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ABSTRACT

Research which resulted in the development of the United States Employment Service Specific Aptitude Test Battery for use in selecting inexperienced or untrained individuals for training as Maintenance Repairer is described. Occupational norms were established in terms of minimum qualifying scores for each significant aptitude measure, which when combined, predict job performance. Statistical data, names of organizations participating in the study, job descriptions and supervisor's rating scales are included. (DEP)

Development of USES Aptitude Test Battery for Maintenance Repairer, Factory or Mill (any ind.) 899.281

U.S. Department of Labor
Manpower Administration
U.S. Employment Service
Technical Report S-363R75
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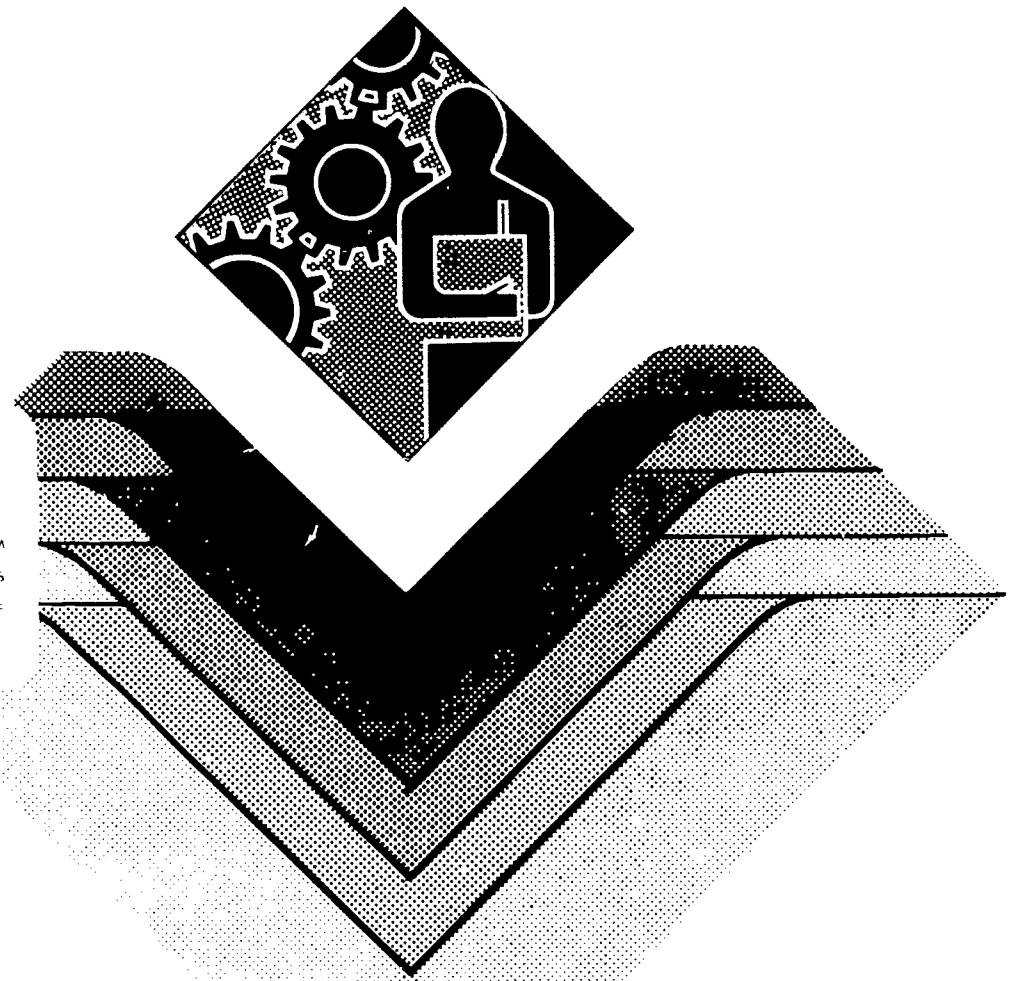

S-363R75

Technical Report on Development of USES Specific Aptitude Test Battery

For

Maintenance Repairer, Factory or Mill (any ind.) 899.281

S-363R75

Developed in Cooperation with the
California, Colorado, Florida, Illinois, Iowa, Louisiana,
Mississippi, Missouri, Nevada, New Mexico, North Carolina,
Pennsylvania, Texas, West Virginia and Wisconsin
State Employment Services

U. S. DEPARTMENT OF LABOR
John T. Dunlop, Secretary

Manpower Administration
William H. Kolberg
Assistant Secretary for Manpower

1975

Development of USES Specific Aptitude Test Battery S-363R75

For

Maintenance Repairer, Factory or Mill (any ind.) 899.281

RESEARCH SUMMARY

This report describes the research which resulted in the development of the following Specific Aptitude Test Battery for use in selecting inexperienced or untrained individuals for training as Maintenance Repairers:

Aptitudes	Cutting Scores
S - Spatial Aptitude	80
Q - Clerical Perception	90
M - Manual Dexterity	85

Sample:
234 male Maintenance Repairers employed in the North, South and West (see Appendix 1). A total of 48 were minority group members (23 Blacks, 16 Spanish Surnamed, 5 American Indians, 2 Filipinos, 1 Japanese and 1 French Canadian) and 186 were nonminority group members.

Criterion:
Supervisory ratings. Criterion data were collected during 1973 and 1974.

Design:
Concurrent (test and criterion data were collected at about the same time).

Validity:
Phi coefficient for total sample = .22 ($P/2 < .0005$)

Comparison of Minority and Nonminority Groups:
It was not technically feasible to compare the validity of the battery for minority and nonminority groups as it was not possible to obtain data on a sufficient number of workers in any specific minority group to permit separate data analysis.

JOB ANALYSIS

Job analysis was performed by observation of the workers' performance on the job and in consultation with the workers' supervisors. On the basis of the job analysis, the job description shown in Appendix 3 was prepared. The job description was used to (1) select experimental samples of workers who were performing the job duties; (2) choose appropriate criteria or measures of job performance; (3) determine which aptitudes are critical, important or irrelevant to job performance (see Tables 1 and 4); and (4) provide information on the applicability of the test battery resulting from this research.

TABLE 1

Qualitative Analysis

Aptitude	Rationale
G - General Learning Ability	Required to understand instructions and underlying principles of electrical and mechanical repairs and in diagnosing equipment problems and choosing the most practical and efficient method of repair.
S - Spatial Aptitude	Required to read blueprints and schematics and to visualize machine parts and wiring in relationship to the total machine operations and functions.
P - Form Perception	Required to inspect equipment for wear and misalignment and to perceive pertinent details in blueprints and sketches.
Q - Clerical Perception	Required to read and record meter readings accurately and to read blueprints accurately.
M - Manual Dexterity	Required to use hand and power tools to dismantle, repair and assemble equipment.

EXPERIMENTAL TEST BATTERY

All 12 tests of the GATB, B-1002B, were administered.

CRITERION

The immediate supervisor rated each worker. The ratings were obtained by means of personal visits of State test development analysts who explained the rating procedure to the supervisors. Two ratings were obtained from each supervisor with an interval of at least two weeks between the ratings. Since sample members' test scores are confidential, supervisors had no knowledge of the test scores of workers.

A descriptive rating scale was used. The scale (see Appendix 2) consists of six items. Five of these items cover different aspects of job performance. The sixth item is a global item on the Maintenance Repairer's "all-around" ability. Each item has five alternative responses corresponding to different degrees of job proficiency. For the purpose of scoring the items, weights of 1 to 5 were assigned to the responses. The total score on the rating scale is the sum of the weights for the six items. The possible range for each rating is 6-30.

A review of the job description indicated that the subjects covered by the rating scale were directly related to important aspects of job performance.

A - Quantity of work: Repairs must be made in a timely manner in order to avoid delays and down time.

B - Quality of work: Repairs must be done properly in order to avoid repetition of work.

C - Accuracy of work: Defects must be diagnosed accurately in order for repairs to be made efficiently.

D - Job knowledge: The worker must have sufficient knowledge to make repairs on the many different kinds of equipment for which he is responsible.

E - Job versatility: Maintenance Repairers are required to repair and maintain a variety of equipment.

F - "All-around" job ability: Maintenance Repairer's value to the employer involves a combination of aspects of job performance listed above.

A reliability coefficient of .82 was obtained between the initial ratings and the reratings, indicating a significant relationship. Therefore, the scores of the two ratings were combined to form the final criterion. The possible range for the final criterion is 12-60. The actual range is 19-60. The mean is 41.9 with a standard deviation of 8.0. The relationship between the final criterion and age, education and job experience is shown in Table 2.

TABLE 2

Means, Standard Deviations (SD) and Pearson Product-Moment Correlations with the Criterion (r) for Age, Education and Experience

	Mean	SD	r	Range
Age (years)	41.1	9.9	.02	20-64
Education (years)	11.4	1.9	-.08	6-16
Experience (months on current job)	106.1	91.4	.20**	3-444

**Significant at the .01 level

About one-third of the workers are considered to be marginal workers. Therefore, the criterion distribution was dichotomized so as to include about one-third of the sample in the low criterion group and the remainder in the high criterion group. The criterion cutting score was set at 40 which places 42% in the low criterion group and 58% in the high criterion group.

SAMPLE

The sample consisted of 234 male Maintenance Repairers employed in the North, South and West (see Appendix 1). A total of 48 were minority group members (23 Blacks, 16 Spanish Surnamed, 5 American Indians, 2 Filipinos, 1 Japanese and 1 French Canadian) and 186 were nonminority group members. The means and standard deviations for age, education and experience of the sample members are shown in Table 2. All workers had at least 3 months of experience in their current job.

STATISTICAL RESULTS

TABLE 3

Statistical Results

N=234

Aptitude	Mean	SD	r	Range
G - General Learning Ability	100.3	15.9	.11	53-138
V - Verbal Aptitude	95.5	13.3	.06	65-139
N - Numerical Aptitude	96.5	17.6	.06	40-147
S - Spatial Aptitude	107.1	18.6	.16*	51-163
P - Form Perception	99.3	21.7	.08	33-162
Q - Clerical Perception	107.0	15.2	.16*	66-141
K - Motor Coordination	93.8	17.0	.02	47-134
F - Finger Dexterity	94.5	20.8	.08	43-151
M - Manual Dexterity	95.2	21.8	.14*	25-157

* Significant at the .05 level

Table 4 summarizes the qualitative analysis and statistical results shown in Tables 1 and 3 and shows the aptitudes considered for inclusion in the battery.

TABLE 4

Summary of Qualitative and Quantitative Data

	Aptitudes								
Type of Evidence	G	V	N	S	P	Q	K	F	M
"Critical" on Basis of Job Analysis									
"Important" on Basis of Job Analysis	X			X	X	X			X
"Irrelevant" on Basis of Job Analysis									
Relatively High Mean	X			X		X			
Relatively Low Standard Deviation		X							
Significant Correlation with Criterion				X		X			X
Aptitudes Considered for Inclusion in the Battery	G			S		Q			M

The information in Table 4 indicates that the following aptitudes should be considered for inclusion in the battery: G, S, Q, and M. The objective is to develop a battery of 2, 3 or 4 aptitudes with cutting scores set at five point intervals at the point (a) where about the same percent will meet the cutting scores as the percent placed in the high criterion group and (b) which will maximize the relationship between the battery and the criterion. The cutting scores are set at approximately one standard deviation below the mean aptitude scores of the sample, with deviations above or below these points to achieve the objectives indicated above.

The following battery resulted:

Aptitudes	Cutting Scores
S - Spatial Aptitude	80
Q - Clerical Perception	90
M - Manual Dexterity	85

VALIDITY OF THE BATTERY

TABLE 5

Validity of Battery

	Below Cutting Scores	Meeting Cutting Scores	Total
High Criterion Group	40	96	136
Low Criterion Group	50	48	98
Total	90	144	234

Phi coefficient = .22
Significance level = P/2 < .0005

OCCUPATIONAL APTITUDE PATTERN

This occupation was incorporated into OAP-37 in Section II of the 1970 edition of the Manual for the USES General Aptitude Test Battery with a double asterisk (**) because the aptitudes in the OAP differ from those in the battery for Maintenance Repairer but a significant phi coefficient was obtained between the criterion and the OAP-37 cutting scores of N-80, S-95 and M-85. A phi coefficient of .20 (P/2 < .005) was obtained for this sample.

APPENDIX 1

Organizations Cooperating in the Study

North

3-M Company, Chicago, Illinois
John Dere Waterloo Tractor Works, Waterloo, Iowa
Chemagro, Kansas City, Missouri
Bethlehem Steel Corporation, Bethlehem, Pennsylvania
National Presto Industries, Inc., Eau Claire, Wisconsin

South

Maxwell House Coffee Company, Jacksonville, Florida
Boise Southern, De Ridder, Louisiana
Calkraft, Inc., Elizabeth, Louisiana
De Soto, Inc., Jackson, Mississippi
General Electric Company, Jackson, Mississippi
Kalston Purina Company, Jackson Mississippi
Sandhills Furniture Company, West End, North Carolina
Owens-Illinois, Waco, Texas
Appalachian Power Company, St. Albans, West Virginia
Food Machinery Corporation, Nitro, West Virginia
National Lead Corporation, Charleston, West Virginia
Owens-Illinois, Huntington, West Virginia

West

Metropolitan Water Districts, La Verne and Yorba Linda, California
Owens-Illinois, Los Angeles, Oakland, Tracy and Vernon, California
Colorado Fuel and Iron Steel Corporation, Pueblo, Colorado
Kennecott Copper Corporation, McGill, Nevada
Arizona Public Service, Fruitland, New Mexico
Sun Bell Corporation, Albuquerque, New Mexico

APPENDIX 2

U.S. DEPARTMENT OF LABOR * MANPOWER ADMIN'STRATION

DESCRIPTIVE RATING SCALE

SCORE _____

RATING SCALE FOR _____

D.O.T. Title and Code

Directions: Please read the "Suggestions to Raters" and then fill in the items which follow. In making your ratings, only one box should be checked for each question.

SUGGESTIONS TO RATERS

We are asking you to rate the job performance of the people who work for you. These ratings will serve as a "yardstick" against which we can compare the test scores in this study. The ratings must give a true picture of each worker or this study will have very little value. You should try to give the most accurate ratings possible for each worker.

These ratings are strictly confidential and won't affect your workers in any way. Neither the ratings nor test scores of any workers will be shown to anybody in your company. We are interested only in "testing the tests." Ratings are needed only for those workers who are in the test study.

Workers who have not completed their training period, or who have not been on the job or under your supervision long enough for you to know how well they can perform this work should not be rated. Please inform the test technician about this if you are asked to rate any such workers.

Complete the last question only if the worker is no longer on the job.

In making ratings, don't let general impressions or some outstanding trait affect your judgment. Try to forget your personal feelings about the worker. Rate only on the work performed. Here are some more points which might help you:

1. Please read all directions and the rating scale thoroughly before rating.

2. For each question compare your workers with "workers-in-general" in this job. That is, compare your workers with other workers on this job that you have known. This is very important in small plants where there are only a few workers. We want the ratings to be based on the same standard in all the plants.

3. A suggested method is to rate all workers on one question at a time. The questions ask about different abilities of the workers. A worker may be good in one ability and poor in another: for example, a very slow worker may be accurate. So rate all workers on the first question, then rate all workers on the second question, and so on.

4. Practice and experience usually improve a worker's skill. However, one worker with six months' experience may be a better worker than another with six years' experience. Don't rate one worker as poorer than another merely because of a lesser amount of experience.

5. Rate the workers according to the work they have done over a period of several weeks or months. Don't rate just on the basis of one "good" day, or one "bad" day or some single incident. Think in terms of each worker's usual or typical performance.

6. Rate only the abilities listed on the rating sheet. Do not let factors such as cooperativeness, ability to get along with others, promptness and honesty influence your ratings. Although these aspects of a worker are important, they are of no value for this study as a "yardstick" against which to compare aptitude test scores.

MA 7-66
Apr. 1973

NAME OF WORKER *(Print)* *(Last)* *(First)*

SEX: MALE_____ FEMALE_____

Company Job Title: _____

How often do you see this worker in a work situation?

- ☐ All the time.
- ☐ Several times a day.
- ☐ Several times a week.
- ☐ Seldom.

How long have you worked with this worker?

- ☐ Under one month.
- ☐ One to two months.
- ☐ Three to five months.
- ☐ Six months or more.

A. How much can this worker get done? (Worker's ability to make efficient use of time and to work at high speed.) (If it is possible to rate only the quantity of work which a person can do on this job as adequate or inadequate, use #2 to indicate "inadequate" and #4 to indicate "adequate.")

- ☐ 1. Capable of very low work output. Can perform only at an unsatisfactory pace.
- ☐ 2. Capable of low work output. Can perform at a slow pace.
- ☐ 3. Capable of fair work output. Can perform at an acceptable pace.
- ☐ 4. Capable of high work output. Can perform at a fast pace.
- ☐ 5. Capable of very high work output. Can perform at an unusually fast pace.

B. How good is the quality of work? (Worker's ability to do high-grade work which meets quality standards.)

- ☐ 1. Performance is inferior and almost never meets minimum quality standards.
- ☐ 2. Performance is usually acceptable but somewhat inferior in quality.
- ☐ 3. Performance is acceptable but usually not superior in quality.
- ☐ 4. Performance is usually superior in quality.
- ☐ 5. Performance is almost always of the highest quality.

C. How accurate is the work? (Worker's ability to avoid making mistakes.)

- ☐ 1. Makes very many mistakes. Work needs constant checking.
- ☐ 2. Makes frequent mistakes. Work needs more checking than is desirable.
- ☐ 3. Makes mistakes occasionally. Work needs only normal checking.
- ☐ 4. Makes few mistakes. Work seldom needs checking.
- ☐ 5. Rarely makes a mistake. Work almost never needs checking.

MA 7-66
Apr. 1973

D. How much does the worker know about the job? (Worker's understanding of the principles, equipment, materials and methods that have to do directly or indirectly with the work.)

- ☐ 1. Has very limited knowledge. Does not know enough to do the job adequately.
- ☐ 2. Has little knowledge. Knows enough to get by.
- ☐ 3. Has moderate amount of knowledge. Knows enough to do fair work.
- ☐ 4. Has broad knowledge. Knows enough to do good work.
- ☐ 5. Has complete knowledge. Knows the job thoroughly.

E. How large a variety of job duties can the worker perform efficiently? (Worker's ability to handle several different operations.)

- ☐ 1. Cannot perform different operations adequately.
- ☐ 2. Can perform a limited number of different operations efficiently.
- ☐ 3. Can perform several different operations with reasonable efficiency.
- ☐ 4. Can perform many different operations efficiently.
- ☐ 5. Can perform an unusually large variety of different operations efficiently.

F. Considering all the factors already rated, and only these factors, how good is this worker? (Worker's all-around ability to do the job.)

- ☐ 1. Performance usually not acceptable.
- ☐ 2. Performance somewhat inferior.
- ☐ 3. A fairly proficient worker.
- ☐ 4. Performance usually superior.
- ☐ 5. An unusually competent worker.

Complete the following ONLY if the worker is no longer on the job.

G. What do you think is the reason this person left the job? (It is not necessary to show the official reason if you feel that there is another reason, as this form will not be shown to anybody in the company.)

- ☐ 1. Fired because of inability to do the job.
- ☐ 2. Quit, and I feel that it was because of difficulty doing the job.
- ☐ 3. Fired or laid off for reasons other than ability to do the job (i.e., absenteeism, reduction in force).
- ☐ 4. Quit, and I feel the reason for quitting was not related to ability to do the job.
- ☐ 5. Quit or was promoted or reassigned because the worker had learned the job well and wanted to advance.

RATED BY	TITLE	DATE
COMPANY OR ORGANIZATION	LOCATION (*City, State, ZIP Code*)	

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APPENDIX 3

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Maintenance Repairer, Factory or Mill (any ind.) 899.281

JOB DUTIES

Repairs and maintains machinery, plumbing and electrical systems.

*Diagnoses defects in equipment during regularly scheduled repairs or when breakdown occurs: Inspects equipment such as motors, generators, switchboards, and production machinery for correct operation. Diagnoses defects in wiring using voltmeter and ammeter and following wiring diagrams and specifications. Diagnoses defects such as wear or misalignment by visual inspection or by measurement to determine if machinery is within tolerances specified by manuals or drawings. Determines best repair methods and selects proper tools for the job.

*Repairs machinery: Dismantles equipment using hand and power tools. Removes defective, worn or broken parts of electrical, mechanical, hydraulic, or pneumatic systems. Repairs or replaces malfunctioning part. Reassembles equipment using knowledge of equipment or following manuals, sketches or blueprints using hand and power tools. Checks and adjusts operation of equipment.

Maintains equipment: Cleans equipment as required. Lubricates motors, shafts, gears and bearings.

Repairs and installs plumbing: Uses plumbing equipment such as threading dies and wrenches to open clogged drains, repair or replace washroom fixtures and to install or replace gas, water, hydraulic or pneumatic lines, using knowledge of building codes and knowledge of system or by following specifications or blueprints.

Repairs electrical system of physical plant by replacing defective components such as switches and fixtures.

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*These job duties were designated as critical since they must be performed competently if the job is to be performed in a satisfactory manner. Maintenance Repairers spend about 90% of their working time performing these duties.

GPO 897-408