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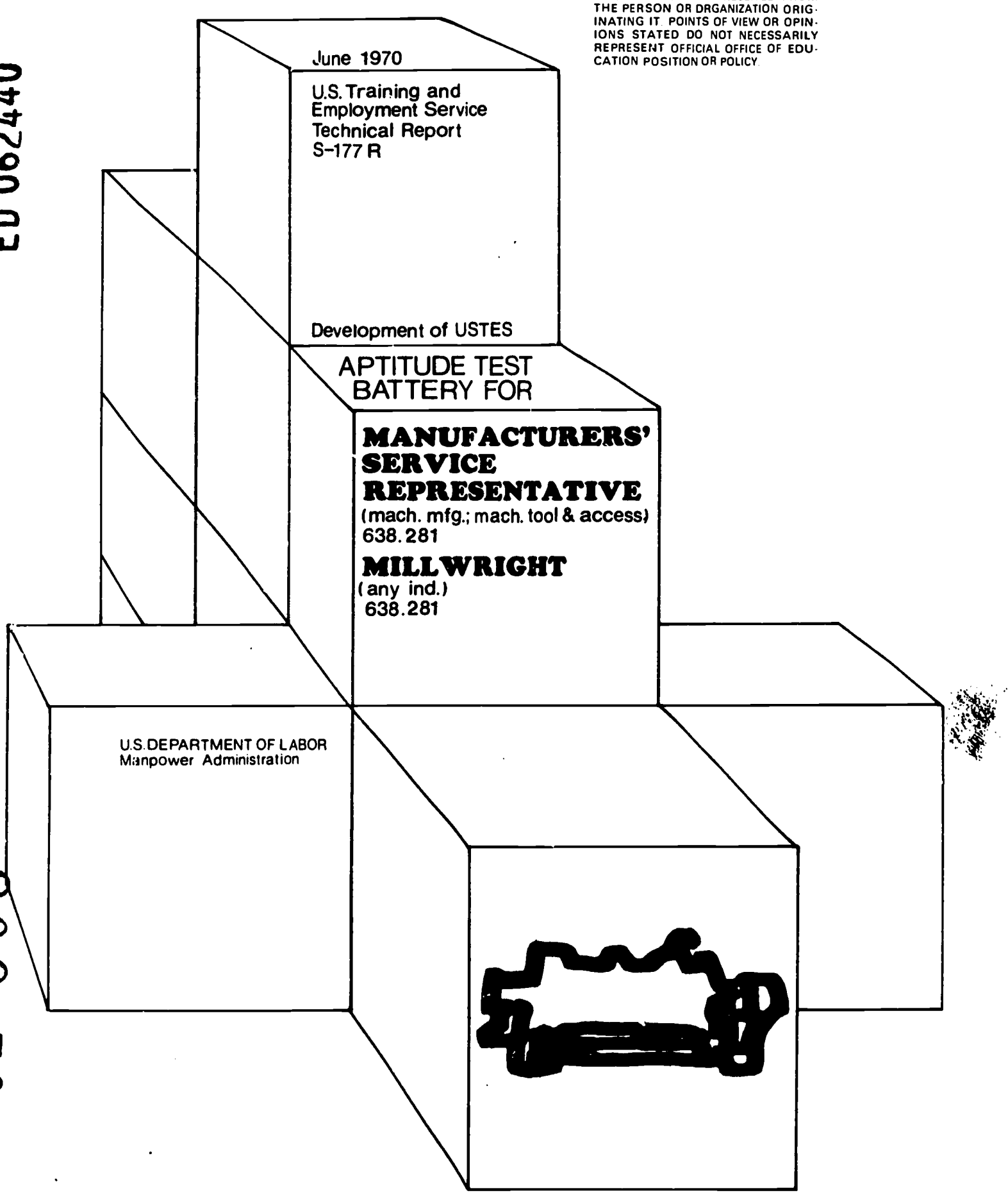
ABSTRACT

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 and a personnel evaluation form are also included. (AG)



Technical Report on Development of USTES Aptitude Test Battery
For . . . . . .

Manufacturers' Service Representative (mach. mfg.; mach. tool & access.)
638.281

Millwright (any ind.) 638.281

S-177R

(Developed in Cooperation with the
Alabama and Wisconsin
State Employment Services)

U.S. Department of Labor
Manpower Administration

June 1970

## FOREWORD

The United States Training and Employment Service General Aptitude Test Battery (GATB) was first published in 1947. Since that time the GATB has been included in a continuing program of research to validate the tests against success in many different occupations. Because of its extensive research base the GATB has come to be recognized as the best validated multiple aptitude test battery in existence for use in vocational guidance.

The GATB consists of 12 tests which measure 9 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, with a standard deviation of 20.

Occupational norms are established in terms of minimum qualifying scores for each of the significant aptitude measures which, in combination, predict job performance. For any given occupation, cutting scores are set only for those aptitudes which contribute to the prediction of performance of the job duties of the experimental sample. It is important to recognize that another job might have the same job title but the job content might not be similar. The GATB norms described in this report are appropriate for use only for jobs with content similar to that shown in the job description included in this report.

GATB Study # 2294,2728

# DEVELOPMENT OF USTES APTITUDE TEST BATTERY FOR Manufacturers' Service Representative (mach. mfg.; mach. tool & access.) 638.281-030

## Millwright (any ind.) 638.281-034 S-177R

This report describes research undertaken for the purpose of developing General Aptitude Test Battery (GATB) norms for the occupations of Manufacturers' Service Representative (mach. mfg.; mach. tool & access.) 638.281-030 and Millwright (any ind.) 638.281-034. The following norms were established.

| GATB Aptitudes | Minimum Acceptable GATB Scores |
|---|---|
| N - Numerical Aptitude | 70 |
| S - Spatial Aptitude | 85 |
| M - Manual Dexterity | 75 |

## RESEARCH SUMMARY

**Sample:**

55 male workers employed as Manufacturers' Service Representatives in Pennsylvania. This study was conducted prior to the requirement of providing minority group information. Therefore, minority group composition is unknown.

**Criterion:**

Supervisory ratings

**Design:**

Concurrent (test and criterion data were collected at approximately the same time).

Minimum aptitude requirements were determined on the basis of a job analysis and statistical analyses of aptitude mean scores, standard deviations, aptitude-criterion correlations and selective efficiencies.

**Concurrent Validity:**

Phi coefficient = .35 ($P/2 < .005$)

**Effectiveness of Norms:**

Only 69% of the nontest-selected workers used in this study were good workers; if the workers had been test-selected with the S-177R norms,

83% would have been good workers. Thirty-one percent of the nontest-selected workers used for this study were poor worker; if the workers had been test-selected with the S-177R norms, only 17% would have been poor workers. The effectiveness of the norms is shown graphically in Table 1:

TABLE 1

Effectiveness of Norms

| | Without Tests | With Tests |
|---|---|---|
| Good Workers | 69% | 83% |
| Poor Workers | 31% | 17% |

## SAMPLE DESCRIPTION

Size:

N = 55

Occupational Status:

Employed workers

Work Setting:

Workers were employed by the McGraw Company in Eddystone; United Engineers in Eddystone and Belt Link Company in Philadelphia.

Employer Selection Requirements:

Education: High school graduate preferred
Previous Experience: None
Tests: None

Principal Activities:

The job duties for each worker are comparable to those shown in the job description in the Appendix.

Minimum Experience:

All workers in the sample had completed a 48 month apprenticeship and had at least 24 months of experience with their present employer.

TABLE 2

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

| | Mean | SD | Range | r |
|---|---|---|---|---|
| Age (years) | 44.6 | 8.4 | 25-63 | .017 |
| Education (years) | 10.0 | 2.2 | 5-16 | .053 |
| Experience (months) | 156.2 | 61.4 | 24-384 | .076 |

## EXPERIMENTAL TEST BATTERY

All 12 tests of the GATB, B-1002 were administered during the months of May and October 1959.

## CRITERION

The criterion data consisted of supervisory ratings of job proficiency made at approximately the same time as test data were collected. The ratings were made by the workers' immediate supervisors.

Rating Scale:

Form SP-21, "Descriptive Rating Scale." (See Appendix) This scale consists of nine items covering different aspects of job performance. Each item has five alternatives corresponding to different degrees of job proficiency.

Reliability:

An estimate of the reliability of the criterion was made by obtaining the relationship between the total descriptive rating scale scores and the ratings on Item I (all around ability) of the same scale. A reliability coefficient of .89 was obtained.

Criterion Distribution:

| | |
|---|---|
| Possible Range: | 9-45 |
| Actual Range: | 20-45 |
| Mean: | 35.1 |
| Standard Deviation: | 5.2 |

Criterion Dichotomy:

The criterion distribution was dichotomized into low and high groups by placing 31% of the sample in the low group to correspond with the percentage of workers considered unsatisfactory or marginal. Workers in the high criterion group were designated as "good workers" and those in the low group as "poor workers." The criterion critical score is 34.



## APTITUDES CONSIDERED FOR INCLUSION IN THE NORMS

Aptitudes were considered for tryout in the norms on the basis of a qualitative analysis of the job duties involved and a statistical analysis

of test and criterion data. Aptitudes G, N, Q, and M which do not have a high correlation with the criterion were considered for inclusion in the norms because the qualitative analysis indicated that they were important in job duties and the sample had relatively high mean scores on aptitudes G and M and relatively low standard deviations on aptitudes N and Q. With the employed workers a relatively high mean score or a relatively low standard deviation may indicate that some sample pre-selection has taken place. Tables 3, 4, and 5 show the results of the qualitative and statistical analyses.

TABLE 3

Qualitative Analysis
(Based on the job analysis, the aptitudes indicated appear to be important to the work performed.)

| Aptitude | Rationale |
|---|---|
| G - General Learning Ability | Required in determining proper assembly procedures and sequence of operations; ability to originate methods of installing equipment and to detect problems and devise solutions. |
| N - Numerical Aptitude | Required in the interpretation of blueprints and in making decisions relative to measuring. |
| S - Spatial Aptitude | Required to interpret blueprints, to plan installations, and to visualize finished product. |
| P - Form Perception | Required in selecting and aligning parts properly during assembly of machinery. |
| Q - Clerical Perception | Required for the accurate use of such measuring instruments as micrometer, etc. |
| F - Finger Dexterity | Required in the handling, aligning and assembly of small fittings and parts in installation activities, using tools such as wrenches, hammers, etc. |

On the basis of the job analysis data, the following aptitude is considered obviously unimportant for performing the duties of this job and is considered an irrelevant aptitude: Aptitude V.

TABLE 4

Means, Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for the Aptitudes of the GATB

| Aptitudes | Mean | SD | Range | r |
|---|---|---|---|---|
| G - General Learning Ability | 99.4 | 15.2 | 71-137 | .239 |
| V - Verbal Aptitude | 97.2 | 16.0 | 66-135 | .179 |
| N - Numerical Aptitude | 93.0 | 12.6 | 68-122 | .219 |
| S - Spatial Aptitude | 103.0 | 19.9 | 68-156 | .313* |
| P - Form Perception | 89.7 | 15.6 | 63-126 | .443** |
| Q - Clerical Perception | 90.9 | 12.3 | 71-124 | .108 |
| K - Motor Coordination | 86.2 | 12.6 | 56-118 | .228 |
| F - Finger Dexterity | 86.7 | 18.3 | 57-130 | .231 |
| M - Manual Dexterity | 97.2 | 20.6 | 51-144 | .258 |

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

TABLE 5

Summary of Qualitative and Quantitative Data

| Type of Evidence | Aptitudes | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | G | V | N | S | P | Q | K | F | M |
| Job Analysis Data | | | | | | | | | |
| Important | X | | X | X | X | X | | X | X |
| Irrelevant | | X | | | | | | | |
| Relatively High Mean | X | X | | X | | | | | X |
| Relatively Low Standard Dev. | | | X | | | X | X | | |
| Significant Correlation with Criterion | | | | X | X | | | | |
| Aptitudes to be Considered for Trial Norms | G | | N | S | P | Q | | | M |

## DERIVATION AND VALIDITY OF NORMS

Final norms were derived on the basis of a comparison of the degrees to which trial norms consisting of various combinations of aptitudes G, N, S, P, Q, and M trial cutting scores were able to differentiate between the 31% of the sample considered good workers and 69% of the sample considered poor workers. Trial cutting scores at five point intervals approximately one standard deviation below the mean are tried because this will eliminate about one third of the sample with three-aptitude norms. For two-aptitude norms, minimum cutting scores slightly higher than one standard deviation below the mean will eliminate about one-third of the sample; for four-aptitude trial norms, cutting scores slightly

lower than one standard deviation below the mean will eliminate about one-third of the sample. The phi coefficient was used as a basis for comparing trial norms. Norms of N-70, S-85 and M-75 provided the optimum differentiation for the occupation of Manufacturers' Service Representative (mach. mfg.; mach. tool & access.) 638.281-030. The validity of these norms is shown in Table 6 and is indicated by a phi coefficient of .35 (statistically significant at the .005 level).

TABLE 6

Concurrent Validity of Test Norms N-70, S-85 and M-75

| | Nonqualifying Test Scores | Qualifying Test Scores | Total |
|---|---|---|---|
| Good Workers | 9 | 29 | 38 |
| Poor Workers | 11 | 6 | 17 |
| Total | 20 | 35 | 55 |

Phi coefficient ($\phi$) = .35
Significance level = $P/2 < .005$

Chi square ($X^2 y$) = 6.9

## DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study met the requirements for incorporating the occupation studied into OAP-37 which is shown in the 1970 edition of Section II of the Manual for the General Aptitude Test Battery. A phi coefficient of .28 is obtained with the OAP-37 norms of N-80, 5-95, M-85.

Millwright (any ind.) 638.281-034

Check Study Research Summary

Sample:

40 male workers employed as Millwrights at American Can Company in Naheola, Alabama and Green Bay, Wisconsin.
All individuals in the sample were non-minority group members.

TABLE 7

Means, Standard Deviations (SD), Ranges and Pearson Product-Moment Correlations with the Criterion (r) for Age, Education and Experience and the Aptitudes of the GATB-Cross Validation Sample

| | Mean | SD | Range | r |
|---|---|---|---|---|
| Age (years) | 42.8 | 8.4 | 29-63 | .271 |
| Education (years) | 10.7 | 1.7 | 7-13 | .046 |
| Experience (months) | 135.8 | 87.9 | 2-331 | .010 |
| G - General Learning Ability | 95.6 | 14.2 | 54-120 | .280 |
| V - Verbal Aptitude | 91.1 | 11.3 | 70-119 | .183 |
| N - Numerical Aptitude | 92.5 | 15.7 | 50-121 | .070 |
| S - Spatial Aptitude | 98.0 | 18.3 | 68-140 | .353* |
| P - Form Perception | 93.6 | 16.6 | 55-131 | .262 |
| Q - Clerical Perception | 98.0 | 11.7 | 59-118 | .215 |
| K - Motor Coordination | 86.3 | 16.7 | 55-120 | .113 |
| F - Finger Dexterity | 82.4 | 19.7 | 49-120 | .257 |
| M - Manual Dexterity | 90.8 | 21.8 | 37-128 | .162 |

*Significant at the .05 level

Criterion:

Supervisory ratings

Design:

Concurrent (test and criterion data were collected at approximately the same time in 1968.)

Principal Activities:

The duties for this sample are comparable to those shown in the job description in the Appendix.

Concurrent Validity:

Phi coefficient (Ø) = .31 P/2 <.025

Effectiveness of Norms:

Only 65% of the nontest-selected workers used for this study were good workers; if the workers had been test-selected with the S-177R norms, 79% would have been good workers. Thirty-five percent of the nontest-selected workers used for this study were poor workers; if the workers had been test-selected with S-177R norms, only 21% would have been poor workers. The effectiveness of the norms is shown graphically on Table 8.

TABLE 8

Effectiveness of S-177R Norms
on Check Study Sample

| | Without Tests | With Tests |
|---|---|---|
| Good Workers | 65% | 79% |
| Poor Workers | 35% | 21% |

TABLE 9

Concurrent Validity of S-177R Norms
(N-70, S-85, M-75) on Check Study Sample

| | Nonqualifying Test Scores | Qualifying Test Scores | Total |
|---|---|---|---|
| Good Workers | 7 | 19 | 26 |
| Poor Workers | 9 | 5 | 14 |
| Total | 16 | 24 | 40 |

Phi coefficient ($\phi$) = .31 Chi square ($X^2y$) = 3.9
Significance level = P/2 $<$ .025

SP-21

A-P-P-E-N-D-I-X

**DESCRIPTIVE RATING SCALE**
**(For Aptitude Test Development Studies)**

Score____

RATING SCALE FOR _____
D. O. T. Title and Code

Directions: Please read Form SP-20, "Suggestions to Raters", and then fill in the items listed below. In making your ratings, only <u>one</u> box should be checked for each question.

Name of Worker (print) _____
(Last) (First)

Sex: Male_____ Female_____

Company Job Title: _____

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

☐ See him at work all the time.

☐ See him at work several times a day.

☐ See him at work several times a week.

☐ Seldom see him in work situation.

How long have you worked with him?

☐ Under one month.

☐ One to two months.

☐ Three to five months.

☐ Six months or more.

A. How much work can he get done? (Worker's ability to make efficient use of his time and to work at high speed.)

☐ 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 but not a fast 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 his 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. The grade of his work could stand improvement. 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 he in his 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.

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

☐ 1. Has very limited knowledge. Does not know enough to do his 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 his job thoroughly.

E. How much aptitude or facility does he have for this kind of work? (Worker's adeptness or knack for performing his job easily and well.)

☐ 1. Has great difficulty doing his job. Not at all suited to this kind of work.

☐ 2. Usually has some difficulty doing his job. Not too well suited to this kind of work.

☐ 3. Does his job without too much difficulty. Fairly well suited to this kind of work.

☐ 4. Usually does his job without difficulty. Well suited to this kind of work.

☐ 5. Does his job with great ease. Exceptionally well suited for this kind of work.

F. How large a variety of job duties can he perform efficiently? (Worker's ability to handle several different operations in his work.)

☐ 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.

G. How resourceful is he when something different comes up or something out of the ordinary occurs? (Worker's ability to apply what he already knows to a new situation.)

☐ 1. Almost never is able to figure out what to do. Needs help on even minor problems.

☐ 2. Often has difficulty handling new situations. Needs help on all but simple problems.

☐ 3. Sometimes knows what to do, sometimes doesn't. Can deal with problems that are not too complex.

☐ 4. Usually able to handle new situations. Needs help on only complex problems.

☐ 5. Practically always figures out what to do himself. Rarely needs help, even on complex problems.

H. How many practical suggestions does he make for doing things in better ways? (Worker's ability to improve work methods.)

☐ 1. Sticks strictly with the routine. Contributes nothing in the way of practical suggestions.

☐ 2. Slow to see new ways to improve methods. Contributes few practical suggestions.

☐ 3. Neither quick nor slow to see new ways to improve methods. Contributes some practical suggestions.

☐ 4. Quick to see new ways to improve methods. Contributes more than his share of practical suggestions.

☐ 5. Extremely alert to see new ways to improve methods. Contributes an unusually large number of practical suggestions.

I. Considering all the factors already rated, and only these factors, how acceptable is his work? (Worker's "all-around" ability to do his job.)

☐ 1. Would be better off without him. Performance usually not acceptable.

☐ 2. Of limited value to the organization. Performance somewhat inferior.

☐ 3. A fairly proficient worker. Performance generally acceptable.

☐ 4. A valuable worker. Performance usually superior.

☐ 5. An unusually competent worker. Performance almost always top notch.

FACT SHEET

Job Title:

Manufacturers' Service Representative (mach. mfg.; mach. tool & access.) 638.281-030 (Validation Sample)

Job Summary:

Lays out, assembles, installs, repairs and dismantles heavy machinery and mechanical equipment in powerplant installations and other industrial plants where moving machinery is installed. Performs all repair and maintenance work on equipment while construction force is on job.

Work Performed:

Studies blueprints and manuals to determine elevation and center lines for positioning such equipment as auxiliary and main boiler feed pumps, coal pulverizers, motors and fans, combustion control operating equipment, main turbine generating units, and other heavy machinery and equipment installed in powerhouses. Sets up, alines, and assembles overhead cranes and load-moving equipment.

Determines size of wire cable, steel pieces, and U-bolts required to raise machinery by overhead crane or chain hoist. Raises machinery and sets in place. Adjusts position of machinery to required level and alinement, using precision level, gages, micrometer, and steel shims.

Installs major parts and shafts of auxiliary equipment, using chain hoist and measuring and alining with bases of other machinery. Assembles and fits on parts and components, such as bearings, lubricators, and speed indicating instruments , using handtools and jack, and acetylene torch for shrink fits.

Adjusts shafts, couplings, bearings, linkages, and machinery bases to achieve final alinements, elevations, and tolerances, using dial indicator, micrometers, feeler gages, and blueprints. Lays out and drills bolt holes in machinery bases, according to blueprints, and bolts into place. Lubricates, starts up, and observes equipment as preliminary test for actual operation.

Job Title:

Millwright (any ind.) 638.281-034 (Cross-Validation Sample)

Job Summary:

Installs, repairs, alters or removes equipment and machinery in a paper mill according to lay-out plans, blueprints and other drawings by using hoists, small hand and power tools, spot welder, measuring tools, and leverage bars. Determines tools, supplies, blueprints, and help needed according to kind of job assigned and machine or equipment involved.

Work Performed:

Installation: Measures securing bolts in foundation to insure agreement with blueprint and alinement of machine with other machines or equipment, using tape and square. Rigs machine or equipment for lifting by chain hoist, overhead crane, or fork lift truck. Lifts machine over bolts and lowers it. Connects shafts and belt or chain driver to power source or other machines, using wrenches, crowbars, measuring tools, and handtools to place and fasten machines, shafts, and drivers in proper alinement.

Repair: Visually and aurally inspects for symptoms of malfunction according to type of machine or equipment. Determines possible source of trouble, such as misalinement, worn bearings or shaft, and defective gaskets or valves. Dismantles machine to the point of trouble, using wrenches and power handtools. Replaces defective parts, measures wear on shaft, using micrometer, and shims shaft or replaces bearing if necessary. Reassembles machine in correct alinement.

Alteration and/or Removal: Dismantle, alters, adds to, or removes machine or equipment, using handtools and leverage bars. When removing, rigs for lift-up by hoist, overhead crane, or fork lift. When altering, may change size and type of rollers, size of pulleys, and direction of flow. Reassembles machine or equipment, connects belt or shaft to power source, and makes necessary alinements and adjustments.

Effectiveness of Norms:

Only 69% of the nontest-selected workers used in the validation study were good workers; if the workers had been test-selected with the S-177R norms, 83% would have been good workers. Thirty-one percent of the nontest-selected workers used for this study were poor workers; if the workers had been test-selected with the S-177R norms, only 17% would have been poor workers.

Only 65% of the non-test selected workers in the cross-validation study were good workers; if the workers had been test-selected with the S-177R norms, 74% would have been good workers. Thirty-five percent of the nontest-selected workers used for this study were poor workers; if these workers had been test-selected with the S-177R norms, only 26% would have been poor workers.

Applicability of S-177 R Norms: 17

The aptitude test battery is applicable to jobs which include a majority of the job duties described above.

GPO 898.701

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