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ABSTRACT

The United States Training and Employment Service General Aptitude Test Battery (GATB), first published in 1947, has been included in a continuing program of research to validate the tests against success in many different occupations. The GATB consists of 12 tests which measure nine aptitudes: General Learning Ability; Verbal Aptitude; Numerical Aptitude; Spatial Aptitude; Form Perception; Clerical Perception; Motor Coordination; Finger Dexterity; and Manual Dexterity. The aptitude scores are standard scores with 100 as the average for the general working population, and a standard deviation of 20. Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, when combined, predict job performance. Cutting scores are set only for those aptitudes which aid in predicting the performance of the job duties of the experimental sample. The GATB norms described are appropriate only for jobs with content similar to that shown in the job description presented in this report. A description of the validation sample is included. (AG)

TECHNICAL REPORT

ON

STANDARDIZATION OF THE GENERAL APTITUDE TEST BATTERY

FOR

GRID OPERATOR 6-98.251

B-377 or S-117

U. S. Employment Service in
Cooperation with
New York State Employment Service

U. S. DEPARTMENT OF LABOR
Bureau of Employment Security
Washington 25, D. C.
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STANDARDIZATION OF THE GENERAL APTITUDE TEST BATTERY FOR GRID OPERATOR 6-98.251

B-377 or S-117

Summary

The General Aptitude Test Battery, B-1002A, was administered in January 1957, to 63 female workers employed as Grid Operators 6-98.251 at the Westinghouse Electric Corporation plant in Bath, New York. Two criteria were used for validation purposes: (1) a composite of four sets of supervisory ratings and (2) production records over a four-week period. On the basis of mean scores, correlations with the criteria, the qualitative analysis of work performed, and their combined selective efficiency, Aptitudes P-Form Perception, F-Finger Dexterity and M-Manual Dexterity were selected for inclusion in the test norms.

GATB Norms for Grid Operator 6-98.251 - B-377 or S-117

Table I shows, for B-1001 and B-1002, the minimum acceptable score for each aptitude included in the test norms for Grid Operator 6-98.251.

TABLE I

Minimum Acceptable Scores on B-1001 and B-1002 for B-377 or S-117

B-1001			B-1002		
Aptitude	Tests	Minimum Acceptable Aptitude Score	Aptitude	Tests	Minimum Acceptable Aptitude Score
P	CB-1-A CB-1-L	90	P	Part 5 Part 7	90
F	CB-1-O CB-1-P	90	F	Part 11 Part 12	85
M	CB-1-M CB-1-N	105	M	Part 9 Part 10	100

Effectiveness of Norms

The data in Table IV indicate that 12 of the 20 poor workers, or 60 percent of them, did not achieve the minimum scores established as cutting scores on the recommended test norms. This shows that 60 percent of the poor workers would not have been hired if the recommended test norms had been used in the selection process. Moreover, 32 of the 40 workers who made qualifying test scores, or 80 percent, were good workers.

TECHNICAL REPORT

I. Problem

This study was conducted to determine the best combination of aptitudes and minimum scores to be used as norms on the General Aptitude Test Battery for the occupation of Grid Operator 6-98.251.

II. Sample

The General Aptitude Test Battery, B-1002A, was administered in January 1957, to 69 workers employed as Grid Operator 6-98.251 at the Westinghouse Electric Corporation plant in Bath, New York. The employees tested included all Grid Operators working at the plant, with the exception of several absentees. Six of those tested were later eliminated from the sample--four because they had not completed the training period and two because complete criterion data could not be obtained for them. This left a final experimental sample of 63 workers. These workers were all female and were about evenly divided between the first and second shifts. (The assignment to first or second shift is made on the basis of the employee's own choice rather than on seniority or other factors.)

On-the-job training is given to new workers. Four months is considered to be the minimum time necessary for complete training.

Thirty-six of the tested sample had been tested with B-125 for Grid Operator and B-212 for Mounter prior to being hired, in many cases several years before this study was conducted. Analysis of the test data for these workers showed that the actual amount of screening done by using these batteries was not extensive and that the screening which was done probably had little effect on the GATB aptitude levels of the experimental sample for this study.

Table II shows the means, standard deviations, ranges and product-moment correlations with the ratings and production records criteria for age, education and experience.

TABLE II

Means (M), Standard Deviations (σ), Ranges and Pearson Product-Moment Correlations with the Production Records Criterion (r_1) and Composite Ratings Criterion (r_2) for Age, Education and Experience

Grid Operator 6-98.251
N = 63

	M	σ	Range	r_1	r_2
Age (years)	33.6	8.9	19-55	-.123	-.108
Education (years)	10.6	1.7	6-15	-.158	.075
Experience (months)	30.9	13.4	4-60	.155	.249*

* Significant at the .05 level

The correlation between experience and the ratings criterion is significant at the .05 level. It is suggested that this correlation may reflect a bias on the part of the raters in favor of the more experienced workers. This explanation seems reasonable because a significant relationship between experience and production records was not obtained. An alternative explanation would be that workers with the longer experience have survived a process of attrition in which many who were less adept at, or congenial to, the job were eliminated. The average age and education of the workers in the sample seem reasonable for workers in this kind of job and the ranges of age and education are within the limits recommended for GATB testing. Therefore, the data in Table II indicate that the sample is suitable for test development purposes.

III. Job Description

Job Title: Grid Operator 6-98.251

Job Summary: Fabricates small electronic-tube grids by winding fine wire around two heavier parallel wires, using an automatic lathe; operates levers and pedals to straighten and cut grids to size; trims grids by twisting off loose wire with fingers.

Work Performed: Winds grids: Sits at automatic lathe and presses button to turn on power. Grasps handle of machine guard-cover to automatically wind a strip of grids. (Strip is about one foot in length and contains from 6 to 20 grids.) When machine stops and guard raises, presses hand clutch lever or turns handwheel to rotate shaft with start-stop mark to "stop" position. Depresses pedal to cut off grid strip. Holds grid strip lightly between thumb and fingers of right hand, opens chuck by raising clamping lever with other hand, and lays grid-strip on bed of machine. Raises lever on split nut to disengage feed screw and pushes spindle forward until chuck encloses stub from which grid strip was cut. Depresses split nut lever to tighten chuck on grid strip, picks up wound strip from machine, and lowers machine guard to wind another strip.

Stretches grid strip: Inserts both ends of grid strip into chucks of stretcher and tightens chucks by pressing down levers with thumb and fingers. Depresses stretching lever fully (1 to 2 inches) to straighten grid strip, and while holding lever down, releases right hand chuck lever. Raises stretching lever and left hand chuck lever.

Cuts grids from strips: Lifts grid strip out of stretcher, inserts left end of strip through cutter guide, over cutter blade, and inserts other end of strip into holding chuck. Presses pedal to cut off surplus end of grid strip. Pulls off loose turns of lateral wire which have not been peened into side wires to expose legs of first grid. Visually checks leg length by noting whether swage mark on leg lines up with guide bar. Turns thumb screw to advance or retract grid strip as needed. Holds grid between thumb and forefinger and presses pedal to cut off a single grid.

Trims grids: Holds grid between thumb and forefinger of left hand, being careful to avoid distortion of delicate lateral wires. Slides thumb and forefinger of right hand along and over end of grid to strip or pull off the several loose turns of lateral wire. Holds grid by stripped wire with thumb and forefinger of left hand along grid to strip other end. Holds opposite ends of grid side wire between thumb and forefinger of left hand. Strips lateral wire at top of grid by circular motion of fingers until it breaks off where peened into side wire. Twists off stripped wire at bottom of grid in the same manner. Places grid in work tray. Continuously observes grids while trimming for presence of unequal spacing, pushed or pulled end turns, insufficient swaging on grid legs, or bowed side wires.

Performs incidental duties: Requests replenishment of supply of side and lateral wire as needed. Threads lateral wire over pulleys and into machine if it breaks during run or when empty spool is replaced.

IV. Experimental Battery

All of the tests of the GATB, B-1002A, were administered to the sample group.

V. Criteria

A. Description of Criterion Measures

1. Rank Order Ratings: The day-shift foreman and the night-shift foreman each ranked the employees under his supervision with regard to overall job performance. These two sets of rank order ratings were combined into a single set by the day-shift foreman, who was well enough acquainted with all employees to be qualified to merge the two sets of ratings. Rerankings one month later were also obtained using the above procedure. For purposes of the statistical analysis, the ranks were converted to linear scores.

2. Descriptive Rating Scale: Each of the two shift foremen rated the employees under his supervision, using a descriptive rating scale, and ratings made by the two foremen were treated as one distribution for the total sample. This scale consisted of three items, each covering an important aspect of performance of the duties of Grid Operator 6-98.251. These three items were as follows: Quality of Production; Quantity of Production; and Flexibility (ability to shift from one size grid to another with minimum loss of production). Each of the three items had five alternative statements referring to the adequacy of performance. The number of the alternative checked by the rater corresponded to the degree of performance of the worker rated, "1" indicating poor performance, and "5" indicating excellent performance. The total score on the scale is equal to the sum of the alternatives checked for all three items. Thus, the minimum possible score was 3 and the maximum possible score was 15. Reratings one month later were also prepared by the same foremen using the descriptive rating scale. The reratings made by the two foremen were also treated as one distribution for the total sample. For the first set of ratings, the mean descriptive rating scale score for the

experimental sample was 9.21, the standard deviation was 2.46, and the range was 3-15. For the second set of ratings, the mean score was 9.57, the standard deviation was 2.32, and the range was 5-15.

3. Production Records: Although Grid Operators work on grids of varying sizes, rather carefully worked-out standards exist for each type of grid, and production is expressed in terms of percentage of the standard for each type. As a matter of fact, the wage system is based on these standards, the worker being paid on the basis of the percent-standard achieved during the preceding week. In a sense, production records are put on a "standard score" basis, and therefore made usable for criterion purposes. To obviate, so far as feasible, short term fluctuations in production due to non-repetitive causes, production records were obtained for four weeks. These four weeks were four alternate weeks taken during the two months prior to testing.

   For the first and third weeks combined, the mean of the production-record measures for the experimental sample was 178.8, the standard deviation was 17.5 and the range was 131-200. For the second and fourth weeks combined, the mean score was 179.4, the standard deviation was 20.4 and the range was 117-200.

B. Analysis of Criterion Data

The reliability of the descriptive rating scale (correlation between ratings and reratings) was .93; the reliability of the rank order ratings (correlation between rankings and rerankings) was .91. These reliability coefficients are not much higher than the .86 correlation between the first set of ratings on the descriptive rating scale and the first set of rank order ratings, indicating that the descriptive rating scale and the rank order ratings were measuring essentially the same thing. Therefore, the four sets of ratings obtained for this study were combined into an equally weighted composite. This was done by converting each set of ratings to standard scores and using the total of the four standard scores as the composite score for each individual in the sample. The reliability of the composite ratings, as estimated by the Spearman-Brown prophecy formula, was .98. This estimate was obtained by considering the reliability of each of the four sets of ratings to be .92 (the median of the .93 reliability of the descriptive rating scale and the .91 reliability of the rank order ratings) and then substituting this value in the Spearman-Brown prophecy formula to predict the reliability of all four sets of ratings combined.

The correlation between production records for the first and third weeks and production records for the second and fourth weeks was .64. The reliability of the total production records for all four weeks, as estimated by use of the Spearman-Brown prophecy formula, was .78. The estimated reliability of the composite ratings (.98) and the estimated reliability of the total production records (.78) were both higher than the correlation between the composite ratings and total production records (.44). This indicates that to some extent, the ratings and production records were measuring different aspects of performance. Therefore, the production records and composite ratings were not combined, but were kept separate in the validation analysis.

VI. Statistical and Qualitative Analysis

Table III shows the means, standard deviations and Pearson product-moment correlations with the criteria for the aptitudes of the GATB. The means and standard deviations of the aptitudes are comparable to general working population norms with a mean of 100 and a standard deviation of 20.

TABLE III

Means (M), Standard Deviations (σ), and Pearson Product-Moment Correlations with the Production Records Criterion (r_1) and Composite Ratings Criterion (r_2) for the Aptitudes of the GATB

Grid Operator 6-98.251
N = 63

Aptitudes	M	σ	r_1	r_2
G-Intelligence	96.6	15.1	.164	.221
V-Verbal Aptitude	96.6	13.8	-.005	.149
N-Numerical Aptitude	95.6	15.5	.210	.192
S-Spatial Aptitude	98.2	15.2	.135	.216
P-Form Perception	103.5	16.1	.126	.292*
Q-Clerical Perception	105.8	13.7	-.006	.281*
K-Motor Coordination	101.5	16.6	-.054	.194
F-Finger Dexterity	105.1	18.4	.331**	.377**
M-Manual Dexterity	111.7	18.5	.181	.254*

** Significant at the .01 level
* Significant at the .05 level

The statistical results were interpreted in the light of the job analysis data. The job analysis data indicated that the following aptitudes measured by the GATB appear to be important for this occupation:

Form Perception (P) - required to position grid strip properly preparatory to cutting strips, to check leg length of grid strips visually before cutting, and to watch for unequal spacing, pushed or pulled end turns, insufficient swaging and bowed side wires while trimming grids.

Motor Coordination (K) - required to coordinate eyes and fingers or hands rapidly and precisely to insert grids into chucks, to trim the grids, and to thread the wires through the lathe.

Finger Dexterity (F) - required to manipulate grid wires which are .0005 inches to .04 inches in diameter without causing distortion. (Distortion of the hair-like lateral grid wires is the greatest obstacle the operators have to overcome in learning the job.)

Manual Dexterity (M) - required to handle grid wires and to manipulate the various wheels and levers of the grid lathe and its attached stretcher.

The data in Table III show that (1) the highest mean scores, in descending order of magnitude, were obtained for Aptitudes M, Q and F, (2) a significant correlation with the production records criterion was obtained for Aptitude F and (3) significant correlations with the composite ratings criterion were obtained for Aptitudes P, Q, F and M.

Based on the qualitative and quantitative evidence cited above, Aptitudes P, F and M were considered further for inclusion in the test norms. The evidence for each of these three aptitudes is indicated below.

Aptitude	Relatively High Mean	Significant Correlation with Production Records	Significant Correlation with Composite Ratings	Importance Indicated by Qualitative Analysis
P			X	X
F	X	X	X	X
M	X		X	X

There was good statistical evidence for Aptitude Q, which had a significant correlation with the composite ratings and a relatively high mean score. However, since Aptitude Q appeared to have no importance in the qualitative analysis, this aptitude was not given further consideration for inclusion in the norms. Aptitude K, which appeared important in the qualitative analysis, was not considered further for inclusion in the norms because of the general lack of statistical evidence for this aptitude.

Various combinations of Aptitudes P, F and M with appropriate cutting scores were selected as trial norms. The relationship between each of these sets of trial norms and the criterion (dichotomized as indicated in section VII below) was determined by means of the tetrachoric correlation technique. A comparison of the results showed that norms consisting of Aptitudes P, F and M with cutting scores of 90, 85 and 100, respectively, had a selective efficiency which was as good as, or better than that of any other set of norms tried.

In test development studies, an attempt is made to develop a set of norms such that the cutting score for each aptitude will be set at a five-point score level close to one standard deviation below the aptitude mean of the experimental sample. Adjustments of cutting scores from one standard deviation below the mean are made to effect better selective efficiency of the norms. In the case of this study the aptitude cutting scores are each within ten points of one standard deviation below the aptitude mean of the experimental sample.

VII. Concurrent Validity of Norms

In order to compute the tetrachoric correlation between the norms and the criteria, the criteria were dichotomized. A multiple-hurdle on production records and composite ratings was used as the basis for forming the dichotomy. In order to give production records and ratings equal weights in the multiple hurdle criterion, the cutting scores on these measures were each set at the same number of standard deviation units (.60) below the mean. The .6 value

was chosen so that the obtained cutting scores, when applied to the data, would result in placing as close as possible to one third of the sample in the low criterion group. Application of this technique resulted in setting a cutting score of 109 on the composite ratings and 84 on the production record measures. All workers with scores of less than 109 on composite ratings and/or less than 84 on production records were placed in the low criterion group and designated as "poor workers"; all other workers were placed in the high criterion group and designated as "good workers." Table IV shows the relationship between test norms consisting of Aptitudes P, F and M with cutting scores of 90, 85 and 100, respectively, and the dichotomized criterion for the experimental sample.

TABLE IV

Relationship between Test Norms Consisting of Aptitudes P, F and M with Critical Scores of 90, 85 and 100, Respectively, and the Criterion for Grid Operator 6-98.251

N = 63

	Non-Qualifying Test Scores	Qualifying Test Scores	Total
Good Workers	11	32	43
Poor Workers	12	8	20
Total	23	40	63

$r_{tet} = .53$ $\quad X^2 = 5.571$

$\sigma_{r_{tet}} = .21$ $\quad P/2 < .01$

The data in the above table indicate a significant relationship between the test norms and the criterion for this sample.

VIII. Conclusions

On the basis of mean scores, correlations with the criterion, job analysis data and their combined selective efficiency, Aptitudes P, F and M with minimum scores of 90, 85 and 100, respectively, are recommended as B-1002 norms for the occupation of Grid Operator 6-98.251. The equivalent B-1001 norms consist of P-90, F-90 and M-105.

IX. Determination of Occupational Aptitude Pattern

When the specific test norms for an occupation include three aptitudes, only those Occupational Aptitude Patterns which include these three aptitudes with cutting scores that are within 10 points of the cutting scores established for the specific norms are considered for that occupation. None of the existing 23 Occupational Aptitude Patterns meet these requirements for this study. Therefore, none of the existing Occupational Aptitude Patterns is recommended for the occupation covered by this study. However, the data for this sample will be considered for future groupings of occupations in the development of new Occupational Aptitude Patterns.