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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)

June 1970

U.S. Training and Employment Service
Technical Report
S-423R

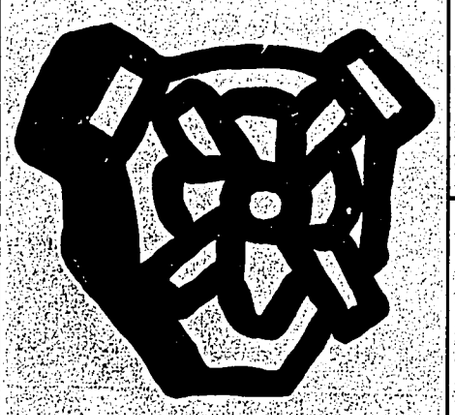
Development of USTES

APTITUDE TEST BATTERY FOR

DIESEL MECHANIC

(any ind.)
625.281

U.S. DEPARTMENT OF LABOR
Manpower Administration



Technical Report on Development of USTES Aptitude Test Battery

For . . . . . .

Diesel Mechanic (any ind.) 625.281

S-423R

(Developed in Cooperation with the
Michigan State Employment Service)

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 #2711

DEVELOPMENT OF USTES APTITUDE TEST BATTERY

For

Diesel Mechanic (any ind.) 625.281-010

S-423R

This report describes research undertaken for the purpose of developing General Aptitude Test Battery (GATB) norms for the occupation of Diesel Mechanic (any ind.) 625.281-010. The following norms were established:

GATB Aptitudes	Minimum Acceptable GATB Scores
N - Numerical Aptitude	95
S - Spatial Aptitude	105
K - Motor Coordination	90
M - Manual Dexterity	100

RESEARCH SUMMARY

Sample:

52 male Heavy Equipment and Diesel Repair students at Ferris State College, Big Rapids, Michigan. This study was conducted prior to the requirement of providing minority group information. Therefore, minority group status is unknown.

Criterion:

Core curriculum grade-point average earned in six-quarter Heavy Equipment and Diesel Repair curriculum.

Design:

Concurrent (all students tested in their 5th or 6th quarter).

Minimum aptitude requirements were determined on an analysis of a job and and course summary and statistical analyses of aptitude mean scores, standard deviations, correlations with the criteria, and selective efficiencies.

Validity:

Phi coefficient = .44 ($P/2 < .005$)

Effectiveness of Norms:

Only 67% of the non-test-selected students used for this study were good students; if the students had been test-selected with the S-423R norms, 87% would have been good students. 33% of the non-test-selected students used for this study were poor students; if the students had been test-selected with the S-423R norms, only 13% would have been poor students. The effectiveness of the norms is shown graphically in Table 1.

TABLE 1

Effectiveness of Norms

	Without Tests	With Tests
Good Students	67%	87%
Poor Students	33%	13%

SAMPLE DESCRIPTION

Size: N = 52

Occupational Status:

Students who completed the six-quarter curriculum in Heavy Equipment and Diesel Repair.

Educational Institution:

Students were enrolled in the Trade and Industrial Division, Ferris State College, Big Rapids, Michigan.

Course Selection Requirements:

Education: High school graduation or equivalent or sufficient maturity, motivation and aptitude to profit from instruction.

Previous Experience: None required but any previous experience is evaluated and the student placed at level of his ability to work.

Tests: None used.

Other: Application for admission into the curriculum and a personal conference if needed to ascertain applicant's fitness for success.

Principal Activities:

The job duties of the occupation and the subjects contained in the course of study are shown in the appendix.

Minimum Experience:

All students in the sample had been enrolled in the curriculum for at least 5 quarters.

TABLE 2

Means, Standard Deviations, Ranges, and Pearson Product-Moment Correlations with the Criteria (total grade-point average) r and (core curriculum grade-point average) r_1 for Age and Education

	Mean	SD	Range	r	r_1
Age (years	21.8	4.2	19-49	.029	.023
Education	14.2	.5	14-16	.131	.090

EXPERIMENTAL TEST BATTERY

All 12 tests of the GATB, B-1002 B, were administered during the period from February 1964 to March 1967.

CRITERION

The criterion consisted of core curriculum grade-point averages earned in the six-quarter Heavy Equipment and Diesel Repair course. Grade-point averages were computed as follows: total number of honor points (A-4, B-3, C-2, D-1, E-0) received divided by course hours taken, and multiplied by 100.

A second criterion measure was also obtained. Although total grade-point averages were also computed for the sample, the core curriculum grade-point averages were used as the final criterion since both criterion measures give the same pattern of aptitude-criterion correlation and the individuals who failed the criterion critical score (235) on the total grade-point average also failed the criterion critical score (240) on the core curriculum grade-point average. The low criterion group would contain the same students regardless of which criterion was used.

Criterion Distribution:	Possible Range:	0 - 400
	Actual Range:	160 - 400
	Mean:	275.3
	Standard Deviation:	59.0

Criterion Dichotomy: The criterion distribution was dichotomized into high and low groups by placing 35% of the sample in the low criterion group to correspond with the percentage of students considered unsatisfactory or marginal. Students in the high group were designated as "good students" and those in the low group as "poor students." The criterion critical score is 241.

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 and course summaries and a statistical analysis of test and criterion data. Aptitudes S, F, and M which do not have a high correlation with the criterion were considered for inclusion in the norms because the qualitative analysis indicated they were important in the job and course duties and the sample had relatively high mean scores on aptitudes S and M and a relatively low standard deviation on aptitude F. Tables 3, 4, and 5 show the results of the qualitative and statistical analyses.

TABLE 3

Qualitative Analysis

Based on an analysis of the job and course summaries, the following aptitudes appear to be important for success in the curriculum.

Aptitude	Rationale
G - General Learning Ability	Necessary for comprehending and learning course work, theories, procedures; making judgments.
N - Numerical Aptitude	Necessary in computing operational costs, calibrations and dimensions.
S - Spatial Aptitude	Necessary in visualizing 3-dimensional relationship of diesel engine parts; in use of proper tools in repair.

F - Finger Dexterity — Necessary in manipulation, adjusting, and use of tools in assembly and disassembly of small engine components.

M - Manual Dexterity — Necessary in repair and service of engines and heavy equipment.

TABLE 4

Means, Standard Deviations, Ranges, and Pearson Product-Moment Correlations with the Criteria of Total Grade-Point Average (r) and Core Curriculum Grade-Point Average (r_1) for the Aptitudes of the GATB

Aptitude	Mean	SD	Range	r	r_1
G - General Learning Ability	110.0	11.8	80-135	.399**	.375**
V - Verbal Aptitude	99.7	9.4	82-125	.237	.173
N - Numerical Aptitude	108.2	14.2	78-138	.410**	.370**
S - Spatial Aptitude	118.3	16.2	74-156	.197	.216
P - Form Perception	116.3	16.5	73-157	.062	.050
Q - Clerical Perception	113.3	15.7	86-151	.246	.206
K - Motor Coordination	102.3	18.9	24-149	.352*	.334*
F - Finger Dexterity	105.0	15.0	80-139	.100	.118
M - Manual Dexterity	120.9	21.6	68-170	.205	.213

* 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	F	F	M
Job Analysis Data Important	X		X	X				X	X
Irrelevant									
Relatively High Mean				X	X				X
Relatively Low Standard Dev.	X	X	X					X	
Significant Correlation with Criterion 1	X		X				X		
Significant Correlation with Criterion 2	X		X				X		
Aptitudes to be Considered for Trial Norms	G		N	S			K	F	M

DERIVATION AND VALIDITY OF NORMS

Final norms were derived on the basis of a comparison of the degree to which trial norms consisting of various combinations of Aptitudes G, N, S, K, F, and M, at trial cutting scores, were able to differentiate between the 67% of the sample considered good students and the 33% of the sample considered poor students. 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 trial norms, minimum cutting scores of slightly more than one standard deviation below the mean will eliminate about one-third of the sample; for four-aptitude trial norms, cutting scores of slightly less 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. Four-aptitude norms of N-95, S-105, K-90 and M-100 provided optimum differentiation for the occupation of Diesel Mechanic (any ind.) 625.281-010. The validity of these norms is shown in Table 6.

TABLE 6

Concurrent Validity of Test Norms
N-95, S-105, K-90, and M-100

	Nonqualifying Test Scores	Qualifying Test Scores	Total
Good Students	9	26	35
Poor Students	13	4	17
Total	22	30	52

Phi coefficient (ϕ) = .44 Chi square (X^2_y) = 10.1
Significance Level = $P/2 < .005$

DETERMINATION OF OCCUPATIONAL APTITUDE PATTERN

The data for this study met the requirements for incorporating the occupation studied into OAP-5 which is shown in the 1970 edition of Section II of the Manual for the General Aptitude Test Battery. A phi coefficient of .33 is obtained with the OAP-5 norms of G-105, N-105 and S-105.

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

Required Course Curriculum: The following courses must be completed by a student before Ferris State College will grant a certificate in Heavy Equipment and Diesel Repair.

Non-Core Curriculum

Basic Electricity 5 hrs./week (1st quarter)

Basic Mathematics 5 hrs./week (1st quarter)

Health and Education 3 hrs./week (1st quarter)

Physical Education 2 hrs./week (1st, 2nd, and 3rd quarter)

Mechanics and Heat 7 hrs./week (2nd quarter)

Political Science 5 hrs./week (2nd quarter)

Combined Welding 4 hrs./week (3rd quarter)

Foremanship Training 3 hrs./week (4th quarter)

Communications 1, II, III 3 hrs./week (4th, 5th, and 6th quarter)

Combined Welding 6 hrs./week (5th quarter)

Man & Society 5 hrs./week (5th quarter)

Core Curriculum:

Electrical and Fuel System I 10 hrs./week (1st quarter)

This is an introductory course in electrical and fuel system service for trucks and heavy equipment. Function, construction, operation, trouble-shooting and servicing to the charging system, cranking system, ignition and fuel system are stressed. This course provides students with experience in disassembly, testing, and assembly of components with accent on serviceability of these components.

Suspensions and Brakes I 10 hrs/week (1st quarter)

This is an introductory course in suspensions and brakes for the Heavy Equipment and Diesel Repair Mechanic. Technical instruction, using the media of lecture, lecture demonstration and laboratory practice,

Core Curriculum (cont'd)

covers nomenclature, theory of operation, and service procedures on passenger car and heavy equipment, suspension systems, brake systems, wheels and tires, standard steering gears and related parts.

Diesel Fuel Injection I 10 hrs/week (2nd quarter)

This course is a lecture and laboratory combination and includes study of diesel fuels, primary and secondary fuel distribution and injection. Instruction is provided on common rail systems, unit injectors, and primary pump systems as used on trucks and heavy equipment applications.

Final Drives 10 hrs./week (2nd quarter)

A course including lecture, demonstration, and student participation in disassembly and reassembly of selected final drive components. Instruction covers clutches, transmissions, rear axles, steering, brakes, and torque converters as used on trucks, tractors, and crawlers.

Service Area 30 hrs./week (3rd quarter)

This service area program is designed to provide the student with field-type service work in a controlled instructional setting. The student is given the opportunity to make practical application of the technical material presented to him in previous courses.

Service Area 30 hrs./week (4th quarter)

Repair of field equipment is continued with emphasis shifted to diesel engine repair and diesel engine tune-up. There is also an accent on final drive and clutch service and repair as it applies to heavy equipment.

Diesel Fuel Injection II 10 hrs/week (5th quarter)

This lecture laboratory course is a continuation of Diesel Fuel Injection I with accent on secondary pumps, high pressure distribution systems and

Core Curriculum (cont'd)

injectors, fuel injection pumps and governors. Service procedures and practices are incorporated in the laboratory.

Diesel Engines 10 hrs./week (5th quarter)

This course is designed to acquaint the student with trouble shooting and service procedures of 2- and 4-stroke cycle diesel engines. Special emphasis is placed on general terminology, combustion chamber design, engine governors, turbochargers, blowers and filters, and testing of the engine for performance characteristics.

Service Area 30 hrs./week (6th quarter)

This course is designed to serve as the last quarter of service instruction for the student. All technical course work from previous quarters is utilized in the preventive maintenance portion of the program. Students are expected to complete normal repair and service requests in a professional manner. During this term accent is not only on quality of repair, but also on the quantity of work completed.

Service Management 4 hrs./week (6th quarter)

This Heavy Equipment Service Management course is designed to offer the students a practieal orientation to the management functions of the Heavy Equipment and trucking service centers. Accent is placed on the following topics: preventive maintenance records, equipment control records, inventory control, vehicle operational costs, part procurement procedures and shop supervision. The rules and regulations pertaining to this industry as prescribed by the Interstate Commerce Commission and the Michigan Public Service Commission are also studied.

Definitions of Terms

Fuel Injectors

In place of the carburetor on some vehicles there is a fuel injection pump that delivers diesel oil to the injectors. The injectors then spray the diesel oil into the cylinders when they are at the compression stroke. The fuel is rapidly vaporized in the process so that the air fuel mixture can burn efficiently.

Overhauling

A strict examination with a view to correction or repairs.

Suspension System

The sytems of springs, etc., supporting the upper part of a vehicle on the axles.

Final Drive Components

The means for transmitting power from the propeller shaft to the rear axle.

Torque Converters

A device for converting the speed and rotation at the driving shaft to that required by the driven shaft.

Governors

An automatic attachment to an engine, turbine, compressor, and the like for controlling its speed, usually by regulating the supply of the working fluid.

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FACT SHEET

Job Title:

Diesel Mechanic (any ind.) 625.281-010.

Job Summary:

The duties of a person working as a heavy duty mechanic may vary greatly with the situation in which he is employed. In some cases, the main work is preventive maintenance of units; in others, complete overhaul of components and complete units. Actually a fairly small portion of the work is done on diesel engines which are usually reliable and long lasting compared to the amount of work required on the equipment powered by diesel engines.

The field of heavy duty mechanic is highly specialized and can be readily divided into a number of categories, the main ones being:

1. Diesel Mechanic
2. Construction Equipment Mechanic
3. Stationary Diesel Engineer
4. Marine Engineer

The Diesel Mechanic deals with mobile on-the-road equipment. He is basically a motor mechanic. His work activities would include running adjustments in the field and major overhauls in garages or specialized shops.

The Construction Equipment Mechanic is concerned chiefly with the following work on construction equipment: Preventive maintenance, overhauling various equipment and running adjustments in the field.

The duties of the Stationary Diesel Engineers in a stationary power plant, for the most, are of a preventive nature. These would include the following: hourly inspection and recording of pressure, temperature, speed and frequency variations and regular maintenance procedures.

The work of the Marine Engineer is a marine power plant consists chiefly of maintenance overhauls. Such overhauls must be carried out in a speedy fashion while a vessel is in port.

Course Summary:

The Heavy Equipment and Diesel Repair Curriculum is designed to include the basic and technical course work which a student must receive prior to his entry into the trade or craft. Successful completion of this program qualifies the student for an entry level of employment in the trade.

Effectiveness of Norms:

Only 67% of the nontest-selected students used for this study were good students; if the students had been test-selected with the S-423R norms, 87% would have been good students. Thirty-three precent of the nontest-selected students used for this study were poor students; if the students had been test-selected with the S-423R norms, only 13% would have been poor students.

Applicability of S-423R Norms:

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

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