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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)

FINAL REPORT

TECHNICAL REPORT

ON

STANDARDIZATION OF THE GENERAL APTITUDE TEST BATTERY

FOR

TABULATING MACHINE OPERATOR 213.782

S-42

Prepared by
Minnesota State Employment Service
From Data Collected By
Minnesota, New Jersey, North Carolina, Wisconsin and California State Employment Services

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TECHNICAL REPORT

I. Problem

This study was conducted in cooperation with the National Machine Accountants Association (NMAA) to determine the best combination of aptitudes and minimum scores, based on the General Aptitude Test Battery (GATB), to be used as norms for the occupation of Tabulating Machine Operator - 213.782.

The present study is an attempt to develop national norms for this occupation. It is an outgrowth of a previous study conducted in 1952 on a sample of 169 tabulating machine operators employed in St. Paul and Minneapolis in cooperation with Northwest Chapter, NMAA.

II. Sample

The total sample consisted of 402 Tabulating Machine Operators employed in five states, i.e., California, North Carolina, New Jersey, Minnesota and Wisconsin. Of the 402 operators included, 169 operators are from the 1952 Minnesota sample which was used in this study for cross-validation purposes only. Thirty operators (from San Francisco) of the 233 tested for the present study were excluded from part of the analysis because criterion data were not available for them. Therefore, the norms developed in this study are based on a final sample of 203 operators, of whom 96 are women and 107 are men.

All types of operations capable of being performed by the machines as listed by the International Business Machines Company and by the Remington Rand Company were performed by operators in the sample. Participating firms were instructed to refer all tabulating machine operators for testing. If this procedure was not feasible, operators tested were to be representative of operators employed within each firm with respect to age, sex, level of operators, and experience.

All operators in the sample had been employed for six months or longer and had therefore completed the probationary period for this occupation. The assumption was made that all workers in the sample had the opportunity to achieve minimum satisfactory performance on the job.

Operators were classified into one of the three following categories:

Level 1 - Operators using only one or two machines and performing only a restricted phase of complete "jobs"

Level 2 - Operators using two or more machines and capable of performing all operations on a "job"

Level 3 - Supervisors and assistant supervisors performing all operations in addition to supervisory functions

Table II shows the characteristics of the sample with respect to level of operator, size of installation, and sex of operator for the states participating in the study and for the total sample of 233 operators used in establishing the norms for Tabulating Machine Operator.

TABLE II

Size of Installation, Level and Sex of Operators for Each Sub-Sample and Total Sample
N = 233

Sample	Size of Installation*	Level 1			Level 2			Level 3			Total		
		Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
New Jersey	Large	3	1	4	16	6	22	3	2	5	22	9	31
	Medium	2	1	3	3	4	7	0	0	0	5	5	10
	Small	0	0	0	3	0	3	4	1	5	7	1	8
	Total	5	2	7	22	10	32	7	3	10	34	15	49
North Carolina	Unknown	0	1	1	0	2	2	0	0	0	0	3	3
	Large	0	0	0	1	0	1	1	1	2	2	1	3
	Medium	0	9	9	6	14	20	0	3	3	6	26	32
	Small	0	3	3	0	7	7	0	0	0	0	10	10
	Total	0	13	13	7	23	30	1	4	5	8	40	48
Wisconsin	Unknown	1	1	2	3	3	6	2	0	2	6	4	10
	Large	1	0	1	7	7	14	3	0	3	11	7	18
	Medium	0	1	1	5	2	7	0	0	0	5	3	8
	Small	2	1	3	13	13	26	7	4	11	22	18	40
	Total	4	3	7	28	25	53	12	4	16	44	32	76
Los Angeles	Large	0	0	0	0	0	0	0	0	0	0	0	0
	Medium	2	0	2	15	2	17	0	0	0	17	2	19
	Small	1	0	1	3	6	9	0	1	1	4	7	11
	Total	3	0	3	18	8	26	0	1	1	21	9	30
San Francisco	Unknown	0	0	0	10	6	16	14	0	14	24	6	30
Total Sample	Unknown	1	2	3	13	11	24	16	0	16	30	13	43
	Large	4	1	5	24	13	37	7	3	10	35	17	52
	Medium	4	11	15	29	22	51	0	3	3	33	36	69
	Small	3	4	7	19	26	45	11	6	17	33	36	69
	Total	12	18	30	85	72	157	34	12	46	131	102	233

*Definition of size of installation:
Small - 1 or 2 Tabulators
Medium - 3 or 4 Tabulators
Large - 5 or more Tabulators

The data in Table II show that 13 percent of the sample is composed of Level 1 tabulating machine operators, 67 percent of Level 2 operators and 20 percent of Level 3 operators. From information obtained from representatives of International Business Machines and Remington Rand it is believed that this distribution is proportionate to that found nationally in tabulating machine installations.

The sample is composed of 131 men and 102 women, or 56 percent male and 44 percent female. Information was not available on the proportionate distribution of men and women in the national tabulating machine operator population so that it was not possible to determine the representativeness of the sample in this respect.

The size of installations was unknown for 18 percent of the 233 operators. Twenty-two percent of the 233 operators were employed in large installations, 30 percent in medium installations and 30 percent in small. Information was not available on the adequacy of this distribution in terms of national representation by size of installation.

It will also be observed that the New Jersey sample had a higher percentage of operators employed in large installations; North Carolina had more operators from medium sized installations and contained a higher proportion of women than the other localities; Wisconsin had a proportionately greater number of operators from small installations; Los Angeles had no operators employed in large installations in the sample, while San Francisco did not have Level 1 operators in the sample.

Table III shows the means (M), standard deviations (σ), ranges (R), and Pearson product-moment correlations with the criterion (r) and standard errors of the correlations (σ_r) for age, education, and experience for the sample of 203 used for establishment of norms (criterion data were not available for 30 of the 233 operators tested).

TABLE III

Means (M), Standard Deviations (σ), Ranges (R), Pearson Product-Moment Correlation Coefficients with the Criterion (r) and Standard Errors of Correlation (σ_r) for Age, Education, and Experience for Tabulating Machine Operators $_{213.782}$

N = 203

	M	σ	Range	r	σ_r
Age (years)	28.9	8.1	17-64	.18*	.07
Education (years)	12.4	1.6	7-18	.01	.01
Experience (months)	59.3	48.5	6-276	.31**	.06

*Significant at 5% level
**Significant at 1% level

The relationship between age and the criterion was significant at the 5% level, although the correlation was small in magnitude. No significant relationship was found between education and the criterion.

Experience and the criterion were significantly related at the 1% level. It is believed, however, that this relationship is due to the fact that three levels of operators are contained in the sample. The more proficient level 1 operators tend to be promoted to level 2, and level 2 operators to level 3 so that the better operators tend to be those who have had longer experience with the company. The statistics subsequently presented in Table V show that the three levels of operators differ significantly with respect to aptitude scores, experience and criterion ratings, and that all three of these variables are positively correlated with operator level. Therefore, it appears that the significant correlation between experience and the criterion for the total sample reflects primarily a true difference in ability between low experience workers and high experience workers. Under these circumstances, a correction of the criterion for this correlation is not warranted.

III. Job Description

Tabulating Machine Operator (Clerical) 213.782

The following job description was developed for the study of Tabulating Machine Operators conducted by the Minnesota Agency in 1952. It was submitted to state agencies cooperating on the present study with instructions to verify the description and to determine the existence of any additional job variables which might have significance for this study. Since no further changes were suggested, it is believed that this composite job description represents the job of Tabulating Machine Operator for all the samples in this study.

Job Summary

Sets up and operates machines that automatically separate, analyze, translate, calculate and print information from punched cards.

Work Performed

The WORK PERFORMED by OPERATORS and SUPERVISORS varies with company policy of work assignment and the complexity of the problems submitted to the Tabulating Section. Some firms assign an OPERATOR to one machine for an indefinite period of time. The machine is set up and adjusted by a SUPERVISOR. Other firms assign an OPERATOR to one machine for a definite period such as one month, and transfer the OPERATOR to other machines so that at the end of six months, he is experienced on most types of machines. Other firms assign problems to an OPERATOR that involve a complete sequence of operations. However, SUPERVISORS usually receive the request for data to be produced by the Tabulating Section, and designate the procedure to be followed to obtain the required result. Wiring boards or wiring units may be changed to fit a specific problem; however, for many routine operations, permanent boards or units are set up.

The work performed by an OPERATOR assigned a complete job ~~is shown below:~~

1. Determines procedures to be followed. Receives request from various operating departments such as research, accounting, payroll, statistics or billing for data reports, calculations, payroll checks or customers bills. Decides procedure to be followed if problem has been outlined in procedures manual. May chart, diagram and show all steps to be followed if problem has not been outlined in manual. This is done for wiring boards or wiring units, as well as for setting and adjusting all switches, and controls for all machines necessary to complete the job, and is usually performed by the SUPERVISOR or HEAD of TABULATING SECTION.

2. Sets up tabulating machines such as Sorter, Interpreter, Reproducer, Collator, Calculator, Printer (Accounting Machine) with or without Summary Punch. Reads procedure manual; selects pre-wired board or wiring unit, or wires board in accordance with wiring diagram in manual. Inserts board in machine. Adjusts all switches and controls as designated by manual or instructions on back of board. Places punched cards from which results are obtained in automatic feed pocket, or places various forms on Printer that records the results in the form of bills, checks and reports of various kinds. Runs one copy of card or form, checks for accuracy of results, and obtains approval from SUPERVISOR if necessary.

3. Operates Tabulating Machines to produce required results; pushes starter button and watches machine for malfunction; stops machine and removes cards that jam; spot checks cards on long run, and checks last card on most runs.

4. Routes processed cards and forms to next work station. Removes processed cards and stacks in tray; removes forms from Printer; carries trays of cards to next work station, and delivers printed forms to SUPERVISOR.

Estimated Aptitudinal Requirements

"G" Intelligence: Necessary for acquiring understanding of operating principles and procedures and application of knowledge to work processes. Needed particularly in charting, diagramming, board wiring and machine set up.

"N" Numerical Aptitude: Understanding of arithmetical and computational processes involved and for checking the correctness of machine computations. Particularly needed for understanding and diagramming the operations of the Printer and Calculator.

"S" Spatial Aptitude: Necessary for diagramming the setting of controls for specific machine operations.

"Q" Clerical Perception: Needed to perceive accurately and compare numerical and printed data on forms, punch cards and reports.

"F" Finger Dexterity: Necessary for operations of checking and selecting cards quickly, carefully, and accurately; to make fine adjustments in replacing or setting machine parts, e.g. controls and switches. It is also involved if wires for boards are required. Involved in Key-Punch operations which may be required of OPERATOR in duplicating damaged cards.

Color Discrimination: May be essential in many operations to identify tabulating cards of various colors and with various colored stripes on the cards.

IV. Experimental Battery

All of the tests of the GATB, B-1002, were administered to the sample. This differs from the Minnesota study of 1952 in that the B-1001 edition of the GATB was administered in the 1952 study.

The Minnesota Interest Inventory developed by Dr. Kenneth E. Clark of the University of Minnesota was also administered to the sample as a separate study. Findings on this test are to be covered in a separate report prepared by Dr. Clark.

V. Criterion

The criterion for this study was a rating scale which included items considered by selected Tabulating Machine Supervisors to be important for successful work performance as a Tabulating Machine Operator. An attempt was made to confine the rating to those items which would give evidence of actual ability to perform, with minimum consideration of personality traits and work habit factors. Several items related to personality traits were included in the rating scale in an attempt to isolate those factors, but these items were not included in the criterion score for the operators.

On the directions sheet supervisors were instructed to rate operators in comparison with Tabulating Machine Operators "in-general." This instruction was used to obtain as nearly as possible, comparability of ratings for the various samples. Instructions also requested a re-rating by the same supervisor within a 2 week period for the purpose of determining reliability of ratings. A reliability coefficient of .878 with a standard error of .004 indicated a high degree of agreement between the first and second ratings. However, since re-ratings were not available for the entire sample, the first rating was used as the criterion.

The criterion was based on each of 8 items on the rating scale on which the rater had 5 choices of responses indicating the degree of performance of the operator. Weights of 1 through 5 were assigned to these responses so that the minimum possible score was 8 and the maximum was 40. The mean score was 26.05 with a standard deviation of 6.7 and a range of 8 through 40 for the sample of 203 operators.

The following tables indicate the mean (M) criterion scores, standard deviations (σ), and significance (F) of mean differences, (Analysis of Variance) with respect to sex, size of installation, level of operator and geographic location of samples.

TABLE IV

Comparison of the Mean Criterion Scores for Sex, Size of Installation, Level of Operator and Geographic Location of Samples.

Sex	Males (N=131)		Females (N=102)		
	M	σ	M	σ	F
Criterion	26.5	6.7	25.5	6.7	1.24

Installation Size	Large (N=52)		Medium (N=69)		Small (N=69)		
	M	σ	M	σ	M	σ	F
Criterion	25.5	6.9	25.2	5.9	27.6	6.8	2.72

Operator Level	Level 1 (N=30)		Level 2 (N=157)		Level 3 (N=46)		
	M	σ	M	σ	M	σ	F
Criterion	20.3	5.4	25.5	5.8	33.8	4.3	47.00**

Location	Wisconsin N = 76		New Jersey N = 49		E. North Carolina N = 48		Los Angeles N = 30		
	M	σ	M	σ	M	σ	M	σ	F
Criterion	28.0	7.3	24.6	5.8	26.2	6.3	23.2	5.4	5.03**

** Significant at the 1% level.

The above tables indicate that there are no significant differences in mean criterion scores between male and female operators nor between operators working in small, medium, and large installations. However, statistically significant differences in mean criterion scores were obtained between the workers in the three defined operator levels and between the operators in geographically different areas.

It is believed that the criterion mean differences, which are significant at the 1% level between levels of operators, reflect true differences in ability between operators at the three levels.

The differences in mean criterion scores for the various geographical areas, which are significant at the 1% level, may be true differences, or may be due to other factors which cannot be determined because of the absence of stratification in terms of comparable characteristics.

VI. Statistical and Qualitative Analysis

In order to determine if the various subgroups were similar with respect to performance on the GATB, age, education and experience, the sample of 233 operators was divided into subgroups on the bases of sex, operator level, wiring experience, size of installation, and geographical location. The Analysis of Variance technique was used for this purpose. The results are shown in Table V.

TABLE V

Means (M), Standard Deviations (σ), and F values from the Analysis of Variance in Cross Classifications for Aptitude Scores, Age, Education, Experience and Criterion Ratings

SEX

Variable	Male (N = 131)		Females (N=102)		F
	M	σ	M	σ	
G	116.4	14.0	106.8	12.4	29.64**
V	111.3	14.9	108.2	15.4	2.41
N	115.0	14.5	108.5	13.7	11.98**
S	111.9	18.3	100.8	15.6	23.95**
P	110.1	12.7	110.3	14.9	00 00
Q	114.3	13.8	119.8	15.7	7.82**
K	111.2	16.4	113.2	15.6	.86
F	103.3	19.4	109.5	19.5	5.74*
M	106.9	19.9	106.9	22.0	00 00
Age	29.7	7.8	28.3	8.0	1.75
Education	12.9	1.7	12.1	1.3	16.80**
Experience	61.1	51.9	59.4	43.4	00 00
Rating	26.6	6.7	25.5	6.7	1.24

*Significant at the 5% level.
**Significant at the 1% level.

OPERATOR LEVEL

Variable	Level 1 N=30		Level 2 N=157		Level 3 N=46		F
	M	σ	M	σ	M	σ	
G	104.3	13.5	111.0	13.4	121.2	12.6	16.18**
V	104.7	15.2	108.5	14.2	118.2	15.3	10.06**
N	104.4	15.5	111.2	13.7	120.2	13.0	12.80**
S	99.3	11.6	107.4	18.1	110.8	19.8	3.86
P	106.6	14.5	110.0	13.5	113.0	13.1	2.04
Q	115.6	16.0	115.5	14.0	121.6	16.3	3.15
K	110.6	16.1	111.8	16.8	113.9	13.2	00 00
F	100.3	17.1	106.6	20.9	107.8	15.7	1.59
M	107.5	17.8	106.9	21.8	106.5	19.3	00 00
Age	24.7	5.8	28.3	8.0	32.4	7.4	9.11**
Education	12.2	1.4	12.5	1.6	12.9	1.7	1.74
Experience	33.1	28.7	57.3	48.1	81.5	50.0	9.53**
Rating	20.3	5.4	25.5	5.8	33.8	4.3	47.00**

* Significant at the 5% level.
** Significant at the 1% level.

WIRING EXPERIENCE

	Wiring N=207		Non Wiring N=26		
Variable	M	σ	M	σ	F
G	113.3	13.8	103.2	14.2	12.38**
V	110.8	14.9	102.8	15.8	6.66*
N	113.1	14.2	102.4	14.9	8.54**
S	108.2	18.2	98.0	13.5	7.47**
P	110.5	13.4	107.5	15.8	1.16
Q	116.7	14.6	116.6	17.7	00 00
K	111.6	16.1	115.7	15.6	1.51
F	106.7	19.5	100.7	20.6	2.16
M	106.7	21.2	108.9	18.1	00 00
Age	29.7	8.0	24.3	4.8	11.21**
Education	12.6	1.7	12.2	1.2	1.54
Experience	64.1	49.4	31.1	25.3	11.12**
Ratings	26.7	6.7	21.6	5.1	14.05**

SIZE OF INSTALLATION[1]

	Large N = 52		Medium N = 69		Small N = 69		
Variable	M	σ	M	σ	M	σ	F
G	110.65	15.06	106.65	13.01	117.01	13.34	9.83**
V	109.92	17.65	104.70	12.80	112.72	13.73	5.26**
N	110.85	12.86	106.99	15.50	117.57	13.65	9.68**
S	106.46	20.34	101.39	16.04	111.97	17.46	5.99**
P	110.44	13.05	104.45	13.62	115.46	12.11	12.32**
Q	119.46	17.15	110.74	13.03	121.13	13.98	9.69**
K	111.54	17.23	110.94	14.65	115.84	16.17	1.85
F	105.10	18.78	103.68	20.70	109.71	18.60	1.76
M	100.92	19.36	110.58	18.66	107.57	23.41	3.24
Age	29.37	7.69	29.49	8.32	27.68	7.55	1.08
Education	12.12	1.37	12.17	1.60	12.88	1.48	5.29**
Experience	56.10	42.44	67.81	52.92	55.87	48.90	1.27
Rating	25.50	6.90	25.22	5.88	27.64	6.78	2.72

*Significant at the 5% level.
**Significant at the 1% level.

[1]Unknown for 43 operators.

GEOGRAPHICAL LOCATION

	Wisconsin N=76		New Jersey N=49		No. Carolina N=48		Los Angeles N=30		San Francisco N=30		
Variable	M	σ	M	σ	M	σ	M	σ	M	σ	F
G	115.0	14.2	112.1	14.5	103.8	12.1	113.1	13.5	117.5	11.4	6.55**
V	111.0	14.3	111.0	16.8	102.3	12.8	112.1	11.6	115.5	14.4	4.64**
N	115.3	13.1	112.8	14.0	105.5	14.3	110.2	17.2	115.4	12.4	4.11**
S	112.0	17.7	106.1	20.0	98.5	13.6	106.0	18.4	110.9	15.9	4.81**
P	112.8	12.9	110.3	14.2	105.2	13.9	109.0	13.8	112.5	11.7	2.61*
Q	118.3	11.7	120.9	18.9	112.1	12.8	111.3	16.2	118.6	13.4	3.59**
K	110.5	18.2	115.6	15.7	113.6	13.7	107.3	14.9	112.3	14.0	1.56
F	104.2	20.2	110.2	16.7	103.8	23.3	104.6	16.8	108.6	17.8	1.04
M	105.8	22.6	102.0	17.0	116.9	16.4	100.1	22.3	108.3	20.9	4.55**
Age	28.8	7.9	28.7	7.0	26.4	5.7	34.0	3.5	30.0	6.7	4.59**
Education	12.8	1.6	12.3	1.4	11.9	1.3	12.7	1.9	13.1	1.6	3.61**
Experience	60.3	54.2	54.1	43.0	53.7	39.5	75.7	51.7	67.4	47.2	1.26
Rating	28.0	7.3	24.6	5.8	26.2	6.3	23.2	5.4	00 0	00 0	5.03**

*Significant at the 5% level.
**Significant at the 1% level.

Significant aptitude differences were observed between and within these subgroups. It was noted that men and women operators differed significantly on Aptitudes G, N, S, Q and F, as well as in mean education. Likewise, operators in the three levels differed in terms of Aptitudes G, V and N as well as in mean age, experience and ratings. Those operators performing wiring operations differed significantly from non-wirers with respect to Aptitudes G, V, N and F as well as in mean age, experience and ratings. Operators employed in large, medium and small installations were different on Aptitudes G, V, N, S, P and Q as well as in mean education. And finally, differences were found on Aptitudes G, V, S, Q and M, as well as in mean age, and ratings for geographical locations of samples.

Because of the many and varied differences found within and between the various subgroups and because, with this experimental design, the specific factors which were contributing to these differences could not be readily identified, it did not appear feasible to develop separate test batteries for the subgroups. By way of example, although men and women were different on 5 out of the ten aptitudes measured by the GATB, they were also unlike in educational background, so that it was not possible to determine whether these differences are unique for men and women or are due to differences in selection (in terms of educational background) upon entrance into the occupation.

The significance of aptitudes for the occupation of Tabulating Machine Operator was established on the bases of mean scores, standard deviations, correlations with the criterion and job analysis data.

Table VI shows the means (M), standard deviations (σ), Pearson Product-moment correlations with the criterion (r), standard errors of correlation (σ_r), and aptitudes indicated as significant on the basis of job analysis data (JA) for the aptitudes of the GATB.

TABLE VI

Means (M), Standard Deviations (σ), Pearson Product-Moment Correlations with the Criterion (r), Standard Errors of Correlation (σ_r) and Job Analysis (JA) for the Aptitudes of the GATB

Tabulating Machine Operator 213.782
N = 203

Aptitude	M	σ	r	σ_r	JA
G-Intelligence	111.384	14.37	.344**	.061	X
V-Verbal Aptitude	109.118	15.11	.217**	.066	
N-Numerical Aptitude	111.645	14.76	.359**	.061	X
S-Spatial Aptitude	106.487	18.27	.203**	.067	X
P-Form Perception	109.852	13.90	.104	.069	
Q-Clerical Perception	116.433	15.13	.153*	.068	X
K-Motor Coordination	111.995	16.39	.083	.069	
F-Finger Dexterity	105.621	19.91	.099	.069	X
M-Manual Dexterity	106.675	20.85	.101	.069	

*Significant at the 5% level.
**Significant at the 1% level.
XRegarded as significant on the basis of job analysis data.

Table VII shows the means (M), standard deviations (σ), standardized means (M') standardized standard deviations (σ'), Pearson product-moment correlations with the criterion (r) and standard errors of correlation (σ_r) for the tests of the GATB.

TABLE VII

Means (M), Standard Deviations (σ), Standardized Means (M'), Standardized Standard Deviations (σ'), Pearson Product-Moment Correlations with the Criterion (r), and Standard Errors of Correlation (σ_r) for the Tests of the GATB

Tabulating Machine Operator 213.782

N = 203

Test	M	σ	M'	σ'	r	σ_r
1-Name Comparison	61.364	13.527	116	15	.152*	.069
2-Computation	27.837	5.015	110	14	.332**	.062
3-Three-Dimensional Space	17.778	5.574	106	18	.204**	.067
4-Vocabulary	24.808	7.775	109	15	.220**	.067
5-Tool Matching	32.759	5.378	106	15	.022	.070
6-Arithmetic Reason	13.532	3.230	112	15	.342**	.062
7-Form Matching	30.798	5.862	115	16	.190**	.068
8-Mark Making	75.660	8.465	112	16	.082	.070
9-Place	92.251	9.039	106	21	.091	.070
10-Turn	103.690	9.604	106	20	.086	.070
11-Assemble	29.379	4.750	105	21	.016	.070
12-Disassemble	30.665	3.693	106	20	.230**	.066

*Significant at the 5% level.
**Significant at the 1% level.

The means and standard deviations of the aptitude scores, and the standardized means and standardized deviations of the test scores, are directly comparable to general working population norms with a mean of 100 and a standard deviation of 20.

From Table VI it can be observed that the highest mean scores were found for Aptitudes Q, K, N, and G respectively in that order of magnitude. Aptitudes G, V, N, and P have the lowest standard deviations. Correlations which are statistically significant at the 1% level were obtained in order of magnitude for Aptitudes N, G, V, and S respectively. Aptitude Q shows a correlation with the criterion which is statistically significant at the 5% level. Job analysis data indicated that Aptitudes G, N, S, Q, and F were estimated to be the most important for success in the occupation.

Aptitudes G, N, and Q were included in the final test norms because of their high means, low standard deviations, significant correlations with the ratings, and because they were indicated in the job analysis as important for success in the occupation being studied. Aptitude S was included in the final norms because it showed significant correlation with the ratings, was indicated as important in the job analysis, and it added to the selective efficiency of the norms which include Aptitudes G, N, and Q.

Although Aptitude V showed significant correlation with the criterion it was not included in the final norms because it did not increase prediction when added to Aptitudes G, N, S, and Q.

Aptitudes P, K, F, and M were not included in the final norms because they did not show significant correlation with the criterion and were supported by no more than one of the factors under consideration.

Thus Aptitudes G, N, S and Q were chosen for inclusion in the final set of norms. Minimum scores for Aptitudes G, N, and Q were set at one standard deviation unit below the mean rounded to the nearest five-point score level. In order to obtain better selective efficiency, the minimum score for Aptitude S was set at one standard deviation unit below the mean rounded to the lower adjacent five-point score level (85), rather than to the nearest five-point score level (90). This resulted in norms consisting of G-95, N-95, S-85 and Q-100.

In order to evaluate the selective efficiency of these norms in terms of the relationship between those operators passing and failing the norms and those in the High and Low criterion groups, the tetrachoric correlation and Chi Square techniques were employed. All operators having scores one standard deviation below the mean or lower on the criterion were placed in the Low Group. Thus thirty-seven operators were placed in the Low criterion group and one hundred and sixty-six operators were placed in the High criterion group. The relationship between the test norms and the criterion is shown in Table VIII. The Low group was designated as "poor workers" and the High group as "good workers."

TABLE VIII

Relationship between Test Norms Consisting of Aptitudes G, N, S, and Q with Critical Scores of 95, 95, 85, and 100 Respectively, and Dichotomized Criterion for Tabulating Machine Operator 213.782

	Non-Qualifying Test Scores	Qualifying Test Scores	Total
Good Workers	40	126	166
Poor Workers	20	17	37
Total	60	143	203

$r_{tet} = .48$ $\quad X^2 = 11.643$

$\sigma_{r_{tet}} = .14$ $\quad p/2 < .001$

The data in Table VIII show that the test norms eliminate 30 percent of the total sample. Fifty-four percent of the Low criterion group failed the norms, whereas 76% of the High group passed the norms. This distribution yielded a tetrachoric correlation of .48 which was statistically significant at the 1% level. The Chi-square test for this distribution indicated significance, with a probability of less than .001 that the obtained relationship occurred by chance. This indicates that there is a statistically significant relationship between passing the test norms and success on the job as measured by the criterion.

VII. Cross-Validation

Several other previously derived test norms were applied to the national sample used in the present study to determine their effectiveness. A battery composed of G-100, N-100 and F-92, developed upon the 1952 Minnesota sample yielded a tetrachoric correlation of .44, and the Chi Square test showed significance at the .01 level for the national sample. These norms eliminated 41% of the total national sample. Sixty-five percent of the Low group failed the battery, whereas sixty-four percent of the High group passed the battery. The norms for XB-587, previously developed for Tabulating Machine Operator consisted of G-100, N-105, S-90 and Q-90. These aptitudes are the same as those included in the norms for the present study but the critical scores are higher. The XB-587 norms yielded a tetrachoric correlation of .41 with a standard error of .13 when applied to the national sample. These norms eliminated 43% of the total sample. Sixty-five percent of the Low group failed the norms, whereas sixty-two percent of the High group passed the norms. The higher critical scores set for Aptitudes G, N, and S on the XB-587 norms account for the elimination of the higher percentage of operators in both the High and Low groups. Although the norms for XB-587 and for the earlier Minnesota study are significantly related to job success, they are not as predictive of job success for the national sample as the norms developed in this study.

To determine the adequacy of the norms developed in this study for an independent sample of Tabulating Machine Operators, these norms were applied to the 1952 sample of 169 operators from Minnesota. This sample of 169 operators had been separated into High and Low groups on the basis of a rating scale criterion similar to the one used in this study. The cutting score for the Low group was set at one standard deviation below the mean. Table IX shows the distribution of those in the High and Low criterion groups of the Minnesota sample who pass and fail the norms derived from the present study. The High group has been designated as "good workers" and the Low group as "poor workers."

TABLE IX

Relationship between Test Norms Consisting of Aptitudes G, N, S, and Q with Critical Scores of 95, 95, 85, and 100 Respectively and Dichotomized Criterion for the Minnesota Sample of Tabulating Machine Operators 213.782

	Non-Qualifying Test Scores	Qualifying Test Scores	Total
Good Workers	34	104	138
Poor Workers	12	19	31
Total	46	123	169

$r_{tet} = .25$ $\quad X^2 = 1.870$

$\sigma_{r_{tet}} = .15$ $\quad p/2 < .10$

These norms eliminate 27 percent of the total sample. Thirty-nine percent of the Low group failed the norms, whereas 75 percent of the High group passed the norms. These statistics indicate that this distribution could have arisen from chance factors alone and that the norms developed in this study do not show good selective efficiency for the Minnesota sample.

It was recognized that the Minnesota sample had higher mean scores on Aptitudes G, N and S than the national sample used for the present study. Since data for the Minnesota sample were not included in the present study, the mean scores obtained for the present study and, therefore, the test norms based in part on these mean scores do not reflect the performance of the Minnesota sample. For this reason, an analysis was made to determine if Aptitudes G, N, S and Q would yield significant predictive value for the Minnesota sample when the cutting scores on these aptitudes were set approximately one standard deviation unit below the mean scores obtained for the Minnesota sample of 169 Tabulating Machine Operators. This resulted in test norms consisting of G-105, N-100, S-100 and Q-95. When these norms were applied to the dichotomized criterion of the Minnesota sample the results shown below in Table X were obtained.

TABLE X

Relationship between Test Norms Consisting of Aptitudes G, N, S, and Q with Critical Scores of 105, 100, 100, and 95, Respectively and Dichotomized Criterion for the Minnesota Sample of Tabulating Machine Operators 213.782

	Non-Qualifying Test Scores	Qualifying Test Scores	Total
Good Workers	37	101	138
Poor Workers	16	15	31
Total	53	116	169

$r_{tet} = .40$ $\quad X^2 = 6.127$

$\sigma_{r_{tet}} = .15$ $\quad p/2 < .01$

The data in Table X show that test norms consisting of G-105, N-100, S-100, and Q-95 yield satisfactory predictive value for the Minnesota sample of Tabulating Machine Operators. The Chi Square value of 6.127, which corresponds to a p/2 value of less than .01, indicates that there is less than one chance in one hundred that the obtained relationship occurred by chance.

VIII. Conclusions

1. Aptitudes G, N, S, and Q with critical scores of 95, 95, 85, and 100 respectively, were found to be the most efficient norms for the national sample used for the present study. These norms are applicable to either the B-1001 or the B-1002 edition of the GATB.

2. Previous Tabulating Machine Operator studies have given supporting evidence for these aptitudes.

3. The critical scores for these aptitudes show some variability from sample to sample, resulting in lower predictive efficiency upon cross-validation.

4. Since the present study includes operator samples from a relatively large and diverse population, it is recommended that the norms resulting from this study be used nationally for the occupation of Tabulating Machine Operator 213.782.