$q = \frac{1}{\sqrt{2\pi}} \int_{x(q)}^{\infty} e^{-\frac{1}{2}t^2} dt, \quad 0 < q < 1$$

However, since  $x(1 - q) = -x(q)$ , only the  $0 < q \leq .5$  range is necessary to be considered.

Hastings (1964) gives a min-max rational approximation to  $x(q)$  which has a maximum error of  $4.5 \times 10^{-4}$  over the range  $0 < q \leq .5$ . Since greater accuracy was desired, the following approach was taken.

(a.) Obtain the derivatives of  $x(q)$  as follows:

$$q = \frac{1}{\sqrt{2\pi}} \int_{x(q)}^{\infty} e^{-\frac{1}{2}t^2} dt$$

$$\frac{dq}{dx} = -\frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}x^2} \quad \text{and} \quad \frac{dx}{dq} = -\sqrt{2\pi} e^{\frac{1}{2}x^2}$$

$$\frac{d^2x}{dq^2} = \left[ \frac{d}{dx} \left( \frac{dx}{dq} \right) \right] \frac{dx}{dq} = \left( \frac{dx}{dq} \right)^2 x$$

$$\frac{d^3x}{dq^3} = \left[ \frac{d}{dx} \left( \frac{d^2x}{dq^2} \right) \right] \frac{dx}{dq} = \left( \frac{dx}{dq} \right)^3 (1 + 2x^2)$$

$$\frac{d^4x}{dq^4} = \left[ \frac{d}{dx} \left( \frac{d^3x}{dq^3} \right) \right] \frac{dx}{dq} = \left( \frac{dx}{dq} \right)^4 (7x + 6x^3)$$

$$\frac{d^5x}{dq^5} = \left[ \frac{d}{dx} \left( \frac{d^4x}{dq^4} \right) \right] \frac{dx}{dq} = \left( \frac{dx}{dq} \right)^5 (7 + 46x^2 + 24x^4)$$

Higher order terms are generated in a similar manner.

(b.) Obtain an initial approximation of  $x_1$  by the Hastings formula (26.2.23).

(c.) Compute the error in  $q(x)$ , say  $\Delta q = q(x_i) - q$ . Most Fortran compilers have the Error Function available from which  $q(x_i)$  can be obtained. For large  $x_i$ , a Gaussian continued fraction can be used to arrive at  $\Delta q$ .

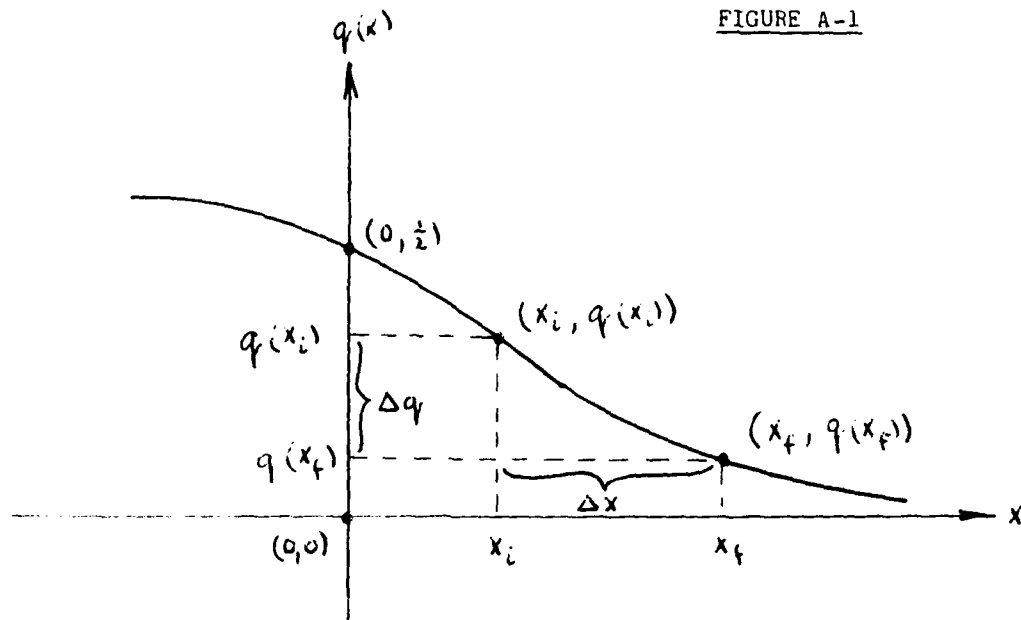
(d.) Write the correction terms as a Taylor series for  $x$  in terms of  $\Delta q$ , expanding about  $q(x_i)$  (which is the  $q$  of the initial approximation),  $10^{-38} q \approx .5$ . The lower limit ( $10^{-38}$ ) is the smallest number on the IBM 7040 computer on which this program was developed.

It was found that only the first two terms of the Taylor series were required to attain desirable precision on an eight-digit machine, yielding an error of the magnitude of  $5 \times 10^{-8}$ . Using the first five terms of the series resulted in an error of less than  $10^{-15}$ .

The first term in the series is equivalent to a single iteration by Newton's method. The reason for using higher order correction terms in lieu of further iterations is that the former can be obtained very quickly from the first-order term, whereas additional iterations would require evaluation of  $q(x)$  and  $dx/dq$  for each iteration.

A graphical illustration may be helpful to understand the algorithm. Figure A-1 shows the initial approximation  $x_i$ , with the associated  $q(x_i)$ ; the derived  $q(x_f)$  associated with the final approximation  $x_f$ , and the error (or difference) between the initial and final approximation ( $x$  and  $q$ ).

FIGURE A-1



$$\Delta x = \frac{dx}{dq} (\Delta q) + \frac{1}{2} \frac{d^2 x}{dq^2} (\Delta q)^2 + \dots$$

The final approximation,  $x_F$ , correct to eight digits can be written as follows:

Let

$$z = \frac{dx}{dq} (\Delta q) = -\sqrt{2\pi} e^{\frac{1}{2}x^2} (\Delta q)$$

Then

$$x_f = x + z \left( 1 + \frac{1}{2} x z \right)$$

For 16-digit accuracy the final approximation,  $x_F$ , takes the form of:

$$x_F = x + Z \left( 1 + Z \left( \frac{\lambda}{2} + Z \left( (1 + 2x^2)/6 + Z \left( x(7+6x^2)/24 \right. \right. \right. \right. \\ \left. \left. \left. + Z (7 + x^2(46 + 24x^2)) / 120 \right) \right) \right) \right)$$

27. Correction for overlap in biserial correlation when item score contributes to criterion score (internal criterion).

Guilford's Method:

$$\text{corrected } r_{\text{bis}} = \frac{r_{h.s.} \sigma - pq/y}{\sqrt{\sigma^2 - (pq/y)^2 - 2r_{h.s.} \sigma (pq/y)}}$$

where  $\sigma$  = standard deviation of test.

$p, q$  are the same as in 14.

Henrysson's Method:

$$\text{corrected } r_{\text{bis}} = \frac{r_{h,y} \sigma - pq/4}{\sqrt{\sigma^2 + pq - 2r_{h,y} \sigma y}}$$

28. Correction for overlap in point biserial correlation.

$$\text{corrected } r_{\text{pbis}} = \frac{r_{ph,y} \sigma - \sqrt{pq}}{\sqrt{\sigma^2 + pq - 2r_{ph,y} \sigma \sqrt{pq}}}$$

29. More on the Item Characteristic Curve

The information given about the item variable is a dichotomy since the item score is either pass or fail. To justify the statements about the shape of the item characteristic curve (i.e., ogive) and the formulas used for estimating its parameters, we have to make certain basic assumptions:

- (1) The item variable is continuous even though we know only dichotomous information about it. That is individuals know various amounts of information about the item, a certain amount of which is necessary to fall into the pass/fail dichotomy.
- (2) The regression of the item variable on the criterion variable is linear.

- (3) The conditional distribution of the item variable (i.e., the distribution of the item variable for a given criterion score) is normal, with a variance independent of the criterion

The following discussion assumes that both the criterion variable and the item variable are in standard scores (i.e., deviations from the mean in standard deviation units). This means that the regression line passes through the origin, has a slope of  $r$ , where  $r$  is the correlation between the two variables, and the variance of the conditional distribution of the item variable is  $(1-r^2)$ . Figure A-2 is a graphic representation of the situation where

$p$  = proportion of individuals passing the item

$q = (1 - p)$  = proportion of individuals failing the item

$c$  = cutoff point on the item variable corresponding to the pass/fail dichotomy

The abscissa represents the criterion variable in standard scores (x-axis).

The ordinate represents the item variable in standard scores (y-axis).  $p(x)$  = proportion of individuals passing the item for a given criterion score  $x$  (shaded areas in Figure A-2).

## Conditional Distributions

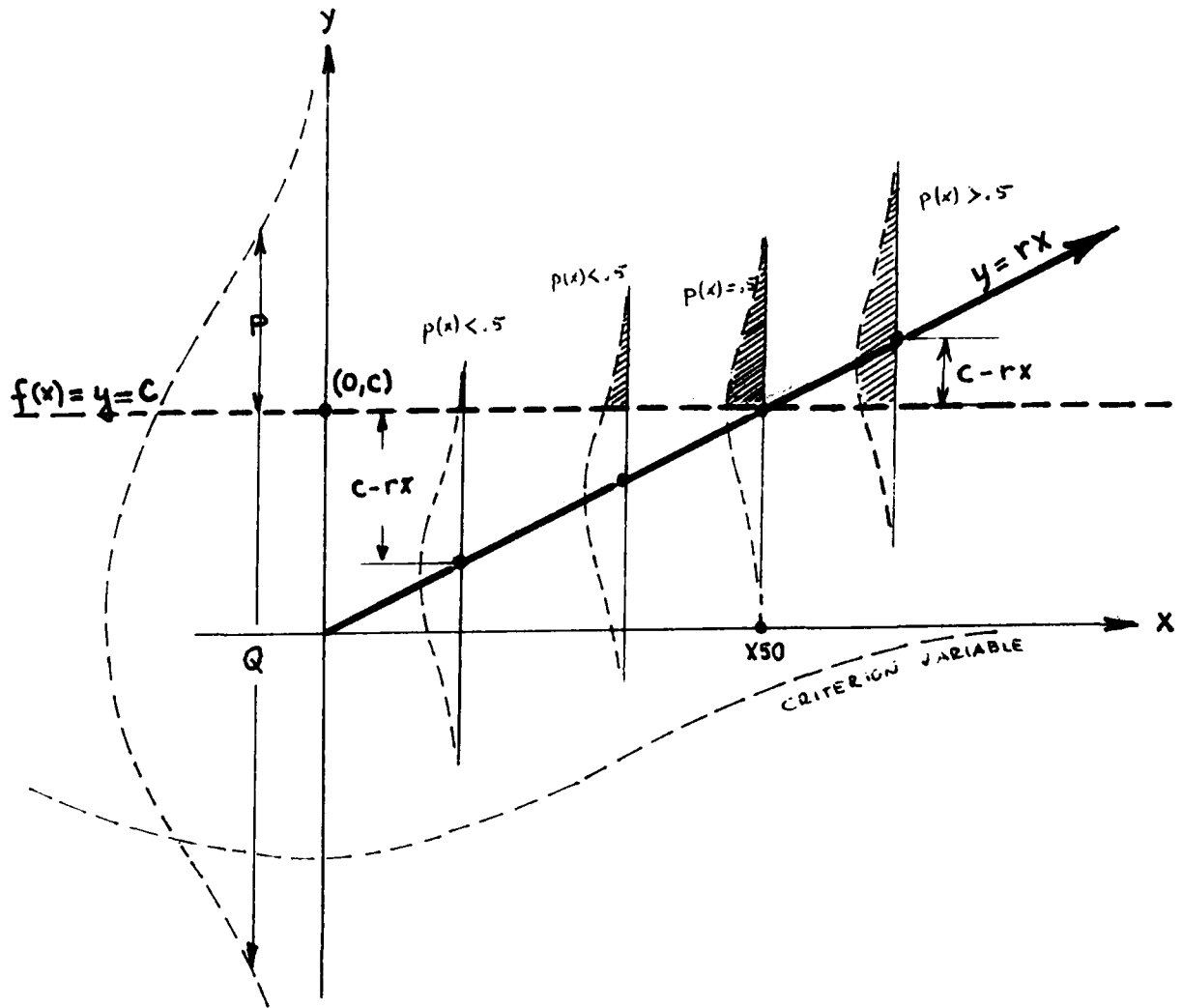


FIGURE A-2

The conditional distributions have means on the line  $y = rx$  since linearity of regression was assumed.

Consider now  $p(x)$ , the proportion above the cutoff point  $C$  in the conditional distribution varies with  $x$ . Since the conditional distribution is normal, its variance is  $1 - r^2$  (see Proof 1) and furthermore this variance is independent from  $x$ . However, as  $x$  increases, the distance between the mean of the conditional distributions and the cutoff point  $C$  increases as well. In fact this distance is  $(C - rx)$ . Since the displacement of the mean from the cutoff is a linear function of  $x$ , the proportion above the cutoff in the conditional distribution produces a normal ogive (cumulative normal distribution) with respect to  $x$ .

Proof 1 To prove that the variance of the conditional normal distribution equals  $(1 - r^2)$ .

By hypothesis, the variance of the conditional distribution is constant, say  $\sigma^2$ . Also by hypothesis, the mean of the conditional distribution is  $(rx)$ . Therefore

$$(1) \quad \int_{-\infty}^{\infty} (y - rx)^2 f(y|x) dy = \sigma^2$$

where  $f(y|x)$  : conditional density of  $y$

Also by hypothesis (normal distribution), the means of  $y$  and  $x$  are zero and their variance is 1.

Thus:

$$(2) \quad \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} y^2 g(x) f(y|x) dy dx = 1 \quad \text{Variance of } y$$

where  $g(x)$  = density of  $x$

and  $g(x)f(y|x)$  = joint density of  $y$  and  $x$

from (1) above

$$\int_{-\infty}^{\infty} y^2 f(y|x) dy - 2rx \int_{-\infty}^{\infty} y f(y|x) dy + r^2 x^2 \int_{-\infty}^{\infty} f(y|x) dy = \sigma^2$$

Collecting terms and realizing that

$$\int_{-\infty}^{\infty} y f(y|x) dy = rx, \quad \int_{-\infty}^{\infty} y^2 f(y|x) dy = 2r^2 x^2 - r^2 x^2 + \frac{2}{\sigma^2} = \frac{2}{\sigma^2} + r^2 x^2$$

Substituting into (2) results in:

$$\int_{-\infty}^{\infty} g(x) \int_{-\infty}^{\infty} y^2 f(y|x) dy dx = \int_{-\infty}^{\infty} \left( \frac{2}{\sigma^2} + r^2 x^2 \right) g(x) dx = \frac{2}{\sigma^2} \int_{-\infty}^{\infty} g(x) dx + r^2 \int_{-\infty}^{\infty} x^2 g(x) dx = 1$$

Since

$$\int_{-\infty}^{\infty} g(x) dx = 1 \quad \text{density of } x$$

and

$$\int_{-\infty}^{\infty} x^2 p(x) dx = 1 \quad \text{variance of } x \text{ by hypothesis}$$

we have

$$\sigma^2(1) + r^2(1) = 1$$

$$\sigma^2 + r^2 = 1$$

$$\sigma^2 = 1 - r^2$$

Returning to Figure A-2, at the point where the cutoff line  $y = C$  intersects the regression line  $y = rx$ , the value of  $x$  is called X50. At this point as it can be seen from Figure A-2, 50% of the conditional distribution falls above and 50% falls below the cutoff since the mean of the conditional distribution coincides with the cutoff at this point. Since  $C = r(X50)$  at this point,  $X50 = C/r$ .

X50 is also the inflection point for the item characteristic curve (the curve of  $p(x)$  plotted against the criterion score). This curve is a normal ogive and has a standard deviation of

$$\sigma = \frac{\sqrt{1 - r^2}}{r}$$

Proof 2 The conditional density of the item variable  $y$  is

$$P(y|x) = \frac{1}{\sqrt{2\pi}(\sqrt{1-r^2})} e^{-\frac{1}{2} \frac{(y-rx)^2}{1-r^2}}$$

The proportion above the cutoff is

$$P(x) = \frac{1}{\sqrt{2\pi}(\sqrt{1-r^2})} \int_c^\infty e^{-\frac{1}{2} \frac{(y-rx)^2}{1-r^2}} dy$$

let  $t = y/r - x$

$$dy = r dt$$

then

$$P(x) = \frac{r}{\sqrt{2\pi}(\sqrt{1-r^2})} \int_{\frac{c}{r}-x}^\infty e^{-\frac{1}{2} \frac{t^2}{(1-r^2)/r^2}} dt$$

which is a normal ogive with standard deviation of

$$\frac{\sqrt{1-r^2}}{r}$$

and inflection point of  $c/r$ .

The reciprocal of the standard deviation of the normal ogive is called

$$\beta \text{ and } \beta = r/\sqrt{1-r^2}$$

There are numerous methods of estimating the parameters  $c$  and  $r$  from a given sample. Probably the best is the maximum likelihood method by which  $\hat{c}$  and  $\hat{r}$ , the estimates of  $c$  and  $r$ , are chosen in such a way as to maximize the probability of occurrence of the sample data at hand, with the hypothesized probability distribution depending only on these two parameters. However, this method leads to non-linear simultaneous equations which must be solved iteratively with considerable labor at each step. A far simpler method for estimating  $r$  is by use of the biserial correlation. This method, however, requires two additional assumptions, namely that the regression of the criterion variable on the item variable is normal. The formula can be arrived at as follows:

Let  $f(x|y)$  be the conditional density  $x$ . The marginal distribution of  $y$  is hypothesized to be standard normal, so the density of  $y$  is

$$g(y) = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}y^2}$$

The assumption of linearity of regression of  $x$  and  $y$  means that

$$\int_{-\infty}^{\infty} xf(x|y)dx = ry$$

that is, the mean of the conditional distribution of  $x$  falls on the line  
 $x = ry$ .

Now consider  $\bar{X}_p$  = mean criterion value for cases above the cutoff line  $y=c$ .

$$\bar{X}_p = \frac{\int_c^\infty \int_{-\infty}^\infty xf(x|y)g(y)dx dy}{\int_c^\infty \int_{-\infty}^\infty f(x|y)g(y)dx dy}$$

where  $f(x|y)g(y)$  is the joint density of  $x$  and  $y$ .

$$\bar{X}_p = \frac{\int_c^\infty g(y) \int_{-\infty}^\infty xf(x|y)dx dy}{\int_c^\infty g(y) \int_{-\infty}^\infty f(x|y)dx dy}$$

Now

$$\int_{-\infty}^\infty xf(x|y)dx = ry$$

by hypothesis and

$$\int_{-\infty}^\infty f(x|y)dx = 1$$

therefore  $\bar{X}_p = \frac{r \int_c^\infty yg(y)dy}{\int_c^\infty g(y)dy}$

out

$$\int_c^{\infty} g(y) dy = P$$

thus

$$\bar{X}_P = \frac{r \int_c^{\infty} y \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}y^2} dy}{P} = \frac{1}{\sqrt{2\pi}} \frac{r}{P} e^{-\frac{1}{2}c^2}$$

hence

$$r = \frac{P \bar{X}_P}{\frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}c^2}}$$

Let

$$z = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}c^2}$$

where  $c$  is simply the abscissa corresponding to a proportion  $P$  in a standard normal distribution, since the item variable was assumed to be normally distributed.

Rewriting  $\bar{X}_p$  in terms of raw scores,

$$r = \frac{P}{Z} \cdot \bar{X}_p = \frac{M_p - M_x}{\sigma_x} \cdot \frac{P}{Z}$$

which is the formula for the biserial correlation.

This relationship is exact for the population but it is only an estimate when written in terms of sample values. It is not as efficient as the maximum likelihood method, particularly for a large  $r$ ; in fact for a large  $r$ , it is a rather poor estimator.

It is possible to incorporate the maximum likelihood method in this item analysis package; however, core limitations of the computer (IBM 7040) for which this program was originally developed would have made the attempt impractical with an added costly time factor. See also Ree (1979).

### 30. Average Item Difficulty

The percent of individuals passing a certain item is converted to a standard difficulty (D):

$$D = 0.5 - 0.16147653x$$

where x is the abscissa corresponding to the proportion of individuals passing the item (upper portion of the normal distribution).

To convert back from standard difficulty to the corresponding proportion:

$$\text{Proportion} = \frac{1}{\sqrt{2\pi}} \int_x^{\infty} e^{-\frac{1}{2}t^2} dt$$

$$\text{where } x = (.5 - D)/.16147653$$

Averaging is done with standard difficulties and then converted back to proportion passing.

A proportion of .999 converts to a D = .999

" " " .001 " " " D = .001

" " " .500 " " " D = .500

" " " <.001 " " " D = 0

" " " >.999 " " " D = 1

31. Mean of the  $j^{\text{th}}$  alternative of item i

$$\bar{X}_{ij} = \sum_{k=1}^{N_i} X_{ijk} / N_i$$

where  $N_i = N$  if the test was a power test and

= the number of people reaching item i if the test was a speed test.

32. Standard Deviation of the  $j^{\text{th}}$  alternative of item i

$$SD_{ij} = \sqrt{\bar{X}_{ij} (1 - \bar{X}_{ij})}$$

33. Correlation between alternatives a and b if item i

$$r_{ab} = \sqrt{\frac{\bar{X}_{ia} \bar{X}_{ib}}{(1 - \bar{X}_{i.a})(1 - \bar{X}_{i.b})}}$$

(Formulas 31 and 32 are derived from the regular formulas by noting that the individual values of the alternatives are 1's and 0's only and that the alternatives are mutually exclusive.)

34. Point-Biserial correlation between the criterion Y and the jth alternatives of item i

$${}^{pbis}r_{jY} = \frac{\sum_{k=1}^{N_i} X_{ijk} Y_k / N_i - \bar{X}_{ij} \bar{Y}_i}{SD_{ij} SD_{Y_i}}$$

(Note that in a speed test  $\bar{Y}_i$  and  $SD_{Y_i}$  are based on the  $N_i$  reaching item i; in a power test, they are computed on the full sample).

35. Biserial correlation between the criterion Y and the jth alternative of item i

$${}^{bis}r_{jY} = \frac{{}^{pbis}r_{jY} SD_{Y_i}}{Z}$$

where Z = the ordinate of the unit normal distribution curve with area equal to 1.0, at the point of division between segments containing p and q ( $\bar{X}_{ij}$  and  $1-\bar{X}_{ij}$ ) proportions of the cases.

36. Biserial validity significance test value =

$$\text{RTEST} = \frac{r_{jy} \sqrt{N}}{SD_{jy} / z - r_{jy}^2}$$

the significance test is bis<sup>r</sup><sub>jy</sub> is then:

$P \leq .05$  if  $\text{RTEST} \geq 1.96$

$P \leq .01$  if  $\text{RTEST} \geq 2.576$

APPENDIX B

IAP Sample Run

180 CLASS RUN

## SPECIFIED CONTROL PARAMETERS

| WSTIME | DUPLIM | NTM | 1 | KI     | 10 | KO    | 0 | KS    | 13  | NB    | 35 | EASY   | 80 |
|--------|--------|-----|---|--------|----|-------|---|-------|-----|-------|----|--------|----|
| DIFFLT | 0      | 0   | 0 | ICORGS | 1  | KIV   | 0 | ICRIT | 0   | OUT   | 0  | NOCASE | 0  |
| IPHI   | 1      | 2   | 0 | IOVER  | 0  | JPLAY | 0 | EIGN  | 100 | ICEND | 0  | IRWIND | 0  |
| ATCST  | 0      | 1   | 1 | IATY   | 0  | ICARD | 0 | NERR  | 2   | K32   | 19 | KERR   | 0  |

TITLE: JAP CLASS RUN

INPUT FORMAT FOR DATA ON FORTRAN FILE  
(EX. 16/11X, 3011)

MAILED 15X REASONS

172213323342323332232322362222

ATTACHATE RESPONSE CARD GIVEN

NUMBER OF ITEMS IS 30

| FIRST RECORD READ | ID IS                            | 1 |
|-------------------|----------------------------------|---|
| RESPONSES READ    | 22322333362623232633263326433319 |   |

MANPOWER AND PERSONNEL DIVISIO  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

IAP : ITEM ANALYSIS PROGRAM  
IAP CLASS RUN

225 SUBJECTS SELECTING EACH RESPONSE

ITEM INFORMATION

PROPORTION OF

3 4

2

1

OMITS

DIFFICULTY

ITEM  
NUMBER

|    |       |      |      |      |      |      |
|----|-------|------|------|------|------|------|
| 1  | -.191 | .000 | .107 | .627 | .249 | .018 |
| 2  | .547  | .000 | .231 | .698 | .071 |      |
| 3  | .401  | .000 | .138 | .551 | .284 | .027 |
| 4  | .259  | .000 | .044 | .444 | .440 | .071 |
| 5  | -.126 | .000 | .156 | .431 | .369 | .044 |
| 6  | .028  | .000 | .218 | .476 | .271 | .036 |
| 7  | .230  | .000 | .027 | .204 | .422 | .347 |
| 8  | .334  | .000 | .042 | .502 | .387 | .049 |
| 9  | .366  | .000 | .044 | .369 | .524 | .062 |
| 10 | .301  | .000 | .084 | .280 | .476 | .160 |
| 11 | .396  | .000 | .013 | .107 | .333 | .547 |
| 12 | .324  | .000 | .062 | .493 | .351 | .093 |
| 13 | .361  | .004 | .036 | .329 | .520 | .111 |
| 14 | .502  | .000 | .240 | .627 | .102 | .031 |
| 15 | .265  | .000 | .053 | .160 | .449 | .338 |
| 16 | .340  | .000 | .036 | .378 | .520 | .047 |
| 17 | .579  | .000 | .009 | .222 | .684 | .084 |
| 18 | .567  | .000 | .173 | .676 | .142 | .009 |
| 19 | .479  | .000 | .271 | .609 | .102 | .018 |
| 20 | .295  | .000 | .058 | .351 | .471 | .120 |
| 21 | .413  | .000 | .076 | .560 | .333 | .031 |
| 22 | .313  | .000 | .040 | .418 | .484 | .058 |
| 23 | .526  | .000 | .196 | .644 | .142 | .018 |
| 24 | .354  | .000 | .116 | .516 | .316 | .053 |
| 25 | .295  | .000 | .049 | .387 | .471 | .093 |
| 26 | -.073 | .000 | .022 | .178 | .604 | .196 |
| 27 | .456  | .004 | .067 | .591 | .316 | .022 |
| 28 | .479  | .000 | .076 | .609 | .302 | .013 |
| 29 | .526  | .000 | .182 | .644 | .169 | .004 |
| 30 | .396  | .000 | .191 | .547 | .244 | .018 |

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CONTROLLED ITEM  
\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552a) \*\*\*

IAP : ITEM ANALYSIS PROGRAM

IAP CLASS RUN

THE FOLLOWING ITEMS FALL OUTSIDE OF THE SPECIFIED DIFFICULTY RANGE AND SHOULD BE ELIMINATED BECAUSE OF EXTREME DIFFICULTY/EASINESS

EASY ITEMS ABOVE .80 DIFFICULT ITEMS BELOW .20

1

5

6

26

## IAP : ITEM ANALYSIS PROGRAM

IAP CLASS RUN

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552a) \*\*\*

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

## ITEM ALTERNATIVE INFORMATION ROSTER (BASED ON "CORRECTED TEST SCORE" CRITERION)

| ITEM-ALT | MEAN  | STD<br>DEV | DIFF. | CRIT.<br>PT | VALIDITY<br>BIS | O-UIT | 1     | 2     | 3     | 4     | 5 | 6 | 7 |
|----------|-------|------------|-------|-------------|-----------------|-------|-------|-------|-------|-------|---|---|---|
| 1-OMIT   | .0000 | .0000      |       |             |                 | 1.000 |       |       |       |       |   |   |   |
| 1-1 *    | .1067 | .3027      | .000  | .0000       | .0000           | .000  | 1.000 |       |       |       |   |   |   |
| 1-2      | .6267 | .4837      | .502  | .7038       | .0799           | .000  | .000  | 1.000 |       |       |   |   |   |
| 1-3      | .2489 | .4324      | .000  | .0000       | .0000           | .000  | .000  | .000  | 1.000 |       |   |   |   |
| 1-4      | .6173 | .1324      | .000  | .0000       | .0000           | .000  | .000  | .000  | .000  | 1.000 |   |   |   |
| 2-OMIT   | .0000 | .0000      |       |             |                 | 1.000 |       |       |       |       |   |   |   |
| 2-1      | .2311 | .4215      | .000  | .0000       | .0000           | .000  | 1.000 |       |       |       |   |   |   |
| 2-2 *    | .6973 | .4592      | .547  | .2671       | .3607 **        | .000  | .000  | 1.000 |       |       |   |   |   |
| 2-3      | .0711 | .2570      | .000  | .0000       | .0000           | .000  | .000  | .000  | 1.000 |       |   |   |   |
| 3-OMIT   | .0000 | .0000      |       |             |                 | 1.000 |       |       |       |       |   |   |   |
| 3-1      | .1373 | .3247      | .000  | .0000       | .0000           | .000  | 1.000 |       |       |       |   |   |   |
| 3-2 *    | .5511 | .4974      | .401  | .1743       | .2210 **        | .000  | .000  | 1.000 |       |       |   |   |   |
| 3-3      | .2546 | .4511      | .046  | .0518       | .1125           | .000  | .000  | .000  | 1.000 |       |   |   |   |
| 3-4      | .0267 | .1511      | .000  | .0000       | .0000           | .000  | .000  | .000  | .000  | 1.000 |   |   |   |
| 4-OMIT   | .0000 | .0000      |       |             |                 | 1.000 |       |       |       |       |   |   |   |
| 4-1      | .0446 | .2061      | .000  | .0000       | .0000           | .000  | 1.000 |       |       |       |   |   |   |
| 4-2 *    | .4446 | .4969      | .259  | .7411       | .0557           | .000  | .000  | 1.000 |       |       |   |   |   |
| 4-3      | .4400 | .4924      | .253  | .0204       | .0277           | .000  | .000  | .000  | 1.000 |       |   |   |   |
| 4-4      | .0711 | .2570      | .000  | .0000       | .0000           | .000  | .000  | .000  | .000  | 1.000 |   |   |   |
| 5-OMIT   | .0000 | .0000      |       |             |                 | 1.000 |       |       |       |       |   |   |   |
| 5-1 *    | .1556 | .3624      | .000  | .0000       | .0000           | .000  | 1.000 |       |       |       |   |   |   |
| 5-2      | .4311 | .4052      | .241  | .1032       | .1416           | .000  | .000  | 1.000 |       |       |   |   |   |
| 5-3      | .3699 | .4825      | .159  | .0723       | .1021           | .000  | .000  | .000  | 1.000 |       |   |   |   |
| 5-4      | .0446 | .2061      | .000  | .0000       | .0000           | .000  | .000  | .000  | .000  | 1.000 |   |   |   |
| 6-OMIT   | .0000 | .0000      |       |             |                 | 1.000 |       |       |       |       |   |   |   |
| 6-1      | .2173 | .4127      | .000  | .0000       | .0000           | .000  | 1.000 |       |       |       |   |   |   |
| 6-2      | .4756 | .4994      | .301  | .6443       | .0584           | .000  | .000  | 1.000 |       |       |   |   |   |
| 6-3 *    | .2711 | .4445      | .028  | .0288       | .0739           | .000  | .000  | .000  | 1.000 |       |   |   |   |
| 6-4      | .0355 | .1852      | .000  | .0000       | .0000           | .000  | .000  | .000  | .000  | 1.000 |   |   |   |
| 7-OMIT   | .0000 | .0000      |       |             |                 | 1.000 |       |       |       |       |   |   |   |
| 7-1      | .0267 | .1611      | .000  | .0000       | .0000           | .000  | 1.000 |       |       |       |   |   |   |
| 7-2      | .2044 | .4033      | .000  | .0000       | .0000           | .000  | .000  | 1.000 |       |       |   |   |   |
| 7-3 *    | .4222 | .4939      | .230  | .2046       | .2836 **        | .000  | .000  | .000  | 1.000 |       |   |   |   |
| 7-4      | .3467 | .4759      | .129  | .1110       | .1769 *         | .000  | .000  | .000  | .000  | 1.000 |   |   |   |
| 8-OMIT   | .0000 | .0000      |       |             |                 | 1.000 |       |       |       |       |   |   |   |
| 8-1      | .0622 | .2416      | .000  | .0000       | .0000           | .000  | 1.000 |       |       |       |   |   |   |
| 8-2 *    | .5022 | .5000      | .336  | .1268       | .1642 *         | .000  | .000  | 1.000 |       |       |   |   |   |
| 8-3      | .3967 | .4870      | .182  | .0425       | .0621           | .000  | .000  | .000  | 1.000 |       |   |   |   |
| 8-4      | .0489 | .2156      | .000  | .0000       | .0000           | .000  | .000  | .000  | .000  | 1.000 |   |   |   |

\* FLAGS CORRECT ANSWER

\* INDICATES BICERIAL VALIDITY SIGNIFICANT AT .05 LEVEL &amp; \*\* FOR .01 LEVEL

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

IAP : ITEM ANALYSIS PROGRAM

IAP CLASS RUN

ITEM ALTERNATIVE INFORMATION ROSTER ( BASED ON "CORRECTED TEST SCORE" CRITERION)

| ITEM-ALT | MEAN  | STD<br>DEV | DIFF. | PT BIS | CRIT. VALIDITY<br>BIS | ***** ALTERNATIVE INTERCORRELATIONS ***** |       |       |       |       |       |       |
|----------|-------|------------|-------|--------|-----------------------|-------------------------------------------|-------|-------|-------|-------|-------|-------|
|          |       |            |       |        |                       | OMIT                                      | 1     | 2     | 3     | 4     | 5     | 6 7 8 |
| 9-OMIT   | .0000 | .0000      | .0000 | .0000  | .0000                 | 1.000                                     | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 9-1      | .0444 | .2061      | .000  | .0000  | .0000                 | .000                                      | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 9-2      | .3689 | .4825      | .159  | -.0106 | -.0160                | .000                                      | -.165 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 9-3 *    | .5244 | .4994      | .366  | .1475  | .1889 *               | .000                                      | -.226 | -.803 | 1.000 | 1.000 | 1.000 |       |
| 9-4      | .0622 | .2416      | .000  | .0000  | .0000                 | .000                                      | -.056 | -.197 | 1.000 | 1.000 | 1.000 |       |
| 10-OMIT  | .0000 | .0000      | .0000 | .0000  | .0000                 | 1.000                                     | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 10-1     | .0844 | .2781      | .000  | .0000  | .0000                 | .000                                      | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 10-2     | .2800 | .4490      | .040  | -.0208 | -.0473                | .000                                      | -.189 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 10-3 *   | .4756 | .4994      | .301  | .2143  | .2823 **              | .000                                      | -.289 | -.594 | 1.000 | 1.000 | 1.000 |       |
| 10-4     | .1600 | .3666      | .000  | .0000  | .0000                 | .000                                      | -.133 | -.272 | 1.000 | 1.000 | 1.000 |       |
| 11-OMIT  | .0000 | .0000      | .0000 | .0000  | .0000                 | 1.000                                     | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 11-1     | .0133 | .1147      | .000  | .0000  | .0000                 | .000                                      | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 11-2     | .1067 | .3087      | .000  | .0000  | .0000                 | .000                                      | -.040 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 11-3     | .3333 | .4716      | .111  | .0119  | .0197                 | .000                                      | -.082 | -.244 | 1.000 | 1.000 | 1.000 |       |
| 11-4 *   | .5467 | .4978      | .396  | .1072  | .1361                 | .000                                      | -.128 | -.379 | 1.000 | 1.000 | 1.000 |       |
| 12-OMIT  | .0000 | .0000      | .0000 | .0000  | .0000                 | 1.000                                     | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 12-1     | .0622 | .2416      | .000  | .0000  | .0000                 | .000                                      | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 12-2 *   | .4933 | .5000      | .324  | .2052  | .2671 **              | .000                                      | -.254 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 12-3     | .3511 | .4773      | .135  | -.0754 | -.1187                | .000                                      | -.189 | -.726 | 1.000 | 1.000 | 1.000 |       |
| 12-4     | .0933 | .2909      | .000  | .0000  | .0000                 | .000                                      | -.083 | -.317 | 1.000 | 1.000 | 1.000 |       |
| 13-OMIT  | .0744 | .0665      | .000  | -.0556 | -.2842                | 1.000                                     | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 13-1     | .0356 | .1852      | .000  | .0000  | .0000                 | .000                                      | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 13-2     | .3289 | .4693      | .107  | -.0700 | -.1175                | .000                                      | -.134 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 13-3 *   | .5200 | .4994      | .361  | .1934  | .2479 **              | .000                                      | -.070 | -.729 | 1.000 | 1.000 | 1.000 |       |
| 13-4     | .1111 | .3143      | .000  | .0000  | .0000                 | .000                                      | -.068 | -.248 | 1.000 | 1.000 | 1.000 |       |
| 14-OMIT  | .0000 | .0000      | .0000 | .0000  | .0000                 | 1.000                                     | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 14-1     | .2400 | .4271      | .000  | .0000  | .0000                 | .000                                      | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 14-2 *   | .6267 | .4837      | .502  | .2772  | .3474 **              | .000                                      | -.728 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 14-3     | .1022 | .3029      | .000  | .0000  | .0000                 | .000                                      | -.190 | -.437 | 1.000 | 1.000 | 1.000 |       |
| 14-4     | .0311 | .1736      | .000  | .0000  | .0000                 | .000                                      | -.101 | -.232 | 1.000 | 1.000 | 1.000 |       |
| 15-OMIT  | .0000 | .0000      | .0000 | .0000  | .0000                 | 1.000                                     | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 15-1     | .0533 | .2247      | .000  | .0000  | .0000                 | .000                                      | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 15-2     | .1600 | .3666      | .000  | .0000  | .0000                 | .000                                      | -.104 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 15-3 *   | .4489 | .4974      | .265  | .2355  | .3172 **              | .000                                      | -.214 | -.394 | 1.000 | 1.000 | 1.000 |       |
| 15-4     | .3373 | .4730      | .117  | -.0810 | -.1325                | .000                                      | -.170 | -.312 | 1.000 | 1.000 | 1.000 |       |
| 16-OMIT  | .0000 | .0000      | .0000 | .0000  | .0000                 | 1.000                                     | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 16-1     | .0356 | .1852      | .000  | .0000  | .0000                 | .000                                      | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 16-2     | .3778 | .4848      | .170  | -.0711 | -.1054                | .000                                      | -.150 | 1.000 | 1.000 | 1.000 | 1.000 |       |
| 16-3 *   | .5200 | .4994      | .360  | .1859  | .2386 **              | .000                                      | -.200 | -.811 | 1.000 | 1.000 | 1.000 |       |
| 16-4     | .0667 | .2494      | .000  | .0000  | .0000                 | .000                                      | -.051 | -.208 | 1.000 | 1.000 | 1.000 |       |

\* FLAGS CORRECT ANSWER

\* INDICATES BISERIAL VALIDITY SIGNIFICANT AT .05 LEVEL & \*\* FOR .01 LEVEL.

## IAP : ITEM ANALYSIS PROGRAM

IAP CLASS RUN

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

## ITEM ALTERNATIVE INFORMATION ROSTER ( BASED ON "CORRECTED TEST SCORE" CRITERION)

| ITEM-ALT | MEAN  | STD<br>DEV | DIFF. | CRIT. VALIDITY<br>PT BIS | BIS      | OMIT  | 1     | 2     | 3     | 4     | 5 | 6 | 7 | 8 |
|----------|-------|------------|-------|--------------------------|----------|-------|-------|-------|-------|-------|---|---|---|---|
| 17-OMIT  | .0000 | .0000      | .0000 | .0000                    | .0000    | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |   |   |   |   |
| 17-1     | .0089 | .0939      | .000  | .0000                    | .0000    | .000  | .000  | .000  | .000  | .000  |   |   |   |   |
| 17-2     | .2222 | .4157      | .000  | .0000                    | .0000    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 17-3 *   | .6844 | .4647      | .579  | .2051                    | .2589 ** | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 17-4     | .0844 | .2781      | .000  | .0000                    | .0000    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 18-OMIT  | .0000 | .0000      | .0000 | .0000                    | .0000    | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |   |   |   |   |
| 18-1     | .1733 | .3785      | .000  | .0000                    | .0000    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 18-2 *   | .6756 | .4682      | .567  | .2115                    | .2665 ** | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 18-3     | .1422 | .3493      | .000  | .0000                    | .0000    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 18-4     | .0089 | .0939      | .000  | .0000                    | .0000    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 19-OMIT  | .0000 | .0000      | .0000 | .0000                    | .0000    | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |   |   |   |   |
| 19-1     | .2711 | .4445      | .028  | .0717                    | .1836    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 19-2 *   | .6089 | .4880      | .479  | .2736                    | .3431 ** | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 19-3     | .1022 | .3029      | .000  | .0000                    | .0000    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 19-4     | .0178 | .1321      | .000  | .0000                    | .0000    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 20-OMIT  | .0000 | .0000      | .0000 | .0000                    | .0000    | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |   |   |   |   |
| 20-1     | .0578 | .2333      | .000  | .0000                    | .0000    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 20-2     | .3511 | .4773      | .135  | .0197                    | .0311    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 20-3 *   | .4711 | .4992      | .295  | .1510                    | .1996 ** | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 20-4     | .1200 | .3250      | .000  | .0000                    | .0000    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 21-OMIT  | .0000 | .0000      | .0000 | .0000                    | .0000    | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |   |   |   |   |
| 21-1     | .0756 | .2643      | .000  | .0000                    | .0000    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 21-2 *   | .5600 | .4964      | .413  | .1314                    | .1661 *  | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 21-3     | .3333 | .4714      | .111  | .0351                    | .0583    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 21-4     | .0311 | .1736      | .000  | .0000                    | .0000    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 22-OMIT  | .0000 | .0000      | .0000 | .0000                    | .0000    | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |   |   |   |   |
| 22-1     | .0400 | .1960      | .000  | .0000                    | .0000    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 22-2     | .4178 | .4932      | .224  | .1321                    | .1841 *  | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 22-3 *   | .4844 | .4998      | .313  | .1978                    | .2590 ** | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 22-4     | .0578 | .2333      | .000  | .0000                    | .0000    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 23-OMIT  | .0000 | .0000      | .0000 | .0000                    | .0000    | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |   |   |   |   |
| 23-1     | .1956 | .3966      | .000  | .0000                    | .0000    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 23-2 *   | .6444 | .4787      | .526  | .2938                    | .3685 ** | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 23-3     | .1422 | .3493      | .000  | .0000                    | .0000    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 23-4     | .0178 | .1321      | .000  | .0000                    | .0000    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 24-OMIT  | .0000 | .0000      | .0000 | .0000                    | .0000    | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |   |   |   |   |
| 24-1     | .1156 | .3197      | .000  | .0000                    | .0000    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 24-2 *   | .5156 | .4998      | .354  | .1676                    | .2155 ** | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 24-3     | .3156 | .4647      | .087  | .0253                    | .0450    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |
| 24-4     | .0533 | .2247      | .000  | .0000                    | .0000    | .000  | .000  | .000  | 1.000 | 1.000 |   |   |   |   |

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IAP : ITEM ANALYSIS PROGRAM  
IAP CLASS RUN

ITEM ALTERNATIVE INFORMATION ROSTER ( BASED ON "CORRECTED TEST SCORE" CRITERION)

| ITEM-ALT | MEAN  | STD<br>DEV | DIFF. | CRIT. VALIDITY<br>PT BIS | BIS      | OMIT  | 1     | 2     | 3     | 4     | 5     | 6     | 7     | 8     |
|----------|-------|------------|-------|--------------------------|----------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 25-OMIT  | .0000 | .0000      | .0000 | .0000                    | .0000    | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 25-1     | .0489 | .2156      | .000  | .0000                    | .0000    | .000  | .000  | .000  | .000  | .000  | .000  | .000  | .000  | .000  |
| 25-2     | .3867 | .4870      | .182  | -.0411                   | -.0600   | .000  | -.180 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 25-3 *   | .4711 | .4992      | .295  | .1548                    | .2046 ** | .000  | -.214 | -.749 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 25-4     | .0933 | .2909      | .000  | .0000                    | .0000    | .000  | -.073 | -.255 | -.303 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 26-OMIT  | .0000 | .0000      | .0000 | .0000                    | .0000    | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 26-1     | .0222 | .1474      | .000  | .0000                    | .0000    | .000  | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 26-2     | .1778 | .3823      | .000  | .0000                    | .0000    | .000  | -.070 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 26-3     | .6044 | .4890      | .473  | .0023                    | .0029    | .000  | -.186 | -.575 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 26-4 *   | .1956 | .3966      | .000  | .0000                    | .0000    | .000  | -.074 | -.229 | -.609 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 27-OMIT  | .0044 | .0665      | .000  | -.0337                   | -.1720   | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 27-1     | .0667 | .2494      | .000  | .0000                    | .0000    | .000  | -.016 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 27-2 *   | .5911 | .4916      | .456  | .2585                    | .3247 ** | .000  | -.321 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 27-3     | .3156 | .4647      | .089  | -.0985                   | -.1742   | .000  | -.181 | -.816 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 27-4     | .0222 | .1474      | .000  | .0000                    | .0000    | .000  | -.040 | -.181 | -.102 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 28-OMIT  | .0000 | .0000      | .0000 | .0000                    | .0000    | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 28-1     | .0756 | .2643      | .000  | .0000                    | .0000    | .000  | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 28-2 *   | .6089 | .4880      | .479  | .1541                    | .1932 ** | .000  | -.357 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 28-3     | .3022 | .4592      | .070  | -.0467                   | -.0888   | .000  | -.188 | -.821 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 28-4     | .0133 | .1147      | .000  | .0000                    | .0000    | .000  | -.033 | -.145 | -.077 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 29-OMIT  | .0000 | .0000      | .0000 | .0000                    | .0000    | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 29-1     | .1922 | .3860      | .000  | .0000                    | .0000    | .000  | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 29-2 *   | .6444 | .4787      | .526  | .1682                    | .2110 ** | .000  | -.636 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 29-3     | .1689 | .3747      | .000  | .0000                    | .0000    | .000  | -.213 | -.607 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 29-4     | .0044 | .0665      | .000  | .0000                    | .0000    | .000  | -.032 | -.090 | -.030 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 30-OMIT  | .0000 | .0000      | .0000 | .0000                    | .0000    | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 30-1     | .1911 | .3932      | .000  | .0000                    | .0000    | .000  | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 30-2 *   | .5467 | .4978      | .396  | .2531                    | .3213 ** | .000  | -.534 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 30-3     | .2444 | .4298      | .000  | .0000                    | .0000    | .000  | -.276 | -.625 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |
| 30-4     | .0178 | .1321      | .000  | .0000                    | .0000    | .000  | -.065 | -.148 | -.077 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |

\* FLAGS CORRECT ANSWER

\* INDICATES BISERIAL VALIDITY SIGNIFICANT AT .05 LEVEL & \*\* FOR .01 LEVEL.

MANPOWER AND PERSONNEL DIVISIO  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

CONTROLLED ITEM  
\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

IAP : ITEM ANALYSIS PROGRAM  
IAP CLASS RUN

| SUMMARY OF TEST STATISTICS |       |      |         |      |          |      |          |      |                 |
|----------------------------|-------|------|---------|------|----------|------|----------|------|-----------------|
| VARIABLE                   | MEAN  | S.E. | ST.DEV. | S.E. | SKEWNESS | S.E. | KURTOSIS | S.E. | NO. OF SUBJECTS |
| RAW SCORE                  | 15.01 | .23  | 3.41    | .18  | -.25     | .16  | .50      | .32  | 225             |
| CORRECTED SCORE            | 9.96  | .30  | 4.57    | .24  | -.25     | .16  | .50      | .32  | 225             |

TEST RELIABILITY= .760

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552a) \*\*\*

IAP : ITEM ANALYSIS PROGRAM  
IAP CLASS RUN

FREQUENCY DISTRIBUTION OF SCORES

| SCORE        | Z-SCORE | T-SCORE | FREQUENCY | PERCENT | HISTOGRAM - EACH ) = .5 PERCENT |
|--------------|---------|---------|-----------|---------|---------------------------------|
| ZERO OR LESS |         |         |           |         |                                 |
| 1            | -1.96   | 30.39   | 6         | 1.3     | *)                              |
| 3            | -1.52   | 33.77   | 3         | 4.9     | *)                              |
| 5            | -1.09   | 37.15   | 11        | 4.9     | *)                              |
| 6            | -.87    | 41.53   | 18        | 8.0     | *)                              |
| 7            | -.65    | 45.91   | 18        | 8.0     | *)                              |
| 8            | -.43    | 50.29   | 1         | .4      | *)                              |
| 9            | -.21    | 54.67   | 28        | 12.4    | *)                              |
| 10           | .01     | 59.05   | 26        | 11.6    | *)                              |
| 11           | .23     | 63.43   | 29        | 12.9    | *)                              |
| 13           | .66     | 71.83   | 26        | 11.6    | *)                              |
| 14           | .88     | 76.21   | 16        | 7.1     | *)                              |
| 15           | 1.10    | 80.59   | 15        | 6.7     | *)                              |
| 17           | 1.54    | 89.00   | 5         | 2.2     | *)                              |
| 18           | 1.76    | 93.38   | 5         | 2.2     | *)                              |
| 19           | 1.98    | 97.76   | 4         | 1.8     | *)                              |
| 21           | 2.41    | 106.15  | 2         | .9      | *)                              |
| 22           | 2.63    | 110.53  | 1         | .4      | *)                              |

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

IAP : ITEM ANALYSIS PROGRAM  
IAP CLASS RUN

| INDIVIDUAL SCORES |       |                |         | CORRECTED |         |         | T-SCORE | OMITS |
|-------------------|-------|----------------|---------|-----------|---------|---------|---------|-------|
| ID                | SCORE | RAW<br>Z-SCORE | T-SCORE | SCORE     | Z-SCORE | T-SCORE |         |       |
| 1                 | 14    | -.296          | 47.740  | 8.67      | -.284   | 47.162  | 0       |       |
| 2                 | 16    | -.291          | 52.908  | 11.33     | -.299   | 52.994  | 0       |       |
| 3                 | 14    | -.296          | 47.740  | 8.67      | -.284   | 47.162  | 0       |       |
| 4                 | 16    | -.291          | 52.908  | 11.33     | -.299   | 52.994  | 0       |       |
| 5                 | 4     | -3.230         | 17.699  | -4.83     | -3.237  | 17.635  | 0       |       |
| 6                 | 8     | -2.056         | 29.435  | .67       | -2.034  | 29.564  | 0       |       |
| 7                 | 17    | -.564          | 55.842  | 12.67     | -.591   | 55.910  | 0       |       |
| 8                 | 23    | 2.345          | 73.447  | 20.67     | 2.341   | 73.407  | 0       |       |
| 9                 | 17    | -.584          | 55.842  | 12.67     | -.591   | 55.910  | 0       |       |
| 10                | 13    | -.589          | 44.106  | 4.17      | -.575   | 44.245  | 0       |       |
| 11                | 16    | -.291          | 52.908  | 11.33     | -.299   | 52.994  | 0       |       |
| 12                | 12    | -.583          | 41.172  | 6.00      | -.567   | 41.329  | 0       |       |
| 13                | 17    | -.584          | 55.842  | 12.50     | -.555   | 55.546  | 0       |       |
| 14                | 16    | -.291          | 52.908  | 11.17     | -.263   | 52.629  | 0       |       |
| 15                | 14    | -.296          | 47.740  | 8.50      | -.320   | 46.797  | 0       |       |
| 16                | 12    | -.883          | 41.172  | 5.83      | -.904   | 40.965  | 0       |       |
| 17                | 15    | -.003          | 49.974  | 10.00     | -.008   | 50.078  | 0       |       |
| 18                | 10    | -1.470         | 35.304  | 3.33      | -1.450  | 35.697  | 0       |       |
| 19                | 17    | -.584          | 55.842  | 12.50     | -.555   | 55.546  | 0       |       |
| 20                | 14    | -.296          | 47.740  | 8.67      | -.284   | 47.162  | 0       |       |
| 21                | 13    | -.589          | 44.106  | 7.17      | -.612   | 43.881  | 0       |       |
| 22                | 16    | -.291          | 52.908  | 11.17     | -.263   | 52.629  | 0       |       |
| 23                | 13    | -.589          | 44.106  | 7.17      | -.612   | 43.881  | 0       |       |
| 24                | 12    | -.883          | 41.172  | 5.83      | -.904   | 40.965  | 0       |       |
| 25                | 16    | -.291          | 52.908  | 11.33     | -.299   | 52.994  | 0       |       |
| 26                | 17    | -.584          | 55.842  | 12.67     | -.591   | 55.910  | 0       |       |
| 27                | 7     | -2.350         | 26.501  | -.83      | -2.162  | 26.384  | 0       |       |
| 28                | 19    | 1.171          | 61.710  | 15.33     | 1.174   | 61.743  | 0       |       |
| 29                | 18    | -.878          | 58.776  | 14.00     | -.883   | 58.826  | 0       |       |
| 30                | 16    | -.291          | 52.908  | 11.17     | -.263   | 52.629  | 0       |       |
| 31                | 14    | -.296          | 47.740  | 8.67      | -.284   | 47.162  | 0       |       |
| 32                | 19    | 1.171          | 61.710  | 15.33     | 1.174   | 61.743  | 0       |       |
| 33                | 13    | -.589          | 44.106  | 7.33      | -.575   | 44.245  | 0       |       |
| 34                | 18    | -.878          | 58.776  | 14.00     | -.883   | 58.826  | 0       |       |
| 35                | 19    | 1.171          | 61.710  | 15.33     | 1.174   | 61.743  | 0       |       |
| 36                | 22    | 2.051          | 70.512  | 19.33     | 2.049   | 70.491  | 0       |       |
| 37                | 18    | -.878          | 58.776  | 14.00     | -.883   | 58.826  | 0       |       |
| 38                | 16    | -.291          | 52.908  | 11.33     | -.299   | 52.994  | 0       |       |
| 39                | 16    | -.291          | 52.908  | 11.33     | -.299   | 52.994  | 0       |       |
| 40                | 12    | -.883          | 41.172  | 6.00      | -.867   | 41.329  | 0       |       |
| 41                | 17    | -.584          | 55.842  | 12.67     | -.591   | 55.910  | 0       |       |
| 42                | 20    | 1.464          | 64.644  | 16.67     | 1.466   | 64.659  | 0       |       |
| 43                | 16    | -.291          | 52.908  | 11.33     | -.299   | 52.994  | 0       |       |
| 44                | 10    | -1.470         | 35.304  | 3.33      | -1.450  | 35.697  | 0       |       |
| 45                | 17    | -.584          | 55.842  | 12.67     | -.591   | 55.910  | 0       |       |
| 46                | 11    | -1.176         | 38.238  | 4.50      | -1.195  | 38.048  | 0       |       |
| 47                | 10    | -1.470         | 35.304  | 3.17      | -1.487  | 35.132  | 0       |       |
| 48                | 16    | -.291          | 52.908  | 11.33     | -.299   | 52.994  | 0       |       |
| 49                | 17    | -.584          | 55.842  | 12.67     | -.591   | 55.910  | 0       |       |
| 50                | 14    | -.296          | 47.740  | 8.50      | -.320   | 46.797  | 0       |       |

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

IAP - ITEM ANALYSIS PROGRAM  
IAP CLASS RUN

| ID  | SCORE | RAW   |         | T-SCORE |         | INDIVIDUAL SCORES |         | CORRECTED<br>Z-SCORE | T-SCORE | OMITS |
|-----|-------|-------|---------|---------|---------|-------------------|---------|----------------------|---------|-------|
|     |       | SCORE | Z-SCORE | SCORE   | T-SCORE | SCORE             | T-SCORE |                      |         |       |
| 51  | 13    |       | -589    | 44.106  | 7.67    |                   | -503    |                      | 44.974  | 1     |
| 52  | 19    |       | 1.171   | 61.710  | 15.17   |                   | 1.138   |                      | 61.378  | 0     |
| 53  | 14    |       | -296    | 47.040  | 8.67    |                   | -284    |                      | 47.162  | 0     |
| 54  | 23    |       | 2.345   | 73.447  | 20.67   |                   | 2.341   |                      | 73.407  | 0     |
| 55  | 6     |       | -2.643  | 23.567  | -2.00   |                   | -2.617  |                      | 23.832  | 0     |
| 56  | 12    |       | -883    | 41.172  | 6.00    |                   | -867    |                      | 41.329  | 0     |
| 57  | 19    |       | 1.171   | 61.710  | 15.33   |                   | 1.174   |                      | 61.743  | 0     |
| 58  | 11    |       | -1.176  | 39.238  | 4.67    |                   | -1.159  |                      | 38.413  | 0     |
| 59  | 16    |       | -291    | 52.908  | 11.33   |                   | -299    |                      | 52.994  | 0     |
| 60  | 18    |       | -878    | 58.776  | 14.00   |                   | -883    |                      | 58.826  | 0     |
| 61  | 19    |       | 1.171   | 61.710  | 15.33   |                   | 1.174   |                      | 61.743  | 0     |
| 62  | 15    |       | -003    | 49.974  | 10.00   |                   | -008    |                      | 50.078  | 0     |
| 63  | 17    |       | -584    | 55.842  | 12.50   |                   | -555    |                      | 55.546  | 0     |
| 64  | 15    |       | -003    | 49.974  | 10.00   |                   | -008    |                      | 50.078  | 0     |
| 65  | 22    |       | 2.051   | 70.512  | 19.33   |                   | 2.049   |                      | 70.491  | 0     |
| 66  | 19    |       | 1.171   | 61.710  | 15.33   |                   | 1.174   |                      | 61.743  | 0     |
| 67  | 17    |       | -584    | 55.842  | 12.67   |                   | -591    |                      | 55.910  | 0     |
| 68  | 17    |       | -584    | 55.842  | 12.67   |                   | -591    |                      | 55.910  | 0     |
| 69  | 17    |       | -584    | 55.842  | 12.67   |                   | -591    |                      | 55.910  | 0     |
| 70  | 16    |       | -291    | 52.908  | 11.33   |                   | -299    |                      | 52.994  | 0     |
| 71  | 14    |       | -296    | 47.040  | 8.50    |                   | -320    |                      | 46.797  | 0     |
| 72  | 15    |       | -003    | 49.974  | 10.00   |                   | -008    |                      | 50.078  | 0     |
| 73  | 13    |       | -589    | 44.106  | 7.17    |                   | -612    |                      | 43.981  | 0     |
| 74  | 13    |       | -589    | 44.106  | 7.33    |                   | -575    |                      | 44.245  | 0     |
| 75  | 14    |       | -296    | 47.040  | 8.67    |                   | -284    |                      | 47.162  | 0     |
| 76  | 19    |       | 1.171   | 61.710  | 15.33   |                   | 1.174   |                      | 61.743  | 0     |
| 77  | 18    |       | -878    | 58.776  | 14.00   |                   | -883    |                      | 58.826  | 0     |
| 78  | 20    |       | 1.464   | 64.644  | 16.50   |                   | 1.429   |                      | 64.294  | 0     |
| 79  | 16    |       | -291    | 52.908  | 11.33   |                   | -299    |                      | 52.994  | 0     |
| 80  | 16    |       | -291    | 52.908  | 11.33   |                   | -299    |                      | 52.994  | 0     |
| 81  | 13    |       | -589    | 44.106  | 7.33    |                   | -575    |                      | 44.245  | 0     |
| 82  | 12    |       | -883    | 41.172  | 6.00    |                   | -867    |                      | 41.329  | 0     |
| 83  | 12    |       | -883    | 41.172  | 6.00    |                   | -867    |                      | 41.329  | 0     |
| 84  | 16    |       | -291    | 52.908  | 11.33   |                   | -299    |                      | 52.994  | 0     |
| 85  | 19    |       | 1.171   | 61.710  | 15.33   |                   | 1.174   |                      | 61.743  | 0     |
| 86  | 14    |       | -296    | 47.040  | 8.67    |                   | -284    |                      | 47.162  | 0     |
| 87  | 13    |       | -589    | 44.106  | 7.33    |                   | -575    |                      | 44.245  | 0     |
| 88  | 13    |       | -589    | 44.106  | 7.33    |                   | -575    |                      | 44.245  | 0     |
| 89  | 14    |       | -296    | 47.040  | 8.50    |                   | -320    |                      | 46.797  | 0     |
| 90  | 15    |       | -003    | 49.974  | 10.00   |                   | -008    |                      | 50.078  | 0     |
| 91  | 13    |       | -589    | 44.106  | 7.33    |                   | -575    |                      | 44.245  | 0     |
| 92  | 11    |       | -1.176  | 39.238  | 4.50    |                   | -1.195  |                      | 38.048  | 0     |
| 93  | 14    |       | -296    | 47.040  | 8.50    |                   | -320    |                      | 46.797  | 0     |
| 94  | 10    |       | -1.470  | 35.304  | 3.33    |                   | -1.450  |                      | 35.497  | 0     |
| 95  | 13    |       | -589    | 44.106  | 7.17    |                   | -612    |                      | 43.981  | 0     |
| 96  | 15    |       | -003    | 49.974  | 10.00   |                   | -008    |                      | 50.078  | 0     |
| 97  | 16    |       | -291    | 52.908  | 11.33   |                   | -299    |                      | 52.994  | 0     |
| 98  | 15    |       | -003    | 49.974  | 10.00   |                   | -008    |                      | 50.078  | 0     |
| 99  | 12    |       | -883    | 41.172  | 5.83    |                   | -904    |                      | 40.965  | 0     |
| 100 | 10    |       | -1.470  | 35.304  | 3.17    |                   | -1.487  |                      | 35.132  | 0     |

IAP : ITEM ANALYSIS PROGRAM  
IAP CLASS RUN

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

MANPOWER AND PERSONNEL DIVISIO  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

| ID  | SCORE | INDIVIDUAL SCORES |         |       | CORRECTED<br>Z-SCORE | T-SCORE | OMITS |
|-----|-------|-------------------|---------|-------|----------------------|---------|-------|
|     |       | RAW<br>Z-SCORE    | T-SCORE | SCORE |                      |         |       |
| 101 | 15    | -.003             | 49.974  | 10.00 | .008                 | 50.078  | 0     |
| 102 | 11    | -1.176            | 38.238  | 4.50  | -1.195               | 38.048  | 0     |
| 103 | 16    | .291              | 52.908  | 11.33 | .299                 | 52.994  | 0     |
| 104 | 12    | -.883             | 41.172  | 6.00  | -.867                | 41.329  | 0     |
| 105 | 17    | .584              | 55.842  | 12.50 | .555                 | 55.546  | 0     |
| 106 | 16    | .291              | 52.908  | 11.33 | .299                 | 52.994  | 0     |
| 107 | 12    | -.883             | 41.172  | 6.00  | -.867                | 41.329  | 0     |
| 108 | 21    | 1.758             | 67.578  | 18.00 | 1.758                | 67.575  | 0     |
| 109 | 16    | .291              | 52.908  | 11.33 | .299                 | 52.994  | 0     |
| 110 | 17    | .584              | 55.842  | 12.67 | .591                 | 55.910  | 0     |
| 111 | 20    | 1.464             | 64.644  | 16.67 | 1.466                | 64.559  | 0     |
| 112 | 19    | 1.171             | 61.710  | 15.33 | 1.174                | 61.743  | 0     |
| 113 | 13    | -.589             | 44.106  | 7.17  | -.612                | 43.881  | 0     |
| 114 | 14    | -.296             | 47.040  | 8.50  | -.320                | 46.797  | 0     |
| 115 | 14    | -.296             | 47.040  | 8.50  | -.320                | 46.797  | 0     |
| 116 | 21    | 1.758             | 67.578  | 18.00 | 1.758                | 67.575  | 0     |
| 117 | 16    | .291              | 52.908  | 11.33 | .299                 | 52.994  | 0     |
| 118 | 11    | -1.176            | 38.238  | 4.50  | -1.195               | 38.048  | 0     |
| 119 | 12    | -.883             | 41.172  | 6.17  | -.831                | 41.694  | 1     |
| 120 | 19    | 1.171             | 61.710  | 15.17 | 1.138                | 61.378  | 0     |
| 121 | 11    | -1.176            | 38.238  | 4.50  | -1.195               | 38.048  | 0     |
| 122 | 8     | -2.056            | 29.435  | .50   | -2.070               | 29.307  | 0     |
| 123 | 17    | .584              | 55.842  | 12.67 | .591                 | 55.910  | 0     |
| 124 | 11    | -1.176            | 38.238  | 4.50  | -1.195               | 38.048  | 0     |
| 125 | 22    | 2.051             | 70.512  | 19.33 | 2.049                | 70.491  | 0     |
| 126 | 20    | 1.464             | 64.644  | 16.67 | 1.466                | 64.559  | 0     |
| 127 | 11    | -1.176            | 38.238  | 4.50  | -1.195               | 38.048  | 0     |
| 128 | 14    | -.296             | 47.040  | 8.67  | -.284                | 47.162  | 0     |
| 129 | 21    | 1.758             | 67.578  | 18.00 | 1.758                | 67.575  | 0     |
| 130 | 5     | -2.937            | 20.633  | -3.50 | -2.945               | 20.551  | 0     |
| 131 | 16    | .291              | 52.908  | 11.17 | .263                 | 52.629  | 0     |
| 132 | 11    | -1.176            | 38.238  | 4.67  | -1.159               | 38.413  | 0     |
| 133 | 15    | -.003             | 49.974  | 10.00 | .008                 | 50.078  | 0     |
| 134 | 15    | -.003             | 49.974  | 9.83  | -.029                | 49.713  | 0     |
| 135 | 17    | .584              | 55.842  | 12.67 | .591                 | 55.910  | 0     |
| 136 | 15    | -.003             | 49.974  | 10.00 | .008                 | 50.078  | 0     |
| 137 | 14    | -.296             | 47.040  | 8.67  | -.284                | 47.162  | 0     |
| 138 | 8     | -2.056            | 29.435  | .67   | -2.034               | 29.664  | 0     |
| 139 | 14    | -.296             | 47.040  | 8.67  | -.284                | 47.162  | 0     |
| 140 | 14    | -.296             | 47.040  | 8.67  | -.284                | 47.162  | 0     |
| 141 | 16    | .291              | 52.908  | 11.33 | .299                 | 52.994  | 0     |
| 142 | 18    | .878              | 58.776  | 14.00 | .883                 | 58.826  | 0     |
| 143 | 15    | -.003             | 49.974  | 10.00 | .008                 | 50.078  | 0     |
| 144 | 18    | .878              | 58.776  | 13.83 | .846                 | 58.462  | 0     |
| 145 | 16    | .291              | 52.908  | 11.33 | .299                 | 52.994  | 0     |
| 146 | 17    | .584              | 55.842  | 12.67 | .591                 | 55.910  | 0     |
| 147 | 24    | 2.638             | 76.381  | 22.00 | 2.632                | 76.324  | 0     |
| 148 | 14    | -.296             | 47.040  | 8.50  | -.320                | 46.797  | 0     |
| 149 | 14    | -.296             | 47.040  | 8.50  | -.320                | 46.797  | 0     |
| 150 | 15    | -.003             | 49.974  | 9.83  | -.029                | 49.713  | 0     |

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552a) \*\*\*

IAP : ITEM ANALYSIS PROGRAM  
TAP CLASS RUN

| ID  | SCORE | RAW   |         | INDIVIDUAL SCORES |       |         | CORRECTED<br>Z-SCORE | T-SCORE | ONITS |
|-----|-------|-------|---------|-------------------|-------|---------|----------------------|---------|-------|
|     |       | SCORE | Z-SCORE | T-SCORE           | SCORE | Z-SCORE |                      |         |       |
| 151 | 15    |       | -.003   | 49.974            | 9.83  | -.029   |                      | 49.713  | 0     |
| 152 | 18    |       | -.878   | 58.776            | 14.00 | -.883   |                      | 58.826  | 0     |
| 153 | 15    |       | -.003   | 49.974            | 9.33  | -.029   |                      | 49.713  | 0     |
| 154 | 17    |       | -.584   | 55.842            | 12.67 | -.591   |                      | 55.910  | 0     |
| 155 | 21    |       | 1.758   | 67.578            | 18.00 | 1.758   |                      | 67.575  | 0     |
| 156 | 17    |       | -.584   | 55.842            | 12.67 | -.591   |                      | 55.910  | 0     |
| 157 | 15    |       | -.003   | 49.974            | 9.83  | -.029   |                      | 49.713  | 0     |
| 158 | 15    |       | -.003   | 49.974            | 10.00 | -.008   |                      | 50.078  | 0     |
| 159 | 18    |       | -.878   | 58.776            | 14.00 | -.883   |                      | 58.826  | 0     |
| 160 | 15    |       | -.003   | 49.974            | 10.00 | -.008   |                      | 50.078  | 0     |
| 161 | 13    |       | -.589   | 44.106            | 7.17  | -.612   |                      | 43.881  | 0     |
| 162 | 17    |       | -.584   | 55.842            | 12.67 | -.591   |                      | 55.910  | 0     |
| 163 | 17    |       | -.584   | 55.842            | 12.67 | -.591   |                      | 55.910  | 0     |
| 164 | 19    |       | 1.171   | 61.710            | 15.33 | 1.174   |                      | 61.743  | 0     |
| 165 | 14    |       | -.295   | 47.040            | 8.50  | -.320   |                      | 46.797  | 0     |
| 166 | 23    |       | 1.464   | 64.644            | 16.67 | 1.466   |                      | 64.659  | 0     |
| 167 | 22    |       | 2.051   | 70.512            | 19.33 | 2.049   |                      | 70.491  | 0     |
| 168 | 19    |       | 1.171   | 61.710            | 15.33 | 1.174   |                      | 61.743  | 0     |
| 169 | 13    |       | -.589   | 44.106            | 7.17  | -.612   |                      | 43.881  | 0     |
| 170 | 11    |       | -1.176  | 38.238            | 4.50  | -1.195  |                      | 38.048  | 0     |
| 171 | 12    |       | -.883   | 41.172            | 5.83  | -.904   |                      | 40.965  | 0     |
| 172 | 10    |       | -1.470  | 35.304            | 3.17  | -1.487  |                      | 35.132  | 0     |
| 173 | 14    |       | -.296   | 47.040            | 8.50  | -.320   |                      | 46.797  | 0     |
| 174 | 13    |       | -.589   | 44.106            | 7.33  | -.575   |                      | 44.245  | 0     |
| 175 | 17    |       | -.584   | 55.842            | 12.67 | -.591   |                      | 55.910  | 0     |
| 176 | 16    |       | -.291   | 52.908            | 11.33 | -.299   |                      | 52.994  | 0     |
| 177 | 12    |       | -.883   | 41.172            | 6.00  | -.867   |                      | 41.329  | 0     |
| 178 | 11    |       | -1.176  | 38.238            | 4.67  | -1.159  |                      | 38.413  | 0     |
| 179 | 18    |       | -.878   | 58.776            | 14.00 | -.883   |                      | 58.826  | 0     |
| 180 | 14    |       | -.296   | 47.040            | 8.50  | -.320   |                      | 46.797  | 0     |
| 181 | 17    |       | -.584   | 55.842            | 12.67 | -.591   |                      | 55.910  | 0     |
| 182 | 13    |       | -.589   | 44.106            | 7.33  | -.575   |                      | 44.245  | 0     |
| 183 | 12    |       | -.883   | 41.172            | 5.83  | -.904   |                      | 40.965  | 0     |
| 184 | 15    |       | -.003   | 49.974            | 10.00 | -.008   |                      | 50.078  | 0     |
| 185 | 6     |       | -2.643  | 23.567            | -2.17 | -2.653  |                      | 23.467  | 0     |
| 186 | 19    |       | 1.171   | 61.710            | 15.33 | 1.174   |                      | 61.743  | 0     |
| 187 | 12    |       | -.883   | 41.172            | 5.83  | -.904   |                      | 40.965  | 0     |
| 188 | 19    |       | 1.171   | 61.710            | 15.33 | 1.174   |                      | 61.743  | 0     |
| 189 | 21    |       | 1.758   | 67.578            | 18.00 | 1.758   |                      | 67.575  | 0     |
| 190 | 13    |       | -.589   | 44.106            | 7.33  | -.575   |                      | 44.245  | 0     |
| 191 | 16    |       | -.291   | 52.908            | 11.33 | -.299   |                      | 52.994  | 0     |
| 192 | 10    |       | -1.470  | 35.304            | 3.17  | -1.450  |                      | 35.497  | 0     |
| 193 | 10    |       | -1.470  | 35.304            | 3.17  | -1.487  |                      | 35.132  | 0     |
| 194 | 14    |       | -.296   | 47.040            | 8.67  | -.184   |                      | 47.162  | 0     |
| 195 | 14    |       | -.296   | 47.040            | 8.67  | -.284   |                      | 47.162  | 0     |
| 196 | 18    |       | -.878   | 58.776            | 14.00 | -.883   |                      | 58.826  | 0     |
| 197 | 15    |       | -.003   | 49.974            | 10.00 | -.008   |                      | 50.078  | 0     |
| 198 | 16    |       | -.291   | 52.908            | 11.33 | -.299   |                      | 52.994  | 0     |
| 199 | 10    |       | -1.470  | 35.304            | 3.33  | -1.450  |                      | 35.497  | 0     |
| 200 | 17    |       | -.584   | 55.842            | 12.67 | -.591   |                      | 55.910  | 0     |

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

CONTROLLED ITEM  
\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

INDIVIDUAL SCORES

|     | RAW<br>Z-SCORE | T-SCORE | SCORE | CORRECTED<br>Z-SCORE | T-SCORE | OMITS |
|-----|----------------|---------|-------|----------------------|---------|-------|
| 13  | -.003          | 49.974  | 9.83  | -.029                | 49.713  | 0     |
| 14  | -.296          | 47.040  | 8.67  | -.284                | 47.162  | 0     |
| 12  | -.883          | 41.172  | 6.07  | -.867                | 41.329  | 0     |
| 12  | -.883          | 41.172  | 5.83  | -.904                | 40.965  | 0     |
| 13  | -1.470         | 35.304  | 3.33  | -1.450               | 35.497  | 0     |
| 17  | .584           | 55.842  | 12.67 | .591                 | 55.910  | 0     |
| 7   | -2.350         | 26.501  | -.83  | -2.362               | 26.384  | 0     |
| 14  | -.296          | 47.040  | 8.67  | -.284                | 47.162  | 0     |
| 12  | -.883          | 41.172  | 5.83  | -.904                | 40.965  | 0     |
| 15  | -.003          | 49.974  | 10.00 | .008                 | 50.078  | 0     |
| 16  | .291           | 52.908  | 11.17 | .263                 | 52.629  | 0     |
| 15  | -.003          | 49.974  | 10.00 | .008                 | 50.078  | 0     |
| 19  | .876           | 59.776  | 14.00 | .883                 | 58.826  | 0     |
| 15  | -.003          | 49.974  | 10.00 | .008                 | 50.078  | 0     |
| 14  | -.296          | 47.040  | 8.67  | -.284                | 47.162  | 0     |
| 17  | .584           | 55.842  | 12.67 | .591                 | 55.910  | 0     |
| 13  | -.589          | 44.106  | 7.17  | -.612                | 43.881  | 0     |
| 18  | .878           | 58.776  | 14.00 | .883                 | 58.826  | 0     |
| 15  | -.003          | 49.974  | 10.00 | .008                 | 50.078  | 0     |
| 10  | -1.470         | 35.304  | 3.17  | -1.487               | 35.132  | 0     |
| 18  | .878           | 58.776  | 14.00 | .883                 | 58.826  | 0     |
| 16  | .291           | 52.908  | 11.33 | .299                 | 52.994  | 0     |
| 223 | .878           | 58.776  | 14.00 | .883                 | 58.826  | 0     |
| 224 | .878           | 58.776  | 14.00 | .883                 | 58.826  | 0     |
| 225 | -.003          | 49.974  | 10.00 | .008                 | 50.078  | 0     |

IAP : ITEM ANALYSIS PROGRAM  
IAP CLASS RUN

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552a) \*\*\*

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

PHI CORRELATION COEFFICIENTS (BASED ON MEDIAN)

| ITEM | PHI   |
|------|-------|
| 1    | -.003 |
| 2    | .451  |
| 3    | .054  |
| 4    | -.012 |
| 5    | .021  |
| 6    | .013  |
| 7    | .218  |
| 8    | .147  |
| 9    | .116  |
| 10   | .241  |
| 11   | .085  |
| 12   | .256  |
| 13   | .233  |
| 14   | .275  |
| 15   | .283  |
| 16   | .162  |
| 17   | .189  |
| 18   | .208  |
| 19   | .276  |
| 20   | .144  |
| 21   | .146  |
| 22   | .222  |
| 23   | .312  |
| 24   | .189  |
| 25   | .233  |
| 26   | -.001 |
| 27   | .278  |
| 28   | .240  |
| 29   | .126  |
| 30   | .265  |

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

IAP : ITEM ANALYSIS PROGRAM

IAP CLASS RUN

| ITEM | DIFFICULTY<br>PROP'N. STD. | STANDARD<br>DEVIATION | ITEM ANALYSIS SUMMARY TABLE |        |                         |        | X-FIFTY   | BETA  | REL.<br>INDEX |
|------|----------------------------|-----------------------|-----------------------------|--------|-------------------------|--------|-----------|-------|---------------|
|      |                            |                       | BISERIAL<br>CORR.           | T-TEST | POINT BISERIAL<br>CORR. | T-TEST |           |       |               |
| 1    |                            |                       |                             |        |                         |        |           |       |               |
| 2    | .547                       | .519                  | .263                        | 4.053  | .209                    | 3.191  | -4.47     | .272  | .134          |
| 3    | OVERLAP CORRECTED          |                       | .128                        | 1.926  | .102                    | 1.528  | -9.17     | .129  | .051          |
| 4    | .401                       | .460                  | .134                        | 2.026  | .136                    | 1.593  | 1.855     | .136  | .052          |
| 5    | OVERLAP CORRECTED          |                       | -.001                       | -.322  | -.001                   | -.018  | 167.891   | -.001 | -.001         |
| 6    | .250                       | .396                  | -.010                       | -.142  | -.007                   | -.105  | 67.739    | -.010 | -.003         |
| 7    | OVERLAP CORRECTED          |                       | -.138                       | -2.098 | -.102                   | -1.537 | 4.662     | -.140 | -.045         |
| 8    | .025                       | .192                  | .041                        | .612   | .016                    | .238   | 46.638    | .041  | .007          |
| 9    | OVERLAP CORRECTED          |                       | -.052                       | -.774  | -.020                   | -.302  | 36.860    | -.052 | -.033         |
| 10   | .320                       | .320                  | .222                        | 3.400  | .160                    | 2.422  | 3.334     | .228  | .067          |
| 11   | OVERLAP CORRECTED          |                       | .095                        | 1.432  | .069                    | 1.031  | 7.754     | .096  | .020          |
| 12   | .736                       | .432                  | .096                        | 1.446  | .074                    | 1.114  | 4.385     | .097  | .035          |
| 13   | OVERLAP CORRECTED          |                       | -.018                       | -.561  | -.029                   | -.433  | 11.264    | -.038 | -.014         |
| 14   | .766                       | .445                  | .116                        | 1.740  | .090                    | 1.355  | 2.961     | .117  | .044          |
| 15   | OVERLAP CORRECTED          |                       | -.019                       | -.287  | -.015                   | -.224  | 17.817    | -.019 | -.007         |
| 16   | .701                       | .416                  | .212                        | 3.233  | .161                    | 2.430  | 2.668     | .216  | .074          |
| 17   | OVERLAP CORRECTED          |                       | .090                        | 1.294  | .061                    | .912   | 6.501     | .081  | .028          |
| 18   | .796                       | .457                  | .061                        | .912   | .048                    | .718   | 4.346     | .061  | .023          |
| 19   | OVERLAP CORRECTED          |                       | -.075                       | -1.120 | -.059                   | -.881  | 3.542     | -.075 | -.029         |
| 20   | .724                       | .426                  | .194                        | 2.948  | .149                    | 2.247  | 2.351     | .197  | .070          |
| 21   | OVERLAP CORRECTED          |                       | .061                        | .912   | .047                    | .700   | 7.467     | .061  | .022          |
| 22   | .361                       | .443                  | .170                        | 2.574  | .132                    | 1.995  | 2.087     | .172  | .064          |
| 23   | OVERLAP CORRECTED          |                       | .035                        | .529   | .028                    | .412   | 10.018    | .035  | .013          |
| 24   | .502                       | .501                  | .250                        | 3.855  | .199                    | 3.040  | -.022     | .258  | .100          |
| 25   | .765                       | .390                  | .253                        | 3.912  | .188                    | 1.373  | -.049     | .116  | .046          |
| 26   | OVERLAP CORRECTED          |                       | .125                        | 1.892  | .093                    | 1.392  | 5.018     | .126  | .041          |
| 27   | .760                       | .442                  | .164                        | 2.492  | .128                    | 1.924  | 2.186     | .166  | .061          |
| 28   | OVERLAP CORRECTED          |                       | .030                        | .441   | .023                    | .344   | 12.143    | .030  | .011          |
| 29   | .579                       | .532                  | .150                        | 2.271  | .119                    | 1.791  | -1.330    | .152  | .059          |
| 30   | OVERLAP CORRECTED          |                       | .014                        | .211   | .011                    | .167   | -14.127   | .014  | .006          |
| 31   | .567                       | .527                  | .154                        | 2.335  | .123                    | 1.845  | -1.099    | .156  | .061          |
| 32   | OVERLAP CORRECTED          |                       | .018                        | .270   | .014                    | .215   | -9.382    | .018  | .007          |
| 33   | .479                       | .491                  | .245                        | 3.777  | .196                    | 2.978  | .220      | .253  | .099          |
| 34   | OVERLAP CORRECTED          |                       | .110                        | 1.651  | .088                    | 1.314  | .490      | .111  | .044          |
| 35   | .295                       | .413                  | .132                        | 1.986  | .100                    | 1.497  | 4.091     | .133  | .045          |
| 36   | OVERLAP CORRECTED          |                       | .000                        | .001   | .000                    | .000   | 15529.874 | .000  | .000          |
| 37   | .413                       | .465                  | .082                        | 1.228  | .065                    | .970   | 2.673     | .082  | .032          |
| 38   | OVERLAP CORRECTED          |                       | -.054                       | -.812  | -.043                   | -.642  | 4.033     | -.054 | -.021         |
| 39   | .713                       | .421                  | .191                        | 2.907  | .146                    | 2.203  | 2.556     | .195  | .068          |
| 40   | OVERLAP CORRECTED          |                       | .059                        | .882   | .045                    | .673   | 8.288     | .059  | .021          |
| 41   | .526                       | .511                  | .267                        | 4.143  | .213                    | 3.258  | -.243     | .277  | .106          |
| 42   | OVERLAP CORRECTED          |                       | .133                        | 1.999  | .106                    | 1.588  | -4.90     | .134  | .053          |
| 43   | .554                       | .440                  | .137                        | 2.060  | .106                    | 1.596  | 2.740     | .138  | .051          |
| 44   | OVERLAP CORRECTED          |                       | .002                        | .032   | .002                    | .025   | 173.192   | .002  | .001          |
| 45   | .295                       | .413                  | .144                        | 2.176  | .109                    | 1.639  | 3.740     | .146  | .050          |
| 46   | OVERLAP CORRECTED          |                       | .012                        | .186   | .009                    | .141   | 43.312    | .012  | .004          |

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

IAP : ITEM ANALYSIS PROGRAM  
IAP CLASS RUN

| ITEM | DIFFICULTY<br>PROP'N. STD. | STANDARD<br>DEVIATION | ITEM ANALYSIS SUMMARY TABLE |        |                         |        | X-FIFTY | BETA  | REL.<br>INDEX |
|------|----------------------------|-----------------------|-----------------------------|--------|-------------------------|--------|---------|-------|---------------|
|      |                            |                       | BISERIAL<br>CORR.           | T-TEST | POINT BISERIAL<br>CORR. | T-TEST |         |       |               |
| 26   |                            |                       |                             |        |                         |        |         |       |               |
| 27   | .456                       | .482                  | .230                        | 3.535  | .183                    | 2.786  | .477    | .237  | .091          |
|      | OVERLAP CORRECTED          |                       | .095                        | 1.423  | -.076                   | 1.131  | 1.157   | .095  | .038          |
| 28   | .479                       | .491                  | .101                        | 1.522  | .081                    | 1.211  | .531    | .102  | .040          |
|      | OVERLAP CORRECTED          |                       | -.036                       | -.534  | -.028                   | -.426  | 1.508   | -.036 | -.014         |
| 29   | .526                       | .511                  | .106                        | 1.591  | .084                    | 1.266  | -.614   | .107  | .042          |
|      | OVERLAP CORRECTED          |                       | -.031                       | -.466  | -.025                   | -.371  | -2.087  | -.031 | -.012         |
| 30   | .396                       | .457                  | .244                        | 3.750  | .192                    | 2.919  | 1.088   | .251  | .094          |
|      | OVERLAP CORRECTED          |                       | .109                        | 1.644  | .086                    | 1.292  | 2.421   | .110  | .042          |

MEAN STANDARDIZED ITEM DIFFICULTY = .402  
CORRESPONDING PROPORTION = .272

## IAP : ITEM ANALYSIS PROGRAM

## IAP CLASS RUN

## CONTROLLED ITEM

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

MANPOWER AND PERSONNEL DIVISION  
AT HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

## PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

| ITEM | -4.0 | -3.5 | -3.0 | -2.5 | -2.0 | -1.5 | -1.0 | -0.5 | 0.0 | +0.5 | +1.0 | +1.5 | +2.0 | +2.5 | +3.0 | +3.5 | +4.0 | XFIFTY |
|------|------|------|------|------|------|------|------|------|-----|------|------|------|------|------|------|------|------|--------|
| 1    | .00  | .00  | .00  | .00  | .00  | .00  | .05  | .10  | .15 | .10  | .12  | .10  | .20  | .00  | .00  | .00  | .00  | UNDEF  |
| 2    | .00  | .00  | .00  | .00  | .00  | .00  | .41  | .54  | .47 | .90  | .96  | .85  | 1.00 | 1.00 | 1.00 | .00  | .00  | UNDEF  |
| 3    | .00  | .00  | .00  | .00  | .00  | .00  | .76  | .57  | .56 | .43  | .60  | .85  | .60  | 1.00 | 1.00 | .00  | .00  | 1.86   |
| 4    | .00  | .00  | .00  | .00  | .00  | .00  | .76  | .51  | .47 | .41  | .40  | .45  | .80  | .67  | .00  | .00  | .00  | 67.74  |
| 5    | .00  | .00  | .00  | .00  | .00  | .00  | .18  | .14  | .12 | .15  | .19  | .10  | .20  | .00  | 1.00 | .00  | .00  | UNDEF  |
| 6    | .00  | .00  | .00  | .00  | .00  | .00  | .27  | .24  | .29 | .20  | .24  | .35  | .80  | .50  | 1.00 | .00  | .00  | 46.64  |
| 7    | .00  | .00  | .00  | .00  | .00  | .00  | .72  | .75  | .74 | .61  | .43  | .75  | .80  | 1.00 | 1.00 | .00  | .00  | 3.83   |
| 8    | .00  | .00  | .00  | .00  | .00  | .00  | .45  | .32  | .53 | .55  | .52  | .55  | 1.00 | .57  | 1.00 | .00  | .00  | 4.59   |
| 9    | .00  | .00  | .00  | .00  | .00  | .00  | .76  | .49  | .56 | .51  | .60  | .55  | 1.00 | .67  | 1.00 | .00  | .00  | 2.66   |
| 10   | .00  | .00  | .00  | .00  | .00  | .00  | .27  | .75  | .47 | .49  | .60  | .75  | .80  | .50  | 1.00 | .00  | .00  | 2.47   |
| 11   | .00  | .00  | .00  | .00  | .00  | .00  | .45  | .51  | .53 | .53  | .62  | .50  | .60  | 1.00 | 1.00 | .00  | .00  | 4.55   |
| 12   | .00  | .00  | .00  | .00  | .00  | .00  | .74  | .24  | .53 | .51  | .74  | .50  | .80  | .67  | 1.00 | .00  | .00  | 2.35   |
| 13   | .00  | .00  | .00  | .00  | .00  | .00  | .32  | .35  | .53 | .53  | .76  | .45  | .80  | .83  | 1.00 | .00  | .00  | 2.09   |
| 14   | .00  | .00  | .00  | .00  | .00  | .00  | .32  | .54  | .62 | .69  | .69  | .85  | 1.00 | 1.00 | 1.00 | .00  | .00  | 1.02   |
| 15   | .00  | .00  | .00  | .00  | .00  | .00  | .14  | .35  | .38 | .47  | .60  | .75  | .80  | .50  | 1.00 | .00  | .00  | 2.48   |
| 16   | .00  | .00  | .00  | .00  | .00  | .00  | .23  | .51  | .53 | .53  | .62  | .60  | .60  | .83  | 1.00 | .00  | .00  | 2.19   |
| 17   | .00  | .00  | .00  | .00  | .00  | .00  | .50  | .70  | .62 | .76  | .71  | .80  | .80  | 1.00 | 1.00 | .00  | .00  | -1.33  |
| 18   | .00  | .00  | .00  | .00  | .00  | .00  | .73  | .45  | .47 | .65  | .71  | 1.00 | 1.00 | 1.00 | 1.00 | .00  | .00  | -1.10  |
| 19   | .00  | .00  | .00  | .00  | .00  | .00  | .76  | .32  | .74 | .61  | .76  | .85  | .80  | 1.00 | 1.00 | .00  | .00  | .22    |
| 20   | .00  | .00  | .00  | .00  | .00  | .00  | .41  | .38  | .44 | .39  | .64  | .50  | .80  | .83  | 1.00 | .00  | .00  | 4.59   |
| 21   | .00  | .00  | .00  | .00  | .00  | .00  | .45  | .49  | .53 | .59  | .57  | .75  | .80  | .83  | .60  | .00  | .00  | 2.67   |
| 22   | .00  | .00  | .00  | .00  | .00  | .00  | .77  | .41  | .38 | .47  | .57  | .80  | .60  | .83  | 1.00 | .00  | .00  | 2.56   |
| 23   | .00  | .00  | .00  | .00  | .00  | .00  | .50  | .51  | .56 | .69  | .83  | .80  | .80  | 1.00 | 1.00 | .00  | .00  | 2.74   |
| 24   | .00  | .00  | .00  | .00  | .00  | .00  | .27  | .32  | .65 | .69  | .69  | .80  | .40  | .50  | .00  | .00  | .00  | 3.74   |
| 25   | .00  | .00  | .00  | .00  | .00  | .00  | .32  | .24  | .44 | .55  | .52  | .75  | .40  | .67  | 1.00 | .00  | .00  | UNDEF  |
| 26   | .00  | .00  | .00  | .00  | .00  | .00  | .36  | .05  | .24 | .20  | .19  | .20  | .00  | .33  | .00  | .00  | .00  | .48    |
| 27   | .00  | .00  | .00  | .00  | .00  | .00  | .76  | .49  | .56 | .69  | .64  | .85  | .80  | .83  | 1.00 | .00  | .00  | .53    |
| 28   | .00  | .00  | .00  | .00  | .00  | .00  | .41  | .54  | .50 | .82  | .60  | .70  | .80  | .83  | 1.00 | .00  | .00  | UNDEF  |
| 29   | .00  | .00  | .00  | .00  | .00  | .00  | .45  | .57  | .74 | .61  | .79  | .65  | .80  | .83  | 1.00 | .00  | .00  | -51    |
| 30   | .00  | .00  | .00  | .00  | .00  | .00  | .23  | .65  | .35 | .63  | .57  | .85  | .60  | 1.00 | 1.00 | .00  | .00  | 1.09   |

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

IAP : ITEM ANALYSIS PROGRAM  
IAP CLASS RUN

TETRACHORIC INTERITEM CORRELATION MATRIX

| ITEM | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   | 11   | 12   | 13   | 14   | 15   | 16   | 17   | 18   | 19   | 20   |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1    | 1.00 | -.12 | .11  | .32  | -.20 | -.20 | -.13 | -.06 | -.28 | .04  | -.13 | -.30 | -.09 | .06  | -.05 | -.15 | -.03 | -.26 | .09  | .04  |
| 2    | -.12 | 1.00 | -.21 | -.15 | -.02 | .02  | .15  | .04  | .12  | .20  | .04  | .11  | -.02 | .37  | .27  | .39  | .09  | .20  | .30  | -.03 |
| 3    | .11  | -.21 | 1.00 | .20  | -.11 | -.16 | .30  | .05  | -.09 | -.11 | -.05 | -.15 | -.07 | .07  | .09  | -.10 | .07  | .07  | .01  | .12  |
| 4    | .32  | -.15 | .20  | 1.00 | .11  | -.14 | .02  | -.06 | -.32 | .04  | -.16 | -.07 | -.06 | -.08 | .00  | .08  | .38  | .05  | .00  | .25  |
| 5    | -.20 | -.02 | -.11 | .11  | 1.00 | .38  | -.04 | -.17 | .03  | .16  | .28  | .13  | .18  | .32  | -.19 | -.20 | .05  | -.13 | -.34 | -.12 |
| 6    | -.20 | .02  | -.16 | -.14 | .38  | 1.00 | -.09 | -.22 | .27  | .27  | .36  | .30  | .11  | -.28 | .19  | -.12 | .17  | .15  | -.04 | .04  |
| 7    | -.13 | .15  | .30  | .02  | -.04 | -.09 | 1.00 | .15  | -.14 | -.03 | -.11 | .17  | .07  | .22  | .15  | .13  | .03  | .18  | .12  | .05  |
| 8    | -.06 | .04  | .05  | -.06 | -.17 | -.22 | .15  | 1.00 | -.12 | -.02 | .01  | .12  | .01  | .15  | .01  | .17  | .10  | .08  | .03  | .15  |
| 9    | -.28 | .12  | -.09 | -.32 | .03  | .27  | -.14 | -.12 | 1.00 | .22  | .10  | .27  | .07  | .03  | .00  | .07  | .29  | .02  | .05  | .34  |
| 10   | .04  | .20  | -.11 | .04  | .16  | .27  | -.03 | -.02 | .22  | 1.00 | .07  | .25  | .18  | -.06 | .17  | -.07 | .06  | .21  | -.01 | .01  |
| 11   | -.13 | .04  | -.05 | -.16 | .28  | .36  | -.11 | .01  | .10  | .07  | 1.00 | .18  | .09  | -.06 | -.18 | .00  | .12  | .00  | .08  | .17  |
| 12   | -.30 | .11  | -.15 | -.07 | .13  | .30  | .17  | .12  | .27  | .25  | .18  | 1.00 | .28  | -.02 | .03  | -.08 | .00  | .09  | .19  | .08  |
| 13   | -.09 | -.02 | .07  | -.06 | .18  | .11  | .07  | .01  | .07  | .18  | .09  | .28  | 1.00 | .08  | .15  | .06  | .15  | .12  | .05  | .06  |
| 14   | .06  | .37  | .07  | -.08 | -.32 | -.28 | .22  | .15  | .03  | -.06 | -.06 | -.02 | .08  | 1.00 | .29  | .20  | .24  | .25  | .33  | .02  |
| 15   | -.05 | .27  | .09  | .00  | -.18 | .19  | .15  | .01  | .00  | .17  | -.18 | .03  | .15  | .29  | 1.00 | -.04 | .25  | .01  | .19  | .15  |
| 16   | -.15 | .39  | -.10 | .08  | -.20 | -.12 | .13  | .17  | .07  | -.07 | .00  | -.08 | .06  | .20  | -.04 | 1.00 | .12  | .21  | .05  | .09  |
| 17   | -.03 | .09  | .07  | -.38 | .05  | -.17 | .03  | -.10 | .29  | .06  | .12  | .00  | .15  | .24  | .25  | .12  | 1.00 | .04  | .14  | .23  |
| 18   | -.26 | .20  | .07  | .05  | -.13 | .15  | .18  | .08  | -.02 | .21  | -.00 | -.09 | .12  | .25  | -.01 | .21  | .04  | 1.00 | .11  | .09  |
| 19   | .09  | .30  | -.01 | .00  | -.34 | -.04 | .12  | .03  | -.05 | -.00 | -.08 | .19  | .05  | .33  | .19  | .05  | .14  | .11  | 1.00 | .10  |
| 20   | .04  | -.03 | .10  | -.26 | -.12 | .04  | -.05 | -.15 | .31  | -.01 | .17  | .09  | -.06 | .02  | .15  | -.09 | .23  | .08  | .10  | 1.00 |
| 21   | .22  | -.09 | .38  | .17  | -.12 | -.30 | .08  | .16  | -.23 | -.03 | .11  | -.06 | -.10 | -.12 | .01  | .13  | .07  | .15  | .02  | .15  |
| 22   | -.41 | .09  | -.00 | .02  | -.04 | .35  | .08  | -.13 | .14  | .09  | .04  | .17  | .12  | .11  | .17  | .04  | .23  | .07  | .22  | .13  |
| 23   | -.09 | .38  | .03  | -.01 | -.08 | .02  | .15  | .15  | .12  | .03  | -.22 | .19  | .14  | .25  | .09  | .03  | .08  | .20  | .38  | .05  |
| 24   | .28  | .03  | .11  | .15  | -.19 | -.47 | -.08 | -.16 | -.16 | -.12 | -.07 | -.12 | -.01 | -.13 | -.06 | -.06 | .01  | .04  | .10  | .22  |
| 25   | -.20 | .00  | .02  | -.20 | .12  | .11  | .06  | -.12 | -.04 | .16  | .17  | -.01 | -.02 | -.22 | .10  | .09  | .17  | .04  | .20  | .09  |
| 26   | -.16 | -.08 | -.17 | -.10 | -.13 | .14  | -.07 | -.08 | -.04 | .08  | .08  | .09  | -.04 | -.11 | .01  | .12  | .05  | .08  | .20  | .09  |
| 27   | .18  | .17  | .14  | .14  | -.03 | -.14 | .05  | .01  | -.02 | .02  | -.08 | -.10 | .05  | .23  | .10  | .22  | .13  | .13  | .03  | .07  |
| 28   | -.04 | .18  | .13  | .18  | -.16 | -.31 | .21  | .09  | -.26 | .08  | -.32 | -.10 | -.07 | .21  | .25  | .07  | .12  | .17  | .04  | .13  |
| 29   | -.27 | .16  | -.12 | -.28 | -.03 | .02  | -.01 | -.02 | .15  | .00  | -.08 | .01  | -.04 | .10  | -.00 | .14  | .06  | .03  | .18  | .04  |
| 30   | -.13 | .13  | .26  | .01  | -.19 | -.05 | .23  | .09  | .13  | .10  | -.09 | .04  | -.17 | .20  | .08  | .14  | .27  | .07  | .29  | .11  |

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

MAP 3 ITEM ANALYSIS PROGRAM  
\*\*\* PERSONAL DATA - PRIVATE ACT OF 1974 (5 USC 552A) \*\*\*

MAP CLASS RUN

TETRACHORIC INTERITEM CORRELATION MATRIX

| ITEM | 21   | 22   | 23   | 24   | 25   | 26   | 27   | 28   | 29   | 30   |
|------|------|------|------|------|------|------|------|------|------|------|
| 21   | 1.00 | -.17 | -.07 | .33  | -.01 | -.03 | .27  | .24  | -.17 | .00  |
| 22   | -.17 | 1.00 | .23  | -.12 | .13  | -.05 | -.13 | -.30 | .17  | .10  |
| 23   | -.07 | .23  | 1.00 | .13  | -.01 | -.14 | .04  | .05  | .21  | .25  |
| 24   | .33  | -.12 | .13  | 1.00 | .20  | -.11 | .45  | .30  | .10  | -.07 |
| 25   | -.01 | .13  | -.01 | .20  | 1.00 | .05  | .15  | -.02 | -.07 | .00  |
| 26   | -.03 | -.05 | -.14 | -.11 | .05  | 1.00 | -.20 | .05  | -.22 | -.32 |
| 27   | .27  | -.13 | .04  | .45  | .15  | -.20 | 1.00 | .29  | .16  | .12  |
| 28   | .24  | -.30 | .05  | .30  | -.02 | .04  | .29  | 1.00 | -.04 | .06  |
| 29   | -.13 | .17  | .21  | .10  | -.07 | -.22 | .16  | -.04 | 1.00 | .40  |
| 30   | .00  | .10  | .26  | -.07 | .00  | -.32 | .12  | .06  | .40  | 1.00 |

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

IAP : ITEM ANALYSIS PROGRAM  
IAP CLASS RUN

FACTOR ANALYSIS OF 30 ITEMS RESULTED IN 5 FACTORS

| FACTOR | RESIDUAL SUMSQ | FACTOR SUMSQ | PERCENT TOT SUMSQ<br>FACTOR | EIGENVALUE | PERCENT MAX-V<br>FACTOR | PERCENT COMMUNALITY<br>FACTOR | ACCUM  |
|--------|----------------|--------------|-----------------------------|------------|-------------------------|-------------------------------|--------|
| 1      | 25.890         | 9.045        | 34.94                       | 3.007537   | 10.03                   | 32.77                         | 32.77  |
| 2      | 16.844         | 7.436        | 28.72                       | 2.726855   | 9.09                    | 29.71                         | 62.49  |
| 3      | 9.409          | 1.728        | 6.67                        | 1.514442   | 4.38                    | 14.32                         | 76.81  |
| 4      | 7.681          | 1.286        | 4.97                        | 1.134079   | 3.78                    | 12.36                         | 89.17  |
| 5      | 6.395          | .991         | 3.83                        | .995462    | 3.32                    | 10.85                         | 100.02 |
| REST   | 5.404          |              | 20.87                       |            |                         |                               |        |
|        |                |              | 100.00                      |            |                         |                               |        |

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

IAP : ITEM ANALYSIS PROGRAM

IAP CLASS RUN

FACTOR ANALYSIS \*\* FACTOR LOADINGS

| ITEM      | COMMUNALITY | 1      | 2      | 3      | 4      | 5      |
|-----------|-------------|--------|--------|--------|--------|--------|
| 1         | .3144       | .4026  | -.3298 | .2357  | -.0860 | -.0244 |
| 2         | .3607       | .0655  | .5496  | -.2148 | -.0947 | .0315  |
| 3         | .2337       | .3325  | .0119  | .0973  | .3864  | -.0200 |
| 4         | .3620       | .3630  | -.2639 | -.3244 | .1138  | .0500  |
| 5         | .4373       | -.4045 | -.2333 | -.2697 | .1829  | .3363  |
| 6         | .5609       | -.4787 | .0378  | -.2070 | .1811  | .0558  |
| 7         | .2150       | .1943  | .2971  | -.2289 | .1199  | -.1422 |
| 8         | .1142       | .2445  | .1115  | -.1486 | -.1408 | -.0390 |
| 9         | .2898       | -.4076 | .3037  | .1757  | -.0085 | .0973  |
| 10        | .2108       | -.1904 | .1578  | -.2411 | .2766  | .0063  |
| 11        | .2454       | -.4726 | -.0237 | .0697  | .1176  | .2419  |
| 12        | .2535       | -.3329 | .2535  | -.2339 | .1521  | -.0245 |
| 13        | .1556       | -.1643 | .1670  | -.2042 | .2526  | -.0277 |
| 14        | .4198       | .3245  | .5155  | .0329  | -.1090 | -.1891 |
| 15        | .3083       | -.0577 | .3484  | -.0276 | .2949  | -.3096 |
| 16        | .2529       | .1645  | .3141  | -.1408 | -.2829 | .1650  |
| 17        | .3713       | -.1237 | .3646  | .4395  | .1095  | -.1341 |
| 18        | .1937       | .1759  | .2545  | -.3097 | .0231  | -.0400 |
| 19        | .2964       | .1626  | .5023  | .0965  | .0116  | -.0977 |
| 20        | .3378       | -.1664 | .1781  | .4557  | .2570  | -.0628 |
| 21        | .3181       | .4837  | -.1520 | -.0627 | .2209  | .0913  |
| 22        | .2859       | -.3203 | .4117  | -.0215 | .0990  | -.0543 |
| 23        | .3051       | .1058  | .5095  | -.1798 | -.0325 | .0350  |
| 24        | .4458       | .5358  | -.0000 | .2050  | .2368  | .2461  |
| 25        | .2238       | -.1322 | .0820  | .1285  | .4129  | .0978  |
| 26        | .2329       | -.2131 | -.2077 | -.0452 | .0467  | -.3743 |
| 27        | .4386       | .4280  | .1379  | -.0260 | .2730  | .4015  |
| 28        | .3556       | .4954  | .0428  | -.2219 | .1542  | -.1239 |
| 29        | .3942       | -.0571 | .3994  | .1133  | -.2369 | .4030  |
| 30        | .3142       | .1393  | .4795  | .1750  | -.0493 | .1786  |
| SUM SQ    | 9.1768      | 3.0071 | 2.7268 | 1.3147 | 1.1327 | .9955  |
| PERCENT N | 30.59       | 10.02  | 9.09   | 4.38   | 3.78   | 3.32   |
| PCT. COM. |             | 32.77  | 29.71  | 14.33  | 12.34  | 10.85  |

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

IAP : ITEM ANALYSIS PROGRAM  
IAP CLASS RUN

FACTOR ANALYSIS \*\* ROTATED FACTOR LOADINGS

| ITEM      | COMMUNALITY | 1      | 2      | 3      | 4      | 5      |
|-----------|-------------|--------|--------|--------|--------|--------|
| 1         | .3546       | .3969  | -.0963 | -.1699 | .3721  | -.0176 |
| 2         | .3607       | -.0570 | .4458  | .3346  | -.2005 | -.0046 |
| 3         | .2337       | .4511  | .1160  | -.0306 | .0067  | .1908  |
| 4         | .3080       | .3275  | .0232  | -.1194 | .0044  | -.4312 |
| 5         | .4173       | -.0400 | -.4601 | .0723  | -.4249 | .1905  |
| 6         | .4409       | -.3625 | -.2498 | -.0674 | -.5713 | .0760  |
| 7         | .2120       | .1298  | .4127  | .0125  | -.1690 | -.0598 |
| 8         | .3142       | .0445  | .2369  | .1114  | .0263  | -.1831 |
| 9         | .2988       | -.2849 | -.0725 | .2088  | -.2101 | .3529  |
| 10        | .2102       | .0104  | .0516  | -.0373 | .4545  | .0112  |
| 11        | .2654       | -.1316 | -.3523 | .1054  | -.2633 | .1534  |
| 12        | .2535       | -.1963 | .0621  | .0225  | -.4529 | .0570  |
| 13        | .1556       | .0119  | .0234  | -.0394 | -.3904 | .0223  |
| 14        | .4198       | .0151  | .5926  | .1840  | .1108  | .1404  |
| 15        | .3533       | .0950  | .4059  | -.1500 | -.2320 | .2400  |
| 16        | .2229       | -.0818 | .2586  | .3919  | .0825  | -.1466 |
| 17        | .3713       | -.0555 | .1398  | .0614  | -.0066 | .5873  |
| 18        | .1337       | .0592  | .3487  | .0954  | -.1614 | -.1830 |
| 19        | .2664       | .0163  | .4340  | .2080  | -.0190 | .2512  |
| 20        | .3378       | -.0556 | -.0552 | -.0351 | -.0480 | .5728  |
| 21        | .3191       | .5135  | .0652  | -.0364 | .1040  | -.1869 |
| 22        | .2351       | -.2301 | .1603  | .1107  | -.3452 | .2701  |
| 23        | .3051       | -.0270 | .4216  | .3053  | -.1921 | .0133  |
| 24        | .4458       | .6105  | .0412  | .1776  | .1915  | .0557  |
| 25        | .2208       | -.2050 | -.1206 | -.0175 | -.2898 | .2827  |
| 26        | .2329       | -.1628 | -.0334 | -.4389 | -.0426 | .0124  |
| 27        | .4366       | .5556  | .0611  | .3386  | -.0671 | -.0611 |
| 28        | .3356       | .3907  | .3599  | -.0688 | .0972  | -.2277 |
| 29        | .3942       | -.1292 | .0245  | .6504  | -.0009 | .1278  |
| 30        | .3142       | .0636  | .2528  | .4282  | .0183  | .2502  |
| SUM SS    | 9.1768      | 2.0441 | 2.2179 | 1.5043 | 1.7859 | 1.6245 |
| PERCENT N | 30.59       | 6.81   | 7.39   | 5.01   | 5.95   | 5.42   |
| PCT. COM. |             | 22.27  | 24.17  | 16.39  | 19.46  | 17.70  |

END OF IAP PASS.

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

IAP : ITEM ANALYSIS PROGRAM  
IAP CLASS RUN (PROB. 2 - PLOTS)

SPECIFIED CONTROL PARAMETERS

|         |     |         |   |         |   |        |    |       |   |        |     |        |    |         |     |
|---------|-----|---------|---|---------|---|--------|----|-------|---|--------|-----|--------|----|---------|-----|
| NSIITM= | 10  | IUPLIM= | 4 | NFM=    | 1 | KI=    | 10 | KO=   | 0 | KS=    | 13  | NB=    | 35 | EASY=   | .80 |
| DIFFLT= | .20 | IALPHA= | 0 | NSPEED= | 0 | ICRGS= | 0  | KIV=  | 0 | ICRIT= | 0   | OUT=   | .0 | NOCASE= | 1   |
| IPHI=   | 0   | IFREQ=  | 0 | IOVER=  | 2 | JPLOT= | 1  | NF=   | 0 | EIGN=  | .00 | IDEND= | 0  | IRWIND= | 0   |
| ICUT=   | 0   | ATEST=  |   | IALT=   | 1 | ICARD= | 0  | IHAM= | 0 | NERR=  | 2   | KS2=   | 0  | KERR=   | 0   |

TITLE: IAP CLASS RUN (PROB. 2 - PLOTS)

INPUT FORMAT FOR DATA ON FORTRAN FILE  
(3X,A6/11X,10I1)

NUMERIC ANSWER KEY GIVEN  
122133233

ALTERNATE RESPONSE CARD GIVEN  
4. 3. 4. 4. 4. 4. 4. 4. 4. 4.

NUMBER OF ITEMS IS 10

FIRST RECORD READ ID IS 1  
RESPONSES READ 23223333

MANPOWER AND PERSONNEL DIVISION  
 AIR FORCE SYSTEMS COMMAND

CONTROLLED ITEM  
 \*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552a) \*\*\*

IAP : ITEM ANALYSIS PROGRAM  
 IAP CLASS RUN (PROB. 2 - PLOTS)

SPECIFIED CONTROL PARAMETERS

|         |    |        |   |         |   |         |    |       |   |        |    |        |    |         |
|---------|----|--------|---|---------|---|---------|----|-------|---|--------|----|--------|----|---------|
| NSITR=  | 10 | IUPLM= | 4 | NFM=    | 1 | XI=     | 10 | K0=   | 0 | K5=    | 13 | N8=    | 35 | EASY=   |
| DIFFLT= | 20 | IAPHA= | 0 | NSPEED= | 0 | ICOPGS= | 0  | XIV=  | 0 | ICRIT= | 0  | OUT=   | 0  | NOCASE= |
| IPHI=   | 0  | IFREQ= | 0 | IOVER=  | 2 | JPLDT=  | 1  | NF=   | 0 | EIGN=  | 0  | IDEND= | 0  | IRWIND= |
| ICUT=   | 0  | ATEST= |   | IALT=   | 1 | ICARD=  | 0  | IHAM= | 0 | NERR=  | 2  | KS2=   | 0  | KERR=   |

TITLE: IAP CLASS RUN (PROB. 2 - PLOTS)

INPUT FORMAT FOR DATA ON FORTRAN FILE  
 (3X, A6, I1X, I011)

NUMERIC ANSWER KEY GIVEN  
 122133233

ALTERNATE RESPONSE CARD GIVEN  
 4. 5. 6. 4. 6. 4. 6. 4. 6. 4.

NUMBER OF ITEMS IS 10

FIRST RECORD READ ID IS 1  
 RESPONSES READ 223223333

## IAP : ITEM ANALYSIS PROGRAM

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

CONTROLLED ITEM

IAP CLASS RUN (PROB. 2 - PLOTS)

225 SUBJECTS SELECTING EACH RESPONSE

## ITEM INFORMATION

PROPORTION OF

225 SUBJECTS SELECTING EACH RESPONSE

| ITEM<br>NUMBER | DIFFICULTY | OMITS | 1    | 2    | 3    | 4    |
|----------------|------------|-------|------|------|------|------|
| 1              | .107       | .000  | .107 | .627 | .249 | .018 |
| 2              | .698       | .000  | .231 | .698 | .071 |      |
| 3              | .551       | .000  | .138 | .551 | .284 | .027 |
| 4              | .444       | .000  | .044 | .444 | .440 | .071 |
| 5              | .156       | .000  | .156 | .431 | .369 | .044 |
| 6              | .271       | .000  | .218 | .476 | .271 | .036 |
| 7              | .422       | .000  | .027 | .204 | .422 | .347 |
| 8              | .502       | .000  | .062 | .502 | .387 | .049 |
| 9              | .524       | .000  | .044 | .369 | .524 | .062 |
| 10             | .476       | .000  | .084 | .280 | .476 | .160 |

AD-A107 884

AIR FORCE HUMAN RESOURCES LAB BROOKS AFB TX  
ITEM ANALYSIS PROGRAM (IAP) FOR ACHIEVEMENT TESTS.(U)  
OCT 81 J B KOPLYAY  
AFHRL-TP-81-22

F/6 5/10

UNCLASSIFIED

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A1  
A107-884



END  
DATE  
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DTIC

IAP : ITEM ANALYSIS PROGRAM

IAP CLASS RUN (PROB. 2 - PLOTS)

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

MANPOWER AND PERSONNEL DIVISI  
AF HUMAN RESOURCES LABORATOR  
AIR FORCE SYSTEMS COMMAND

THE FOLLOWING ITEMS FALL OUTSIDE OF THE SPECIFIED DIFFICULTY RANGE AND SHOULD BE ELIMINATED BECAUSE OF EXTREME DIFFICULTY/EASINES  
EASY ITEMS ABOVE .80 DIFFICULT ITEMS BELOW .20

1  
5

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

CONTROLLED ITEM  
\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

IAP : ITEM ANALYSIS PROGRAM  
IAP CLASS RUN (PROB. 2 - PLOTS)

SUMMARY OF TEST STATISTICS

| VARIABLE  | MEAN | S.E. | ST.DEV. | S.E. | SKEWNESS | S.E. | KURTOSIS | S.E. | NO. OF SUBJECTS |
|-----------|------|------|---------|------|----------|------|----------|------|-----------------|
| RAW SCORE | 4.15 | .10  | 1.48    | .08  | .22      | .16  | .37      | .32  | 225             |

TEST RELIABILITY= .035

IAP : ITEM ANALYSIS PROGRAM  
IAP CLASS RUN (PROP. 2 - PLOTS)

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

| ITEM | DIFFICULTY<br>PROP'N. STD. | STANDARD<br>DEVIATION | ITEM ANALYSIS SUMMARY TABLE |        |                         |        | BETA | REL.<br>INDEX |
|------|----------------------------|-----------------------|-----------------------------|--------|-------------------------|--------|------|---------------|
|      |                            |                       | BISERIAL<br>CORR.           | T-TEST | POINT BISERIAL<br>CORR. | T-TEST |      |               |
| 1    | .107                       | .299                  | .251                        | 3.872  | .150                    | 2.258  | .259 | .046          |
| 2    | .698                       | .584                  | .433                        | 7.167  | .329                    | 5.197  | .480 | .151          |
| 3    | .551                       | .521                  | .427                        | 7.050  | .340                    | 5.392  | .472 | .169          |
| 4    | .444                       | .477                  | .379                        | 6.118  | .301                    | 4.721  | .410 | .150          |
| 5    | .156                       | .336                  | .436                        | 7.241  | .288                    | 4.483  | .485 | .104          |
| 6    | .271                       | .402                  | .433                        | 7.173  | .323                    | 5.092  | .480 | .143          |
| 7    | .422                       | .468                  | .496                        | 8.529  | .393                    | 6.381  | .571 | .194          |
| 8    | .502                       | .501                  | .346                        | 5.500  | .276                    | 4.284  | .368 | .138          |
| 9    | .524                       | .510                  | .363                        | 5.821  | .290                    | 4.518  | .390 | .145          |
| 10   | .476                       | .490                  | .587                        | 10.823 | .468                    | 7.906  | .725 | .234          |

MEAN STANDARDIZED ITEM DIFFICULTY = .459  
CORRESPONDING PROPORTION = .399

IAP : ITEM ANALYSIS PROGRAM  
 IAP CLASS RUN (PROB. 2 - PLOTS)

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

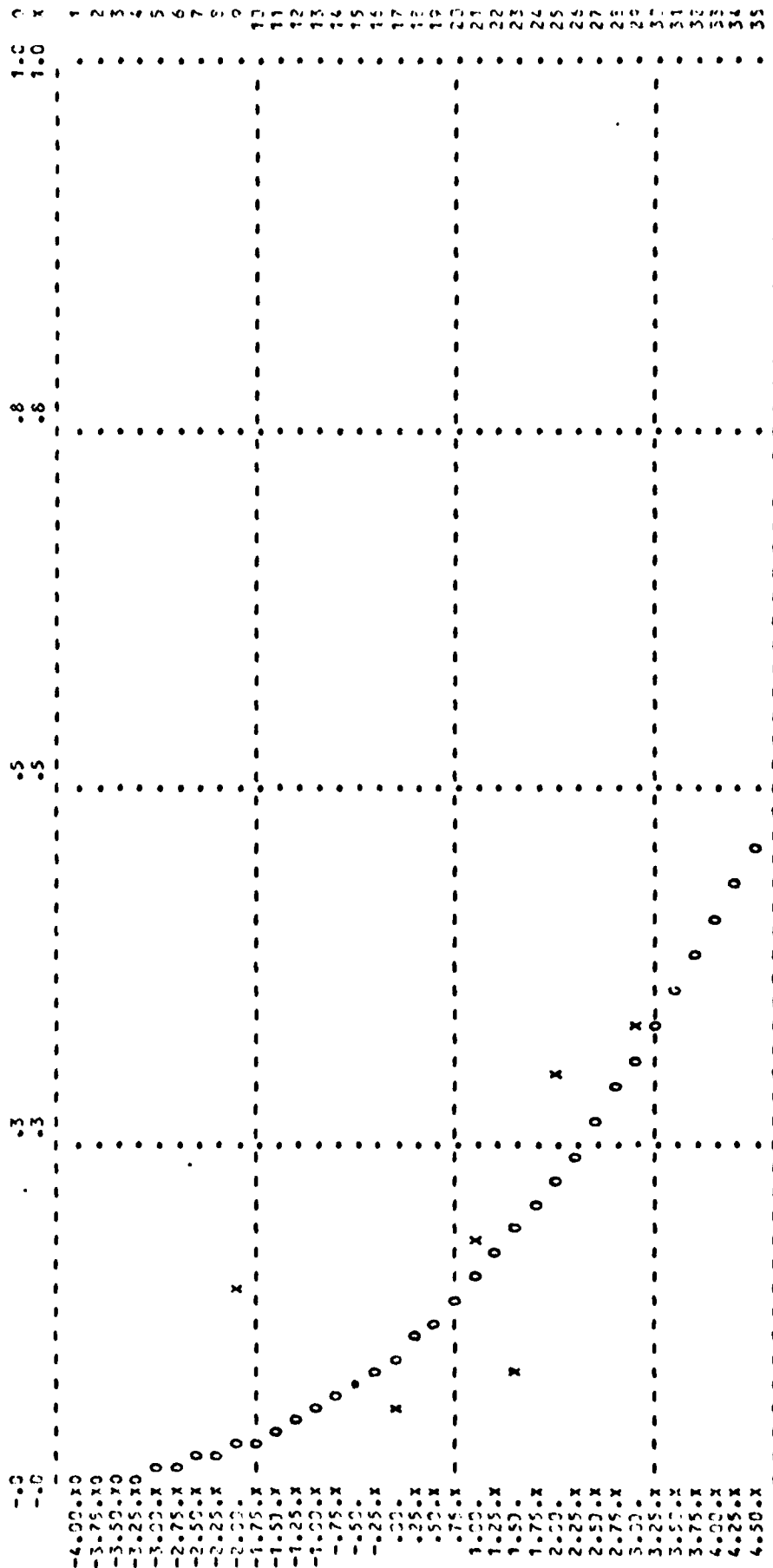
MANPOWER AND PERSONNEL DIVISION  
 AF HUMAN RESOURCES LABORATORY  
 AIR FORCE SYSTEMS COMMAND

PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

| ITEM | -4.0 | -3.5 | -3.0 | -2.5 | -2.0 | -1.5 | -1.0 | -0.5 | 0.0 | +0.5 | +1.0 | +1.5 | +2.0 | +2.5 | +3.0 | +3.5 | +4.0 | FIFTY |
|------|------|------|------|------|------|------|------|------|-----|------|------|------|------|------|------|------|------|-------|
| 1    | .00  | .00  | .00  | .00  | .14  | .00  | .00  | .08  | .06 | .00  | .18  | .09  | .30  | .00  | .33  | .00  | .00  | 4.96  |

SCALED ABSOLUTELY, MIN/MAX VALUES DEFINED BY CALLING PROGRAM.  
 ITEM CHARACTERISTIC CURVE

THEORETICAL PROPORTION AT -4.0 = .010



PLOT DESCRIPTION

| TRACE | PLOT          | CHARACTER | MINIMUM | MAXIMUM | RESOLUTION |
|-------|---------------|-----------|---------|---------|------------|
| 1     | FITTED VALUES | 0         | .000    | 1.000   | .000       |
| 2     | ACTUAL VALUES | X         | .000    | 1.000   | .000       |

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

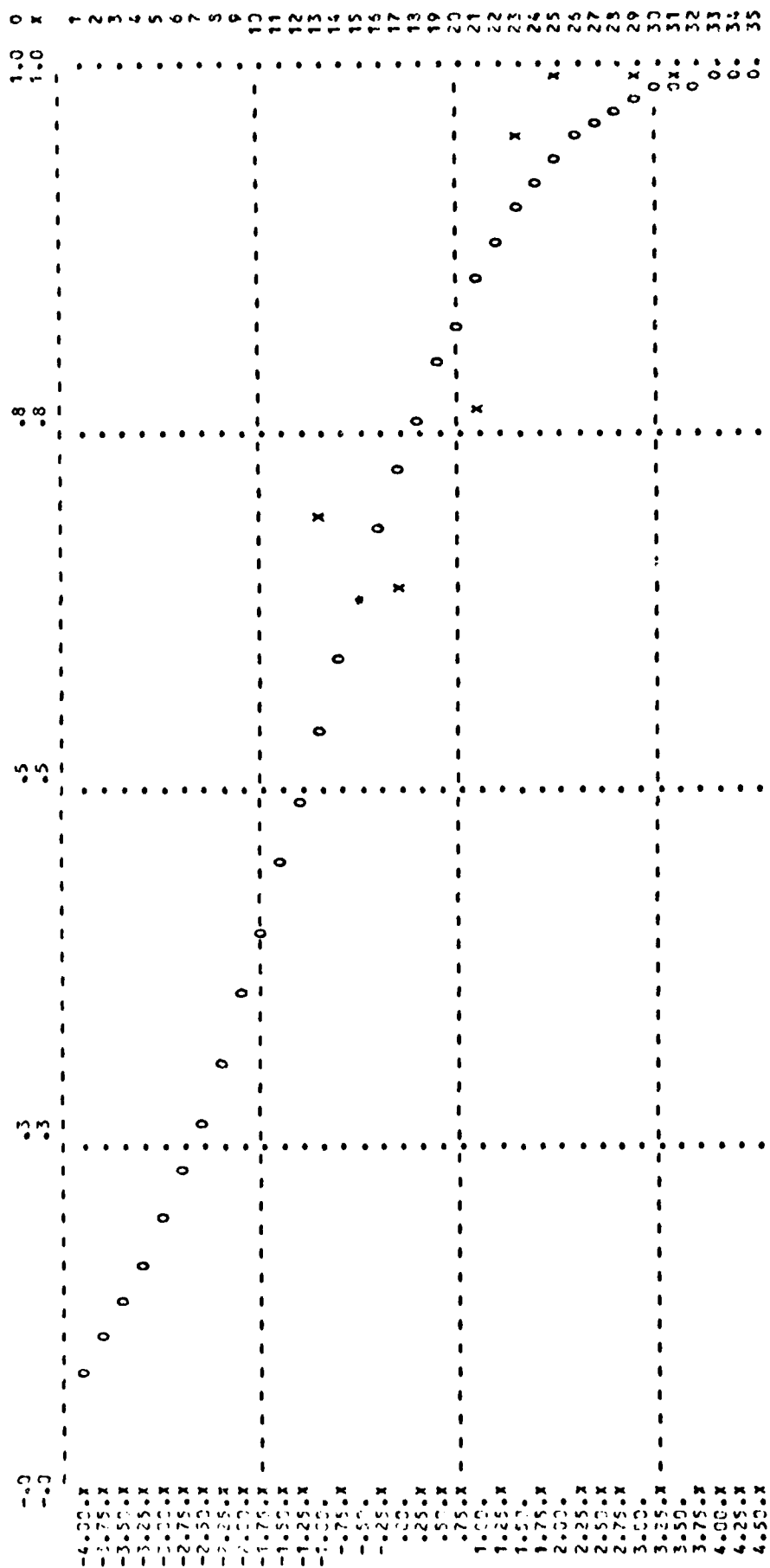
CONTROLLED ITEM  
PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*

ITEM ANALYSIS PROGRAM  
TRAP CLASS RUN (PPCB. 2 - PLOTS)

PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

| ITEM | -4.0 | -3.5 | -3.0 | -2.5 | -2.0 | -1.5 | -1.0 | -0.5 | 0.0 | +0.5 | +1.0 | +1.5 | +2.0 | +2.5 | +3.0 | +3.5 | +4.0 | X FIFTY |
|------|------|------|------|------|------|------|------|------|-----|------|------|------|------|------|------|------|------|---------|
| 2    | .00  | .00  | .00  | .00  | .00  | .00  | .63  | .63  | .00 | .76  | .95  | 1.00 | .00  | 1.00 | 1.00 | .00  | .00  | -1.20   |

THEORETICAL PROPORTION AT -4.0 = .039



PLOT DESCRIPTION

| TRACE | 1 | 2 | MINIMUM | MAXIMUM | RESOLUTION |
|-------|---|---|---------|---------|------------|
| 1     | 0 | 0 | .000    | 1.000   | .008       |
| 2     | x | x | .000    | 1.000   | .008       |

IAP = ITEM ANALYSIS PROGRAM  
 IAP CLASS RUN (PROB. 2 - PLOTS)

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

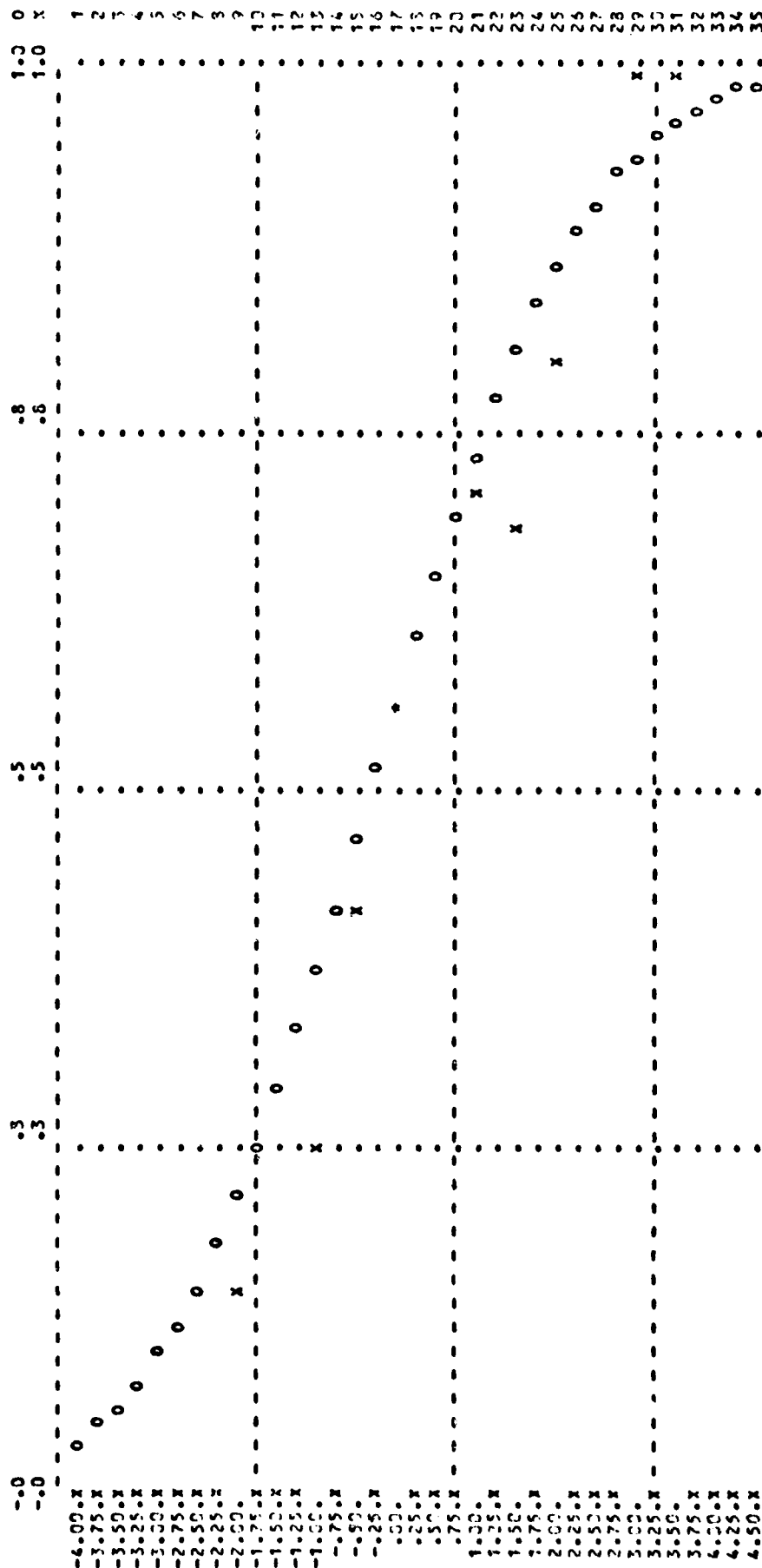
MANPOWER AND PERSONNEL DIVISION  
 AF HUMAN RESOURCES LABORATORY  
 AIR FORCE SYSTEMS COMMAND

PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

| ITEM | -4.0 | -3.5 | -3.0 | -2.5 | -2.0 | -1.5 | -1.0 | -0.5 | 0.0 | +0.5 | +1.0 | +1.5 | +2.0 | +2.5 | +3.0 | +3.5 | +4.0 | FIFTY |
|------|------|------|------|------|------|------|------|------|-----|------|------|------|------|------|------|------|------|-------|
| 3    | .00  | .00  | .00  | .00  | .14  | .00  | .25  | .41  | .56 | .00  | .71  | .68  | .80  | .00  | 1.00 | 1.00 | .00  | -.30  |

SCALED ABSOLUTELY, MIN/MAX VALUES DEFINED BY CALLING PROGRAM.

ITEM CHARACTERISTIC CURVE



PLOT DESCRIPTION

| TRACE | PLOT | FITTED VALUES | ACTUAL VALUES | CHARACTER | MINIMUM | MAXIMUM | RESOLUTION |
|-------|------|---------------|---------------|-----------|---------|---------|------------|
| 1     |      |               |               | 0         | .000    | 1.000   | .003       |
| 2     |      |               |               | X         | .000    | 1.000   | .008       |

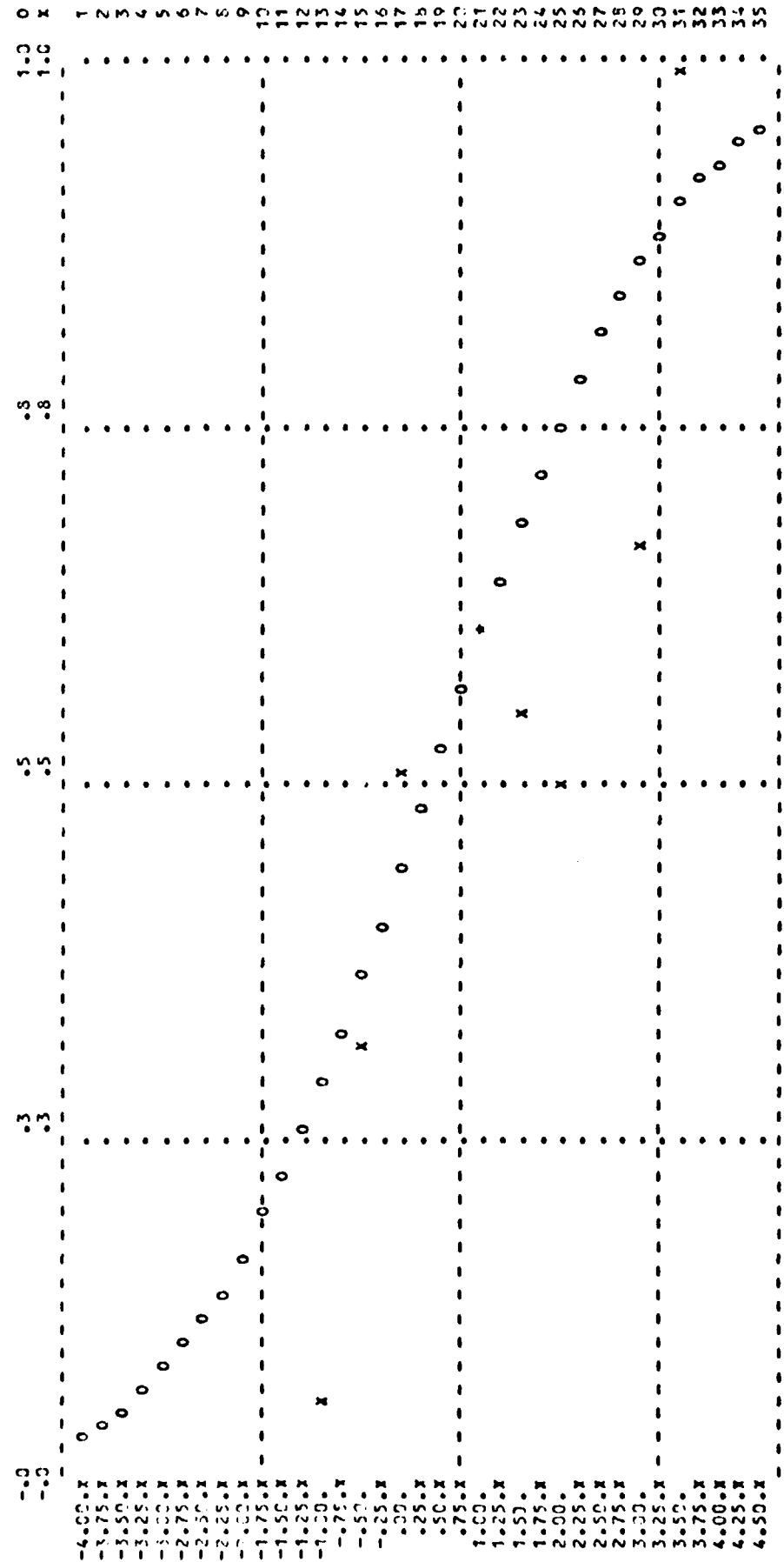
IAP = ITEM ANALYSIS PROGRAM  
 \*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*  
 IAP CLASS RUN (PFCB. 2 - PLOTS)  
 MANPOWER AND PERSONNEL DIVISION  
 AF HUMAN RESOURCES LABORATORY  
 AIR FORCE SYSTEMS COMMAND

PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

| ITEM | -4.0 | -3.5 | -3.0 | -2.5 | -2.0 | -1.5 | -1.0 | -0.5 | 0.0 | +0.5 | +1.0 | +1.5 | +2.0 | +2.5 | +3.0 | +3.5 | +4.0 | FIFTY |
|------|------|------|------|------|------|------|------|------|-----|------|------|------|------|------|------|------|------|-------|
| 4    | .00  | .00  | .00  | .00  | .00  | .00  | .06  | .31  | .51 | .00  | .61  | .55  | .50  | .00  | .67  | 1.00 | .00  | .00   |

SCALED ABSOLUTELY, MIN/MAX VALUES DEFINED BY CALLING PROGRAM.  
 ITEM CHARACTERISTIC CURVE

THEORETICAL PROPORTION AT -4.0 = .037



PLOT DESCRIPTION

| TRACE | PLOT          | CHARACTER | MINIMUM | MAXIMUM | RESOLUTION |
|-------|---------------|-----------|---------|---------|------------|
| 1     | FITTED VALUES | 0         | .000    | 1.000   | .008       |
| 2     | ACTUAL VALUES | X         | .000    | 1.000   | .008       |

IAP = ITEM ANALYSIS PROGRAM  
 IAP CLASS RUN (PROB. 2 - PLOTS)

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

MANPOWER AND PERSONNEL DIVISION  
 AF HUMAN RESOURCES LABORATORY  
 AIR FORCE SYSTEMS COMMAND

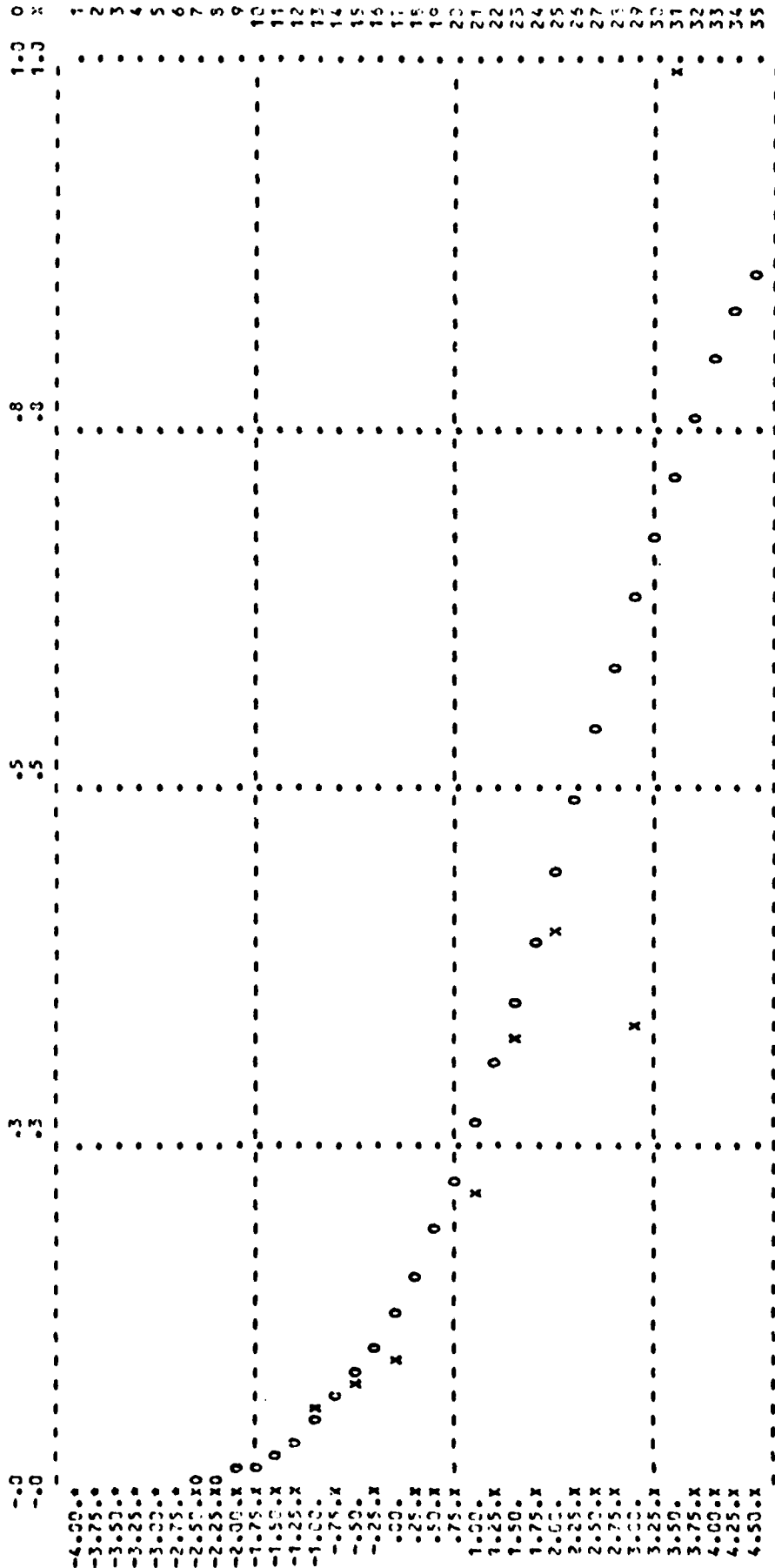
PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

| ITEM | -4.0 | -3.5 | -3.0 | -2.5 | -2.0 | -1.5 | -1.0 | -0.5 | 0.0 | +0.5 | +1.0 | +1.5 | +2.0 | +2.5 | +3.0 | +3.5 | +4.0 | FIFTY |
|------|------|------|------|------|------|------|------|------|-----|------|------|------|------|------|------|------|------|-------|
| 5    | .00  | .00  | .00  | .00  | .00  | .00  | .06  | .08  | .10 | .00  | .22  | .32  | .40  | .00  | .33  | 1.00 | .00  | 2.32  |

SCALED ABSOLUTELY, MIN/MAX VALUES DEFINED BY CALLING PROGRAM.

ITEM CHARACTERISTIC CURVE

THEORETICAL PROPORTION AT -4.0 = .001



PLOT DESCRIPTION

| TRACE | PLOT          | MINIMUM | MAXIMUM | RESOLUTION |
|-------|---------------|---------|---------|------------|
| 1     | FITTED VALUES | .000    | 1.000   | .008       |
| 2     | ACTUAL VALUES | .000    | 1.000   | .008       |

MAP - ITEM ANALYSIS PROGRAM  
 \*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*  
 IAP CLASS RUN (PROB. 2 - PLOTS)

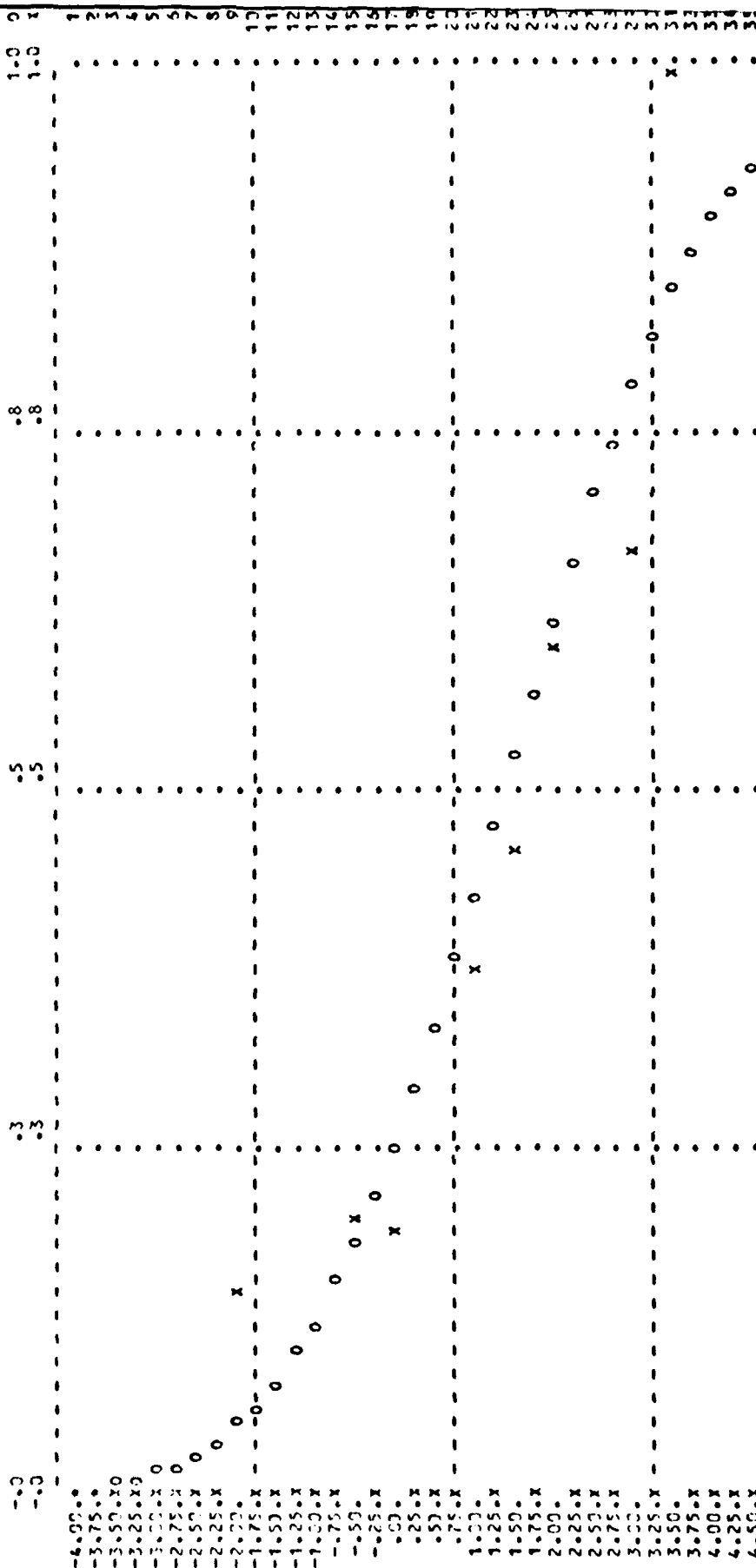
CONTROLLED ITEM  
 MAPPOWER AND PERSONNEL DIVISION  
 AF HUMAN RESOURCES LABORATORY  
 AIR FORCE SYSTEMS COMMAND

PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

| ITEM | -4.0 | -3.5 | -3.0 | -2.5 | -2.0 | -1.5 | -1.0 | -0.5 | 0.0 | +0.5 | +1.0 | +1.5 | +2.0 | +2.5 | +3.0 | +3.5 | +4.0 | FIFTY |
|------|------|------|------|------|------|------|------|------|-----|------|------|------|------|------|------|------|------|-------|
| 6    | .00  | .00  | .00  | .00  | .14  | .00  | .00  | .20  | .19 | .00  | .37  | .45  | .60  | .00  | .67  | 1.00 | .00  | 1.00  |

SCALED ABSOLUTELY, MIN/MAX VALUES DEFINED BY CALLING PROGRAM.  
 ITEM CHARACTERISTIC CURVE

THEORETICAL PROPORTION AT -4.0 = .005



PLOT DESCRIPTION

| TRACE      | 1     | 2     |
|------------|-------|-------|
| CHARACTER  | 0     | X     |
| MINIMUM    | .000  | .000  |
| MAXIMUM    | 1.000 | 1.000 |
| RESOLUTION | .003  | .003  |

IAP = ITEM ANALYSIS PROGRAM  
 IAP CLASS RUN (PROB. 2 - PLOTS)

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552a) \*\*\*

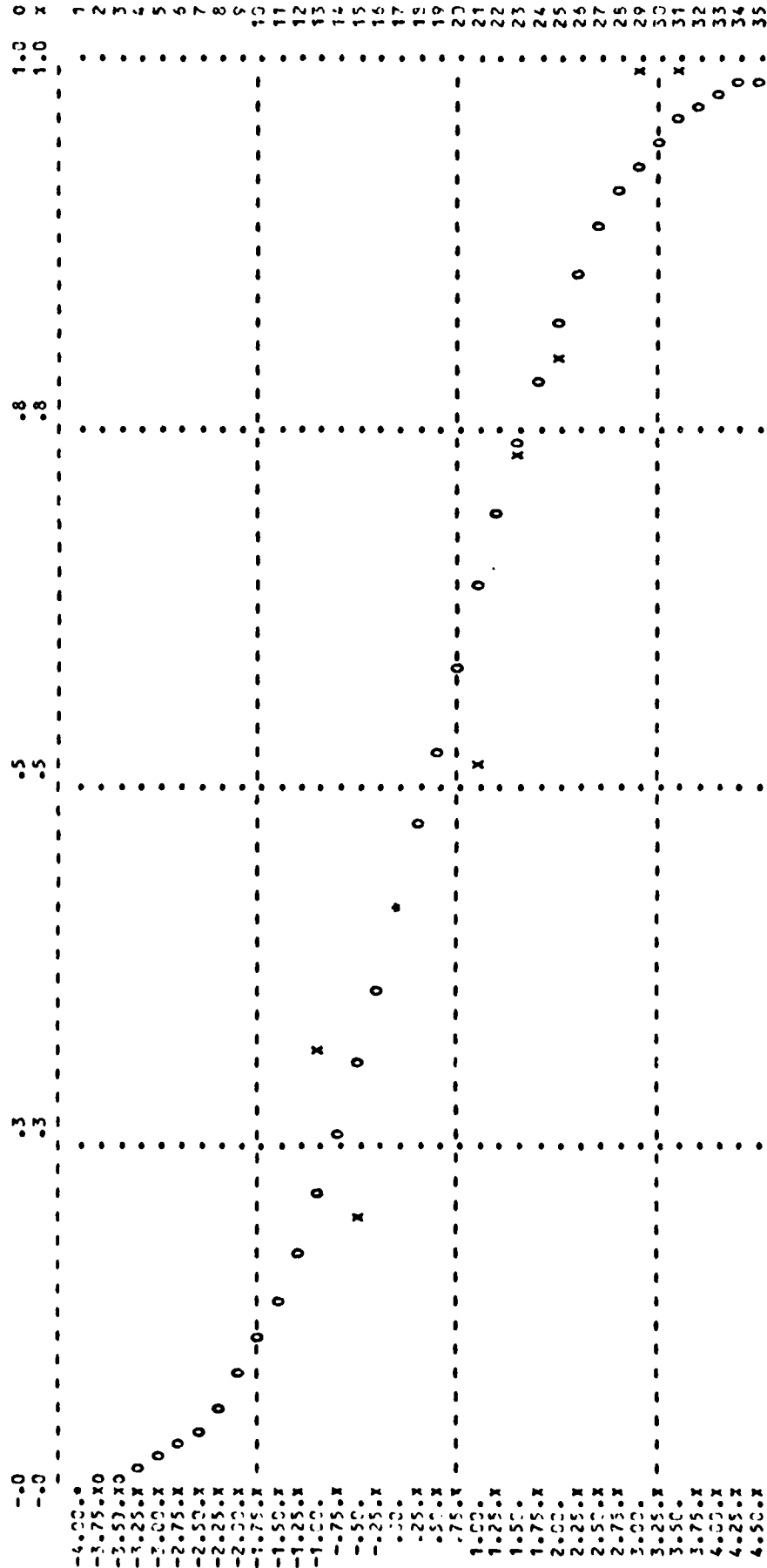
MANPOWER AND PERSONNEL DIVISION  
 AF HUMAN RESOURCES LABORATORY  
 AIR FORCE SYSTEMS COMMAND

CONTROLLED ITEM

PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

| ITEM | -4.0 | -3.5 | -3.0 | -2.5 | -2.0 | -1.5 | -1.0 | -0.5 | 0.0  | +0.5 | +1.0 | +1.5 | +2.0 | +2.5 | +3.0 | +3.5 | +4.0 | X FIFTY |
|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|---------|
| 7    | -0.0 | -0.0 | -0.0 | -0.0 | -0.0 | -0.0 | -0.0 | -0.0 | -0.0 | -0.0 | -0.0 | -0.0 | -0.0 | -0.0 | -0.0 | -0.0 | -0.0 | -0.0    |

THEORETICAL PROPORTION AT -4.0 = .006



PLOT DESCRIPTION

| TRACE | PLOT          | CHARACTER | MINIMUM | MAXIMUM | RESOLUTION |
|-------|---------------|-----------|---------|---------|------------|
| 1     | FITTED VALUES | 0         | -0.00   | 1.000   | .008       |
| 2     | ACTUAL VALUES | X         | -0.00   | 1.000   | .008       |

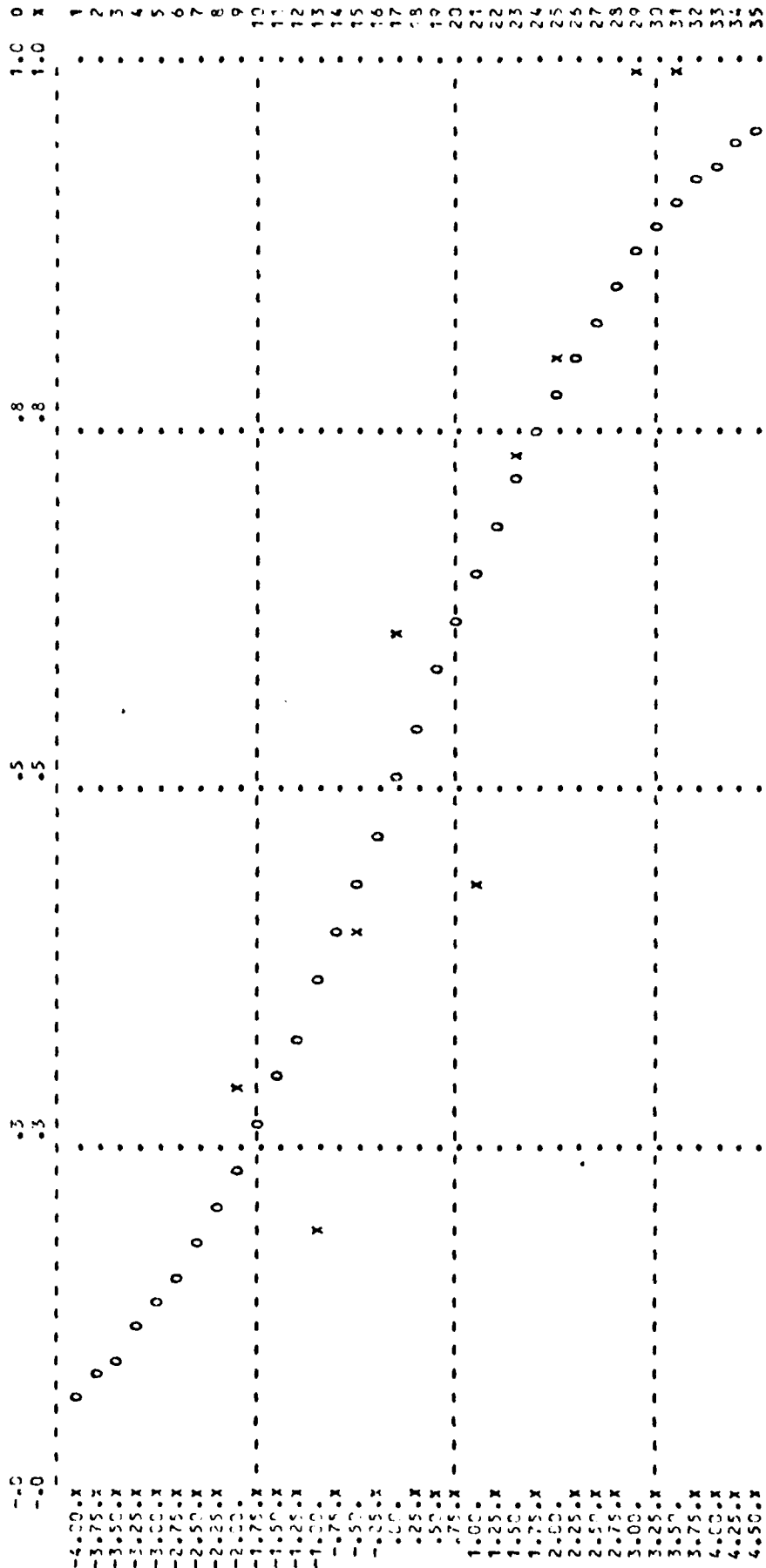
PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

| ITEM | -4.0 | -3.5 | -3.0 | -2.5 | -2.0 | -1.5 | -1.0 | -0.5 | 0.0 | +0.5 | +1.0 | +1.5 | +2.0 | +2.5 | +3.0 | +3.5 | +4.0 | MEFFTY |
|------|------|------|------|------|------|------|------|------|-----|------|------|------|------|------|------|------|------|--------|
| 8    | .00  | .00  | .00  | .00  | .29  | .00  | .19  | .39  | .60 | .00  | .43  | .73  | .80  | .00  | 1.00 | 1.00 | .00  | .00    |

SCALED ABSOLUTELY, MIN/MAX VALUES DEFINED BY CALLING PROGRAM.

ITEM CHARACTERISTIC CURVE

THEORETICAL PROPORTION AT -4.0 = .071



PLOT DESCRIPTION

| TRACE | PLOT          | CHARACTER | MINIMUM | MAXIMUM | RESOLUTION |
|-------|---------------|-----------|---------|---------|------------|
| 1     | FITTED VALUES | 0         | .000    | 1.000   | .025       |
| 2     | ACTUAL VALUES | X         | .000    | 1.000   | .008       |

MANPOWER AND PERSONNEL DIVISION  
AF HUMAN RESOURCES LABORATORY  
AIR FORCE SYSTEMS COMMAND

\*\*\* PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

TAP : ITEM ANALYSIS PROGRAM  
TAP CLASS RUN (PROB. 2 - PLOTS)

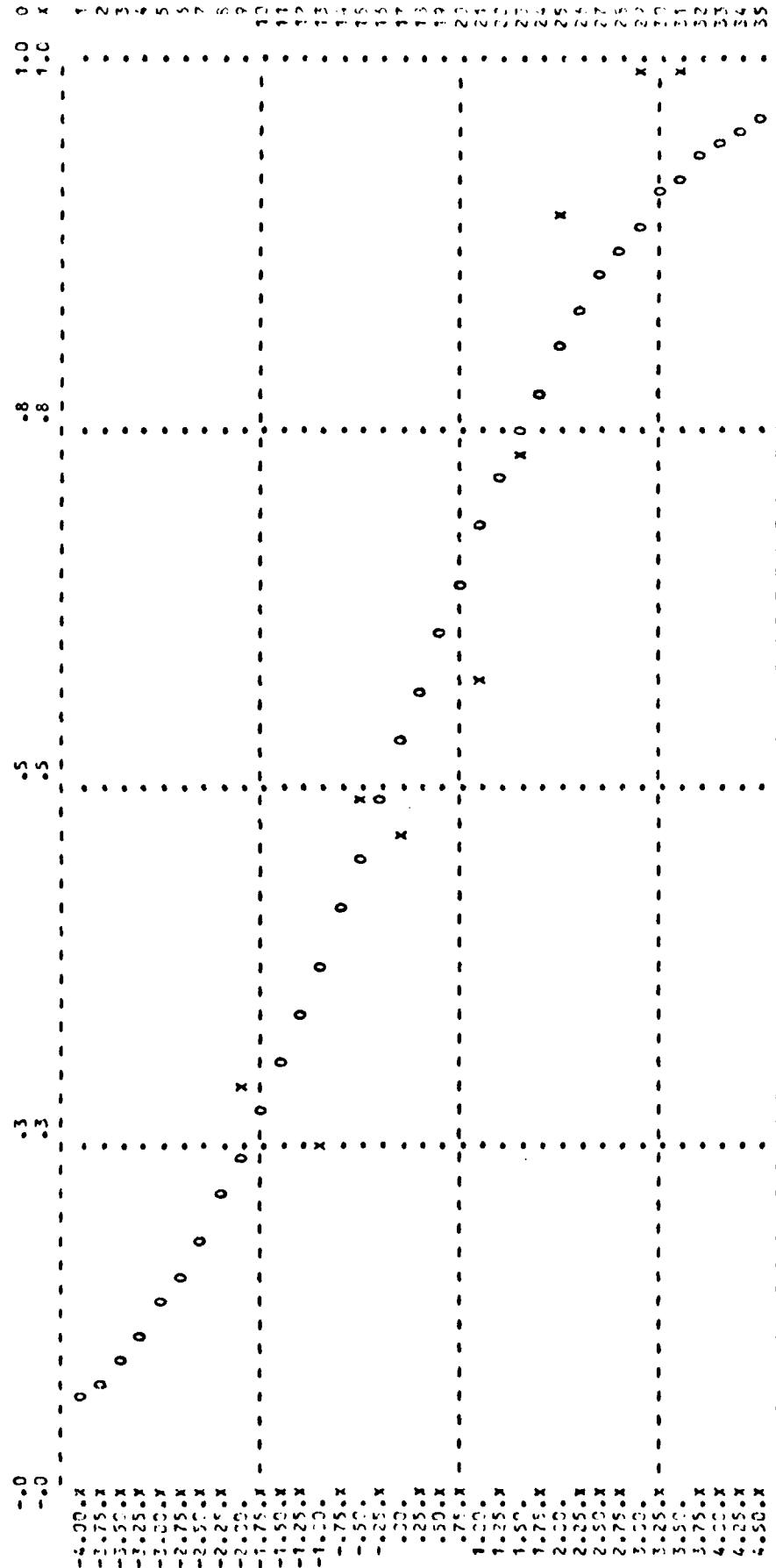
PROPORTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

| ITEM | -4.0 | -3.5 | -3.0 | -2.5 | -2.0 | -1.5 | -1.0 | -0.5 | 0.0 | +0.5 | +1.0 | +1.5 | +2.0 | +2.5 | +3.0 | +3.5 | +4.0 | FIFTY |
|------|------|------|------|------|------|------|------|------|-----|------|------|------|------|------|------|------|------|-------|
| 9    | .00  | .00  | .00  | .00  | .29  | .00  | .25  | .49  | .46 | .00  | .57  | .73  | .90  | .00  | 1.00 | 1.00 | .00  | .17   |

SCALED ABSOLUTELY, MIN/MAX VALUES DEFINED BY CALLING PROGRAM.

ITEM CHARACTERISTIC CURVE

THEORETICAL PROPORTION AT -4.0 = .069



PLOT DESCRIPTION

TRACE 1 PLOT  
2 FITTED VALUES  
ACTUAL VALUES

CHARACTER  
0  
X

MINIMUM  
.000  
-0.00

MAXIMUM  
1.000  
1.000

RESOLUTION  
.003  
.003

UNCLASSIFIED ITEM  
 AIR FORCE SYSTEMS COMMAND

PERSONAL DATA - PRIVACY ACT OF 1974 (5 USC 552A) \*\*\*

ITEM ANALYSIS PROGRAM

TAP CLASS RUN (PROG. 2 - PLOTS)

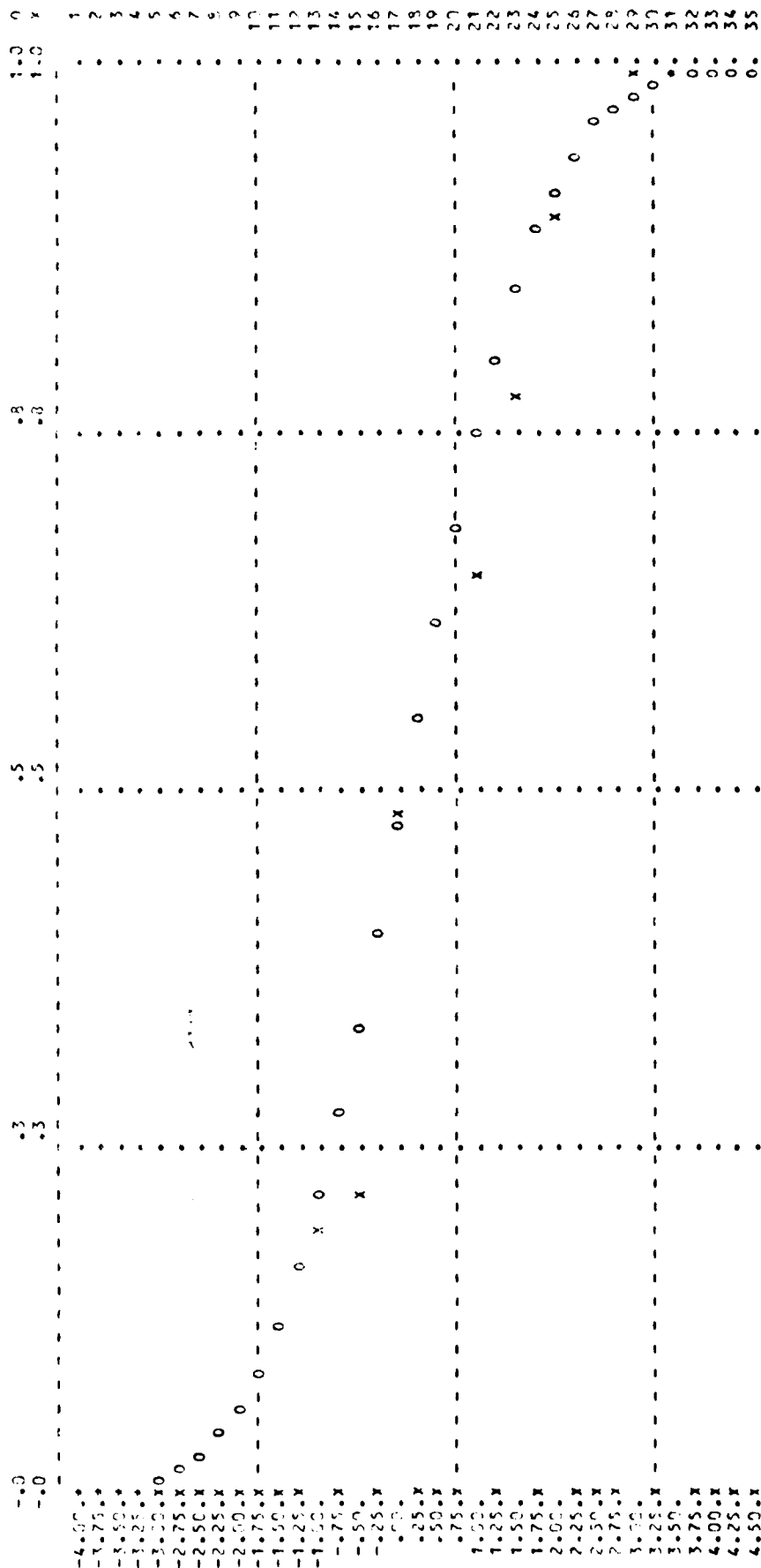
PROJECTION OF SUBJECTS CHOOSING THE CORRECT RESPONSE AT VARIOUS ABILITY LEVELS MEASURED IN Z-SCORES

| ITEM | -4.0 | -3.5 | -3.0 | -2.5 | -2.0 | -1.5 | -1.0 | -0.5 | 0.0 | +0.5 | +1.0 | +1.5 | +2.0 | +2.5 | +3.0 | +3.5 | +4.0 | ABILITY |
|------|------|------|------|------|------|------|------|------|-----|------|------|------|------|------|------|------|------|---------|
| 10   | .00  | .00  | .00  | .00  | .00  | .00  | .19  | .22  | .48 | .00  | .43  | .77  | .90  | .00  | 1.00 | .00  | .00  | .10     |

SCALED ABSOLUTELY, MIN/MAX VALUES DEFINED BY CALLING PROGRAM.

ITEM CHARACTERISTIC CURVE

THEORETICAL PROPORTION AT -4.0 = .001



PLOT DESCRIPTION

| TRACE | PLOT          | CHARACTER | MINIMUM | MAXIMUM | RESOLUTION |
|-------|---------------|-----------|---------|---------|------------|
| 1     | FITTED VALUES | O         | .000    | 1.000   | .008       |
| 2     | ACTUAL VALUES | X         | .000    | 1.000   | .008       |

END OF IAP PASS.

END OF IAP RUN. RUN TIME = 109(CLOCK)/ 21(CPU) SECONDS.

FREE TEMP.

READY

FREE DATA CLASS DATA.

READY

SCRIPT PRINTS